INTERNATIONAL HIGHER SCHOOL OF MEDICINE

Department of Fundamental disciplines

SYLLABUS

Biochemistry

2026-2027 academic year

for students of medical faculty

1 course 2nd semester, groups 1-6

Credits: 4 (120 h, including auditorial - 72 h, independent work - 48 h)

Practical classes: Gainullina Irina Pavlovna
0555 451 897(Whatsapp)
Email: Gainullinairina72@rambler.ru
Groups: 1-4
Keneshova Kanykei Sadyrbekovna
0500 023 326(Whatsapp)
Email: kanykeisadyrbekovna@gmail.com
Groups: 5-6

Venue: **Educational and Morphological Center**
Lev Tolstoy street 114/1
Room № 301,303,304,102,003.

The Syllabus is considered

at the meeting of Fundamental Disciplines Department

Protocol № 1 dated 07.09.2026

Head of the department Dzh.N. Abdullaev

Course objective: The purpose of mastering the academic discipline "Biochemistry" is to master the fundamentals of classical and modern biochemistry; formation of skills and abilities to work with biochemical equipment, setting up a biochemical experiment and analyzing clinical biochemical parameters for making a preliminary diagnosis based on it.
After study of the discipline the student must:
Knowledge: Students should understand the structure and metabolic pathways of key biomolecules in health and disease, the integration and regulation of these pathways, diagnostically important metabolites in tissues and fluids, as well as the principles of laboratory equipment and the basics of modeling biochemical experiments.
Skill: Students should be able to search, analyze, evaluate, and apply knowledge to solve professional tasks while effectively using key laboratory equipment in biomedical research.
Attitude: Students should possess a solid medical and biological conceptual framework, along with biochemical thinking skills, and be proficient in basic biochemical laboratory methods applied in clinical practice.
Pre-requisites: Chemical and biological disciplines of the school educational program.
Post-requisites: Pathology, pharmacology, internal medicine, pediatric diseases and medical genetics.

THEMATIC PLAN OF LECTURES

№	Theme of lecture	Hours	Date
1	Carbohydrates in the body: digestion, utilization, assimilation, excretion.	2	15.09.26-19.09.26
2	Generation of energy in cells: mechanisms and regulation, and integration of carbohydrate, lipid and protein metabolism in the body.	2	21.09.26-26.09.26
3	Disorders in intracellular energy generation.	2	28.09.26-03.10.26
4	Glucose homeostasis: regulation and disorders.	2	5.10.26 - 10.10.26
5	Pathology of carbohydrate metabolism. Testing of metabolites of carbohydrate metabolism in clinical practice.	2	12.10.26-17.10.26
6	Characteristics of the main lipids in the human body. Digestion, absorption, utilization, and excretion. Eicosanoids.	2	19.10.26-24.10.26
7	Lipoprotein metabolism. Regulation of lipoprotein metabolism. Atherosclerosis.	2	26.10.26-31.10.26
8	Impact of overweight, obesity and metabolic syndrome on health across life stages and pregnancy: causes, risks and macronutrient roles.	2	02.11.26-07.11.26
9	Pathology of lipid metabolism. Dyslipidemia: classification, causes, laboratory diagnostics.	2	09.11.26-14.11.26
10	Amino acid metabolism. Digestion and absorption of proteins.	2	16.11.26-21.11.26
11	Heme metabolism and jaundice.	2	23.11.26-28.11.26
12	Nitrogenous waste products and renal function	2	30.11.26-05.12.26
13	Metabolism of purines and pyrimidines	2	07.12.26-12.12.26
14	Molecular mechanisms of oncogenesis: biochemical tumor markers and biochemical basis of cancer therapy.	2	14.12.26-19.12.26
15	Xenobiotics and antioxidants. Oxidative stress and its diagnosis.	2	21.12.26-26.12.26
16	Remodeling of bone tissue and metabolic bone diseases.	2	28.12.26-02.01.27
17	Biochemistry of the liver. Interpretation of liver function test.	2	04.01.27-09.01.27
18	Biochemistry of thyroid gland.	2	11.01.27-16.01.27
19	**Clinical training**		18.01.27-23.01.27
Total 36			

THEMATIC PLAN OF PRACTICAL CLASSES

№	Theme of seminar and laboratory works	Hours	Date
1	Qualitative reactions to carbohydrates.	2	15.09.26-19.09.26
2	Stages of intracellular energy generation: glycolysis in various organs and tissues.	2	21.09.26-26.09.26
3	Stages of intracellular energy generation: pyruvate dehydrogenase complex, Krebs cycle, oxidative phosphorylation.	2	28.09.26-03.10.26

4	Blood glucose estimation: GOD-POD method, glucometer. Interpretations.	2	05.10.26-10.10.26
5	Gluconeogenesis. Glycogen metabolism.	2	12.10.26-17.10.26
6	Alternative oxidation of glucose (HMP shunt). Minor carbohydrates metabolism.	2	19.10.26-24.10.26
7	***Assessment # 4***	2	26.10.26-31.10.26
8	Lipogenesis. Lipolysis. Oxidation of fatty acids.	2	02.11.26-07.11.26
9	Ketone bodies. Cholesterol and TAG metabolism	2	09.11.26-14.11.26
10	Determination of blood cholesterol & TAG.	2	16.11.26-21.11.26
11	***Assessment # 5***	2	23.11.26-28.11.26
12	Ammonia metabolism: production and detoxification. Clinical cases	2	30.11.26-05.12.26
13	Amino acid products (Gly, Phe, Tyr, etc.) and congenital disorders; newborn screening.	2	07.12.26-12.12.26
14	Testing of glomerular filtration of the kidneys. Determination of urea and creatinine in the blood. Calculation of BUN and GFR.	2	14.12.26-19.12.26
15	***Assessment # 6***	2	21.12.26-26.12.26
16	DNA: organization, replication, repair, and mutations. Gene expression — transcription, translation, regulation, and disorders	2	28.12.26-02.01.27
17	Molecular technologies in diagnostics: recombinant DNA, PCR, microarrays, FGIS (fluorescent in situ hybridization), CRSPR (clustered regularly interspersed short palindromic repeats)	2	04.01.27-09.01.27
18	***Assessment # 7***	2	11.01.27-16.01.27
19	**Clinical training**		18.01.27-23.01.27
	Total	**36**	

