MODULE
Nutrients uptake and metabolism

Second year
Spring semester

Faculty of Medicine
LUHS
2014-2015
1. General information

Prior your studies of this and other modules you have to get acquainted with the main document of study process at LUHS. This is The Regulation of Studies issued on June 20, 2014 by LUHS Senate order Nr. 47-05.

The booklet of the module is also available on www.personalas.ktu.lt/~julivan/PBL-II and III year. On this web site you can also find information related with the module.

The main source of flexible information is provided by module organizers and contributors at Intranet of LUHS – FC.

Supervisor of the module: prof. L. Ivanovienė (laima.ivanoviene@lsmuni.lt)
Coordinator of the module: prof. R. Morkūnienė (ramune.morkuniene@lsmuni.lt)

Departments
Institute of Human anatomy
Environmental and occupational medicine
Biochemistry
Institute of Physiology and Pharmacology
Human Histology and Embryology
Pathological anatomy
Internal Diseases

Subjects and teachers in charge:
Human anatomy (assoc. prof. V. Gedrimas; 327238; dr. I. Saburkina, tedeinga@yahoo.com)
Biochemistry (prof. L. Ivanovienė, 327323, laima.ivanoviene@lsmuni.lt; prof. V. Borutaite; vilmane.borutaite@lsmuni.lt)
Pharmacology (lecturer, dr. R. Jankūnas, 327242)
Physiology (lecturer I. Korotkich, 327285, igor.korotkich@lsmuni.lt)
Human Histology and Embryology (prof. A. Valančiūtė, 327210, angelija.valanciute@lsmuni.lt, doc. K. Lasiene, 327235, krislasi@itc.kmu.lt)
Pathological physiology (dr. D. Akramienė, 327285)
Pathological anatomy (Identified in the progress of the module)
Environmental and occupational medicine (assoc. prof. D. Lukšienė, 327360, dalia.luksiene@lsmuni.lt)
Essentials of medical diagnosis (doc. dr. E. Mašanauskienė, 306093)
2. General content of the module

In the module „Nutrients uptake and metabolism“, students study fundamental subjects, which are essential to understand and know pathogenesis mechanisms, morphological aspects of pathology and to have notion about common death causes. Analyzing the problems of this module the students gain new knowledge and apply it to the following domains:

- Anatomic and histological structure of digestive system
- Mechanisms of digestion and uptake of nutrients
- Regulation of metabolism
- Relationship between metabolism and tissue function
- Relationship between disorders of metabolism and pathological processes
- Metabolic disorder-caused changes of digestive system morphology, the most common death causes
- Clinical evaluation of metabolic disorders
- Prevalence and social aspects of most frequent metabolic disorders.
3. Aim of the Module

The student after have studied this module should know how to define, analyze, explain and relate phenomena to the cases analyzed in the module. Attaining this aim, students must gain knowledge about:

- Anatomic and histological structure, function and embryogenesis of the digestive system
- Mechanisms, regulation and disorders of nutrients digestion and uptake
- Changes in morphology of digestive system caused by diseases of digestive system, metabolic disorders, endoinfections and pancreatitis; causes of death in aforementioned conditions.
- Bile secretion, origin of bile pigments, enterohepatic circulation
- Cholestasis: ethiopathogenesis and impact to human health
- Mechanisms, regulation and disorders of synthesis, storage and breakdown of reserve compounds (lipids)
- Epidemiology, ethiopathogenesis and principles of obesity treatment
- Integration of carbohydrate, lipid and protein metabolism in cells; disorders of integration
- Blood lipid metabolism and disorders; molecular causes of disorders, laboratory and clinical diagnostics, principles of treatment
- Ethiopathogenesis and molecular mechanisms of atherosclerotic lesions; principles of diagnostics and treatment
- Synthesis and regulation of pancreatic hormone secretion; mechanism of insulin action, tissue and whole organism responses to insuline; causes of insuline hyposcretion and hypofunction
- Regulation of glucose metabolism and blood glucose concentration, disorders of glucose uptake in tissues; diabetes mellitus: diagnostics, multiple lesions of organs and tissues, changes in metabolism and ketogenesis, principles of patient observation and treatment
- Metabolism of nitrogenous compounds and it’s regulation. Importance of imbalance of synthesis and degradation of nucleotides in pathogenesis. Excretion of final products of nucleotide degradation.
- Role of liver in detoxification of toxic metabolites and in xenobiotic metabolism. Liver damage: morphological aspects and influence on the physiological and biochemical function. Relationship between liver damage and functions of other organs.
- Principles of pancreas and digestive system clinical investigation
4. Tutorials

4.1. Case 1. Yellow lady

A 40-year-old woman was healthy. Suddenly she felt very strong pain in the bottom of the navel and her back. The pain had been continuing for 12 hours. She called for a doctor. The patient complained about acute pain below navel during the last two days. Color of her excrements was whitish, color of urine was brown. The woman complained of itchy skin. Her skin and eyes obtained yellow color. The patient was obese, had a slight fever.

During physical examination it was observed: during palpation woman felt pain in the area of epigastrium and below right rib arch. The blood tests were performed: level of hemoglobin was normal; concentration of total bilirubin 290 µmol/l (normal 17 µmol/l); concentration of conjugated bilirubin 150 µmol/l (normal 5 µmol/l); activity of blood amylase 800 U/l (normal 70-235 U/l); activity of blood lipase 1000 U/l (normal 0-200 U/l).

What do these alterations indicate?

How did these alterations appear?

Do these symptoms and patient’s complains match?
**Concept of problem:** Relationship between disorders of metabolism and formation of bile stones and outcome of this process.

**Clinical symptoms:** pains of abdomen, jaundice

**Aim**
To study mechanisms of bile and pancreas juice secretion, the structure of bile and pancreas ducts, origin of bile components, degradation mechanisms of hemoproteins as main precursors of bile pigments, role of bile in digestion, causes and clinical outcomes of obstruction of bile ducts.

**Learning objectives and contents**

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

- Anatomy of digestive system components (digestive tract, major digestive glands). Anatomic structure of major digestive glands - pancreas and liver; anatomic structure and topography of bile ducts and gall bladder, to be able to recognize preparations of these organs.

**Subject – Anatomy**

**Institute of Anatomy**

**References:**

**Supplementary readings:**


**Features of histology of digestive system and liver**

**Subject – Human Histology and Embryology**

**Department of Histology and Embryology**

**References:**


**Supplementary readings:**

**Moore Persaud.** Before we are born, 2003,p.p.201 - 227

- Main classes of nutrients and their digestion in different parts of digestive tract

**Subject – Biochemistry**

**Department of Biochemistry**
Transport of digestion products through intestinal mucosa. Composition and role of gastric juice in degradation of nutrients.

**Subject – Biochemistry**

**Department of Biochemistry**

**References:**


Composition and role of bile. Mechanisms and regulation of bile acid synthesis; mechanisms of gallstones formation.

**Subject – Biochemistry**

**Department of Biochemistry**

**References:**


Regulation of the secretion of pancreatic juice and bile. Role of gastrointestinal hormones.

**Subject – Physiology**

**Institute of Physiology and Pharmacology**

**References:**

**Supplementary readings:**


- Pathological physiology of digestion. Jaundice; etiology, types and changes of body functions.

