Question set № 1

- **Biopolymers**. Monomers forming different classes of biopolymers. Bifunctional nature of monomers. Linear polymers. Branched polymers. Diversity of monomer sequence in irregular polymers. Direction of polymer sequence. “Strong” (covalent) and “weak” (hydrogen, ionic, WDW) bonds in biopolymers.
- **Basic biochemical methods.** Spectrophotometry. Chromatography (3-4 types). Electrophoresis (native/denatured). 2D-gel and IEF and CE.
- **Catabolism – carbohydrates (CH).** Principal features of stage1 catabolism of CH (what are the resulting blocks) and absorption. Aims of utilization of glucose. ATP as universal energetic currency. Total energy balance of glucose utilization.

Question set № 2

- **Lipids.** Lipids. Basic chemical classification. Fatty acids (even/odd chain, saturated/unsaturated). Acetic acid, butyric acid, palmitic acid, propionic acid. Essential FA. Composition of body fat. Omega3-6-9. Minor FA – branched/modified/cyclic. Etherification of FA. Oxidation and hydrogenation of FA.
- **Basic biochemical methods.** Immunoassays and blotting. Molecular weight. Centrifugation and sedimentation equilibrium. Centrifugation. Mass spectrometry. PCR.
- **Catabolism** – glycolysis. Principal stages of glycolysis. Transformation of C-backbone. Migration of phosphate groups. Structure of glucose, fructose-1,6-biphosphate and glyceraldehyde-phosphate/dihydroxyacetone-phosphate, 3-phosphoglycerate, pyruvate. Aerobic/anaerobic glycolysis – reconversion of NAD+, structure of lactate.

Question set № 3

- **Aminoacid composition of proteins.** Aminoacids as protein monomers. Bifunctional nature of AA. AA core and side-chain. Diversity of AA. Aminoacid charge and hydrophobicity. Spectral properties and stereochemistry. pI and hydrophobicity.
- **Basic biochemical methods.** NMR and X-ray analysis. Sequencing (protein and nucleic acids. Edman sequencing/Sanger sequencing.
- **Catabolism** – glycolysis. Total energy balance (aerobic/anaerobic glycolysis). Conversion of pyruvate to acetyl-CoA. Transformation of C-backbone. PDH complex. Requirements of vitamins.

Question set № 4

- **Nucleic acids.** DNA and RNA and their involvement in different parts of metabolism. Nucleosides and nucleotides – low molecular weight components of nucleic acids. Ribose and deoxyribose in cyclic form. Purines and pyrimidines. Major heterocycles – adenine, guanine, cytosine, thymine or uracil. Minor nucleobases. Ribo- and deoxyribonucleosides structure. Nucleotides – phosphates of nucleosides. Mono-, di-, trinucleotides. Intranucleotide bond, glycosidic bond.
- **Enzymes.** Catalysis. Activation energy. Specific properties of biocatalysts of enzymes. Classification of enzymes – major classes with schematic reactions.
- **Catabolism** – Krebs' cycle. TCA. Features. Principal stages. Cycling compound – oxaloacetate (OAA). Transformation of C-backbone. Structure of OAA, citrate, ketoglutarate, succinyl-coA, fumarate.

Question set № 5

- **Classification and variety of aminoacids.** Classes of AA. Aliphatic AA: glycine, alanine, valine, leucine, isoleucine. Aminoacid – proline. Aromatic aminoacids – phenylalanine, tryptophan. tyrosine. Oxiaminoacids – serine and threonine. Bicarbonic aminoacids and amides – glutamic and asparagine aminoacid, glutamine and asparagine. Basic aminoacids – lysine, arginine and histidine. Sulfur-containing aminoacids – cysteine, methionine. Minor residues (cystine, hydroxyproline, selenocysteine, ornithine, citrulline).
- **Enzymes.** Michaelis-Menten mechanism (2 stages). Key-lock and induced fit models of 1 stage. Catalysis – 2^{nd} stage. Structure of enzyme – binding pocket and active center. Shape of kinetic curve and Km, Vmax.
- **Catabolism – TCA.** Requirement of vitamins. Regulation. Catabolic/anabolic property of TCA. Total balance of energy from glucose (glycolysis and TCA).