THEMATIC PLAN OF INDEPENDENT WORK OF STUDENTS

Unit	Independent work	Hours	Date
Intracellular generation of energy. Carbohydrate metabolism	1) work with tasks on the platform "Proceum" on the topic "Biological oxidation. Carbohydrate metabolism";	2	15.09.26–31.10.26
	2) work with educational literature;	2	
	3) individual assignments (PBL)	2	
	Total	*6*	
Lipids metabolism	1) work with tasks on the platform "Proceum" on the topic "Lipids metabolism";	2	02.11.26–28.11.26
	2) work with educational literature;	8	
	3) individual assignments (PBL)	2	
	4) Lab.w.: Digestion of nutrients by pancreatic juice	2	
	Total	*14*	
N-containing compounds metabolism	1) work with tasks on the platform "Proceum" on the topic "Amino acids metabolism"	3	30.11.26–26.12.26
	2) work with educational literature;	10	
	3) individual assignments (PBL)	3	
	Total	*16*	
Molecular biology. Clinical biochemistry	1) work with tasks on the platform "Proceum" on the topic "DNA, RNA"	2	28.12.26-

	2) work with educational literature;	6	16.01.27
	3) individual assignments (PBL)	2	
	4) Lab.w.: Determination of blood urea	2	
	Total	*12*	
	Total	***48***	

Recommended reading for the discipline:

1. Basic:

1. Biochemistry. 6th ed. Satyanaryana U. 2021
2. Textbook of Biochemistry. 9th ed.Vasudevan D.M. 2019
3. Lippincott's Iliustrated Reviews: Biochemistry. 7th ed. Ferrier D.R. 2017
4. Biochemistry. 5th ed. Satyanaryana U. 2017
5. Textbook of Biochemistry. 4th ed. DM Vasudevan. 2016
6. Harper's Biochemistry. 30ed. V.W. Rodwell, D.A. Bender, K.M.Kennely. 2015
7. Viva in Anatomy, Physiology, & Biochemistry. 2nd ed. Anjula Vij. 2015
8. Biochemistry Practical Book. Mukhamedova I. 2010

2. Additional:

1. Textbook of Biochemistry. 8th ed. Vasudevan D.M. 2016
2. Biochemistry. 4th ed. Satyanaryana U. 2011
3. Lippincott's Illustrated Reviews: Biochemistry. Champe P.C. 2005
4. Textbook of Medical Biochemistry. 8th ed. Chatterjea M.N. 2012

Grading policy and procedures for all types of work

For the period of studying the discipline, the student gains points for the relevant parameters (per unit):
current score - 40 points
independent work - 20 points
control score (final assessment of knowledge per unit)- 40 points
Maximum score: 100 = (40 + 20 + 40)

Grading system for student's achievements

Grading criteria per discipline				
Maximum score	Intervals			
	Unsatisfactory	Satisfactory	Good	Excellent
Current and Final control work (module)-40	0-23	24-30	31-35	36-40
Consistency and completeness of knowledge in relation to the objects under study	Possesses partial and scattered knowledge, logically unrelated	Possesses a minimum set of knowledge necessary for a systematic approach to the object under study	Possesses a set of knowledge sufficient for a systematic approach to the object under study	Possesses complete knowledge and a systematic view of the object under study
Scientific understanding of the studied phenomenon, process, object	Cannot draw scientifically correct conclusions from available information	Able to analyze some of the available information	Able to carry out a systematic and scientifically correct analysis of the information provided	Involves new data relevant to the task in the analysis, offers new perspectives on the task

Mastering standard algorithms for solving professional problems	Able to solve only fragments of the task in accordance with the given algorithm	Able to solve the task in accordance with the given algorithm	Understands the basics of the proposed algorithm and solves the problem in accordance with it	Understands the basics of the proposed algorithm and offers new solutions within the framework of the task
Mastering the technique of a laboratory experiment	Did not master the proposed algorithm of the laboratory experiment and its design	Carries out an experiment in accordance with the proposed algorithm, but makes mistakes in presenting the results	Conducts an experiment in accordance with the proposed algorithm, but partially makes mistakes in presenting the results	Conducts an experiment in accordance with the proposed algorithm, draws up and correctly interprets the results
Independent work - 20	0-11	12-15	16-17	18-20
Solution of the task **(clinical case)**	Not independent (rewritten work)	The problem is defined correctly, but the proposed explanation is not correct.	The correct solution of the problem is given and a brief interpretation is given.	The correct solution of the task is given, the analysis and interpretation of the results obtained are fully and systematically presented.
Working with information	Unable to find the necessary information, or find its individual fragments within the framework of the task	Can find the necessary information within the task	Can both interpret and systematize the necessary information within the framework of the task.	Can find and systematize the necessary information, as well as identify additional sources of information within the framework of the task.
Conducting a laboratory experiment	Does not participate in the laboratory experiment, but presents its result	Conducting an experiment with the help of laboratory assistants	Conducts the experiment independently and only draws up the results without interpreting the results	Conducts an experiment in accordance with the proposed algorithm independently, draws up and correctly interprets the results

Conduct Policy: (lateness, absence, behavior in the auditorium, late submission of work).
- Punctuality and completion of tasks.
- Mandatory attendance of classes.
- Attending class in a clean medical uniform.
- Eliminating conversations on a cell phone in the classroom.
- Active participation in the learning process.
- Doing homework on time.
- Academic detention at the time specified by the teacher.