**Subject – Pathological Physiology**

**Institute of Physiology and Pharmacology**

**References:**

- Characteristics and catabolic pathway of hemoproteins

**Subject – Biochemistry**

**Department of Biochemistry**

**References:**


- Bilirubin formation pathways. Transport of bilirubin to liver and bile. Urobin formation in intestine; diagnostic importance of heme catabolites.

**Subject – Biochemistry**

**Department of Biochemistry**

**References:**


- To understand clinical investigation of gall bladder and bile ducts, to understand cholestasis.
Subject – Essentials of Medical Diagnostics

Clinic of Internal Diseases

References:

4.2. Case 2. Weak muscles.

The sixteen-year-old boy sought medical help for progressive muscle weakness. He experienced painful muscle cramps on severe exercise but he could tolerate moderate exercise normally. The exercise test was done and blood and urine was analysed biochemically. Results show, that severe exercise was followed by dramatically elevated serum levels of lactate dehydrogenase, creatine kinase and aldolase. Myoglobinuria was also present. The blood glucose level was normal and could be elevated by treatment with glucagon. Serum lactate concentration before exercise was 1,1 mM (normal 0,5-1,8 mM), after 5 min of severe exercise increased to 1,5 mM (normal 6,0-12,1 mM). It was decided to do a muscle biopsy. The results of the biopsy analysis: the glycogen deposited in increased amounts had a normal structure, concentration of glucose-6-phosphate was increased and fructose-1,6-phosphate was decreased if compare to normal values.

What is the significance of his serum enzyme levels and the myoglobinuria after severe exercise test?
Why is there an increased deposition of muscle glycogen?
Why is patient able to tolerate moderate, but not severe, exercise?
What do the results of treating patient with glucagon indicate about his condition?
Concept of the problem. The supply of energy during muscle contraction
Clinical symptoms. Muscle cramps, myoglobinuria, intolerance of severe exercise

Aim

To understand the main mechanisms of nutrients utilization and storage in muscle cells, the principles of energy metabolism regulation, to relate processes of energy formation and transmission to muscle contraction-relaxation, to evaluate the state of muscle and to interpret biochemical analysis data for characterisation of pathological process.

Learning objectives and contents:

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

- Histological features of digestive system implicated in digestion of carbohydrates

Subject – Histology

Department of Histology and Embryology

References:


- Principles, regulation, energy yield and biological importance of degradation of carbohydrates (the main muscle energy substrate) in a cell under metabolism in anaerobic and aerobic conditions

Subject – Biochemistry

Unit - Department of Biochemistry

References:


Supplementary readings:

- Structure of carbohydrates glycogen and glucose, principles, regulation and biological importance of synthesis of glycogen and glucose

**Subject – Biochemistry**

**Unit - Department of Biochemistry**

**References:**

**Supplementary readings:**

- To relate processes of energy formation and transmission to muscle contraction-relaxation

**Subject – Biochemistry**

**Unit - Department of Biochemistry**

**References:**

**Supplementary readings:**

- Repeat! Muscle contraction physiology from the module Locomotion.
4.3. Case 3. Obesity

A 48 years old man for several years has been willing to slim down. He was consulted by many therapists, and various diets were recommended for him. Unfortunately nothing helped out. And several days ago he decided to start starving and to get rid of several kilos. Therefore he consulted to his doctor about the new diet, which lacks carbohydrates but is rich in fat.

It has turned out that this man has been having overweight since he was 15 or 16 years old. As he grew up he always had not less than 100 kilograms. His father and his brother were also obese. At the moment this man weighs 108 kilograms, and is 178 cm tall. The majority of fat are allocated in the belly area. The concentration of blood glucose is at the normal level.

*What mechanisms are responsible for the overweight of this man?*

*Is it an important problem?*

*What could you propose for this man?*
**Concept of the problem:** the mechanisms of reserved fat accumulation and use.

**Clinical symptoms:** overweight

**Aim**

To investigate the structural features and transport, the mechanisms of accumulation and assimilation of lipids and their components in tissues.

**Learning objectives and contents**

*By the time the students have solved this problem they will have been showing knowledge on or known the following:*

- The mechanisms of hydrolysis and synthesis of depot fats, and the regulation of these processes.

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

- The biosynthesis of fatty acids in human body.

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

- The mechanisms of obesity resulting in the disproportion of accumulation and hydrolysis of fats and the body-mass regulation principals.

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

**Additional readings:**

   - Causes, morphology aspects and the most common death causes of obesity

**Subject – Pathological Anatomy**

**Subdivision - Clinic of Pathological Anatomy**

**References:**

- Clinical evaluation of obesity

**Subject – Essentials of Medical Diagnosis**

**Subdivision – Clinic of Internal Diseases**

**References:**


- Prevention of obesity and evaluation of dietary on a caloric basis

**Subject – Environmental and Occupational Medicine**

**Subdivision – Department of Environmental and Occupational Medicine**

**References:**

   - Histological features of white and brown adipose tissue.

**Subject - Histology**

**Subdivision – Department of Histology and embriology**
4.4. Case 4. Worried about heart attack

A 38-year-old self-employer businessman, Brian C., went to his physician concerned about his health. His business was doing badly and he was working long hours. He ate irregularly, smoked heavily and drank substantial quantities of alcohol. He had noticed a number of raised areas (xanthomata) on his hands and legs. His doctor found by questioning that some members of his family had died relatively young from heart attacks. Patient’s blood was taken and biochemical analysis was performed. A fasting blood sample was assayed for plasma lipids (table 1).

Table 1. Plasma lipid analysis

<table>
<thead>
<tr>
<th>Lipid</th>
<th>Patient</th>
<th>Normal</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAG (mM)</td>
<td>1.7</td>
<td>0.6-3.2</td>
</tr>
<tr>
<td>Cholesterol (mM)</td>
<td>9.5</td>
<td>3.7-6.8</td>
</tr>
</tbody>
</table>

The cholesterol content of each of the main plasma lipoproteins was detected in laboratory and presented in the table 2.

Table 2. Cholesterol analysis of plasma electrophoretic components in mM

<table>
<thead>
<tr>
<th>Subject</th>
<th>β</th>
<th>Pre-β</th>
<th>α</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>3.18</td>
<td>0.41</td>
<td>1.37</td>
</tr>
<tr>
<td>Patient</td>
<td>7.70</td>
<td>0.70</td>
<td>1.14</td>
</tr>
</tbody>
</table>

Fibroblasts were cultured from Brian’s skin. The ability to bind radiolabeled LDL was compared with that of control fibroblasts (figure 2). After incubation with LDL their 3-hydroxy-3-methylglutaryl-CoA (HMG-CoA) reductase activity was also measured (figure 2).

Brian was given general advice about his life-style and put on a course of oral cholestyramide (a synthetic anion-exchange compound which is not absorbed from the gut) and lovastatin (a competitive inhibitor of HMG-CoA reductase). Four months later, his fasting plasma cholesterol has fallen by 30%.
Figure 2. Effects of LDL concentration on binding of radiolabelled LDL to cultured fibroblasts (a) and on the activity of HMG-CoA reductase (b).