Question set № 6

- **Nucleic acids.** Total charge and hydrophobicity. Spectral properties of nucleosides and nucleotides. Complementary nature of nucleic acids interaction. Specific interactions between complementary strands of nucleic acid as a example of specific interactions. Watson-Crick base pairing. Stacking. Hoogsteen base pairing. Triplexes and quadruplexes. Stability of nucleic acids.
- **Enzymes.** Co-enzymes. Type 1 (for oxidoreductases). Major type 1 coenzymes. Type 2 (co-enzymes used in transfer reactions). Names and groups transferred (CoA, ATP, Biotin, FH4 – THFH). ATP a cofactor and ATP as a energy source. Metals as cofactors.
- **Catabolism – biological oxidation.** Stages of metabolism. Types of biological oxidation and enzymes – oxidases, aerobic dehydrogenases, anaerobic dehydrogenases (and NAD+, NADP+, FAD subclasses), peroxidases, mixed function oxidases.

Question set № 7

- **Protein structure.** Size of proteins. Primary-secondary-tertiary and quaternary structure of proteins. Peptide chain. Spectral characteristics of peptide chain, sidechains and terminal end groups of proteins and peptides. Chain flexibility. Alpha-spirals and beta-sheets. Folds. Role of side chains in protein structure formation. Protein denaturation (native-molten globule-denatured state and reversibility). Several energy minimums for the same polypeptide as a partially denatured/conformationally different states.
- **Metabolism.** Basic features. Catabolism-anabolism. Metabolic pathways. Levels of metabolism: Primary-secondary-tertiary metabolism. Major aim of catabolism of carbohydrates/lipids and aminoacids.
- **Biological oxidation.** Electron transfer chain. 4 complexes. Inputs and outputs in the chain: ETC1 (in – NADH, out – QH2), ETC2 (in – Succinate, out – QH2, ETC3 (in - QH2, out – Cytochrome C-Red), ETC4 (in – Cytochrome-C-red, out – H2O). Formation of proton gradient. ATP synthesis. FADH2 and NADH as input sources.

Question set № 8

- **Nucleic acids.** Structure of DNA. Types of spiral. B-spiral as a common structure. Minor groove-major groove. Flexibility of bonds in nucleic acid. Peculiarities of RNA structures – hairpins and loops. T-RNA and r-RNA as an examples.
- **Enzymes.** What factors affect velocity of reaction and inhibitors (competitive/noncompetitive and reversible/irreversible and suicide inhibition). Basic principle of allosteric regulation. Allosteric effects (activators/inhibitors). Multisubunit enzymes.
- **Catabolism – lipids.** Stage 1 principal features. Emulsification. Role of bile. Absorption. Transformation of tryacylglycerides (TAG), cholesterol esters, phospholipids. Resynthesis of TAG. Transfer of chylomicrons.

Question set № 9

- **Nucleic acids.** DNA and RNA and their involvement in different parts of metabolism. Nucleosides and nucleotides – low molecular weight components of nucleic acids. Ribose and deoxyribose in cyclic form. Purines and pyrimidines. Major heterocycles – adenine, guanine, cytosine, thymine or uracil. Minor nucleobases. Ribo- and deoxyribonecleosides structure. Nucleotides – phosphates of nucleosides. Mono-, di-, trinucleotides. Intranucleotide bond, glycosidic bond.
- **Biological chemistry** subject– compounds forming biological organisms and chemical processes taking place within biological organisms. Biopolymers as borderline living matter organization. Biochemistry-genetics-molecular biology triad. **Biocatalysis** – Enzymes as essential components of biochemical processes. Catalysts. Reaction intermediates. Biocatalysts – function, structure and features.
- **Catabolism – lipids.** Beta-oxidations of fatty acids. Principal steps: activation of FA, formation of double bond (dehydrogenation), hydration, oxidation to beta-keto-acid, splitting of Acetyl-CoA. “Spiral” nature of beta-oxidation.