For violations of the Conduct Policy, the total points for discipline might be reduced to1-10 points.

Academic Ethics Policy.
- Be tolerant, respect the opinions of others.

- Formulate objections in the correct form.
- Constructively support feedback in all classes.
- Plagiarism and other forms of dishonest work are unacceptable. Plagiarism includes the following: the absence of references when using printed and electronic materials, quotes, thoughts and works of other authors or students.
- For violations of the Academic Ethics Policy, the total points for the discipline may be reduced to 1-10 points.

Guidelines for the lecture classes:

Key questions covered in lecture N 1: *Carbohydrates in the body: digestion, utilization, assimilation, excretion.*

1.1. Monosaccharides: glucose, galactose, fructose, ribose — structure, chemical reactions, and biological roles.
1.2. Disaccharides: maltose, lactose, sucrose — structure, chemical reactions, reducing and non-reducing sugars, biological role.
1.3. Polysaccharides: starch and glycogen — structure and biological significance.
1.4. Dietary sources of carbohydrates. Digestion in the oral cavity and small intestine.
1.5. Absorption of monosaccharides in the intestine.
1.6. Glucose transporters: SGLT and GLUT — types, mechanisms, and clinical aspects.
1.7. Defects of carbohydrate digestion and absorption: lactase deficiency, monosaccharide malabsorption.
1.8. Assimilation and storage of carbohydrates (glycogenesis, glycogen storage sites).

Recommended reading for the lecture N1:

1. Ferrier D.R. Lippincott's Illustrated reviews: Biochemistry. (7th ed 2017) pp. 83–90; pp. 117–124; pp. 125–136;
2. Biochemistry. 6th ed. Satyanaryana U. 2021 pp. 237–426;
3. Satyanaryana U. Biochemistry (5th education) 2017 pp.9-28.
4. Harper's Biochemistry. 30ed. V.W. Rodwell, D.A. Bender, K.M.Kennely. 2015 pp. 152–160; pp. 168–175; pp. 185–195; pp. 176–184;

Key questions covered in lecture N 2: *Generation of energy in cells: mechanisms and regulation, and integration of carbohydrate, lipid and protein metabolism in the body.*

2.1. Sources of energy in the human body. Regulation of energy balance.
2.2. Structure of mitochondria. ATP and reducing equivalents: NADH and $FADH_2$.
2.3. ATP formation under aerobic and anaerobic conditions: main steps and regulation (overview).
2.4. Intracellular energy states: high- and low-energy status and their metabolic significance.

Recommended reading for the lecture N2:

1. Satyanarayana U.. Biochemistry (6th ed. 2021) pp. 1–164;
2. Ferrier D.R.. Lippincott's Illustrated Reviews: Biochemistry (7th ed. 2017) pp. 1–52;
3. Rodwell V.W., Bender D.A., Kennelly K.M.. Harper's Illustrated Biochemistry (30th ed. 2015) pp. 25–35;

Key questions covered in lecture N 3: *Disorders in intracellular energy generation.*

3.1. Impaired mitochondrial energy metabolism due to genetic mutations. Mitochondrial diseases.
3.2. Impaired mitochondrial energy metabolism: electron transport chain (ETC) disorders.
3.3. Impaired intracellular energy metabolism due to enzymopathies (genetic and functional).
3.4. Reversible and irreversible cellular injury caused by decreased or prolonged loss of energy production.

Recommended reading for the lecture N3:

1. Ferrier D.R.. Lippincott's Illustrated Reviews: Biochemistry (7th ed. 2017) pp. 411–432; pp. 433–446; pp. 447–464; pp. 465–480; pp. 481–504;
2. Rodwell V.W., Bender D.A., Kennelly K.M.. Harper's Illustrated Biochemistry (30th ed. 2015) pp. 370–393; pp. 394–412; pp. 413–427; pp. 428–450; pp. 451–476;
3. Satyanaryana U. Biochemistry (5th education) 2017 pp. 239-242; 242-284;

Key questions covered in lecture N 4: *Glucose homeostasis: regulation and disorders.*

4.1. Sources of blood glucose, normal range, and measurement units.
4.2. Regulation of glucose homeostasis.
4.3. Hypoglycemia and hyperglycemia.
4.4. Diabetes mellitus (types and pathophysiology).
4.5. Gestational diabetes mellitus (GDM).

Recommended reading for the lecture N4:

1. Satyanarayana U.. Biochemistry (6th ed. 2021) pp. 237–426;
2. Satyanaryana U. Biochemistry (5th education) 2017 pp.9-28;
2. Ferrier D.R.. Lippincott's Illustrated Reviews: Biochemistry (7th ed. 2017) pp. 83–90; pp. 117–124; pp. 125–136;
3. Rodwell V.W., Bender D.A., Kennelly K.M.. Harper's Illustrated Biochemistry (30th ed. 2015) pp. 152–160; pp. 168–175; pp. 185–195; pp. 176–184;

Key questions covered in lecture N 5: *Pathology of carbohydrate metabolism.Testing of metabolites of carbohydrate metabolism in clinical practice*

5.1. Glucose metabolism in cancer cells: The Warburg effect.
5.2. Lactic acidosis: types and pathological effects.
5.3. Impaired carbohydrate metabolism due to enzymopathies and vitamin deficiencies.
5.4. Glycogen storage diseases (glycogenoses).

