

**MEDICAL UNIVERSITY- PLOVDIV**  
**FACULTY OF PHARMACY**

**PROGRAMME SCHEDULE**  
**IN CLINICAL LABORATORY**

**for obtaining an education and qualification degree “Master” and  
professional qualification „Physician”**

**Accepted by Department council: Protocol № 8/03.12.2019**

## CLINICAL LABORATORY

**Education course:** III course

**Speciality:** Medicine

**Semester of education:** VI semester

**Examination:** after VI semester

**Workload of the auditorium sessions:** 60 hours

**Lecturer:** Habilitated professor and Assistant professor from Dept. Clinical Laboratory

### ACADEMIC CURRICULUM

| <i>Classes</i>             | <i>Workload of the auditorium sessions</i> |               |                 |                 | <i>Credits</i> |
|----------------------------|--|---------------|-----------------|-----------------|----------------|
|                            | <i>weekly</i>                              | <i>V sem.</i> | <i>VI sem.</i>  | <i>Total</i>    |                |
| <i>Lectures</i>            | 2  | -             | 30              | 30              | 3,0            |
| <i>Practical exercises</i> | 2  | -             | 30              | 30              |                |
| <i>Total</i>               | <i>4 hours</i>                             | -             | <i>60 hours</i> | <i>60 hours</i> |                |

**GOAL OF THE DISCIPLINE:** To organize and implement optimum education in clinical laboratory to provide medical students preparation of the discipline for a complete, successful and effective work in the medical profession.

#### **TASKS OF THE DISCIPLINE:**

- ✓ Implementation and observing the requirements for preanalytical preparation of the patient and biological material, providing results with high reliability. To know and eliminate errors in preanalytical stage and the possible interference (pharmaceutical, diagnostic and therapeutic procedures) on the results of clinical laboratory analysis.
- ✓ Creating skills to fully use the capacity of clinical laboratory diagnostics for correct choice of parameters, taking into account the economic aspects of laboratory activities.
- ✓ Creating a critical attitude towards the individual analytical methods, knowing their advantages and disadvantages.
- ✓ Creating skills for correct and complete interpretation of the results of clinical laboratory analysis, knowledge of their diagnostic reliability, the correlation between parameters in different diseases, allowing the selection of the most informative combination of indicators.
- ✓ Learning of close practical skills to perform basic clinical laboratory activities (analysis of urine, microscope smears of peripheral blood, bone marrow, CSF, etc.) which are important for future independent practice. Learning the rules for using tests for express diagnostics. Acquiring skills for solving clinical laboratory tasks after learning the reference range and the correlation between parameters.

**TEACHING METHODS:** Lectures, practical exercises.

- ✓ Each exercise begins with a test on previous material
- ✓ The exercises are held after student's preliminary preparation of announced theme.
- ✓ The exercises are conducted mainly through dialogue between assistant and students.

- ✓ Each exercise ends with a solution of appropriate clinical and laboratory tasks, relevant to the material.

**TECHNICAL TOOLS AND EQUIPMENT APPLYING IN TEACHING:** Multimedia, computers, microscopes and collections of smears, tables, diagrams, charts, albums, prints of the analyzers, displaying the available modern equipment, specialized library; CD animation to illustrate the principles and methods, documented quality control data.

**CONTROL AND EVALUATION:**

- ✓ *Current control:* The students fill in test on material from previous exercise and lecture and solve problems of the current theme. Tests and tasks are made by individual assistants for various topics and discussed by the Departmental Board. Evaluations of tests, tasks and current testing form assessment for the semester.
- ✓ *Examination:* Exam with a test. The test is passive with 20 questions taken from the material of lectures and exercises. By 60 % correct answers to test the student is allowed a theoretical examination. The theoretical exam is written on two questions from the questionnaire of clinical laboratory for the entire group of students. Written examination questions are drawn from one of the students examined. The time for submission of written material on these themes is two hours.