Question set № 10

- **Aminoacid composition of proteins.** Aminoacids as protein monomers. Bifunctional nature of AA. AA core and side-chain. Diversity of AA. Aminoacid charge and hydrophobicity. Spectral properties and stereochemistry. pI and hydrophobicity.
- **Enzymes.** Co-enzymes. Type 1 (for oxidoreductases). Major type 1 coenzymes. Type 2 (co-enzymes used in transfer reactions). Names and groups transferred (CoA, ATP, Biotin, FH4 – THFH). ATP a cofactor and ATP as a energy source. Metals as cofactors.
- **Catabolism – lipids.** Total energy gain on the example of palmitic acid. Beta-oxidation of odd-chain FA. Interconnection with TCA. Role of cofactors and shuttling of Acyl-CoA through mitochondrial membrane (carnitine-acylcarnitine shuttle)

Question set № 11

- **Nucleic acids.** Total charge and hydrophobicity. Spectral properties of nucleosides and nucleotides. Complementary nature of nucleic acids interaction. Specific interactions between complementary strands of nucleic acid as a example of specific interactions. Watson-Crick base pairing. Stacking. Hoogsteen base pairing. Triplexes and quadruplexes. Stability of nucleic acids.
- **Enzymes.** Michaelis-Menten mechanism (2 stages). Key-lock and induced fit models of 1 stage. Catalysis – 2^{nd} stage. Structure of enzyme – binding pocket and active center. Shape of kinetic curve and Km, Vmax.
- **Metabolism – aminoacids.** Stage 1 metabolism principal features (enzymes and absorption). Degradation-synthesis of proteins in the body. Lysosomes. Ubiquitin proteasomes. General use of aminoacids in the metabolism.

Question set № 12

- **Lipids.** Neutral FAT – triglycerides. Mixed triglycerides. Waxes. Properties of triglycerides. Phospholipids structure and function. Lecitin, cephalin.
- **Basic biochemical methods.** Spectrophotometry. Chromatography (3-4 types). Electrophoresis (native/denatured). 2D-gel and IEF and CE.
- **Metabolism – aminoacids.** Fate of NH3 group. 1. Transamination principles, important aminoacids. Structure of ketoglutarate-glutamate pair and pyruvate-alanine pair. Enzymes of transamination. 2. Transdeamination – spatially separated transamination and deamination of glutamate in liver. 3. Deamination – other pathways. 4. Disposal of ammonia. 5. Disposal of NH3 from glycine – formation of THFA-methylene – input of single-C into the flow of carbon skeletons.

Question set № 13

- **Nucleic acids.** Structure of DNA. Types of spiral. B-spiral as a common structure. Minor groove-major groove. Flexibility of bonds in nucleic acid. Peculiarities of RNA structures – hairpins and loops. T-RNA and r-RNA as an examples.
- **Enzymes.** What factors affect velocity of reaction and inhibitors (competitive/noncompetitive and reversible/irreversible and suicide inhibition). Basic principle of allosteric regulation. Allosteric effects (activators/inhibitors). Multisubunit enzymes.
- **Disposal of ammonia – urea cycle.** Major steps in urea cycle. Cycling compound – ornithine. Origins of N atoms in urea. Fate of C-backbone. Migration of N-atoms. Arginine structure. Citrulline structure. Aspartate structure. Fumarate structure. Hydrolysis of urea from arginine.

