Programme of Medical studies

MODULE

Nutrients Uptake and Metabolism

Second year
Spring semester

Faculty of Medicine
Kaunas University of medicine
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1. General information

**Supervisor of the module:** professor Laima Ivanovienė (ivanoviene@med.kmu.lt)

**Coordinator of the module:** associate professor Ramunė Morkūnienė (ramunemo@delfi.lt)

**Departments/institutes**
- Human Anatomy
- Environmental and Occupational Medicine
- Biochemistry
- Physiology
- Human Histology and Embryology
- Pathological Anatomy
- Theoretical and Clinical Pharmacology
- Clinic of Internal Diseases

**Subjects and responsible persons:**
- Human Anatomy (assoc. prof. V. Gedrimas; 327238)
- Biochemistry (prof. L.Ivanovienė; 327323)
- Pharmacology (assoc. prof. Milašius, 327242; lect. R. Jankūnas, 327242)
- Physiology (assoc. prof. Ž. Senikienė, assoc. prof. R. Lazauskas, 327256)
- Human Histology and Embryology (prof. A. Valančiūtė, 327235)
- Pathological Physiology (prof. A. Kondrotas, assist. D. Akraničienė, 327258)
- Pathological Anatomy (prof. R.Gailys; 327013, prof. V.Lesauskaitė)
- Environmental and Occupational Medicine (assoc. prof. R. Radišauskas, 327360, lect. D.Lukšienė)
- Essentials of Medical Diagnosis (assoc.prof. P.Leišytė, assist. E.Mašanauskienė, assist. A.Bernotienė, 306092)
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 organs
- 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 organs
- Mechanisms, regulation and disorders of nutrients digestion and uptake
- Changes in morphology of digestive system caused by diseases of digestive organs, metabolic disorders, endoinfections and pancreatitis; complications and causes of death.
- 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 of obesity and principles of 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 secretion of pancreatic hormones insulin and glucagon, mechanism of insulin action, tissue and whole organism responses to insulin, causes of insulin 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 its 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 organs 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 sclera of eyeballs 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 haemoglobin 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 occlusion of bile ducts.

Learning objectives and contents
To complete an analysis of this problem the students must know:
- Anatomy of digestive system components (digestive canal, 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:

- Features of histology of digestive system and liver

Subject – Human Histology and Embryology
Department of Histology and Embryology
References:

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

Subject – Biochemistry
Department of Biochemistry
References:

- Transport of digestion products through intestinal mucosa. Composition of gastric juice and its role 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:**


- Jaundice morphology and causes. Causes and consequences of gallstones formation.
Subject – Pathological Anatomy
Clinic of Pathological Anatomy
References:

- Regulation of secretion of pancreas juice and bile

Subject – Physiology
Department of Physiology
References:

- Pathological physiology of digestion. Disorders of bile function

Subject – Pathological Physiology
Department of Physiology
References:

- Characteristics and catabolic pathway of hemoproteins

Subject – Biochemistry
Department of Biochemistry
References:

- Bilirubin formation pathways. Transport of bilirubin to liver and bile. Urobilin 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**

**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

Department of Biochemistry

References:


Supplementary readings:


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

Subject – Biochemistry

Department of Biochemistry

References:


Supplementary readings:

4.3. Case 3. Obesity

A 48 years old man has been willing to slim down for several years. 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, transport, mechanisms of accumulation and assimilation of lipids and their components in tissues.

Learning objectives and contents
To complete an analysis of this problem the student must know:

• 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:

Supplementary readings:

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

Subject – Pathological Anatomy
Clinic of Pathological Anatomy
References:

- Clinical evaluation of obesity

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

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

Subject – Environmental Medicine
Department of Environmental and Occupational Medicine
References:
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 plasma lipoproteins were separated by agarose gel electrophoresis and were then visualised by staining with a lipophilic dye (figure 1). The cholesterol content of each of the main plasma components identified by electrophoresis was calculated (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>

**Figure 1.** Agarose gel electrophoresis of plasma proteins (N, normal; P, patient). The gel was stained with a lipophilic dye and the protein bands are designated by their electrophoretic mobilities relative to the plasma α and β globulins.
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**

*To complete an analysis of this problem the student 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:

• Groups of antihyperlipidemic medicines, possibilities and methods for correction of dyslipidemia, comparison of efficacy and risk-benefit ratio of antihyperlipidemic medicines.