**TEST METHODS FOR KNOWLEDGE:**

- ✓ Test from previous exercise and lectures
- ✓ Solving practical problems associated with interpretation of laboratory constellations
- ✓ Answering questions related to material from the new exercise
- ✓ Practical application of acquired theoretical knowledge:
  - completing the form for clinical laboratory analysis
  - choice of laboratory parameters
  - choice of proper type closed system (tube)
  - microscopy of blood smears

**REQUIRED SKILLS:** theoretical knowledge and practical skills of the student:

**1. The result in clinical laboratory.**

1. Be aware of the theoretical basis and practical application of the term “reference range”. Be able to use the reference intervals for interpretation of results.
2. To assimilate main groups of of clinical laboratory parameters. To properly select, order the necessary analysis and fill in the request forms.
3. To know the main types of request forms. To be able to fill in the required information for the patient.
4. To be aware of the possible sources of preanalytical and postanalytical errors in clinical laboratory analysis and the measures to limit them.
5. To know the basic and special requirements for preparing the patient for clinical laboratory testing and be able to apply them in practice.
6. To know the interference from medical procedures and drugs on clinical laboratory results and to apply in practice the measurements for control of this effect.
7. To know and apply the basic rules and requirements, to observe basic procedures and avoid sources of errors in taking of biological material for analysis.

8. To know the requirements for storage and transport of biological material, different types of closed systems for biological material. Selection of the proper tubes for analysis.
9. To be aware of the principles and rules of internal quality control and external quality assessment. To be able to interpret data from control charts.
10. Have theoretical knowledge and practical skills for dealing with dry tests for qualitative and semi-quantitative analysis of urine.
11. Know the principles of rational ordering of clinical laboratory tests in diagnosis and monitoring of treatment and be able to apply them in practice.

## ***2. Electrolytes and trace elements in blood serum.***

1. Know the basic macro- and micronutrients, their biological meaning, metabolism, regulation, indications for analysis. To properly select parameters for assessment of water electrolyte balance.
2. Know the reference ranges of main oligoelements. To properly interpret the results.

## ***3. Haematological parameters.***

1. Know haematological parameters, the rules for taking of biological material, indications for analysis for analysis and the reference ranges. To properly interpret the results.
2. Know the maturation lines and being able to recognize microscopically normal cell distribution in bone marrow.
3. Know the main parameters of leukocyte, erythrocyte and platelet line in peripheral blood and their reference intervals, indications for analysis, clinical meaning. Be able to interpret the results.
4. To know the morphological characteristics of leukocytes and be able to make a DBC. To know the morphological characteristics of red blood cells and be able to distinguish microscopically normal from abnormal cell.

## ***4. Red blood cell line abnormalities.***

1. To know and be able to select clinical laboratory parameters in red blood cell line disorders: iron deficiency, posthemorrhagic, pernicious and hemolytic anemia.
2. To know the reference ranges of these parameters and to properly interpret the results.
3. To know and be able to recognize the microscopic characteristics of red blood cell line on peripheral blood smear and bone marrow in different types of anemia.
4. To know the laboratory constellations and be able to make differential diagnosis of anemias.

## ***5. White blood cell line abnormalities.***

1. To know and be able to select clinical laboratory parameters in white blood cell line disorders: agranulocytosis, leukemoid reaction, acute and chronic leukemia, plasmocytoma.
2. To know the reference ranges of these parameters and to properly interpret the results.
3. To know and be able to recognize the microscopic characteristics of blast cells on peripheral blood smear and bone marrow in acute blast leukemia.
4. To know the laboratory constellations and be able to make differential diagnosis of leukemias.

## ***6. Haemostasis.***

1. To know the key stages of coagulation, coagulation plasma factors and inhibitors, laboratory tests and reference intervals. Be able to make interpretation of the results.
2. To know factors and inhibitors of fibrinolysis. To properly order the necessary tests and make interpretation of the results.
3. To know the main clinical laboratory tests for monitoring therapy with direct and indirect anticoagulants and to determine the therapeutic range.
4. To know and be able to order laboratory tests in DIC syndrome, thrombophilia, hemorrhagic diathesis.
5. To know the informative value and clinical significance of screening tests and to analyze the type and phase of haemostatic disorders by using the received results.

### **7. Disorders of carbohydrate metabolism.**

1. To know basic, extended and specialized analysis of disorders of carbohydrate metabolism in patients with diabetes mellitus. To properly choose laboratory tests according to diagnostic, prognostic and therapeutic need.
2. To know the opportunities of the “fasting glucose” assessment in impaired carbohydrate metabolism, preparation of the patient, to know and avoid interfering factors on the results, reference intervals and interpretation of the results.
3. To know clinical significance of glucose load tests, to order and perform these tests, to properly interpret the results.
4. To know glycated proteins as parameters of therapeutic evaluation in diabetes. Being able to correctly select the optimal parameter for monitoring hyperglycemia for a prior period of time in different types of diabetes.