Question set № 14

- **Carbohydrates.** Structure and monomers. Length of carbohydrates. Branched carbohydrates. Carbohydrate monomers. Aldoses and ketoses. Number of C-atoms in common carbohydrates. En-diol isomerization. Stereoscopic properties – chiral centers in monosaccharides (D- and L-monosaccharides). Cyclic and linear forms of monosaccharides (most common – furanoses and pyranoses). Common examples: glyceraldehyde, dihydroxyacetone, ribose, glucose, fructose, galactose.
- **Basic biochemical methods.** Immunoassays and blotting. Molecular weight. Centrifugation and sedimentation equilibrium. Centrifugation. Mass spectrometry. PCR.
- **Urea cycle -** Interconnection to TCA. Urea bicycle. Energy requirement. Muscle-liver:glucose-alanine cycling.

Question set № 15

- **Lipids.** Sphingolipids. Basic structure. Steroids. Basic structure. Lipids function.
- **Basic biochemical methods.** NMR and X-ray analysis. Sequencing (protein and nucleic acids. Edman sequencing/Sanger sequencing.
- **Anabolism of carbohydrates (CH).** Gluconeogenesis. Structure of initial compound – pyruvate. Fate of carbon skeleton. Migration of phosphates. Attachment of acetyl to pyruvate with the formation of oxaloacetate (OAA). Conversion of OAA to phosphoenolpyruvate. Reversal steps of glycolysis. 2 other reactions specific for gluconeogenesis. Significance of gluconeogenesis.

Question set № 16

- **Lipids.** Sphingolipids. Basic structure. Steroids. Basic structure. Lipids function.
- **Enzymes.** Catalysis. Activation energy. Specific properties of biocatalysts of enzymes. Classification of enzymes – major classes with schematic reactions.
- **Anabolism of carbohydrates (CH).** Sources in the gluconeogenesis (direct pyruvate sources, input at the level of 3 carbon glyceraldehyde-3-phosphate from 3 carbon glycerol, use of glucogenic aminoacids through the connection to TCA, input of odd chain fatty acids derivatives at the level of TCA).

Question set № 17

- **Carbohydrates.** Reactivity of carbohydrates in connection to metabolism. Basic structure of derivatives of monosaccharides: glucuronic acid, aminosugars (1. glucosamine, 2. Ribosylamine, 3. Sialic acids), glycosides. Basic structure of disaccharides: maltose, lactose, sucrose. Oligosaccharides. Biological role of disaccharides and oligosaccharides.
- **Metabolism.** Basic features. Catabolism-anabolism. Metabolic pathways. Levels of metabolism: Primary-secondary-tertiary metabolism. Major aim of catabolism of carbohydrates/lipids and aminoacids.
- **Anabolism of fatty acids (FA).** Comparison of fatty acids synthesis with fatty acids oxidation. Starting point for anabolism – acetyl-CoA. Localizaton of synthetic machinery and citrate-malate shuttle of acetyl-CoA through mitochondrial membrane. Fatty acid synthase (FAS) complex (structure and domain function).

Question set № 18

- **Carbohydrates.** Structure and monomers. Length of carbohydrates. Branched carbohydrates. Carbohydrate monomers. Aldoses and ketoses. Number of C-atoms in common carbohydrates. En-diol isomerization. Stereoscopic properties – chiral centers in monosaccharides (D- and L-monosaccharides). Cyclic and linear forms of monosaccharides (most common – furanoses and pyranoses). Common examples: glyceraldehyde, dihydroxyacetone, ribose, glucose, fructose, galactose.
- **Biological chemistry** subject– compounds forming biological organisms and chemical processes taking place within biological organisms. Biopolymers as borderline living matter organization. Biochemistry-genetics-molecular biology triad. **Biocatalysis** – Enzymes as essential components of biochemical processes. Catalysts. Reaction intermediates. Biocatalysts – function, structure and features.
- **Anabolism of fatty acids (FA).** Fatty acid synthesis – major steps. Fate of carbon skeleton. Ac-CoA and malonyl-CoA. Site of synthesis – role of CE and ACP domains of FAS. Condensation-Reduction-Dehydration-Reduction. Reaction spiral. Release on the example of palmitic acid. Summary of the reaction. NADPH co-enzyme and source of it. Regulation**.**