Subject – Pharmacology

Department of Theoretical and Clinical Pharmacology

References:
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:**


- Medicines used for the treatment of diabetes mellitus: classification, pharmacodynamics, pharmacokinetics, principles of use, undesirable effects, and precautions for use.

**Subject – Pharmacology**

**Department of Theoretical and Clinical Pharmacology**

**References:**


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

**Subject – Pathological Physiology**

**Department of Physiology**

**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 breath. 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-oesophageal 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 concern about her alcohol consumption.

It was felt advisable to perform a set of liver function tests on both patients. 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>

How alcohol change metabolism 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 also a 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 and death causes 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:*

- 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

- Motor functions of stomach and their regulation.

**Subject – Physiology**

**Department of Physiology**

**References:**

- Functions of small and large intestine and their regulation. Mechanism of defecation.

**Subject – Physiology**

**Department of Physiology**

**References:**

- Regulation and phases of gastric secretion.

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


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

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

3. Smith C., Marks A.D., Lieberman M. Marks' Basic Medical Biochemistry: A Clinical approach. 2\textsuperscript{nd} ed, Lippincot Williams & Wilkins, 2005, p. 687-696.

- 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:


- Metabolism of nucleotides and consequences of its disturbances, molecular mechanisms of the development of gout and orotic aciduria.

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, professor V. Borutaitė

Description


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

Department of Biochemistry

In charge – professor L. Ivanovienė, professor V. Borutaitė

Description


5.3. **Histological structure of digestive organs. (2 h)**

Department of Histology and Embryology

In charge – professor A. Valančiūtė

Description

Embryological origin and main developmental stages of special parts of digestive system. Histological structure of oral cavity: lips, tongue, hard and soft palate, teeth, minor and major salivary glands. Common and special points of structure of digestive tract: oesophagus, stomach, small and large intestine. Major glands in the digestive system: pancreas and liver. Microscopic structure of liver
lobules, liver blood circulation, ultrastructure of hepatocytes, bile secretion. Structure of pancreas exocrine part, exocrine secretion.

5.4. Pathological physiology of digestion. The disorders of bile production and secretion (2 h.)

Department of Physiology (Pathological Physiology)
In charge - prof. A. Kondrotas, asist. D. Akramienė

Description
The pathological physiology of disordered digestion in the mouth, stomach and intestine; disorders of the main functions of liver; the disturbances in the production and secretion of bile; the mechanisms of the origin of jaundice and gall bladder stones.

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

Clinic of Internal Diseases
In charge – associate professor A. Unikauskas

Description
Examination of main symptoms of patients suffering from digestive system and liver diseases (pain, nausea, vomit, eructation, heartburn, disorder of swallow, distension, diarrhoea, constipation, haemorrhage, pain in the right hypochondrium, jaundice, itch). Analysis of digestive system and liver: analysis of faeces, H. Pylori diagnosis, pH-metria, endoscopic (oesophagogastroduodenoscopy) and echoscopic analysis, bilirubin and liver enzymes tests. Syndromes: acute abdominal pain, GERL (Gastro-oesophageal reflux disease) syndrome, syndromes of haemorrhage, malabsorbtion and irritable bowel syndrome (IBS). Understanding of liver cirrhosis and alcoholic liver diseases.

