Topic list 1 for preparation to the exam*
in Biochemistry and Molecular Biology

(* The text in parenthesis and italics provides help for the preparation, however they do not necessarily cover the whole topic. These parts will be omitted from the topic list used on the exam - see the „Topic list on the exam".)

A1.
Energetics an factors that determine the direction of (bio)chemical processes (*the direction and equlibrium of chemical processes, the principle of activated reaction partner, coupled reaction and reaction series*), high energy bonds, high energy compounds (*a the free energy sources of chemical reactions, binding energy and stability of chemical bonds, the structural basis of the high energy level (insatbility) in high energy bonds*).

A2.
The nucleotides (*the building blocks of nucelic acids and other, rare or modified nucleotides, nucleotides with coenzyme function: structures and nomenclature*), the concept and storage of system information (*definition, the role of size and H-bonding pattern of bases, the oxo-enol (amino-imino) tutomerism, interpretation of the selection of the four „basic" bases*). The primary and secondary structure of nucleic acids (*types and forms nucleic acids and their role, strand structure, polarity*). Proteins that influence/change the secondary structure (*types of helices: conditions of their appearance, their structural features and stability, base complementarity,*).

A3.
The tertiary structure of nucleic acids (*properties characterization and significance of superhelicity (nucleic acid packaging, DNA-dependent reactions)*) and the proteins that determine/change/modify the tertiary structure (*topoizomerases, histone and their role*). Nucleosomal and higher structural organizations of the DNA (*chemical modifications in the chromatin, domain, sub-domain, terrtory and their properties and roles*).

A4.
The problems and roles of the replication process (*the Meselson-Stahl experiment*), and their solutions: the functions and enzymatic features of the (core) polymerase complex (*template dependence, error correction, types and functions of DNA polymerases*). The elongation reactions during replication, the direction and mechanism (*the reaction cataysed by the core polymerase, energetics*). Supplementary functions and processes in the replication fork (*leading and lagging strand, Okazaki fragments, accesory proteins and their functions*).

A5.
The initiation and termiantion processes during replication (*regulators signals and proetins, accesory proteins in the initiation of replication*). Finishing works (*nick translation and the replacement of RNA segments, DNA ligase reaction, other accessory reactions (telomerase function, chemical and structural modifications in the DNA*). Replication strategies.

A6.
The causes, frequency and dangers of changes in the DNA encoded information (*spontaneous and environment induced changes in the sequence, the difficulty of mismatch error*), Ames' test, repair mechanisms (*photoreactivation, types of excision repair mechanisms recombination reapir*).

A7.
The definition of genetic and extragenetic information and the gene and its structure (*the definition and parts of a gene*). Features of the structural segment of genes (the "structure gene") (*code/anticode, degenearncy, wobling, universality, density etc.*). The role of the regulatory part of genes (*regulator and signal functions*). The function of signals (*their position, role with examples (promoter, terminator, signal peptide etc.)*). Genome density (*segments and regions with and without function, virus-prokaryote-eukaryote: tendencies and explanations*).

A8.
Possible ways and main characters of rearrangements in the genome (*the main types and mechanisms of rearrangements, information loosing and information keeping types*): examples with their mechanisms (*the G-conversion of μ-phage, phage integration, transposon and retrovirus insertion and transposition, the variability of antigenes and antibodies*).

A9.
Types and functions of RNA-s (*mRNA, tRNA, rRNA, miRNA, LncRNA*). RNA polymerases and their functions, the comparison of properties of RNA and DNA polymerases. The initiation, elongation and termination of RNA synthesis (*prokaryotes, eukaryotes, the nucleotide coupling, σ-depnedent and σ-independent termination*), some inhibitors of RNA synthesis.

A10.
The roles and nature of the post-transcriptional modification processes (*cap, poli-A tail, splicing, fragmentation, editing*). mRNA export to the cytosol, factors that determine the half life of mRNA.

A11.