Questions:
What is the origin of raised areas around muscle-tendon?
What is the rational for determination of blood lipids and lipoproteins?
How is the atheromatous plaque thought to arise?
If you had been Brian’s doctor what recommendations would you have made concerning his life-style?
Patient has a brother, a sister and a teenage son. Is it worth to examine them and how?
Concept of the problem: hypercholesterolemia and its consequences.

Clinical symptoms: xanthomata on shin near Achil’s tendon.

Aim:
To understand metabolism of cholesterol, the role of hypercholesterolemia in development of atherosclerosis; to know molecular mechanisms of atherosclerotic injury to blood vessels.

Learning objectives and contents
At the end students must know:
• The role of cholesterol in human organism, biochemical pathways of its synthesis and excretion.

Subject – Biochemistry
Department of Biochemistry
References:

• Blood lipoproteins, their metabolism and role in the pathogenesis of atherosclerosis.
Biochemical analyses for evaluation of cholesterol metabolism, interpretation of the data of such analyses.

Subject – Biochemistry
Department of Biochemistry
References:

• The role of hypercholesterolemia in the development of atherosclerosis and molecular
mechanisms of atherosclerotic injury to blood vessels.

Subject – Biochemistry
Department of Biochemistry

References:

- Metabolism of membrane phospholipids, possible damage to phospholipids and their consequences.

Subject – Biochemistry
Department of Biochemistry

References:

- Risk factors and development of atherosclerosis

Subject – Pathological Anatomy
Clinic of Pathological Anatomy

References:
- Classification and mechanisms of action of antihyperlipidemic medicines, changes in plasma lipoprotein levels, related therapeutc effects and benefit-risk ratio.

Subject: Pharmacology
Unit: Institute of Physiology and Pharmacology

References:

**Supplementary readings:**
4.5. Case 4. Persistent thirst

So far, a girl of 17 has been of good health. Today, however, she has visited her doctor because she had been worrying about loosing weight despite of normal nutrition. Within 2 last months she has lost 5 kg of her body weight. Now, she feels tired, has lost endurance (until recently she enjoyed walking), suffers of thirst constantly, her mouth is dry and urination is frequent. During her medical examination, the doctor perceived a sharp odor of girl’s breath. The doctor has sent specimens of the girl’s blood and urine for biochemical analysis. The analysis of blood showed that glucose concentration was as high as 20 mmol/l (normal concentration is 3.3-5.5 mmol/l). Glucose and ketone bodies were found in the urine.

How can you explain the presence of glucose and ketone bodies in girl’s urine?
Are these findings related to subjective sensations of this patient?
What additional examinations have to be performed to confirm diagnosis?
**Concept of the problem:** regulation of metabolism of carbohydrates, fats and proteins and consequences of disturbances of this regulation.

**Clinical symptoms:** polydipsia, polyuria, hyperglycemia, ketonuria.

**Aim**

To understand principles of metabolism regulation by pancreatic hormones, ascertain consequences of regulation disturbances on functioning of tissues and whole organism.

**Learning objectives and contents**

For completion of the problem analysis, students should know:

- Features of external and internal structure of the pancreas as one of the biggest gland of digestion, to define the pancreas as exocrine gland (characterisation of pancreatic duct system) and as endocrine gland (know how to characterise pancreatic islets and their location in the pancreas), know functions of the pancreas and other glands of digestion (liver), their age-dependent alterations.

**Subject – Human anatomy**

**Institute of Anatomy**

**References:**

- Histological structure of the pancreas; be able to recognise histological sections of the pancreas, differentiate pancreatic islets and cell types.

**Subject – Histology**

**Department of Histology and Embryology**

**References:**

- Principles of synthesis and secretion regulation of both insulin and glucagon.

**Subject – Biochemistry**

**Department of Biochemistry**

**References:**

• Features of structure and molecular mechanisms of action of insulin and glucagon

**Subject – Biochemistry**

**Department of Biochemistry**

**References:**

• Regulation of metabolism of carbohydrates, fats and proteins by insulin.

**Subject – Biochemistry**

**Department of Biochemistry**

**References:**

• Principles of diagnostics of diabetes mellitus; to have notion about complications of diabetes mellitus and treatment.

**Subject – Essentials of Medical Diagnostics**

**Clinic of Internal Diseases**

**References:**

**Supplementary readings:**

• Mechanism of regulation of blood glucose concentration, biochemical markers of diabetes mellitus, principles of glucose tolerance test and its interpretation.

**Subject – Biochemistry**

**Department of Biochemistry**

**References:**

- Pathogenesis, morphology, complications and death causes in diabetes mellitus.

**Subject – Pathological Anatomy**
**Clinic of Pathological Anatomy**
**References:**

- Classification, pharmacological and clinical properties of antidiabetic agents.

**Subject: Pharmacology**
**Unit: Institute of Physiology and Pharmacology**
**References:**

**Supplementary readings:**

- Abnormalities of carbohydrate metabolism, their etiology; etiology and pathogenesis of diabetes mellitus.

**Subject – Pathological Physiology**
**Institute of Physiology and Pharmacology**
**References:**
4.6. Case 6. Dizziness

A 55-year-old unemployed labourer man B.C., had been a heavy beer drinker for years and was admitted to hospital after collapsing in the street. He was clearly unsteady on his feed, vomit, confused and with strong smell of alcohol on his breach. His blood alcohol concentration was 78 mM. Physical examination revealed tender enlargement of the liver. He complained on general loss of appetite, fatigue, early-morning nausea and frequent gastrointestinal problems. Occasional vomiting of blood had been reported and enlarged gastro-esophageal veins (verices) were detected.

His wife M.C., aged 42, also presented with gastrointestinal problems and frequent diarrhea. She had been under considerable stress at work and admitted to concerns about her alcohol consumption.

It was felt advisable to perform a set of liver function tests on both patients and the results are shown in Table 1. The blood calcium and magnesium levels were low and man B.C. urinary urea excretion was also low. In addition, his blood clotting time was found to be impaired.

<table>
<thead>
<tr>
<th>Blood levels</th>
<th>B.C.</th>
<th>M.C.</th>
<th>Normal range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total protein (g/l)</td>
<td>68</td>
<td>77</td>
<td>60-84</td>
</tr>
<tr>
<td>Albumin (g/l)</td>
<td>31</td>
<td>39</td>
<td>35-50</td>
</tr>
<tr>
<td>Total bilirubin (µM)</td>
<td>58</td>
<td>15</td>
<td>3-15</td>
</tr>
<tr>
<td>Alkaline phosphatase (U/I)</td>
<td>725</td>
<td>339</td>
<td>100-300</td>
</tr>
<tr>
<td>Alanin transaminase (U/I)</td>
<td>35</td>
<td>94</td>
<td>5-35</td>
</tr>
<tr>
<td>Aspartate transaminase (U/I)</td>
<td>42</td>
<td>177</td>
<td>10-40</td>
</tr>
<tr>
<td>γ-Glutamyl transferase (U/I)</td>
<td>790</td>
<td>463</td>
<td>7-45</td>
</tr>
</tbody>
</table>

What happens with alcohol in the liver?

What is significance of the biochemical test of liver function?