Recommended reading for the lecture N 5:

1. Ferrier D.R.. Lippincott's Illustrated Reviews: Biochemistry (7th ed. 2017) pp. 377–398;

2. Champe P.C., Richard A. Harvey Lippincott's Illustrated reviews of Biochemistry 2005 pp. 87-97;
3. Satyanaryana U. Biochemistry (5th education) 2017 pp.239-242, Pp.242-284;

Key questions covered in lecture N 6: *Characteristics of the main lipids in the human body. Digestion, absorption, utilization, and excretion. Eicosanoids.*

6.1. Lipids: general characteristics and classification.
6.2. Fatty acids: types (short-, medium-, and long-chain fatty acids), neutral fats, ω-3 and ω-6 fatty acids.
6.3. Eicosanoids: prostaglandins, leukotrienes, thromboxanes — biological roles.
6.4. Digestion, absorption, re-synthesis, chylomicron formation, circulation, utilization, and storage of lipids.

Recommended reading for the lecture N 6:

1. Ferrier D.R.. Lippincott's Illustrated Reviews: Biochemistry (7th ed. 2017) pp. 173–180; pp. 181–200; pp. 201–218; pp. 219–244;
2. Satyanaryana U. Biochemistry (5th education) 2017 pp.29-44.
3. Mukhamedova I. Biochemistry practical book 2010 pp.142-146
4. DM Vasudevan. Textbook of Biochemistry 4th ed. 2016 pp. 72; 127; 141;

Key questions covered in lecture N 7: *Liporotein metabolism. Regulation of lipoprotein metabolism. Atherosclerosis.*

7.1. Lipoproteins: composition of lipoprotein complexes, types and classification.
7.2. Exogenous lipid transport system: chylomicron metabolism.
7.3. Endogenous lipid transport system: metabolism of VLDL and LDL.
7.4. Biological role of HDL in lipid transport.
7.5. Plasma lipid profile: atherogenic and antiatherogenic indexes.
7.6. Atherosclerosis: basic molecular and biochemical mechanisms.

Recommended reading for the lecture N7:

1. Satyanarayana U.. Biochemistry (6th ed. 2021) pp. 1–164;
2. Ferrier D.R.. Lippincott's Illustrated Reviews: Biochemistry (7th ed. 2017) pp. 1–52;
3. Rodwell V.W., Bender D.A., Kennelly K.M.. Harper's Illustrated Biochemistry (30th ed. 2015) pp. 25–35;

Key questions covered in lecture N 8: *Impact of overweight, obesity and metabolic syndrome on health across life stages and pregnancy: causes, risks and macronutrient roles.*

8.1. Obesity: metabolic complications and biochemical mechanisms.
8.2. Clinical risks of obesity and metabolic syndrome in children, adults, and during pregnancy.
8.3. Role of macronutrients (carbohydrates, fats, and proteins) in the development and prevention of obesity.
8.4. Metabolic and hormonal changes associated with obesity and metabolic syndrome across the lifespan.
8.5. Pathophysiology of insulin resistance in obesity.
8.6. Metabolic syndrome: biochemical aspects.

Recommended reading for the lecture N 8:

1. Satyanarayana U.. Biochemistry (6th ed. 2021) pp. 1–164;
2. Ferrier D.R.. Lippincott's Illustrated Reviews: Biochemistry (7th ed. 2017) pp. 1–52;
3. Rodwell V.W., Bender D.A., Kennelly K.M.. Harper's Illustrated Biochemistry (30th ed. 2015) pp. 25–35;

Key questions covered in lecture N 9: *Pathology of lipid metabolism. Dyslipidemia: classification, causes, laboratory diagnostics.*

9.1. Hyperlipoproteinemias: primary and secondary forms.
9.2. Primary hyperlipoproteinemias: lipid phenotypes, enzyme defects, lipoprotein analysis, and clinical features.
9.3. Hypolipoproteinemias: hypobetalipoproteinemia, Tangier disease, and fish-eye disease.
9.4. Hepatic steatosis (alcoholic and non-alcoholic): disorders of lipid metabolism and biochemical mechanisms.

Recommended reading for the lecture N9:

1. Ferrier D.R. Lippincott's Illustrated reviews: Biochemistry. (7th ed 2017) pp.173- 219;
2. Satyanarayana U.. Biochemistry (6th ed. 2021) pp. 1–164;
3. Satyanaryana U.Biochemistry (5th education) 2017 pp 285-330;

Key questions covered in lecture N 10: *Amino acid metabolism. Digestion and absorption of proteins.*

10.1. Digestion and absorption of proteins. Amino acid pools in the body. Nitrogen balance.
10.2. Amino acid transport systems. Disorders of amino acid transport. Hartnup disease.
10.3. Transamination reactions: aminotransferases (ALT, AST), specificity, enzymes involved, and biological role.
10.4. Clinical significance of serum AST and ALT in the diagnosis of acute myocardial infarction and liver diseases.
10.5. Oxidative and non-oxidative deamination of amino acids. Role of glutamate dehydrogenase and biological importance.
10.6. Decarboxylation of amino acids as a pathway for biogenic amine synthesis: histamine, serotonin, GABA, catecholamines (adrenal medulla).
10.7. Transmethylation reactions: methionine cycle, S-adenosylmethionine (SAM); synthesis of creatine, epinephrine, phosphatidylcholine; DNA methylation and methylation of xenobiotics in the liver.
10.8. Biological role of tetrahydrofolate (THF, folic acid) in one-carbon transfer reactions: nucleotide synthesis and homocysteine methylation.