### **8. Serum proteins.**

1. To know separation methods of serum proteins (electrophoresis and immunoelectrophoresis), their informative value, performance, advantages and disadvantages. Be able to distinguish normal from abnormal results.
2. To know the changes in protein fractions obtained by electrophoresis, basic terminology and interpretation. Be able to match them with the main groups of disorders. To know the acute phase proteins (positive and negative reactants), their biological and clinical significance. To properly select laboratory parameters for inflammatory and neoplastic diseases.
3. To know the meaning of hyperimmunoglobulinemia, polyclonal gammopathy, be able to distinguish polyclonal and monoclonal gammopathy on electrophoresis.
4. To know immunoglobulins, their structure, biological significance, classification, dynamics, synthesis, indications for analysis, reference ranges. Be able to specify groups of diseases in which to order and properly interpret the results.

### **9. Enzymes.**

1. To know the main cellular and secretory enzymes. Be able to make constellations of laboratory parameters and interpret increased blood levels according cell and organ pathology.
2. To know organ and subcellular localization of enzymes (ASAT, ALAT, AP, LDH, HBDH, Amylase, GGT, Cholinesterase, indications for analysis, required biological material,

reference ranges. Be able to evaluate results of their analysis in cardiovascular, liver and malignant diseases.

#### **10. Bile pigments**

1. To know the bile pigments in blood and urine, their pathobiochemistry, indications for analysis, reference ranges. To be able to make differential diagnosis between hemolytic, mechanical and parenchymal icterus by the results obtained.
2. Be able to interpret the results of bile pigments analysis in main liver and nonliver diseases.

#### **11. Non-protein nitrogen containing fractions.**

1. To know the informative value of urea, creatinine and uric acid. To be able to make proper selection and interpretation of these laboratory parameters in renal diseases.
2. To know the advantages and the way to avoid their disadvantages by examination of renal function.

#### **12. Lipid parameters.**

1. To know the requirements for analysis of lipid parameters, risk levels and sources of errors. To be able to distinguish the main types hyperlipidemia using laboratory results.

### **PROGRAMME OF LECTURE COURSE IN CLINICAL LABORATORY**

**LECTURE №1 – 2 hours: The analysis and the result in clinical laboratory. Clinical laboratory parameters.**

1. The clinical laboratory in the field of medical sciences. Subject and tasks.
2. Analytical reliability of the methods in the clinical laboratory.
3. Reference ranges – populational and individual.
4. Diagnostic reliability of clinical laboratory parameters. Requirements and criteria for diagnostic reliability of clinical laboratory parameters in different diseases.

**LECTURE №2 – 2 hours: The clinical laboratory result and its reliability.**

1. Reliability of clinical laboratory results.
2. Basic groups of factors affecting the clinical laboratory results. Mechanism of action.
3. The clinical laboratory investigations in the diagnostic process.

**LECTURE №3 – 2 hours: Clinical laboratory parameters for evaluation of water-electrolyte exchange.**

1. Body water and its distribution in the human body.
2. Osmolality and osmolarity. Methods of investigation. Reference ranges. Result interpretation.
3. Water-electrolyte balance disturbance and its evaluation.
4. Sodium and chloride. Analytical methods, indication of investigation, interferences, reference ranges, result interpretation.
5. Potassium. Analytical methods, indication of investigation, interferences, reference ranges, result interpretation.

***LECTURE №4 – 2 hours: Clinical laboratory parameters' evaluation of the results of hormonal analysis.***

Hormonal distribution and analysis. Biological meaning – classification of hormones, interactions and correlations.

1. Pituitary and adrenal (suprarenal) glands hormones' – methods of analysis, indications for investigation, patient preparation.
2. Valuation of laboratory data and correlations in pituitary and adrenal glands disorders.
3. Thyroid hormones. Methods of analysis, indications for investigation, patient preparation.
4. Valuation of laboratory data and correlations in thyroid gland disorders.
5. Hormones of reproductive system – evaluation of the results of the laboratory analysis.