Which of the patient’s state is better and why?

Why alcoholism is not only medical but and social problem?
**Concept of the problem:** Disturbances of metabolism causes intoxication and after-effect of its progression.

**Clinical symptoms:** confusion, unsteadying on his feed, nausea, vomiting, diarrhea, enlargement of the liver, loss of appetite, fatigue

**Aim**

To get knowledge’s about disturbances of metabolism, pathological and morphological alterations of the liver and other organs in patients with alcoholism and psychosocial aspects of this problem.

**Learning objectives and contents**

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

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

- Anatomy of the wall components of the digestive canal, structural and functional features.
- Anatomic structure, topography and function of the liver; its intraorganic blood vessels.

**Subject – Human Anatomy**

**Institute of Anatomy**

**References:**

2. Atlases of anatomy

**Subject – Physiology**

**Institute of Physiology and Pharmacology**

**References:**


References:

- Functions of small and large intestine and their regulation. Role of enteric nervous system. Mechanism of defecation.

Subject – Physiology

Institute of Physiology and Pharmacology

References:

- Biochemical mechanisms of protein digestion. Mechanism of HCl synthesis in stomach.

Subject – Biochemistry

Department of Biochemistry

References:

- Liver failure, etiology, pathogenesis and changes of body functions. Portal hypertension.

Subject – Pathological Physiology

Institute of Physiology and Pharmacology

References:

• Etiology and pathogenesis of the alcoholism, morphological alterations of the pancreas, liver and gastrointestinal canal and death causes in patients with this disease. Endoinfectional processes of digestive canal and pancreatitis.

Subject – Pathological Anatomy

Clinic of Pathological Anatomy

References:

• Metabolism of amino acids, detoxification of ammonia and subsequences of the disturbance of this process.

Subject – Biochemistry

Department of Biochemistry

References:

Supplementary readings:

• Role of the liver in detoxification processes, its molecular mechanisms.

Subject – Biochemistry

Department of Biochemistry
References:

Supplementary readings:
   • Clinical assessment, complications and treatment of the disturbances of the liver and gastrointestinal canal.

Subject – Essentials of Medical Diagnostic
Clinic of Internal Diseases

References:
   • Psychosocial aspects of alcoholism

Subject – Environment Medicine

Department of Environment and Occupational Medicine

References:

Supplementary readings:
http://www.who.int/topics/alcohol_drinking/en/
5. Lectures

5.1. *Biochemical mechanisms of nutrients digestion. Regulation of digestion.* (2 h)

Department of Biochemistry

In charge – professor L. Ivanovienė

Description


5.2. *Heme catabolism: relationship to formation of bile pigments.* (2 h)

Department of Biochemistry

In charge – professor V. Borutaitė

Description


5.3. *Histologic structure of digestive system.* (2 h)

Department of Histology and Embriology

In charge – professor A. Valančiūtė

Description

Embryological origin and main developmental stages of special parts of digestive system. Histologic structure of the oral cavity: lips, tongue, hard and soft palate, teeth, minor and major salivary glands. Common and special points of structure of the digestive tube: esophagus, stomach, small and large intestines. Major glands in digestive system: pancreas and liver. Microscopic structure of liver lobulae,
liver blood circulation, ultrastructure of hepatocytes, bile excretion. Structure of pancreas exocrine and endocrine parts, secretion of hormones.

5.4. Pathological physiology of digestion. The disorders of liver functions (2 h.)
Institute of Physiology and pharmacology (Pathological Physiology)

In charge - lect. D. Akramienė

Description

5.5. The understanding of clinical analysis data for diagnosis of digestive system and liver diseases. (2 h)
Clinic of Internal Diseases

In charge – lect. E. Mašanauskienė

Description
Examination of main symptoms of patients suffering from digestive system and liver diseases (pain, nausea, vomit, waterbrash, disorder of swallow, distension, diarrhoea, constipation, haemorrhage, pain in the right side, jaundice, itch). Analysis of digestive system and liver: analysis of faeces, H. Pylori diagnosis, pH-metry, fibroesophagogastroduodenoscopy, endoscopic and echoscopic analysis, bilirubin and liver enzymes tests. Syndromes: acute abdominal pain, GERL syndrome, syndromes of haemorrhage, malabsorbtion. Understanding of liver cirrhosis and alcoholic liver diseases.

5.6. Gastrointestinal functions and their regulation (2h)
Institute of Physiology and Pharmacology

Responsible person – lect. I. Korotkich

Description
Swallowing. Nervous and humoral regulation of secretory and motor functions of the stomach. Regulation of the secretion of pancreatic juice and bile. Regulation of functions of small and large intestines. Defecation.

5.7. **Metabolism of triacylglycerols and phospholipids. (2 h)**

Department of Biochemistry

Responsible persons – prof. L.Ivanovienė

Description


5.8. **Disorders of carbohydrate metabolism: Hyperglycaemia and hypoglycaemia. Diabetes mellitus, its etiology, mechanisms of pathogenesis, changes of body functions. (2 h)**

Institute Physiology and Pharmacology (subject Pathological Physiology)

In charge - lect. D. Akramienė

Description:

Causes of disturbances in carbohydrate metabolism. Hyperglycaemia and hypoglycemia; causes and pathogenesis. Etiology and pathogenesis of diabetes mellitus, changes in metabolism, its acute and chronic complications.

5.9. **Metabolism and transport of cholesterol. (2 h)**

Department – Biochemistry

In charge – prof. L.Ivanoviene

Description:

5.10. Antidiabetic and antihyperlipidemic agents (2 hours)
Unit: Institute of Physiology and Pharmacology
In charge: dr. R.Jankūnas

Description:

5.11. Regulation of metabolism by hormones of pancreas: molecular mechanism of action and signs of insufficiency. (2 h)
Department of Biochemistry
In charge – professor L. Ivanovienė
Description

5.12. Mechanisms of regulation of blood glucose concentration. (2 h)
Department of Biochemistry
In charge – prof. V.Borutaite
**Description**

**5.13. Diabetes mellitus, its pathogenesis and morphology, complications and death causes. (2 h)**

Clinic of Pathological anatomy
In charge – prof. R. Gailys and prof. V.Lesauskaitė

Description

**5.14. Notion of metabolic endocrine diseases. (2 h)**

Clinic of Internal diseases
In charge – lect. E. Mašanauskienė

Description
Clinical examinations implicated in diagnosis of endocrine diseases that manifest as striking metabolic abnormalities. Complaints: weakness, obesity, thirst, polyphagia, polyuria. Clinical examinations: anthropometry, glucose tolerance test, examination of glycemia. The main symptoms of diabetes mellitus are revise as well as diagnostic criteria, complications, notion about treatment of diabetes mellitus.