5.6. Review of functions and their regulation of special parts of digestive canal (2 h)

Department of Physiology
In charge – lect. I. Korotkich

Description

5.7. Metabolism of triacylglycerols and phospholipids. (2 h)
Department of Biochemistry
In charge – professor L. Ivanovienė, professor V. Borutaitė
Description

Department of Physiology (subject Pathological Physiology)
In charge - prof. A. Kondrotas, asist. D. Akramienė
Description:

5.9. Metabolism and transport of cholesterol. (2 h)
Department – Biochemistry
In charge - professor L. Ivanovienė, professor V. Borutaitė
Description:
Cholesterol and products of its metabolism. Biosynthesis of cholesterol, its regulation. Isoprenoid compounds. Formation of esters of cholesterol. Transport of cholesterol: from intestine, liver,
extrahepatic tissues. LDL and HDL metabolism. LDL receptors. Coefficient of atherogenecity. HDL.
Hypercholesterolemia, its causes.

5.10. Medicines used for the treatment of diabetes mellitus. Medicines lowering the blood cholesterol. (2 h)
Department of Theoretical and Clinical Pharmacology
In charge - assoc. prof. Milašius, lect. R. Jankūnas
Description:
Preparations of insulin: classification (by origin and duration of action), pharmacodynamics, routes of
administration, principles of dosage, undesirable effects. Oral antidiabetic agents (sulfonylureas,
meglitinides, biguanides, thiazolidinediones, alpha-glucosidase inhibitors): mechanism of action,
undesirable effects. Precautions to avoid hypoglycemia, medicines used for the treatment of
hypoglycemia.
Antihyperlipidemic medicines (statins, bile acid sequestrants, fibrates, nicotinic acid and its derivatives,
cholesterol absorption inhibitors, fish oil): mechanism of action, indications, undesirable effects,
precautions to avoid severe undesirable effects and dangerous interaction with other medicines.

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, professor V.Borutaitė
Description
Regulation of secretion of glucagon and insulin. Mechanism of glucagon action: target cells,
transduction of glucagon signal to the cell, effects of glucagon on carbohydrate and lipid metabolism.
Cell targets of insulin. Receptors of insulin. Intracellular signal transduction pathway of insulin.
Mechanism of catabolic and anabolic insulin effects. Deficiency of insulin secretion and action.
Somatostatin and amylin as peptides, which regulate pancreatic secretion.

5.12. Mechanisms of regulation of blood glucose concentration. (2 h)
Department of Biochemistry
In charge – prof. L.Ivanovienė
Description

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

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

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

Clinic of Internal Diseases
In charge – prof. A. Naudžiūnas
Description
Clinical examinations implicated in diagnosis of endocrine diseases that manifest as striking metabolic abnormalities. Complains: weakness, weight loss, obesity, thirst, polyphagia, polyuria. Clinical examinations: anthropometry, glucose tolerance test, examination of glycemia. The main symptoms of diabetes mellitus are revised 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 L. Ivanovienė
Description

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

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

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

Department of Biochemistry
In charge – prof. L. Ivanoviené
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.

5.18. Psychosocial aspects of alcoholism. (2 h)

Department of Environment and Occupational Medicine
In charge – assoc. prof. Ričardas Radišauskas
Description
Dependence and harm of alcoholism: influence on physical and mental efficiency – attention, thinking, orientation, mobility of intracentral communication, sensomotoric response rate and alteration of other
6. Practicals

6.1. Anatomical structure of large 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 into major papilla of duodenum. 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, liver surfaces, edges, segments, parts, compartments, furrows, porta, and ligaments of liver. To better understand internal structure of liver, to describe segments, labuli. To study anatomic museum preparations, which illustrate anatomic structure, position, size, and visible parts of gall bladder, bile 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 fold by using sections of this organ, to find major papilla in it. To discuss flow of bile and pancreas juices by inserting a thin flexible probe into major papilla. 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 pancreatic 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: professor L. Ivanovienė

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:

6.3. Structure of the wall of digestive canal (3 h).

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 seruous 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 sparse 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.

References:

6.4. Clinical analysis of digestive system and liver. Syndromes of injury. (3 h)

Clinic of Internal Diseases
In charge – associate professor A. Unikauskas

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:
6.5. **Histological structure of oral cavity organs (3 h)**

**Department of Histology and Embryology**

**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, sebaceous 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 blood-vessels.