***LECTURE №5 – 2 hours: Clinical laboratory evaluation of the tumor markers investigation.***

1. Definition and classification of the tumor markers.
2. Laboratory methods of analysis.
3. The “perfect” tumor marker.
4. The significance of tumor marker investigation in the follow-up and treatment of malignant diseases.

***LECTURE №6 – 2 hours: Steps and approaches for choice of clinical laboratory parameters and their interpretation in red blood cell disorders.***

1. Basic and extended laboratory tests.
2. Specialized laboratory tests.
3. Assessment of clinical laboratory results in different types of anemia.

***LECTURE №7 – 2 hours: Steps and approaches for choice of clinical laboratory parameters and their consideration in white blood cell disorders.***

1. Basic, extended and specialized laboratory tests.
2. Flow cytometry – immunophenotyping of cells in leukemias and lymphomas.

***LECTURE №8 – 2 hours: Choice of laboratory parameters for evaluation of hemostasis disturbances.***

1. Basic, extended and specialized laboratory tests parameters for evaluation of hemostasis disturbances.
2. Choice of clinical laboratory parameters and their consideration in bleeding tendency (hemorrhagic diatheses).
3. Selection of clinical laboratory parameters and their consideration in disorders leading to thrombosis.
4. Selection of clinical laboratory parameters in disseminated intravascular coagulation.

***LECTURE №9 – 2 hours: Clinical laboratory evaluation of carbohydrate metabolism.***

1. Blood sugar (glucose). Concentration in the blood. Regulation.
2. Pathobiochemical changes in diabetes mellitus disturbed carbohydrate metabolism:
  - pathobiochemistry of hyperglycemia and glucosuria
  - pathobiochemistry of changes of the lipid fractions
  - pathobiochemistry of ketoacidosis

- pathobiochemistry of changes ketoacidosis in changes of acid-alkaline and electrolyte equilibrium
- pathobiochemistry of glycated proteins and microalbuminuria.

***LECTURE №10 – 2 hours: Clinical laboratory parameters evaluation of carbohydrate metabolism disturbance.***

1. Selection of clinical laboratory parameters in revealing and follow-up of disturbance in patients with diabetes mellitus:
  - basic laboratory tests
  - extended laboratory tests
  - specialized laboratory tests
2. Control of diabetes mellitus patient's treatment – glycated hemoglobin.
3. Screening for microalbuminuria in patients with diabetes mellitus.

***LECTURE №11 – 2 hours: Clinical laboratory evaluation of porphyrins and bile pigments in the blood.***

1. Laboratory parameter for demonstration of destroyed hem synthesis – principle of methods, indications for investigation, specimen, reference values, results' interpretation.
2. Bilirubin in the serum - pathobiochemistry, principle of the quantity measurement, indications for investigation, results' interpretation.
3. Bile pigments in the serum and urine. Hyperbilirubinemia from different reasons. Correlation with other laboratory parameters.

***LECTURE №12 – 2 hours: Clinical laboratory evaluation of serum proteins.***

1. Changes in protein fractions – basic terminology and its interpretation.
2. Construction of appropriate strategy for clinical laboratory tests ordering for serum proteins evaluation.
3. Monoclonal and polyclonal hypergammaglobulinemia.
4. Selection of clinical laboratory parameters and their consideration in inflammatory and neoplastic diseases.

***LECTURE №13 – 2 hours: Choice and evaluation of clinical laboratory parameters in liver and bile diseases.***

1. Basic pathobiochemical changes in liver diseases.
2. Special features of clinical laboratory diagnosis of destroyed liver function.
3. Basic, extended and specialized laboratory tests parameters.
4. Evaluation of the laboratory results from bile pigments, enzymes, serum proteins in the different groups of liver diseases.
5. Prognostic laboratory tests and parameters showing hepatocellular carcinoma development.

***LECTURE №14 – 2 hours: Choice and evaluation of clinical laboratory parameters in heart (myocardial) diseases.***

1. Clinical laboratory risk factors in ischemic myocardial diseases (IMD)
2. Early and late laboratory parameters for myocardial ischemia.