**5.15. Amino acid metabolism. Ammonia detoxication. (2 h)**

Department of Biochemistry
In charge – professor V. Borutaitė

Description
Stages of amino acid catabolism. Types and main enzymes of amino acid deamination in human body. Aminotransferases, diagnostic value of plasma aminotransferases. Transport of ammonia in the

5.16. Pathologic anatomy of alcoholism. General endoinfectional processes and pacreatites. (2 h)

Clinic of Pathological Anatomy
In charge – prof. R.Gailys, prof. V.Lesauskaitė
Description

5.17. Liver role in detoxification processes. Molecular mechanisms of the biotransformation of xenobiotics and autobiotics. (2 h)

Department of Biochemistry
In charge – prof. L.Ivanovienė
Description
Liver role in the metabolism of carbohydrates, lipids and proteins. Liver role in detoxification of xenobiotics and autobiotics. Metabolism of the xenobiotics in the liver: three phases of biotransformation; role of cytochrome P450 in biotransformation; I phase biotransformation reactions – oxidation, reduction, hydrolysis reactions; II phase reactions – conjugation with glucuronic acid, sulphuric acid, acetic acid, thiosulphates, α-amino acids, glutathione, double conjugation; methylation. Metabolism of alcohol (ethanol). Detoxification of protein decay products appeared in large intestine.
5.17. **Pathologic anatomy of alcoholism. General endoinfectional processes and pancreatites. (2 h)**

Clinic of Pathological Anatomy

In charge – prof. R. Gailys, prof. V. Lesauskaitė

Description


5.18. **Psychosocial aspects of alcoholism. (2h)**

Department of Environment and Occupational Medicine

Responsible person – Prof. R. Radišauskas

Description

Harm of alcoholism: influence on physical and mental efficiency – attention, thinking, orientation, mobility of intracentral communication, sensomotoric rate of response and other alteration of psychophysiological functions. Quality of work, productivity, industrial and home traumatism. Alcohol and traffic causalities. Alcohol and psychosocial climate within the family. Alcohol, criminality and suicide. Influence of alcohol on health (short accents): central nervous, analyzers, heart and vessels, breeching, digestive, endocrine and other systems. Alcohol and cancer.
6. Practicals

6.1. Anatomic structure of major digestive glands. Intraorganic and extrahepatic ducts of bile. Anatomy of gall bladder. Morphofunctional features of pancreas as major digestive gland. (3 h)

Unit– Institute of Anatomy
In charge – associate professor V. Gedrimas

Aim: to learn in details anatomy of major digestive glands, macroanatomic and internal structure of liver and pancreas, anatomic parts and location of gall bladder, peritonisation, vascularisation, bladder duct and its connection to liver ducts, formation of common bile duct, variations of connection, positioning of duct in ligament of duodenum in liver, connection to pancreas duct, anatomy of opening of bile duct major duodenal papilla. To study in details structure, topography, vascularisation of pancreas, to be able to define pancreas as gland of external secretion, to know its ducts and their location including variations, connection to bile ducts, to define pancreas as endocrine gland: structure, location and function of pancreas islets.

Objectives: to study external anatomy of liver. To better understand internal structure of liver, to describe segments, lobules. To study anatomic museum preparations, which illustrate anatomic structure, position, size, and visible parts of gall bladder duct, and to characterise peculiarities of its positioning, and their clinical anatomy, to understand anatomy of other extrahepatic bile ducts. To revise anatomy of duodenum, to find longitudinal wrinkle by using sections of this organ, to find major mammilla in it. To discuss flow of bile and pancreas juices by inserting a thin flexible probe into major mammilla.

To be able to show anatomic parts, structural components, ducts of pancreas in anatomic preparations, models, pictures and sets of internal organs, prepared for dissection. To understand location of pancreas islets, describe vascularisation, frequent variations and anomalies of pancreas.

References:
6.2. Digestion of lipids. Effect of bile on pancreatic lipase activity. (3 h)

Department of Biochemistry
In charge – prof. L. Ivanoviene; prof. R. Morkuniene; prof. V. Borutaite

The aim:
To evaluate the effect of bile on digestion of dietary lipids

Objectives:
1. To investigate digestion of lipids by pancreas enzymes
2. To evaluate the effect of bile acids on digestion of lipids by pancreas enzymes
3. To discuss the molecular mechanism of effect of bile acids on digestion of lipids

References:
Nutrient uptake. Laboratory manual on biochemistry. FC

1. To get knowledge on liver cirrhosis and alcoholic liver diseases.

6.3. Structure of the wall of digestive tract (3 hr.).

Department of Histology and Embryology
In charge – prof. A. Valančiūtė

Aim
To know and to understand the general structure of digestive canal and the structural differences of its separate parts.

Objectives. To comprehend the histological structure of different parts of the digestive canal, and the importance of epithelial cells, glands of the wall of digestive canal, and smooth muscles in the process of digestion and absorption of nutrients.

Acquired competence: To be able to distinguish under the microscope the following histological preparations: oesophagus, cardia, fundus of the stomach, pylorus, duodenum, jejunum, ileum, large intestine, vermiform appendix. It is acquired to recognize different structural elements in every histological preparation and to explain the purpose of these structural elements. To acquire general knowledge on the embryological origin of digestive system: the time of germ appearance and the sources of development.

Questions:
1. General characterization of the histological structure of the digestive canal wall and the structural differences of its separate parts. Structural features related to the function.
2. Types and role of the epithelial cells of digestive canal.
4. Elements of the immune defence system in the wall of digestive canal.

In the esophagus preparation to be able to distinguish the main layers of oesophagus wall: mucous with squamous stratified non keratinized epithelium, subepithelial connective tissue with the esophageal cardiac glands near the stomach, submucous connective tissue with mucous glands and large vascular net, muscular layer, nerve plexuses.

In the transition between esophagus and stomach preparation to be able to find the transition place from esophagus into the stomach, to recognise all layers of the oesophagus wall, cardiac glands in the esophagus and columnar gastric epithelial cells, epithelium covering the gastric mucous membrane and its pits, the subepithelial layer of the cardia with the glands of the mucous membrane.

In the fundus of the stomach preparation to be able to distinguish all layers of the gastric mucous membrane: mucous, submucous layer, muscular layer and seruos covering. In the subepithelial connective tissue to recognise gastric(fundic) glands and four types of cells: mucocytes of the gland neck; chief (zymogenic) cells; parietal cells, gastric endocrine cells.

In the pylorus preparation to distinguish mucous, submucous and muscular layers, serous covering and pylorus glands.

In the duodenum preparation to distinguish the mucous membrane and villi, subepithelial connective tissue, glands of the submucous layer, blood-vessels of the submucous layer and intramural nerve ganglia in the muscular wall.

In the jejunum preparation to be able to recognise the structural differences between jejunum and duodenum, to distinguish the mucous membrane, submucous, muscular and serous layers.

In the ileum preparation to recognise low and spare villi and abundant grouped lymph nodes (Peyer’s patches) in the intestine wall. To distinguish all layers of the ileum preparation.

In the large intestine preparation to distinguish all main layers of the wall: mucous membrane, subepithelial mucous layer, muscular mucous layer, submucous layer, muscular layer and serous covering.

In the vermiform appendix preparation to recognise mucous membrane, much thinner crypts, lymph nodes.
6.4. Clinical analysis of digestive system and liver. Syndromes of injury. (3 h)

Clinic of Internal Diseases
In charge – lect. E. Mašanauskienė

Aim:
to analyse clinical data of digestive system and liver and syndromes of injury.