In the tooth preparation to recognize the stages of the tooth development: Irst - bud, IInd – cap, and IIIrd – bell and 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:

6.6. Determination of creatinine in urine. Determination of carbamide (urea) in urine. (3 h)

Department of Biochemistry
In charge – professor L. Ivanovienė

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 ammonia 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 understand changes in creatine and creatinine concentrations and how they relate 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 learn how to determine 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:

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.

References:


Clinic of Internal Diseases
In charge – 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.


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. Ivanovienë

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 triacylglycerols in blood serum by automatic analyzer.
4. To evaluate the results and to interpret them.

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. Medicines for diabetes mellitus treatment. (2 h)

Department of Theoretical and Clinical Pharmacology
In charge – lect. R. Jankūnas

Aim:
To gain basic knowledge on medicines used for the treatment of diabetes mellitus and their pharmacological properties.

Objectives:
To become familiar with core pharmacodynamic and pharmacokinetic properties, principles of usage and undesirable effects of medicines used for the treatment of diabetes mellitus. The knowledge obtained should make a background for further studies of clinical administration of medicines.

References:
6.12. **Protein digestion. Effect of pepsin. Analysis of gastric juice.**
*Pathological components of gastric juice. (3 h)*

**Department of Biochemistry**

**In charge – prof. L. Ivanovienė**

**Aim:**
To understand mechanism of protein digestion by pepsin.

**Objectives:**
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:**

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

**Clinic of Pathological Anatomy**

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

**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:**


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

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. R. Radišauskas
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.

References:

Supplementary readings:

7.4. Medicines lowering the blood cholesterol (2 h)

Department of Theoretical and Clinical Pharmacology
In charge – doc. A. Milašius

Aim:
To discuss potential of dyslipidemia treatment by pharmacological and non-pharmacological means

Objectives:
1. To get knowledge on groups of the antihyperlipidemc medicines.
2. To discuss modalities and possibilities of the treatment of dyslipidemia.
3. To compare efficacy and risk-benefit ratio of different groups of the antihyperlipidemic medicines.
4. To learn the criteria of administration of the antihyperlipidemic medicines.

References:

Supplementary readings:
7.5. Analysis of amino acid and nucleotide metabolism using metabolic pathways (2 h)

Department of Biochemistry

In charge – professor L. Ivanovienė

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

Objectives:

1. To know patterns of amino acid deamination, to understand causes of increasing of aminotransferase (transferase) amount in blood serum and its diagnostic significance.

2. To get ability using scheme of metabolic pathways follow aminogroups that originate from amino acids conversion to the ammonia ions and its conversion to urea. To understand sources of ammonia in the organism and mechanism of it’s toxically action.

3. To get ability using scheme of metabolic pathways follow and describe glucogenic amino acid conversion to glucose and ketogenic – to ketone bodies. To get ability evaluate production of energy during amino acid metabolism.

4. To get ability using scheme of metabolic pathways follow de novo synthesis reactions of AMP and GMP and write first reactions by structural formulas, and know de novo synthesis regulation mechanisms. To get ability follow synthesis of purine nucleotides from purine basis (“salvage pathway”).

5. To get ability using scheme of metabolic pathways to write sequence of purine nucleotide catabolism reactions, to know possible end products and pathways of its excretion. To know causes of gout and mechanisms of drugs used for gout treatment.

6. To get ability using scheme of metabolic pathways to write sequence of pirimidine nucleotide synthesis and catabolism reactions, to understand regulation of its synthesis.

7. To understand mechanism of deoxiribonucleotides synthesis and principles of drugs action used for cancer treatment.
References:

Supplementary readings:
8. Examination questions

8.1. Human anatomy

1. Relationship between the structure and function of the intestine wall layers.
2. Structural components of the gastric mucosa and submucosal layer, and their structural relationship with the function of stomach.
4. Structural and functional features of the bile ducts.

8.2. Physiology

2. Phases of gastric juice secretion and their features.
3. Nervous and humoral regulation of secretion of pancreatic juice and bile.
4. Regulation of functions of small and large intestine. Defecation.

