



**Study sub-programme: Biotechnology**

**TEST AREA: ORGANIC CHEMISTRY AND BIOCHEMISTRY**

1. Naturally occurring alkanes (e.g. raw oil, pheromones, steroids)
2. Naturally occurring alkenes and alkynes (e.g. terpenes, natural rubber, enediynes, alkyne metabolites)
3. Naturally occurring arenes and heteroarenes (e.g. terpenes, alkaloids)
4. Naturally occurring phenols and quinones (e.g. vitamins, lignans, polyketides)
5. Naturally occurring alcohols (e.g. acetyl-CoA-derived products, macrolides, glycerol)
6. Naturally occurring ethers (e.g. lignans, lignin, cyclic ether natural products - tetrahydrofurans, pyrans)
7. Amines and sulfur compounds in nature: (e.g. alkaloids, neurotransmitters, biogenic amines, lipoic acid)
8. Naturally occurring aldehydes and ketones (e.g. pheromones, fragrances); aldol addition in nature; imines
9. Carbohydrates: structure, properties, and their function in living organisms
10. Carboxylic acids (e.g. fragrances, aroma compounds, fatty acid biosynthesis, soaps, waxes)
11. Amino acids, peptides, proteins, nucleic acids, properties, isolation and characterization of biomacromolecules
12. Non-covalent interactions in biochemistry, affinity, dissociation constant, affinity chromatography, immunochemistry techniques
13. Enzyme function, regulation of enzyme activity, enzyme cofactors, enzyme assays, applications in clinical laboratories
14. Transport of material and information across biological membranes, function of major types of receptors (GPCRs, receptor protein kinases, ion channels, nuclear receptors etc.)
15. Basic metabolic pathways (citric acid cycle, glycolysis, gluconeogenesis, fatty acid degradation and biosynthesis, urea cycle) and their regulation
16. Sources of energy, electrons and carbon in metabolism (photo/chemo, organo/litho, auto/hetero -trophs), metabolism of oxygen, ATP synthesis and utilization
17. Coordination of metabolic functions in multicellular organisms I, biochemistry of gastrointestinal tract and liver, lipid distribution and metabolism
18. Coordination of metabolic functions in multicellular organisms II, biochemistry of blood, immune system, nervous system

**TEST AREA: FOOD MICROBIOLOGY**

1. An overview of food, environmentally and industrially important microorganisms, their sources, isolation, identification, cultivation.
2. Growth curve of microorganisms. Calculation of growth rate. Factors influencing microbial growth
3. Principles of thermal inactivation of microorganisms; Regulating the number of microorganisms, pasteurization, D-value, Z-value
4. Classic and modern methods of the quantification of microorganisms
5. Molecular microbiology methods used for identification of food-borne pathogens.
6. EU Legislative rules valid for pathogens presence in foods.
7. Characteristics of members of genus *Salmonella*, pathogenic strains of *Escherichia coli*, *Listeria monocytogenes*, *Bacillus cereus*, *Staphylococcus aureus*
8. Types of bacterial toxins.
9. Micromycetes as food spoilage agents
10. Mycotoxins.
11. Biogenous amines, food spoilage microflora.
12. Lactic acid bacteria and production of cultured dairy products, probiotics, prebiotics.
13. Control of microbiological quality of foods. Sampling, GMP, HACCP

## **TEST AREA: ANALYSIS AND SAFETY OF FOOD**

1. General requirements on testing laboratories concerned with natural products and foods control
2. Quality management in production and testing facilities; ISO, good laboratory practice (GLP)/ good manufacture practice (GMP) principles, certification, inspection, accreditation, auditing
3. Terms and definitions used in analytical chemistry, traceability and uncertainty of measurement results
4. Analytical method selection, validation and documentation; performance criteria; verification procedures; calibration, quality control procedures; interlaboratory comparison,
5. Reporting of test results, compliance with specification assessment; disputing of results
6. Overview of advanced instrumental techniques employed in analysis of natural products and foods, current trends; principles of target analysis and non-target screening, fingerprinting / profiling
7. Sample preparation strategies - choice of isolation, purification, pre-concentration strategy
8. Separation methods - the application potential of gas chromatography, liquid chromatography, electromigration techniques
9. Spectroscopic methods - the application potential of absorption, emission and mass spectrometry
10. Bioanalytical methods - immunochemical techniques, biosensors - advantages and limitations
11. Summary of major groups of compounds associated with the chemical safety
12. Emerging groups of chemical compounds, global protection of the food chain
13. Food additives - the most important group, E-codes
14. Compounds improving durability and sensory quality of food
15. Natural toxic substances - the most important groups, legislative aspects
16. Process contaminants; characterization of the properties of exogenous contaminant and their enter into the food chain
17. Persistent organic pollutants; modern pesticides and veterinary pharmaceuticals, bio products; toxic metals, nitrates, radionuclides

## **OPTIONAL TEST AERAS**

### **A: MANAGEMENT AND CONTROL OF FOOD TECHNOLOGY**

1. Introduction to quality control methods, sampling and sample treatment. Basic methods: gravimetry, volumetry, spectrophotometry, and their applications in the process control
2. Chromatographic and electrophoretic methods and applications in the process control
3. Applications of spectroscopic methods in the process control
4. Basic principles and application of optical methods, X-ray diffraction and microscopic methods in the process control
5. Basic principles and applications of rheology and image analysis in the process control; particle size distribution and colloidal stability
6. Biochemical and microbiological methods in the process control; evaluation of bacterial, yeast and mould cultures used in food industry/ laboratory.
7. The identification of unknown bacteria.
8. Sensory analysis of foods
9. Data processing and statistical the process control
10. Control methods of sugar and chocolate processing; control methods of mill technology and cereal; control methods of starch technology (quality control of potatoes and wheat starch)
11. Control methods of processing of fruit, vegetables, eggs, meat and fish
12. Control methods of processing of oils and fats
13. Control methods of processing of milk (analysis of proteins in dairy products)
14. Functional properties of food packaging

## **B: BIOENGINEERING/BIO TECHNOLOGY**

1. General principles of modeling and simulation; development of dynamic differential balances; mass and energy balancing for bioreactors
2. Factors affecting the growth rate; kinetics of cell growth and product formation
3. Enzyme kinetics and inhibition
4. The fundamentals of biotechnology; structure of bioprocesses
5. Cell cultivation techniques (batch, fed-batch, semicontinuous, continuous); single- and multi-stage culture systems
6. Mixing in biological reactors
7. Aeration and oxygen transfer in bioreactors; measurement of dissolved oxygen
8. Bioreactors and advanced fermentation technologies
9. Substrates for biotechnology and up-stream processing
10. Genetically modified organisms in biotechnologies
11. Microbial production of recombinant proteins
12. Algal biotechnologies
13. Trends in brewing and winemaking
14. Production of biofuels
15. Biological waste air, waste water and soil treatment
16. Safety in biotechnology and its public perception

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