Objectives:
1. Clinical data analysis
2. Analysis of main clinical syndromes

Skills:
1. To interpret clinical analysis data for diagnosis of digestive system and liver diseases.
2. To understand main syndromes of digestive system and liver injury.

Questions analysed:
1. Complaints of the patients suffering from digestive system and liver diseases.
2. Clinical analysis of diagnosis of digestive system and liver diseases.
4. To get knowledge on liver cirrhosis and alcoholic liver diseases.

References:

Aim: to analyze clinical data of digestive system and liver and syndromes of injury.

6.5. Histological structure of oral cavity organs (3 hr.)

Department of Histology and Embriology
In charge– prof. A. Valančiūtė

Aim:
To analyse the histological structure of oral cavity, salivary glands and their ducts.
Objectives:
To comprehend the importance of different parts of digestive system: teeth and salivary glands in the process of digestion and absorption of nutrients.

Acquired competence: To be able to distinguish under the microscope the following histological preparations: a lip, parotid salivary gland, sublingual salivary gland, submaxillary salivary gland, teeth, tongue.

Questions: Embryological origin of different parts of digestive system. Oral cavity and the structures therein. General characterization of the histological structure of the digestive canal wall and the structural differences of its separate parts. Structural features related to the function.
In the lip preparation to be able to recognize the skin area, transitional and mucous parts. In the skin area to distinguish stratified squamous keratinized epithelium, hair roots, sabecceous and sweat glands, and connective tissue with the blood-vessels. In the transitional part to distinguish the epidermic granular and thin non keratinized layers, subepithelial connective tissue with high papillae and capillaries imparting the reddish colour to the lips. In the mucous part to distinguish the stratified squamous non keratinized (possessing lower papillae of the connective tissue) epithelium, mucous and serous glands, striated muscles.
In the parotid salivary gland preparation to be able to recognize the parenchyma and stroma of the glands, lobules, serous alveoli, secretory ducts, connective tissue.
In the sublingual salivary gland preparation to be able to recognize the mixed terminal parts of secretory gland, acinus, predominant mucous cells and demilunes of serous cells within and in a connective tissue – secretory ducts.
In the submaxillary salivary gland preparation to be able to recognize the serous (proteinaceous) and mixed (mucoserous) alveoli of the glands, in the connective tissue between lobules – ducts and bloodvessels.
In the tooth preparation to recognize the stages of the tooth development: Irst - bud, IInd – cap, and IIIrd – belland crown stages of the development.
In the tongue preparation to recognize the foliate papillae covered by the stratified squamous non keratinized epithelium, and the connective tissue papillae with the blood-vessels therein. In the lateral surface of epithelium to recognize the taste buds. Also to recognize filiform papillae covered with squamous stratified keratinized epithelium.

References:

**3 h**

**Department of Biochemistry**

In charge – prof. L. Ivanoviene; prof. R. Morkuniene; prof. V. Borutaite

**Aims:**

1. To quantify the daily amount of creatinine excreted with urine, to use data obtained to evaluate functional state of skeletal muscle and kidney.
2. To determine the amount of carbamide in urine.
3. To be able to interpret data obtained and to evaluate the efficiency of processes of amonia detoxification.

**Objectives:**

1. To learn how to determine the amount of creatinine in urea and to calculate daily amount of excreted creatinine in urine.
2. To get knowledge on metabolism of creatine and creatinine and their biological significance.
3. To practice in interpretation of changes in creatine and creatinine concentrations and realation to physiological and pathological processes.
4. To be able to evaluate changes in creatine and creatinine concentrations and in activity of isoenzymes of creatine kinase in biological samples during pathological or physiological processes.
5. To get knowledge on metabolic production of ammonia, its toxicity and ways of detoxification in human organism.
6. To skill in determination of the main product of ammonia detoxification – carbamide in biological fluids.
7. To be able to evaluate changes in carbamide concentrations in biological fluids during various pathological processes.

**References:**

Nutrient uptake. Laboratory manual on biochemistry. FC

6.7. *Structure and histophysiology of large digestive glands (3 h)*

**Department of Histology and Embryology**
In charge – prof. A. Valančiūtė

Aim:
To learn histological structure of the liver, ultrastructure of hepatocytes, system of blood supply to the liver, histological structure of the exocrine part of pancreas and pancreatic ducts.

Objectives:
During studies of structure of liver and ultrastructure of hepatocytes, to understand bile secretion, significance of blood circulation system, the role of phagocytic cells in immune response. To study structure of exocrine part of pancreas, ultrastructure of secreting cells, histological structure of ducts of the pancreas.

Skills:
Students will learn to distinguish histological preparations by microscope, to identify structural elements in the histological preparations and to explain their significance.

Questions:
1. Structure of pancreas exocrine part, ducts, significance of exocrine part of pancreas for digestion.
2. Histology of the liver and blood supply system.
3. Macrophagocytes in the liver and their significance.

In pancreas preparation to identify acini lined by conus-form cells – exocrinocytes of pancreas with acidophylic apical parts (zymogen granules) and basophylic basal parts, septa of connective tissue with capillaries, intercalated and intralobular ducts, islets of pancreas.

In human liver preparation to identify lobules of the liver, central vein of the lobule, portal spaces with bile ducts, lymphatics nerves, blood vessels in the corners, plates of multi-angular hepatocytes, sinusoidal capillaries between them.

In preparations of pig liver, to identify lobules surrounded by connective tissue between lobules, central vein and plates of hepatocytes, bile ducts, arteries, veins and nerves in the corners of the lobule.

Gallbladder preparation – to distinguish layers of gallbladder wall: epithelial lining, folds of mucosa, muscles and adventitia.


Clinic of Internal diseases

In charge – lect. E. Mašanauskienė, prof. A. Naudžiūnas

**Aim:**
To analyse clinical evaluation of obesity and principles of diabetes mellitus diagnosis; to have a notion of diabetes mellitus complications and treatment

**Objectives:**
to analyze types of obesity and clinical diagnostics; to know principles of diabetes mellitus diagnostics; to have a notion of diabetes mellitus complications and treatment.

**Skills gained:**
1. To be able to rate normal body mass and obesity.
2. To know clinical and laboratory signs of diabetes mellitus.

Questions analysed
1. Causes of body mass gain and appetite.
2. Rates and types of obesity.
3. Estimation of normal body mass.
7. Diabetic and hypoglycemic coma.


6.9. **Determination of cholesterol concentration in blood serum. Determination of cholesterol, high density lipoproteins, low density lipoproteins and triacylglycerols by automatic analyzer Cardio-Check. (3 h)**

Department of Biochemistry

In charge – prof. L. Ivanoviene; prof. R. Morkuniene; prof. V. Borutaite
Aim
To learn how to determine and to calculate cholesterol and its transferring lipoprotein concentrations in human blood serum as well as to interpret obtained results.

Objectives:
1. To determine concentration of cholesterol in human blood plasma by Ilck.
2. To calculate concentration of cholesterol in both systemic and non-systemic units.
3. To determine concentrations of cholesterol, high density lipoproteins, low density lipoproteins and triacelglycerols in blood serum by automatic analyzer.
4. To evaluate the results and to interpret them.