Recommended reading for the lecture N10:

1. Ferrier D.R. Lippincott's Illustrated reviews: Biochemistry. (7th ed 2017) pp.411-433;
2. Satyanarayana U.. Biochemistry (6th ed. 2021) pp. 1–164;
3. Satyanaryana U. Biochemistry (5th education) 2017 pp.523- 571;

4. Rodwell V.W., Bender D.A., Kennelly K.M.. Harper's Illustrated Biochemistry (30th ed. 2015) pp. 25–35;

Key questions covered in lecture N 11: *Heme metabolism and jaundice*

11.1. Synthesis of specialized nitrogen-containing products: heme biosynthesis.
11.2. Porphyrias: types, enzyme defects, and clinical features.
11.3. Degradation of heme: bilirubin metabolism, conjugation, and excretion.
11.4. Jaundice: types, pathophysiology, and laboratory diagnosis.

Recommended reading for the lecture N11:

1. Satyanarayana U.. Biochemistry (6th ed. 2021) pp. 1–164;
2. Ferrier D.R. Lippincott's Illustrated reviews: Biochemistry. (7th ed 2017) pp.411-433;
3. Satyanaryana U. Biochemistry (5th education) 2017 pp.523- 571;
4. Rodwell V.W., Bender D.A., Kennelly K.M.. Harper's Illustrated Biochemistry (30th ed. 2015) pp. 60–72; pp. 73–86; pp. 87–96;

Key questions covered in lecture N 12: *Nitrogenous waste products and renal function*

12.1. Nitrogenous waste products: creatinine, urea, indican, and uric acid — biochemical characteristics and clinical significance.
12.2. Azotemia: classification (pre-renal, renal, post-renal) and causative factors.
12.3. Assessment of glomerular filtration rate (GFR) in clinical practice: methods and interpretation.
12.4. Interpretation of renal function tests: biochemical markers and clinical significance.

Recommended reading for the lecture N12:

1. Satyanarayana U.. Biochemistry (6th ed. 2021) pp. 237–426;
2. Ferrier D.R. Lippincott's Illustrated reviews: Biochemistry. (7th ed 2017) pp.411-433;
3. Satyanaryana U. Biochemistry (5th education) 2017 pp.523- 571;
4. Rodwell V.W., Bender D.A., Kennelly K.M.. Harper's Illustrated Biochemistry (30th ed. 2015) pp. 287–296; pp. 297–312;

Key questions covered in lecture N 13: *Metabolism of purines and pyrimidines*

13.1. Nucleotides: definition and chemical structure.
13.2. Pyrimidine biosynthesis: pathway overview, anticancer drugs, and orotic aciduria.
13.3. Purine metabolism: de novo biosynthesis, catabolism, and salvage pathways.
13.4. Clinical syndromes due to enzyme deficiencies: Lesch-Nyhan syndrome (HGPRT deficiency), SCID (ADA deficiency), and their clinical manifestations.
13.5. Dietary sources of purines, uric acid production, and excretion.
13.6. Hyperuricemia: types, influence of alcohol and lactic acidosis, xanthinuria, gout, urate nephropathy, and treatment strategies.

Recommended reading for the lecture N 13

1. Satyanarayana U.. Biochemistry (6th ed. 2021) pp. 1–164;
2. Ferrier D.R. Lippincott's Illustrated reviews: Biochemistry. (7th ed 2017) pp.411-433;
3. Satyanaryana U. Biochemistry (5th education) 2017 pp.523- 571;

Key questions covered in lecture N 14: *Specialized topics: Molecular mechanisms of oncogenesis: biochemical tumor markers and biochemical basis of cancer therapy.*

14.1. Cell cycle: overview of phases, control mechanisms, and checkpoints.
14.2. Biochemical building blocks for proliferating cells (nucleotides, amino acids, lipids).
14.3. Nutrient sensing and signaling pathways regulating cell growth (mTOR, AMPK, PI3K/Akt).
14.4. Oncogenes, tumor suppressors, metabolic enzyme dysregulation, environmental factors, and tumorigenesis.

Recommended reading for the lecture N14:

1. Satyanarayana U.. Biochemistry (6th ed. 2021) pp. 1–164;
2. Satyanaryana U. Biochemistry (5th edition), 2017. – pp.85 -113
2. Chatterjea M.N. Textbook of Medical Biochemistry. 8th ed. 2012 pp. 225-241;
3. V.W. Rodwell, D.A. Bender, K.M.Kennely. Harper's Biochemistry. 30ed. 2015 pp. 370-418;

Key questions covered in lecture N 15: *Specialized topics: Xenobiotics and antioxidants. Oxidative stress and its diagnosis.*

15.1. Xenobiotics: definition, classes, and biotransformation (Phase I–III metabolism).
15.2. Cellular and systemic responses to xenobiotics: enzymatic and non-enzymatic pathways.
15.3. Generation of reactive oxygen species (ROS) and reactive nitrogen species (RNS) and the antioxidant defense system (enzymatic and non-enzymatic).
15.4. Oxidative stress: definition, pathophysiology, and biomarkers (lipid, protein, DNA oxidation).

Recommended reading for the lecture N15:

1. Satyanarayana U.. Biochemistry (6th ed.) 2021 pp. 1–164;
2. Satyanaryana U. Biochemistry (5th edition), 2017. – pp.85 -115
2. Chatterjea M.N. Textbook of Medical Biochemistry. 8th ed. 2012 pp. 225-260;
3. V.W. Rodwell, D.A. Bender, K.M.Kennely. Harper's Biochemistry. 30ed. 2015 pp. 380-450;

Key questions covered in lecture N 16: *Specialized topics: Remodeling of bone tissue and metabolic bone diseases.*

16.1. Osteoclastogenesis and osteoblastogenesis: cellular mechanisms and regulation (RANK/RANKL/OPG, PTH, vitamin D, cytokines).