3. Clinical laboratory changes in IMD (stable angina pectoris, unstable angina pectoris, nontransmural myocardial infarction (MI), transmural MI, reinfarction).
4. Future perspectives for clinical laboratory diagnosis.

***LECTURE №15 – 2 hours: Steps and approaches for clinical laboratory parameters in renal diseases.***

1. Evaluation of changes in values of pH, Osmolality and 24-hours diuresis in the course of renal diseases diagnostics.
2. Evaluation of proteinuria – glomerular and tubular. Sequences of procedures in explanation of proteinuria.
3. Evaluation of hematuria. Sequences of procedures in its explanation.
4. Kidney functional tests and result interpretation.

**THE PRACTICAL EXERCISES PROGRAMME**

***EXERCISE №1- 2 hours: The result in the clinical laboratory.***

1. Organization and management of the laboratory clinical activity (process). Getting familiar with Lab structure (departments, laboratories) and with the working process. Getting familiar with the main groups of clinical laboratory parameters. Ordering the clinical laboratory tests: fill in the request forms (individually, not in groups). Main kinds of request forms. Obligatory data (lab cod, clinic, first name and family name, ages, gender, diagnose, doctor's name, nurse's name, date and time). Types of the obtained results. Methods in the clinic laboratory: basic methods and analyzers in the Cytology clinic laboratory and clinical chemistry. Internal and external quality assessment of the laboratory results. Discussion of the data from control charts.
2. Reliability of the clinical laboratory results. Errors affecting the clinical laboratory result – preanalytical, analytical and post analytical.
3. Reasons, which may influence the clinical laboratory results during the pre analytical stage. Basic rules and requirements. Venous or capillary blood is more appropriate for investigation.
4. Main procedures and sources of errors in the process of biological specimen collection and sending it to the clinical laboratory for analyses. Closed system for biological material collection.
5. Demonstration of different changes of the biologic material that influence on the laboratory results (hemolysis, clots, lipemia, etc).

***EXERCISE №2 – 2hours: Urine. General characteristics and chemical tests.***

1. Filling in test from previous study material.
2. Rules and requirements for urine collection– random urine and diuresis.
3. Urine - general characteristics, reference ranges, results interpretation.
4. Chemical analysis - pH, glucose, protein, ketone bodies, bilirubin, urobilinogen, blood – quality and quantity analysis.
5. Presentation of samples of different color and transparency.
6. Getting to know the rules of processing and storage of express urine tests.

***EXERCISE №3 – 2hours: Evaluation of the laboratory results of Minerals and Trace Elements in human serum.***

1. Filling in test from previous study material.
2. Inorganic Phosphorus, Calcium, Magnesium - total and ionized: laboratory methods, indications for investigation, reference ranges, results interpretation.
3. Serum Iron and Iron Binding Capacity. Laboratory methods, interferences, indications for investigation, reference ranges, results interpretation.

***EXERCISE №4 – 2hours: Evaluation of the laboratory results of hematological parameters.***

1. Filling in test from previous study material.
2. Hematological parameters - reference ranges.
3. Cell composition of the bone marrow. Microscopic investigation of normal bone marrow smears.
4. Bone marrow and venous blood evaluation in red blood cells disorders. Types of anemia: posthemorrhagic, Iron deficient, pernicious, hemolytic. Anemia's laboratory characterization. Microscopy.

***EXERCISE №5 – 2 hours: Evaluation of the laboratory results of hematological parameters (continuation).***

1. Filling in test from previous study material.
2. Microscopic observation of bone marrow and venous blood smears in different diseases (continuation).
3. Solving clinical laboratory diagnostic tasks.

***EXERCISE №6 – 2 hours: Microscopic observation of bone marrow and venous blood smears.***

1. Filling in test from previous study material.
2. Bone marrow and venous blood evaluation in white blood cells disorders – agranulocytosis, leukemoid reaction, acute and chronic leukemias, plasmacytoma, etc. Microscopic observation.
3. Solving clinical laboratory diagnostic tasks.

***EXERCISE №7 – 2 hours: Microscopic observation of bone marrow and venous blood smears (continuation).***

***EXERCISE №8 – 2 hours: Clinical laboratory evaluation of hemostasis.***

1. Filling in test from previous study material – exercise and lecture.
2. The hemostasis as an integrated functional system. The action of vessels' wall, platelets and blood plasma in the hemostasis.
3. Coagulation. Key phases in the process of coagulation.
4. Plasma factors of coagulation and their inhibitors– necessity and opportunity for investigation.
5. Fibrinolysis – factors and their inhibitors - necessity and opportunity for investigation.