References: Nutrient uptake. Laboratory manual on biochemistry. FC

6.10. Pathological anatomy of diabetes mellitus and obesity. (3 h)

Clinic of Pathological Anatomy

In charge – prof. R. Gailys, prof. V. Lesauskaitė

Aim:
To identify macro and micro preparations with macro and micro angiopathies and to indicate possible causes of death; to study pathological anatomy of the obesity; solve morphologic diagnostic tasks.
Nephroangiosclerosis diabetica histological slide (H+E ir PAS reaction). Pay attention to thick walls of the loops of glomerular capillaries. There are PAS positive deposits in the walls glomerular capillaries and the mesangium as well. Some glomeruli are atrophic and sclerotic, surrounded by connective tissue.

References:

6.11. Antidiabetic agents (2 hours)

Unit: Institute of Physiology and Pharmacology

In charge: dr. R.Jankūnas

Aim:
To gain basic knowledge on classification, pharmacological and clinical properties of antidiabetic agents.
Objectives:

1. Describe and compare mechanisms of action and effects of antidiabetic agents on target tissues/enzymes including pancreas, hepatocytes, muscles, adipose tissue, kidneys, SGLT-2, DPP-4 etc.
2. List and compare most important adverse reactions of antidiabetic agents.
3. Explain pharmacodynamic basis of most important adverse reactions of antidiabetic agents.
4. Describe major risks of insulin therapy.
5. Explain relation of pharmacokinetic properties to timing of administration (dosage interval and relation to meals) of insulin preparations.
6. Relate pharmacodynamic properties of antidiabetic agents to their use depending on the diabetes type.

References:


Supplementary readings:


Department of Biochemistry

In charge – prof. L. Ivanoviene; prof. R. Morkuniene; prof. V. Borutaite

Aim

To understand mechanism of protein digestion by pepsin.

Subjectives

1. Evaluate effect of hydrochloric acid on pepsin action.
2. Evaluate factors that arouse pepsin inactivation.
3. To know molecular mechanism of pepsin action. Perform quantitative analysis of gastric juice.
4. Calculate acidity of gastric juice.
5. Acquit with essential types of gastric juice and its clinical importance. Determine pathological compounds of gastric juice.

References:
Nutrient uptake. Laboratory manual on biochemistry. FC

6.13. Alcoholism. Diseases and syndromes of digestive system. (3 h)

Clinic of Pathological Anatomy

In charge— prof. R. Gailys, prof. V. Lesauskaitę

Aim:
To help students to get theoretical knowledge’s and practical skills to evaluate morphology of alcohol-induced injury of digestive canal, pancreas and liver, study pathology of the endoinfective processes.

Objectives:
To isolate preparation that illustrate morphology of alcoholism and preparations that illustrate colitis, appendicitis, candidosis, bile stone disease and acute necrosis of pancreas and ulcer disease; dissolve morphological diagnostic tasks.

Hepatocyte in case of alcoholism. Electron micrograph (x30 000). Pay attention and draw alcoholic “hyaline” (Mallory bodies) within the cytoplasm of hepatocytes.

Alcoholismus: lipidosis hepatocytorum et cirrhosis hepatis. Histological slide (H+E). Pay attention to fat hepatocytes and to the changed architecture of the liver, which is caused by the proliferation of connective tissue and regenerating hepatocytes. Find out so called untrue liver lobules (pseudolobuli) with proliferating small bile ducts and interstitial infiltration by immune cells.

References:


Institutue of Physiology and Pharmacology
Subject Pathological physiology
Objectives:
1. To understand the use of the terms insulin, Type I diabetes mellitus, Type II diabetes mellitus.
2. To understand how fasting plasma glucose levels are used to diagnose diabetes mellitus.
3. To understand the assay that is used to measure plasma glucose

Description:

The simulatory laboratory work will be performed. You will develop a Glucose Standard Curve and measure fasting plasma glucose levels in the blood samples from different patients.

Literature:
7. Seminars

7.1. Features of structure of the digestive canal wall and liver (2 h)
Institute of Anatomy
In charge – associate professor V. Gedrimas, dr. I. Saburkina
Aim:
To know structure and localisation of the digestive canal parts such as mouth, fauces, oesophagus, stomach, small and large intestine; to know structural principles of food stuff digestion and absorption (structure of mucosa, features of blood and lymph circulation).

Objectives:
At the end of your independent studies (preparing for a seminar), using material of dissection and preparations, under instructor supervision structures of parts of the digestive canal – mouth, fauces, oesophagus, stomach, and gut wall (structure of mucosa, its folds, glands and etc.), collocation of blood and lymph vessels under mucosa, muscular layers, process of peristalsis are ascertained. Structures, implicated in absorption of components from mash moving along the digestive canal, and their transfer by blood of portal vein into liver are being discussed. Hepatic porta, and their structures – hepatic artery, portal vein, bile ducts are being demonstrated. Anatomy of intraorganic circulation as well as collocation of portal vein, hepatic vein, bile duct and role of liver in utilization of absorbed nutrients are ascertained.

References:
2. Anatomy atlases

7.2. Obesity evaluation and prevention. Evaluation of diet caloric content. (2 h)
Department of Environmental and Occupational Medicine
In charge – assoc. prof. D. Lukšienė
Aim:
To get acquainted to principles of healthy nutrition and to distribution, epidemiology and prophylaxis of obesity.

Objectives:
1. To analyse causes of obesity and to determine main principles of obesity prophylaxis.
2. To discuss distribution of obesity and its social-economical conditions.
3. To determine main principles of obesity prophylaxis.
4. To evaluate dietary caloric content and to compose dietary daily needs.
7.3. Antihyperlipidemic agents (2 hours)
Institute of Physiology and Pharmacology

In charge – dr. R. Jankūnas

Aims:

1. To consider the role of the antihyperlipidemic agents as multifactor intervention strategy to reduce cardiovascular risk.
2. To describe the pharmacological and clinical properties of antihyperlipidemic agents.

Objectives:

1. List non-pharmacological interventions to correct hyperlipidemia.
2. Describe mechanism of action of statins; relate it to changes in plasma lipoprotein levels.
3. List and describe indications for use of statins.
4. List and describe major adverse reactions of statins.
6. Describe mechanism of action of bile acid-binding resins; relate it to changes in plasma lipoprotein levels, indications for use and adverse reactions.
7. Describe mechanism of action of fibrates; relate it to to changes in plasma lipoprotein levels and indications for use; list their adverse reactions.
8. Describe mechanism of action of niacin; relate it to changes in plasma lipoprotein levels; list its adverse reactions.
9. Explain why niacin has not currently been used as anyihyperlipidemic agent.

References:
Aim:
To know amino acid and nucleotide metabolic pathways and understand possible subsequences of metabolism disturbances.

Objectives:
1. To be able to characterize types of amino acid deamination, to relate changes in aminotransferase (transferase) amounts in blood serum and patients‘ clinical condition.
2. To be able to follow up amino groups transfer from amino acids to the ammonia ions and its conversion to urea. To be able to describe source of ammonia in the organism and mechanism of it’s toxically action.
3. To get used in analyzing of metabolic pathways for identification of glucogenic amino acid and ketogenic amino acids. To get ability evaluate production of energy during amino acid metabolism.