16.2. Phases of bone remodeling and regulatory mechanisms (activation, resorption, reversal, formation, mineralization).
16.3. Metabolic bone diseases: osteoporosis, osteopetrosis, Paget's disease, renal osteodystrophy, osteomalacia, rickets — pathophysiology and clinical features.
16.4. Biomarkers of bone diseases: markers of bone formation and resorption, and calcium-phosphate metabolism indicators.

Recommended reading for the lecture N16:

1. Satyanarayana U.. Biochemistry (6th ed. 2021) pp. 1–164;
2. Satyanaryana U. Biochemistry (5th edition), 2017. – pp.85 -115
3. Chatterjea M.N. Textbook of Medical Biochemistry (8th ed.) 2012 pp. 225-260;
4. V.W. Rodwell, D.A. Bender, K.M.Kennely. Harper's Biochemistry. 30ed. 2015 pp. 380-450;

Key questions covered in lecture N 17: *Specialized topics: Biochemistry of the liver. Interpretation of liver function test.*

17.1. Functions of the liver and consequences of impaired hepatic function (metabolic, synthetic, detoxification, excretory).
17.2. Liver function tests (LFTs) in clinical practice: assessment of hepatocyte and cholangiocyte integrity, excretory and synthetic functions.
17.3. Interpretation of LFT results: patterns of abnormalities and their clinical significance.

Recommended reading for the lecture N17:

1. Satyanarayana U.. Biochemistry (6th ed. 2021) pp. 427–520;
2. Ferrier D.R.. Lippincott's Illustrated Reviews: Biochemistry (7th ed. 2017) pp. 1–52;
3. Rodwell V.W., Bender D.A., Kennelly K.M.. Harper's Illustrated Biochemistry (30th ed. 2015) pp. 589–606;

Key questions covered in lecture N 18: *Specialized topics: Biochemistry of thyroid gland*

18.1. Physiological functions of the thyroid gland (metabolic, growth, and developmental roles).
18.2. Synthesis of thyroid hormones: mechanism and regulation (iodide uptake, TPO activity, T3/T4 formation, TSH feedback).
18.3. Transport of thyroid hormones in extracellular fluid and clinical effects of altered transport protein levels (TBG, transthyretin, albumin).
18.4. Physiological and metabolic effects of thyroid hormones (metabolic rate, cardiovascular system, CNS, growth, thermogenesis).
18.5. Hyperthyroidism and hypothyroidism: biochemical and clinical aspects.

Recommended reading for the lecture N18:

1. Satyanaryana U. Biochemistry (5th edition), 2017. – pp.113-117
2. Ferrier D.R. Lippincott's Illustrated reviews: Biochemistry. (7th ed 2017) pp.411-433;
3. Rodwell V.W., Bender D.A., Kennelly K.M.. Harper's Illustrated Biochemistry (30th ed. 2015) pp. 668–688;

Guidelines for the lessons (practical class) of the discipline

Key questions covered in practical class N 1: *Stages of intracellular energy generation: glycolysis in various organs and tissues.*

1.1. Glycolytic pathways: types and conversion of glycogen, galactose, and fructose to glucose-6-phosphate.
1.2. Stepwise reactions of glycolysis with examples in hepatocytes.
1.3. Kinetic properties and tissue localization of glycolytic enzymes in RBCs and liver.
1.4. Regulation of glycolytic enzyme activities by allosteric effectors and hormones.
1.5. Embden-Meyerhof pathway in RBCs and its physiological significance.
1.6. Disorders caused by glycolytic enzyme deficiencies and clinical relevance of LDH.

Recommended reading for the lesson N1:

1. Ferrier D.R. Lippincott's Illustrated reviews: Biochemistry. (7th ed 2017) pp. 53–68;
2. Champe P.C. Lippincott's Illustrated reviews of Biochemistry 2005 pp. 87-97;
3. Satyanaryana U. Biochemistry (5th education) 2017 pp.239-242; 242-284;

Key questions covered in practical class N 2: *Stages of intracellular energy generation: pyruvate dehydrogenase complex, Krebs cycle, oxidative phosphorylation.*

2.1. Pyruvate dehydrogenase (PDH) complex: structure, cofactors, and regulation of activity.
2.2. Pathophysiology and clinical features of PDH deficiency.
2.3. TCA cycle: catabolic and anabolic roles, anaplerotic reactions, and biological significance.
2.4. Oxidation of acetyl-CoA in the TCA cycle: reaction sequence and regulation.
2.5. Regulatory mechanisms of the TCA cycle.
2.6. Pathologies due to TCA cycle enzyme defects and associated tumorigenesis.
2.7. Mitochondrial structure and functions.
2.8. Mitochondrial shuttle systems: glycerol-3-phosphate and malate-aspartate shuttles.
2.9. Electron transport chain: composition, substrates, and function.
2.10. Chemiosmotic theory of mitochondrial ATP synthesis.
2.11. Coupling of ETC and oxidative phosphorylation: inhibitors and uncouplers.
2.12. Clinical aspects of SDH deficiency: genetics, pathophysiology, and tumorigenesis.
2.13. Mitochondrial ROS generation and pathological consequences.