Amino acid activation, the role and significance in translation of coupling the amino acids to tRNA-s (*the mechanism and specificity, precision of the coupling rection*). The structure of ribosome (*components and their roles*). The initiation of translation in prokaryotes and eukaryotes (*initiation factors and their function*).

A12.
The elongation of the polypeptide chain (*the mechanism of peptide bond formation, the direction of peptide synthesis*), the roles of elongation factors, factors that ensure the fidelity of translation (*proof reading*). Termination of translation, the dynamics and energetics of protein synthesis (*termination factors and their role*).

A13.
Some inhibitors of translation (cycloheximide, chloramphenicol, streptomycine, teracycline. The cooperation of ribosomes and the endoplasmic reticulum in the formation of some of the proteins in eukaryotes (*the process and significance of attachment of ribosomes to the enoplasmic reticulum and the transfer of the polypetide into the lumen*). Post-translational modifications and their roles (*hidroxylation, methylation, carboxylation, esterification, proteolysis, coenzyme binding*). The types of glycosylations and the tarns-glycosylation reactions (*O- and N-glycosides, dolichol phosphate, activated intermediers*). . Targeting and transport of proteins into the different compartments of a cell (*co-and post-translational transport, vesicular transport, transports to the mitochondrion and the chloroplast, bacterial transports*). Factors that determine the half life of proteins, intracellular protein degradation.

A14.
Types and mechanisms of regulation of gene expression (*positive, negative, inductive, repressive*). Examples of prokaryotic gene expression regulation (the Lac- and Trp-operon) (*the definition of operon, the Lac-operon: mechanism and role of the Lac repressor and cataboilit repressor proteins, the Trp-operon: the mechanism and role of Trp-repressor protein and attenuation*).

A15.
The mechanism of gene expression regulation in neukaryotes (*cis- and trans-elements, modulator, proximal and distal regulator elements enhancers/silencers, insulator/boundary element*). The epigenetic information and its function along with the chromatin structure on gene expression (*terminology in epigenetics, the effect of epigenetic information and nucleosome position*).

A16.
The levels of control in the realization of molecular system information (genetic information) (*list of the possibilities, the formation of the various molecular forms of the system information (DNA, RNA, protein)during the realization of system information*). The control of mRNA stability as a possible means of quantitative regulation of enzymes (*the RNAi and the mechanism of the iron responsive element*). The regulation of translation in eukaryotes (*the titratinion-out of eIF2, and its role in anti-virus mechanism and in concerting the synthesis of globin and hem*). The possibilities, the extent and necessity of changes and variations in the system information in the molecular adaptation of organisms and species (*the optimal range of variations, influencing factors, the role of mutations and para-mutations*).

A17.
Molecular biotechnologies: the principles of cloning (*clone, resistance factor, transgene, transformant, screening*), some basic methods (*restriction enzymes, ligase, recombinant DNA, polymerase chain reaction, DNA equencing, heterologous expression*), and the utilization of molecular biotechnology in research and technology (*site-directed mutagenesis, knock-out and transgenic organisms, production substances and generation of resistant organisms*). Biological system informatics: the principles and applications of genomics (genome analysis), transcriptome and proteome analysis (with some examples) (*definition of genome, transcriptome and proteom, investigation of transctriptom and gene activity with microarrays, some results of genome analysisi*).

B18.
Structure and chemistry of amino acids (*protein constituent and other amino acids, modified amino acids, isoelectric point*) and the peptide bond (*resonance hybridisation and bond stability, the φ és ψ angle pair, the Ramachandran plot*). Primary sequence and sequence comparisons (*isoenzymes, homology, orthology, paralogy, evolutionary trees*).

B19.
The secondary, tertiary and quaternary levels of organisation in the structure of proteins and their stabilisation (with examples) (*structures and the forces of their stabilization*), intermediate structure elements (*motif, domen*).

B20.
Native, denatured and aggregate state of proteins (*definitions, denaturing agents, reversibility*). The driving forces behind protein folding (*chemical and energetic forces of folding*).