References:

Supplementary readings:
8. Examination programme

8.1. Human anatomy

1. Connection between the structure and function of the intestine wall layers.
2. Classification of the salivary glands according their size, location in the body and salivary content.
   The ducts of large salivary glands, and their release places in the mouth.
4. Structural components of the gastric mucous and submucous membranes, and their structural relationship with the function of stomach.
5. Characterization of liver intraorganic blood circulatory system.
7. Structural components of the pancreas functioning as exocrine gland.

8.2. Physiology

1. Factors affecting secretion of hydrochloric acid in stomach. Machnisms of their action.
2. Phases of gastric juice secretion and their features.
4. Nervous and humoral regulation of the secretion of pancreatic juice and bile.
5. Regulation of functions of small and large intestines. Defecation.

8.3. Human histology and embryology

1. Embryologic origin of the digestive system, main stages of development.
2. Histological structure of the teeth.
3. Embriological origin of the teeth and main stages of the development.
4. Histology of the oesophagus.
5. Similarities and differences of histological structure of small and large intestine. Types of epithelial cells in different parts of intestine.
7. Histological structure of cardiac, fundic and pyloric parts of the stomach. Role of stomach fundic glands in digestive process.

9. Structure of exocrine and endocrine part of the pancreas.

10. Elements of organism’s immune defense system in digestive system.

11. Glands in different parts of digestive tract and their role in digestive process.

12. Histological structure of the tongue.

13. Histological structure of the lips.

8.4. Pathological anatomy. This is a preliminary programme of exam on pathological anatomy course

1. Lipidosis, its kinds, causative factors, morphogenesis, morphology, outcome and significance. Lipidic tezaurismoses, local accumulation of cholesterol and cholesterol esters.

2. Pathological anatomy and complications of the obesity.


4. Calculi (stones), its mechanisms of formation, localisation and morphology. Disorders of urates metabolism.

5. Cholelithiasis and cholecystitis, its morphology and complications.


7. Alcoholism, its pathogenesis, morphology, complications and causes of death.


14. Tumors of liver, gallbladder, bile ducts and pancreas, its morphology, complications and causes of death.

8.5. Pathological physiology

1. Disorders of motor (vomiting, hiccup, eructation) and secretory (hyper- and hypiacidity) functions of the stomach and consequences of stomach resection. Their etiology, pathogenesis, disorders of body functions. Peptic ulcer disease, etiology, pathogenesis.

2. Diarrhea and constipation, their etiology, pathogenesis, disorders of organism functions.

5. Carbohydrate metabolism disorders (hyperglycemia, hypoglycaemia, and diabetes mellitus. Their etiology, pathogenesis, disorders of body functions.

8.6. Essentials of Medical Diagnostics

1. Obesity. The clinical signs and diagnostics.
2. Characteristics of symptoms of diabetes mellitus.
4. Criteria of diagnostic of type 1, type 2 and gestacional diabetes mellitus and understanding about treatment.
5. Complications of acute and chronic diabetes mellitus.
6. Symptoms of gastrointestinal (GI) and liver diseases.
7. Instrumental investigations applied for diagnosis of gastrointestinal and liver diseases.
8. Examination of stool, meanings of pathological findings.
9. Examination of clinical, biochemical enzymes analysis of liver.
10. Main gastrointestinal syndroms: abdominal pain, dyspepsion, GERD, malabsorption, bleeding from GI tract.
11. Main liver syndroms: jaundice, portal hypertension, liver failure.
12. Understanding of liver cirrhosis and alcoholic liver disease.

8.7. Biochemistry

8.7. Biochemistry

1. Digestion of polysaccharides, absorption of products of digestion.
2. Digestion of lipids (TAG, phospholipids, cholesterol esters), absorption of products of digestion.
3. Digestion of proteins, absorption of products of digestion.
5. Structure of bile acids, role of bile in nutrient digestion.
6. Metabolism of hemoproteins.
9. Reaction sequence of glycogen breakdown, enzymes, regulation, energy value, physiological significance.
10. Reaction sequence of glycogen synthesis, enzymes, regulation, physiological significance.
11. Metabolism of acetyl-CoA produced in beta-oxidation; ketogenesis (production of ketone bodies): substrates, reaction, enzymes, products, transportation and consumption of ketone bodies.
12. Synthesis of triacylglycerols in tissues (tissue lipolysis) and its regulation.
13. Breakdown of triacylglycerols in tissues (tissue lipolysis) and its regulation.
15. Approximate composition of chylomicrons, chylomicron formation and metabolism.
16. Approximate composition of very low density lipoproteins (VLDL), VLDL formation and metabolism.
17. Approximate composition of high density lipoproteins (HDL). HDL formation and metabolism.
20. Metabolism and elimination of xenobiotics.

8.4. Pharmacology
1. Classification, common features and differences of antidiabetic agents.
2. Preparations of insulin: classification, pharmacodynamics, relation of timing of administration with pharmacokinetic properties, indications for use, adverse reactions.
3. GLP-1 analogues: pharmacodynamics, indications for use, adverse reactions.
5. Meglitinides: pharmacodynamics, indications for use, adverse reactions.
8. α-glycosidase inhibitors: pharmacodynamics, indications for use, adverse reactions.
9. DPP-4 inhibitors: pharmacodynamics, indications for use, adverse reactions.
10. SGLT-2 inhibitors: pharmacodynamics, indications for use, adverse reactions.

8.9. Environmental and occupational medicine

1. Obesity, its definition, prevalence and causes.
2. Body mass index, its evaluation.
3. Daily energy requirement (DER) and dietary composition assessment.
4. Main principles of obesity prophylaxis.
5. Psychological reasons of alcoholism.
7. Psychosocial damage of alcoholism.

Process of examination and evaluation.

1. Examination conditions and rules are set by a document The Regulation of studies issued on June 20, 2014. LUHS Senate order Nr. 47-05. Student rights and duties are under full regulation of this document.

2. The exam on NUTRIENT UPTAKE is organized by the Department of Biochemistry. Date and time of the exam are scheduled. The information is available at: http://pm.lsmuni.lt/tvarkarasciai/show.php?a=semester&sem=MF4sem20142015.

3. Instructions about student allocation in examination rooms are available at Intranet of the University FC as much as 3 days before the exam.

4. Composition of the exam. The exam is composed of 9 subjects. Format of subject-based questions is MCQ and short answer questions. The content of questions comme from the module programme (see above). Total value of exam questions make 100%. Contribution of specific subjects to the total depends on their complexity and the duration of studies (contact and independent work h). In the auditoria, you will be provided by a set of processed questions. Questions of a particular subject are
printed out on separate pages which are clipped together. Numbering of subject-based questions starts at
1. Instructions how to make your answers are provided at the first subject-approached page.

5. Evaluation. Each department and institute which contributes to the module makes evaluations on
specific subject-based questions. The departments receive student papers in anonymous way (without
names and groups but with particular code). Common grade is composed by the department of
biochemistry after decoding of evaluation data. Student grades are posted on electronic register

6. Feedback. Students can get familiar with their mistakes only after announcement of all grades in
electronic register. Therefore they should know their individual code numbers from the exam
organizing department. Knowing the code numbers, other departments can provide you with needed
information.