***EXERCISE №9 – 2 hours: Clinical laboratory evaluation of hemostasis***

1. Filling in test from previous study material.
2. Clinical laboratory parameters for evaluation of hemostasis – test principles, sources of errors, patient preparation, specimen, indications for investigation.
3. Screening tests for evaluation of hemostasis. Results interpretation

4. Tests for investigation of activity and concentration of individual plasma factors of coagulation and fibrinolysis. Results interpretation.
5. Specialized analysis for evaluation of hemostasis.
6. Control of anticoagulant therapy.
7. Solving clinical laboratory diagnostic tasks.

***EXERCISE №10 – 2 hours: Clinical laboratory parameters for evaluation disturbance of carbohydrate metabolism.***

1. Filling in test from previous study material – exercise and lecture.
2. Glucose in the blood – definition, interferences, indications for investigation, reference ranges, results interpretation.
3. Tests with overload – two hour postprandial test and oral glucose tolerance test - indications for investigation, reference ranges.
4. Evaluation of glycemias for preceded period of time - test principles (demonstration), sources of errors, patient preparation, specimen, reference ranges, indications for investigation.
5. Solving clinical laboratory diagnostic tasks.

***EXERCISE №11 – 2 hours: Clinical laboratory parameters for evaluation of serum proteins.***

1. Filling in test from previous study material – exercise and lecture.
2. Total serum protein: test principles - demonstration, sources of errors, drug interference in laboratory testing, patient preparation, specimen, reference ranges, indications for investigation, results interpretation.
3. Methods for protein fractioning – types, test principles, disadvantages and advantages.
4. Demonstration of electrophoretical fractioning of the proteins in different diseases and discussion.

***EXERCISE №12 – 2 hours: Clinical laboratory parameters for evaluation of serum proteins.***

1. Individual proteins – biological characteristics. Results interpretation.
2. Immunoglobulins – quantity measurement, methods, specimen, reference ranges, indications for investigation, results interpretation in patients with disturbed immunoglobulin synthesis.
3. Demonstration of cases and finding of different types of myeloma multiplex and other diseases with hyperimmunoglobulinemia.
4. Solving clinical laboratory diagnostic tasks.

***EXERCISE №13 – 2 hours: Clinical laboratory parameters for evaluation of enzyme activity in body fluids.***

1. Filling in test from previous study material.
2. Enzymes in the serum. Mechanisms of hyperenzymemia. Advantages and disadvantages of enzyme analysis.
3. Cell and secretory enzymes in the serum - test principles, sources of errors, reference ranges, indications for investigation, results interpretation.
4. Solving clinical laboratory diagnostic tasks.

***EXERCISE №14 – 2 hours: Clinical laboratory parameters for evaluation of nonprotein nitrogen containing substances***

1. Filling in test from previous study material – exercise and lecture.
2. Urea – principle of analytical methods, sources of errors, drug interference in laboratory testing, patient preparation, specimen, reference ranges, indications for investigation, results interpretation.
3. Creatine and creatinine - principle of analytical methods, sources of errors, drug interference in laboratory testing, patient preparation, specimen, reference ranges, indications for investigation, results interpretation.
4. Uric acid and ammonia - principle of analytical methods, sources of errors, drug interference in laboratory testing, patient preparation, specimen, reference ranges, indications for investigation, results interpretation.
5. Solving clinical laboratory diagnostic tasks.

***EXERCISE №15 – 2 hours: Clinical laboratory evaluation of lipid parameters and lipoproteins.***

1. Filling in test form previous study material.
2. Pathobiochemistry of lipid metabolism – changes in the lipid fractions.
3. Basic clinical laboratory parameters for evaluation of lipid metabolism - principle of analytical methods, sources of errors, drug interference in laboratory testing, patient preparation, specimen, reference ranges, indications for investigation, results interpretation, recommended ranges.
4. Steps and approaches in the choice of clinical laboratory parameters in cases of disturbed lipid transportation. Evaluation of hyperlipidemias types.
5. Solving clinical laboratory diagnostic tasks.