Recommended reading for the lesson N2:

1. Ferrier D.R. Lippincott's Illustrated reviews: Biochemistry. (7th ed 2017) pp. 53–68;
2. Champe P.C., Richard A. Harvey Lippincott's Illustrated reviews of Biochemistry 2005 pp. 87-97;
3. Satyanaryana U.Biochemistry (5th education) 2017 pp.239-242; 242-284;
4. Rodwell V.W., Bender D.A., Kennelly K.M.. Harper's Illustrated Biochemistry (30th ed. 2015) pp. 60–72; pp. 73–86; pp. 87–96;

Key questions covered in practical class N 3: *Gluconeogenesis. Glycogen metabolism.*

3.1. Gluconeogenesis: definition, sites, and main substrates.
3.2. Hepatic gluconeogenesis: pathways from pyruvate, lactate, alanine, and glycerol; regulation and biological role.
3.3. Renal gluconeogenesis: biological role, regulation, and adaptation to nutritional states.
3.4. Intestinal gluconeogenesis: biological role and physiological significance.
3.5. Glycogen structure in liver and muscle and its physiological functions.
3.6. Glycogen metabolism: glycogenesis and glycogenolysis — steps, enzymes, and regulation.
3.7. Clinical aspects of glycogen storage diseases: hepatic, myopathic, and other forms.

Recommended reading for the lesson N3:

1. Satyanarayana U.. Biochemistry (6th ed. 2021) pp. 1–164;
2. Ferrier D.R.. Lippincott's Illustrated Reviews: Biochemistry (7th ed. 2017) pp. 53–68;
3. Rodwell V.W., Bender D.A., Kennelly K.M.. Harper's Illustrated Biochemistry (30th ed. 2015) pp. 60–72; pp. 73–86; pp. 87–96;

Key questions covered in practical class N 4: *Alternative oxidation of glucose (HMP shunt). Minor carbohydrates metabolism*

4.1. HMP shunt: oxidative and non-oxidative steps, enzymes, and regulation.
4.2. Biological role of NADPH in metabolism and antioxidant defense.
4.3. Role of NADPH in phagocytosis and microbial killing.
4.4. Hemolytic anemia due to G6PD deficiency: types, pathophysiology, and biochemical screening.

Recommended reading for the lesson N4:

1. Satyanarayana U.. Biochemistry (6th ed. 2021) pp. 1–164;
2. Ferrier D.R.. Lippincott's Illustrated Reviews: Biochemistry (7th ed. 2017) pp. 53–68;
3. Rodwell V.W., Bender D.A., Kennelly K.M.. Harper's Illustrated Biochemistry (30th ed. 2015) pp. 60–72; pp. 73–86; pp. 87–96;
4. DM Vasudevan. Textbook of Biochemistry. 4th ed. 2016 pp. 72; 127; 141;

Key questions covered in practical class N *5*:

Assessment # 4

Module by unit: Intracellular generation of energy. Carbohydrate metabolism.

I. MCQs
II. Check laboratory and practical works
III. PBL and clinical cases

Key questions covered in practical class N 6: *Lipogenesis. Lipolysis. Oxidation of fatty acids.*

6.1. Lipolysis in adipose tissue: definition, reaction, enzyme (HSL), and hormonal regulation.
6.2. Lipogenesis in adipose tissue: pathway, key enzymes, and regulation.
6.3. β-Oxidation of fatty acids: activation, mitochondrial transport, and regulation.
6.4. Carnitine deficiency: myopathic, systemic, and secondary forms.
6.5. β-Oxidation of even-chain fatty acids: steps and bioenergetics.
6.6. β-Oxidation of odd-chain fatty acids: steps and bioenergetics.
6.7. Peroxisomal oxidation of long-chain fatty acids and Zellweger syndrome.
6.8. Oxidation of branched-chain fatty acids and Refsum disease.

Recommended reading for the lesson N6:

1. Satyanarayana U.. Biochemistry (6th ed. 2021) pp. 1–164;
2. Ferrier D.R. Lippincott's Illustrated reviews: Biochemistry. (7th ed 2017) pp.173-181;
3. Champe P.C. Lippincott's Illustrated reviews of Biochemistry 2005 pp. 171-186;
4. Satyanaryana U. Biochemistry (5th education) 2017 pp 29-44;

Key questions covered in practical class N 7: *Ketone bodies. Cholesterol and TAG metabolism*

7.1. Hepatic ketogenesis: pathway, reactions, and regulation.
7.2. Ketolysis in extrahepatic tissues: pathway and enzyme involvement.
7.3. Role of oxaloacetate and blood free fatty acids in ketone body metabolism.
7.4. Biochemistry of diabetic ketoacidosis: ketonemia, ketonuria, ketoacidosis, and metabolic connections.
7.5. Cholesterol biosynthesis: pathway, key regulatory enzymes, and control mechanisms.
7.6. Hypercholesterolemia as a risk factor for atherosclerosis.
7.7. Cholesterol degradation: bile acid and bile salt biosynthesis.
7.8. Bile: composition and biological roles.
7.9. Cholelithiasis: major risk factors and pathogenesis of cholesterol stone formation.
7.10. Cholemia and acholia: clinical features and biochemical basis.

Recommended reading for the lesson N7:

1. Ferrier D.R. Lippincott's Illustrated reviews: Biochemistry. (7th ed) 2017 pp.173- 219
2. Champe P.C., Richard A. Harvey Lippincott's Illustrated reviews of Biochemistry 2005 pp. 171-186;

3. Satyanaryana U. Biochemistry (5th education) 2017 pp.285-330;

Key questions covered in practical class N 8:

Assessment # 5

Module by unit: Lipids metabolism.

I. MCQs
II. Check laboratory and practical works
III. PBL and clinical cases

Key questions covered in practical class N 9: *Amino acid products (Gly, Phe, Tyr, etc.) and congenital disorders; newborn screening.*

9.1. Phenylalanine metabolism. Phenylketonuria (PKU)
9.2. Degradation of tyrosine. Alkaptonuria, ochronosis, tyrosinosis.
9.3. Formation of melanin from tyrosine. Albinism. Vitiligo.
9.4. Biosynthesis of catecholamines. Hormonal effect.