B21.
The role of the primary structure in the formation of the tertiary structure and function (*principles and the Anfinsen's experiment, the structure and function relationship*). The mechanism of protein folding, the main steps in the folding process (*intermediate sates* in vitro, *the different role of the various side chain interactions*), folding in vivo, the catalyst of foldin (*the functions of chaperones, and the disulfide and peptide cis-trans isomerases*).

B22.
The kinetic description of single-substrate enzyme ractions (*Michaelis-Menten és Briggs-Haldane kinetics and their schemes*), kinetic parameters (*the rate constants,* K_M, K_S, k_{cat}/K_M *and their interpretation*), measures of enzyme activity (*specific activity and turnover number*), the diagrams of enzyme ractions (*the time-dependence and saturation curves and the Lineweaver-Burk plot*).

B23.
Interpretation of enzyme catalysis (rate enhancement) (*the enrgy diagram of the enzyme reaction scheme, the energetic and kinetic explanation of reactionrate enhancement*). The optimal range of kinetic parameter values (*the principles that determine (the evolutionary changes in) the values of* k_{cat}/K_M *és a* K_M).

B24.
Structural interpretation of enzyme reactions, reaction models (*key-and-lock and induced fit model*). Types of complex enzyme mechanisms (*bisubstrate, single step, two step enzyme reactions, briefly*). Characteristics of modulated enzymes (*the definition and kinetics of the homotrop and hetrerotrop allostery, the K and the V types, T and R enzyme states and their structural interpretation*).

B25.
The kinetics and mechanism of reversible inhibiton types of enzymes (*competitive, non-competitive, uncompetitive, mixed, interpretation with kinetic diagrams*). The irreversible inhibition (*e.g. the mechanism of DIFP and penicillin*).

B26.
The influence of physiololgical conditions on the activity of enzyme: the adaptation of enzymes to the physical and chemical conditions of their environment (*temperature and pH*). Control of catalytic activity with proteolysis (*activation/inactivation, the role of zymogens, the zymogen activation*) and employing isozymes (*the definition, property and role of isoenzymes, e.g. lactate dehydrogenase and glucokinaase/hexokinase*).

B27.
Control of catalytic activity with allostery (*the scheme of the structural basis of allostery and its illustration with protein kinase A and catabolit repressor protein, the biologicalrole of allostery with 1-2 examples*) and with reversible chemical modification (*(de)phosphorylation (with examples) and other possibilities*).

B28.
The main characteristics of substarte conversion reactions (*concerted electron movements, positioning of the substrate, electrosatic complementarity in the transitional state, proton transfers*). The structural basis of substarte specificity in pancreatic serine proteases (*the structural scheme of enzyme-substrate interaction (primary and secondary interactions), the geometry and polarity in the substrate binding site of trypsin, chymotrypsin and elastase*).

B29.
The mechanism of peptide bond hydrolysis by enzymes which use active serine: the stages and steps in the reaction, the energetics of the reaction. (*the catalytic triade and its role through the steps of the reaction, the formation, stabilization and break-down of the tetrahedral trisitional state and the acyl enzyme intermedier, proton transfers between acidic and basic gropus, amide and ester hydrolysis*).

B30.
The structural basis of O_2 binding in myoglobin, structural mechanisms for avoiding the toxic effects of O_2, the toxicity of CO (*the structure of heme and globin, the coordination of iron, the O_2 activiation inhibiting sub-optimal O_2 coordination*).

B31.
Molecular adaptation I - Structural mechanisms of hemoglobin in the O_2 transport function: the structural basis of accelerating the rate of O_2 exchange and of the incerase in O_2 carrying capacity. (*the cooperativity between subunits (and their alternating roles during it), the CO_2 and 2,3-BPG allostery*).

B32.
Molecular adaptation II - hemoglobin variants and their adaptive value. (*foetal forms (γ), sickle-cell anemia, scuba hemoglobin*).