**SYLLABUS  
CLINICAL LABORATORY EXAMINATION**

1. Analytical reliability of clinical laboratory methods – criteria. Reference ranges – populational constructed (definition, reference groups, reference status, reference condition, choice of statistical method, performance, disadvantages) individual (performance, advantages).
2. Diagnostic reliability of clinical laboratory parameters – criteria. Requirements to the criteria of diagnostic reliability of clinical laboratory tests in different group of diseases.
3. Permanent, long-term and short-term acting factors on the biological variation of the results – examples.
4. Influence of medical procedures and medicines on the clinical laboratory results (chemical and pharmacological interferences). Instructions for control of medicinal effects on the clinical laboratory investigations.
5. Specimen collection for clinical laboratory investigation – basic rules and requirements. Venous and capillary blood for analysis? Closed system for biological samples collection – advantages for the clinic, advantages for the laboratory.
6. Venous blood collection clinical laboratory investigation – basic procedures and sources of errors.

7. Storage of the biological samples for analysis and transportation to the laboratory – requirements and sources of errors. Criteria for rejection of the specimen for laboratory analysis.
8. Urine for clinical laboratory investigation – basic rules and requirements for urine collection, storage and transportation to the laboratory. Sources of errors. Cerebrospinal fluid, body fluid punctats and stool - basic rules and requirements for urine collection, storage and transportation to the laboratory. Sources of errors.
9. The laboratory investigation in the course of the diagnostic process.
10. Body water and its distribution in the human body. Osmolality and osmolarity - methods of investigation, reference ranges, result interpretation.
11. Water-electrolyte balance disturbance. Clinical laboratory parameters for evaluation of water-electrolyte balance.
12. Sodium and chloride – common data for the parameters, indications for investigation, principles of the analytical methods, reference ranges, result interpretation.
13. Potassium - common data for the parameter, indications for investigation, principles of the analytical methods, reference ranges, result interpretation.
14. Total and ionized calcium, total and ionized magnesium - common data for the parameters, indications for investigation, principles of the analytical methods, reference ranges, result interpretation.
15. Inorganic phosphate - common data for the parameter, indications for investigation, principles of the analytical methods, reference ranges, result interpretation.
16. Serum Iron and Iron Binding Capacity - common data for the parameters, indications for investigation, principles of the analytical methods, reference ranges, result interpretation.
17. Diabetes mellitus – metabolism disturbance of: glycolysis, gluconeogenesis, glycogenolysis and glycogen synthesis, ketogenesis, ketonuria, glucosuria, osmotic diuresis, polyuria.
18. Glucose in the blood - common data for the parameters, indications for investigation, principles of the analytical methods, reference, borderline and pathological ranges, result interpretation.
19. Glucose in the blood - tests with overload: two hour postprandial test and oral glucose tolerance test (GTT) - indications for investigation and contraindications, implementation of the tests, source of errors, reference ranges, results interpretation.
20. Evaluation of glycemia for preceded period of time: glycated proteins - glycated hemoglobin HbA1; HbA1c and fructosamine: common data for the parameters, indications for investigation, patient preparation, specimen, reference ranges, informative content and results interpretation.
21. Selection of clinical laboratory tests in detecting and tracking disturbance of carbohydrate metabolism in patients with diabetes mellitus - basic, extended and specialized laboratory tests (glycated proteins, microalbuminuria) and their discussion.
22. Total protein - common data for the parameters, principles of the analytical methods and interferences, indications for investigation, patient preparation, reference ranges, result interpretation.
23. Major protein fractions – electrophoreses: indications for investigation, result interpretation, informational value.