Recommended reading for the lesson N9:

1. Satyanarayana U.. Biochemistry (6th ed. 2021) pp. 1–164;
2. Ferrier D.R.. Lippincott's Illustrated Reviews: Biochemistry (7th ed. 2017) pp. 1–52;
3. Rodwell V.W., Bender D.A., Kennelly K.M.. Harper's Illustrated Biochemistry (30th ed. 2015) pp. 25–35;
4. Champe P.C. Lippincott's Illustrated reviews of Biochemistry 2005 pp. 171-186;
5. Satyanaryana U. Biochemistry (5th education) 2017 pp.331-380;

Key questions covered in practical class N 10 *Ammonia metabolism: production and detoxification. Clinical cases*

10.1. Sources of ammonia in the body. Function of ammonia.
10.2. Glutamine: biological role in detoxification and transport of ammonia. Glutamate-GABA shunt in the brain.
10.3. Renal Glutaminase: activation, role in generation of ammonium ions for regulation of acidosis
10.4. Nitrogen Garbage collection system: liver urea cycle, sequences, regulation. Genetic disorders of urea cycle due to enzymopathy.
10.5. Toxic effects of ammonia: mechanism of toxicity, symptoms of ammonia intoxication (VALIAM-C), causes of hyperammoniemia, treatment.

Recommended reading for the lesson N10:

1. Satyanarayana U.. Biochemistry (6th ed. 2021) pp. 237–426;
2. Ferrier D.R.. Lippincott's Illustrated Reviews: Biochemistry (7th ed. 2017) pp. 245–260; pp. 261–276;
3. Rodwell V.W., Bender D.A., Kennelly K.M.. Harper's Illustrated Biochemistry (30th ed. 2015) pp. 287–296; pp. 297–312;

Key questions covered in practical class N 11:

Assessment # 6

Module by unit: N-containing compounds metabolism

I. MCQs
II. Check laboratory and practical works
III. PBL and clinical cases

Key questions covered in practical class N 12: *DNA: organization, replication, repair, and mutations. Gene expression — transcription, translation, regulation, and disorders*

12.1. Functions of nucleic acids. Genes: definition and organization.
12.2. DNA replication in prokaryotes and eukaryotes
12.3. DNA repair mechanisms
12.4. Disorders associated with defective DNA repair
12.5. Transcription (mRNA synthesis)
12.6. Reverse transcription
12.7. Post-transcriptional processing of eukaryotic pre-mRNA
12.8. Translation of mRNA
12.9. Protein biosynthesis
12.10. Post-translational modifications
12.11. Protein degradation and regulation of gene expression

Recommended reading for the lesson N12:

1. Satyanarayana U.. Biochemistry (6th ed. 2021) pp. 1–164;
2. Satyanaryana U. Biochemistry (5th education) 2017 pp.523- 571;
3. Ferrier D.R. Lippincott's Illustrated reviews: Biochemistry. (7th ed 2017) pp.411-433;
4. Champe P.C. Lippincott's Illustrated reviews of Biochemistry 2005 pp.357-385;

Key questions covered in practical class N 13: *Molecular technologies in diagnostics: recombinant DNA, PCR, microarrays, FGIS (fluorescent in situ hybridization), CRSPR (clustered regularly interspersed short palindromic repeats)*

13.1. Recombinant DNA Technology
13.2. Polymerase Chain Reaction (PCR)
13.3. DNA Microarrays
13.4. Fluorescent In Situ Hybridization (FGIS)
13.5. CRISPR–Cas System

13.6. Comparison of Molecular Diagnostic Techniques

Recommended reading for the lesson N13:

1. Satyanarayana U.. Biochemistry (6th ed. 2021) pp. 521–594;
2. Ferrier D.R.. Lippincott's Illustrated Reviews: Biochemistry (7th ed. 2017) pp. 411–432; pp. 433–446; pp. 447–464; pp. 465–480; pp. 481–504;
3. Rodwell V.W., Bender D.A., Kennelly K.M.. Harper's Illustrated Biochemistry (30th ed. 2015) pp. 370–393; pp. 394–412; pp. 413–427; pp. 428–450; pp. 451–476;

Key questions covered in practical class N 14:

Assessment # 7

Module by unit: Molecular biology. Clinical biochemistry.

I. MCQs
II. Check laboratory and practical works
III. PBL and clinical cases

Guidelines for the lessons (laboratory class) of the discipline

Laboratory class N1: *Qualitative reactions to carbohydrates.*

Lab. w. Reactions of monosaccharides.
Lab. w. Reactions of disaccharides & polysaccharides

Laboratory class N2: *Blood glucose estimation: GOD-POD method, glucometer. Interpretations.*

Lab. w. Determination of blood glucose by GOD-POD method
Lab. w. Determination of urine glucose by strip set method.

Laboratory class N3: *Determination of blood cholesterol & TAG*

Lab. w. Determination of blood cholesterol
Lab. w. Determination of blood triacylglycerides (TAG)

Laboratory class N4: *Testing of glomerular filtration of the kidneys. Determination of urea and creatinine in the blood. Calculation of BUN and GFR.*

Lab. w. Estimation of blood creatinine (Jaffe's method)
Lab. w. Urinalysis by dipstick method

Methodological instructions for the implementation of independent work on the discipline.

Independent extracurricular work ensures the preparation of the student for the current classroom activities and control activities for all disciplines of the curriculum. The results of this preparation are manifested in the student's activity in the classroom and in the quality of completed tests, test assignments, reports made and other forms of control.

Independent work includes the following types of work:

–work with lecture material, providing for the study of lecture notes and educational literature;
– search and review of literature and electronic sources of information on an individually given course problem, writing a report on a given problem;
– doing homework for class;
– preparation for laboratory work, practical and seminar classes;
– independent laboratory work on a given topic;
– preparation for control work;
– preparation for the test and certification.