8.3. Human histology and embryology

1. Embryologic origin of digestive system, main stages of development.
2. Histological structure and development of teeth.
3. Similarities and differences of histological structure of small and large intestine. Types of epithelial cells in different parts of intestine.
4. Similarities and differences of histological structure of major salivary glands.
5. Histological structure of cardiac, fundic and pyloric parts of the stomach. Role of stomach fundic glands in digestive process.
7. Structure of exocrine and endocrine part of the pancreas.
8. Elements of organism’s immune defence system in digestive system.
9. Glands in different parts of digestive tract and their role in digestive process.
10. Structures of oral cavity: tongue, teeth, lip.
8.4. Pathological anatomy

1. Atherosclerosis risk factors and progress.
3. Types of jaundice and progress mechanisms.
4. The pathology and complications of appendicitis.
5. Morphological lesions and death causes associated with diabetes mellitus.
6. Morphological lesions of the organ systems associated with alcoholism.
7. The most common complications and death causes in alcoholism.
9. The pathology and complications associated with obesity.

8.5. Pathological physiology

1. Swallowing and digestion disorders, their etiology, pathogenesis, disorders of organism functions.
2. Stomach digestion disorders and consequences of stomach resection. Their etiology, pathogenesis, disorders of organism functions.
3. Intestine digestion disorders, malabsorption syndrome, irritable bowel syndrome, their etiology, pathogenesis, disorders of organism functions.
5. Gallbladder stones, their etiology, pathogenesis, disorders of organism functions.

8.6. Essentials of Medical Diagnostics

1. Clinical indications, the degree and the diagnostics of obesity.
2. Symptoms of illness in case of the diabetes mellitus.
3. Specimen of the tolerance to glucose.
6. Symptoms of illness in case of malfunctioning of digestive canal or liver.
7. Examination of stools.
9. Instrumental assays used in diagnose the diseases of digestive canal.
10. General clinical symptoms: acute and chronic stomach pain, dyspepsia, GORD (Gastro-oesophageal reflux disease), malabsorption, bleeding, jaundice, portal hypertension, liver deficiency.
11. Comprehension of cirrhosis and liver malfunctioning caused by alcohol consumption.

**8.7. Biochemistry**

1. Digestion of dietary polysaccharides, lipids and proteins. Absorption of products of digestion.
2. Composition of gastric juice and its role in digestion. Biosynthesis of hydrochloric acid.
3. Composition of bile. Structure of bile acids, their biosynthesis and role in digestion.
4. General characteristics of hemoproteins, their catabolic scheme. Diagnostic importance of heme catabolites.
5. Sequence of reactions of glycogenolysis, physiological importance, regulation and energy value of glycogenolysis.
6. Sequence of reactions of glycogen synthesis, enzymes, regulation and biological importance.
7. Metabolism of acetyl-CoA formed in β-oxidation of fatty acids, ketogenesis.
8. Biosynthesis of fatty acids: sequence of reaction of biosynthesis of fatty acids with even number of C-atoms, enzymes implicated.
9. Metabolism of triacylglycerols in tissues, its regulation.
10. Biological importance of cholesterol. Main stages of cholesterol synthesis, regulation of the synthesis.
13. Phases of xenobiotics biotransformation, reactions and biological importance. Metabolism of ethanol, toxic effects of ethanol to humans.

**8.8 Pharmacology**

1. Insulin preparations: classification (by origin and duration of action), relationship between pharmacokinetic properties and timing of administration.
2. Short-acting insulin preparations.
3. Intermediate-acting and long-acting insulin preparations.
4. Sulfonylureas and meglitinides.
5. Biguanidines.
6. Thiazolidinediones and alpha-glucosidase inhibitors.
10. Undesirable effects of medicines used for the treatment of dyslipidemia.

**8.9. Environmental and Occupational Medicine**

1. Obesity; definition, distribution and causes.
2. Body mass index, its evaluation.
5. Psychological aspects of alcoholism.
7. Psychosocial injury of alcoholism
8. Alcoholism prophylaxis measures.