24. Individual proteins – proteins of the acute phase – types, analytical methods for investigation, indications for investigation, patient preparation, reference ranges, results interpretation.
25. Immunoglobulins in the serum – common data for the parameters, classification, dynamic in prenatal and early postnatal period, methods of investigation, results' interpretation.
26. Selection of clinical laboratory tests and their discussion in inflammatory and neoplastic diseases: white blood cells, differential count, hemoglobin, red blood cells, proteins of acute phase, ESR, proteinograma, specific laboratory parameters.
27. Urea - common data for the parameter, principles of the analytical methods, source of errors, indications for investigation, patient preparation, reference ranges, result's interpretation.
28. Creatinine - common data for the parameter, principles of the analytical methods, source of errors and interference, indications for investigation, patient preparation, specimen, reference ranges, result's interpretation.
29. Uric acid - common data for the parameter, principles of the analytical methods, source of errors and interference, indications for investigation, patient preparation, specimen, reference ranges, result's interpretation.
30. Selection of clinical laboratory tests in renal diseases. Evaluation of the results of a study of nonproten nitrogen containing substances – advantages and disadvantages.
31. Transaminases in serum – general information, principles of analytical methods, sources of errors, indications for analysis, biological material, reference ranges, interpretation of results.
32. Alkaline and acid phosphatase in serum - general information, principles of analytical methods, sources of errors, indications for analysis, biological material, reference ranges, interpretation of results.
33. Lactate dehydrogenase and creatine phosphokinase in serum - general information, principles of analytical methods, sources of errors, indications for analysis, biological material, reference ranges, interpretation of results.
34. Amylase, gamma-glutamyltransferase and cholinesterase - general information, principles of analytical methods, sources of errors, indications for analysis, biological material, reference ranges, interpretation of results.
35. Choice and evaluation of clinical laboratory parameters in myocardial diseases.
36. Cholesterol in serum and its fractions - general information, analytical methods, interferences, risk limits, interpretation of results.
37. Triglycerides in serum general information, analytical methods, interferences, risk limits, interpretation of results.
38. Serum bilirubin and fractions – metabolism, methods, interferences, reference ranges, interpretation of results.
39. Choice and evaluation of clinical laboratory parameters in hepatic and bile diseases.
40. Hemostasis as a complex functional system – phases and factors.
41. Blood coagulation and fibrinolysis – factors and inhibitors.
42. Clinical laboratory parameters for evaluation of haemostasis.
43. Choice and discussion of laboratory parameters in hemorrhagic diathesis.
44. Choice and discussion of laboratory parameters in thrombophilia.
45. Choice and discussion of laboratory parameters in DIC syndrome.

46. Choice and assessment of clinical laboratory parameters in renal diseases – basic, extended and specialized analysis.
47. Evaluation of changes in the values of pH, osmolality 24-hour diuresis in the course of diagnosis of renal diseases. Evaluation and procedures for clarifying of hematuria.
48. Choice of clinical laboratory parameters in renal diseases – sequence of procedures for clarifying and assessment of proteinuria – mainly glomerular and mainly tubular proteinuria. Mechanism of appearance, diagnostic significance.
49. Tumor markers. Markers of the first and second choice.
50. Choice and assessment of clinical laboratory parameters in iron deficiency anemias.
51. Choice and assessment of clinical laboratory parameters in megaloblastic anemias.
52. Choice and assessment of clinical laboratory parameters in hemolytic anemias.
53. Choice and assessment of clinical laboratory parameters in white blood cell line disorders. Cytochemical and immunophenotype characteristics of leucocytes in acute leukemia.
54. Choice and assessment of clinical laboratory parameters in white blood cell line disorders. Cytochemical and immunophenotype characteristics of leukocytes in chronic leukemias (lymphocytic and granulocytic).
55. Hormones of thyroid gland. Evaluation of laboratory data and correlations in thyroid diseases.

**RECOMMENDED READING:**

**Basic:**

1. Bishop M., E. Fody, L. Schoeff. Clinical chemistry: principles, techniques, and correlations. 7th ed. Edited by Lippincott Williams&Wilkins. 2013
2. Extended theses of lectures and exercises
3. Thöml H., H. Diem, T. Haferlach. Color Atlas of Hematology. Practical Microscopic and Clinical Diagnosis. 2th revised ed. Thieme, Stuttgart, 2004

**Additional:**

1. Henry's Clinical Diagnosis and Management by laboratory methods, 21st ed., edited by Richard Mcpherson and Matthew Pincus
2. Kaplan LA, Pesce AJ (ed). Clinical Chemistry. Theory, analysis, and correlation. 3th edition. St. Louis, Missouri, Mosby-Year Inc., 1996
3. Burtis CA, Ashwood ER&DEBruns (ed). Tietz Textbook of Clinical Chemistry and molecular diagnostics. 4th ed. Elsevier Saunders, 2006
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