Question set № 19

- **Classification and variety of aminoacids.** Classes of AA. Aliphatic AA: glycine, alanine, valine, leucine, isoleucine. Aminoacid – proline. Aromatic aminoacids – phenylalanine, tryptophan. tyrosine. Oxiamnoacids – serine and threonine. Bicarbonic aminoacids and amides – glutamic and asparagine aminoacid, glutamine and asparagine. Basic aminoacids – lysine, arginine and histidine. Sulfur-containing aminoacids – cysteine, methionine. Minor residues (cystine, hydroxyproline, selenocysteine, ornithine, citrulline).
- **Basic biochemical methods.** Spectrophotometry. Chromatography (3-4 types). Electrophoresis (native/denatured). 2D-gel and IEF and CE.
- **Anabolism of lipids.** Synthesis of triglycerides (TAG). Input – dihydroxyacetonphosphate structure. Input of glycerol-3-phosphate. Fate of carbon-skeleton. TAG synthesis in fed and fasting states. Adipose tissue and liver-adipose tissue axis.

Question set № 20

- **Carbohydrates.** Reactivity of carbohydrates in connection to metabolism. Basic structure of derivatives of monosaccharides: glucuronic acid, aminosugars (1. glucosamine, 2. Ribosylamine, 3. Sialic acids), glycosides. Basic structure of disaccharides: maltose, lactose, sucrose. Oligosaccharides. Biological role of disaccharides and oligosaccharides.
- **Basic biochemical methods.** Immunoassays and blotting. Molecular weight. Centrifugation and sedimentation equilibrium. Centrifugation. Mass spectrometry. PCR.
- **Anabolism of lipids.** Sterol biosynthesis. Cyclopentano perhydro phenanthrene ring system. Input source – Acetyl-CoA. Fate of carbon skeleton. Major steps – condensation-formation of hydroxy-methylglutaryl-CoA- reduction – formation of 5-C moiety. Summary of condensation into squalene. Cyclization and processing.

Question set № 21

- **Carbohydrates.** Polysaccharides principal structure and biological significance: homo- (starch, amylose, amylopectin, glycogen, cellulose, dextrin, dextran) heteroglycans (mucopolysaccharides=MPS). Types of MPS (acidic/neutral sulphate free/sulphate containing with 1 example = hyaluronic acid, chondroitin sulphate, heparin)
- **Basic biochemical methods.** NMR and X-ray analysis. Sequencing (protein and nucleic acids. Edman sequencing/Sanger sequencing.
- **Anabolism of aminoacids.** Essentia/semi-essential/non-essential aminoacids. Glucogenic and ketogenic aminoacids. Biosynthesis of serine – source of Carbon skeleton (3-phosphoglycerate and its source), transamination, removal of phosphate. Biosynthesis of glycine from Ser – source of C-atoms, source of NH3 group. Biosynthesis of alanine – source of C-atoms, interconnection to TCA, source of NH3 group.

Question set № 22

- **Biopolymers**. Monomers forming different classes of biopolymers. Bifunctional nature of monomers. Linear polymers. Branched polymers. Diversity of monomer sequence in irregular polymers. Direction of polymer sequence. “Strong” (covalent) and “weak” (hydrogen, ionic, WDW) bonds in biopolymers.
- **Enzymes.** Michaelis Menten mechanism (2 stages). Key-lock and induced fit models of 1 stage. Catalysis – 2^{nd} stage. Structure of enzyme – binding pocket and active center. Shape of kinetic curve and Km, Vmax.
- **Anabolism of aminoacids.** Biosynthesis of cysteine. Source of C-atoms (methionine-removal of methylene group to THFA – joining with serine – splitting to homoserine and cysteine. Source of NH3 group, source of Sulphur. Glutamate biosynthesis – source of C-skeleton (interconnection to carbohydrates metabolism - ketoglutarate). Aspartate biosynthesis – source of C-skeleton (interconnection to carbohydrates metabolism - oxaloacetate). Glutamine and asparagine – derivatives of Aspartate and glutamate and amidation.

Question set № 23

- **Lipids.** Lipids. Basic chemical classification. Fatty acids (even/odd chain, saturated/unsaturated). Acetic acid, butyric acid, palmitic acid, propionic acid. Essential FA. Composition of body fat. Omega3-6-9. Minor FA – branched/modified/cyclic. Etherification of FA. Oxidation and hydrogenation of FA.
- **Enzymes.** Co-enzymes. Type 1 (for oxidoreductases). Major type 1 coenzymes. Type 2 (co-enzymes used in transfer reactions). Names and groups transferred (CoA, ATP, Biotin, FH4 – THFH). ATP a cofactor and ATP as a energy source. Metals as cofactors.
- **Anabolism of aminoacids.** Arginine biosynthesis. Partial scheme of urea bicycle. Requirement of aspartate, ornithine and carbamoyl. Biosynthesis of His – source of different atoms in the ring system. Tyrosine and phenylalanine interconnection.

Question set № 24

- **Lipids.** Neutral FAT – triglycerides. Mixed triglycerides. Waxes. Properties of triglycerides. Phospholipids structure and function. Lecitin, cephalin.
- **Enzymes.** What factors affect velocity of reaction and inhibitors (competitive/noncompetitive and reversible/irreversible and suicide inhibition). Basic principle of allosteric regulation. Allosteric effects (activators/inhibitors). Multisubunit enzymes.
- **Anabolism of aminoacids.** Biosynthesis of proline.

Question set № 25

- **Protein structure.** Size of proteins. Primary-secondary-tertiary and quaternary structure of proteins. Peptide chain. Spectral characteristics of peptide chain, sidechains and terminal end groups of proteins and peptides. Chain flexibility. Alpha-spirals and beta-sheets. Folds. Role of side chains in protein structure formation. Protein denaturation (native-molten globule-denatured state and reversibility). Several energy minimums for the same polypeptide as a partially denatured/conformationally different states.
- **Metabolism.** Basic features. Catabolism-anabolism. Metabolic pathways. Levels of metabolism: Primary-secondary-tertiary metabolism. Major aim of catabolism of carbohydrates/lipids and aminoacids.
- **Nucleic acids anabolism.** Purine biosynthesis. Source of atoms in the double ring system. Synthesis on ribose-phosphate moiety. Synthesis of small ring – synthesis of big ring. Formation of IMP. Major steps. Conversion of IMP to GMP and AMP. Phosphorylation.

Question set № 26

- **Carbohydrates.** Polysaccharides principal structure and biological significance: homo- (starch, amylose, amylopectin, glycogen, cellulose, dextrin, dextran) heteroglycans (mucopolysaccharides=MPS). Types of MPS (acidic/neutral sulphate free/sulphate containing with 1 example = hyaluronic acid, chondroitin sulphate, heparin)
- **Enzymes.** Catalysis. Activation energy. Specific properties of biocatalysts of enzymes. Classification of enzymes – major classes with schematic reactions.
- **Nucleic acids anabolism.** Pyrimidine biosynthesis. Source of atoms in the double ring system (carbamoyl-phosphate and aspartate). Synthesis of pyrimidine and further attachments to ribosephosphate. Source of PRPP. Major steps. Formation of OMP and UMP. Phosphorylation. Conversion of UTP to CTP. Conversion of ribo to deoxy nucleotides. Synthesis of dTMP from dUMP. Source of additional C (THFA role)/