Engineering Final Examination

BIOTECHNOLOGY

Part 1

Good laboratory practice

1. Principles of Good Laboratory Practice.
2. Describe responsibilities of: study director, principal investigator and test facility manager.
3. Type of waste generated in laboratory and principles of its disposal.
4. General guidelines of sampling liquid samples.
5. Techniques to reduce the overall solid sample. Name features of sampled solid material that influence the size of sample.

Biomonitoring and ecotoxicology

6. Microelements and xenobiotics. Describe the influence on functioning of organisms.
7. Lethal dose vs lethal concentration: definitions and differences. Dose-response curve. Toxicity/ecotoxicity indicators.
8. Animal model in toxicity testing. 3R principle.
9. Advantages and disadvantages of alternative testing methods in ecotoxicology.
10. Basic characteristic and application of biosensors in ecotoxicology and biomonitoring.
11. Environmental risk assessment. Objectives and methods.

Environmental monitoring

12. What is deposition and how we can devide it?
13. What is the toxity of a substance and explain what LD50 mean.
14. Explain the concept of smog. How can we divide it?
15. Explain what is the ecological status or potential of surface waters according to Water Framework Directive.
16. What is oxygen sag or oxygen deficite in the stream?

Environment and organisms interactions

17. What is the symbiosis between organisms and what are their types? Give examples.
18. What is biofilm and what are its stages of formation - when is biofilm a problem and when is it beneficial?
19. What is biocorrosion (give 3 examples)?
20. What is bioleaching and where may this process be applied?

Part 2

Industrial microbiology

1. Discuss the key aspects of industrial microbiology.
2. Explain the concept of "biological control agents". Discuss desired (expected) properties.
3. What is the importance of Effective Microorganisms (EM) in industrial microbiology?
4. What should characterize the microorganisms used in industrial microbiology?
5. Successful development of the industrial microbiology (biotechnological) process requires major contributions from a wide range of disciplines. A typical operation involves both upstream processing (USP) and downstream processing (DSP) stages. Explain the concepts USP and DSP?
6. What is HACCP? How and where are industrial microorganisms used for?
7. Discuss the industrial aspect of food fermentation.

Applied molecular biology

8. Present possible ways to use molecular biology tools biology in the field of environmental science (protection or biotechnology).
9. How to choose the best method for DNA extraction from an environmental sample of interest?
10. What makes the polymerase chain reaction so popular and useful in applied molecular biology?
11. How can you increase fluorescence and thus hybrid detection during fluorescence *in situ* hybridization.
12. What are biodiversity indicators used for? What data is needed to determine such indicators.

Biochemistry

13. Transient interactions form the basis of biochemistry and life itself. Give 3 examples of weak interactions which are important in biochemistry. What are benefits of weak interactions?
14. Peptide bond – characteristic and mechanism of proteins synthesis.
15. Proteins: diversity and 4 levels of structure.
16. Instrumental techniques in protein analysis. Describe ELISA tests.
17. Polysaccharides – important structural compounds of living organisms. Give 2 examples of polysaccharides and characterize them briefly.
18. Enzymes: characteristic features and mechanism of catalysis.
19. Describe the role of the TCA cycle in metabolism?
20. How do microbial fuel cells (MFCs) work and what components must they contain?
21. If you were to design a microbial fuel cell (MFC) for what purpose would you want to use it?
22. Explain briefly the chemistry of the bioluminescence phenomenon?
23. List and briefly describe the three general components of operon. Give an example of an known operon.
24. What does it mean that lactose operon is inductible?
25. Draw Michaelis – Menten and Lineweaver-Burk plot showing all types of inhibition.

26. Classification of enzymes. Complete the table.

CLASSIFICATION	REACTION CATALYZED	EXAMPLES
	biological oxidation-reduction reaction in which one compound is oxidized and another is reduced	
		transaminase, kinase
		glycosidases, peptidases, phosphatases
	these are the group of enzymes which catalyzes the removal of specific groups from their substrate and introduce double bonds	
		epimerases, racemases
	catalyzes the joining together of two molecules coupled with the breakdown of phosphate bonds in ATP	

27. List tests that may be used to characterize sugars.

Part 3

Biotechnology in environmental protection and Wastewater biotechnology

1. Discuss and characterize the processes related to nitrogen transformations such as ammonification, nitrification and denitrification.
2. Anammox technology - discuss the conditions of the process, technological solutions and limitations.
3. Characterize the individual phases of anaerobic digestion process.
4. What is the technique of sewage treatment by means of constructed wetlands - where is it used and what are the limitations of this method?
5. Discuss the biological removal of phosphorus from wastewater - what is the process and what conditions must be ensured for this process to run smoothly?
6. In activated sludge wastewater treatment systems, if nitrogen removal is required, nitrification and denitrification chambers are used, with the denitrification chamber usually upstream of the nitrification chamber. Such a system requires the construction of additional recirculation - internal recirculation. Give a reason why the denitrification chamber is usually in front of the nitrification chamber and not vice versa.
7. Heterotrophic and autotrophic bacteria are required to remove nutrients in activated sludge, with the latter having a much lower maximum growth rate than the former. How are bacteria of both types maintained in activated sludge reactors, since, given their higher growth rate, heterotrophic bacteria would completely dominate the activated sludge biocenosis after some time?
8. Some activated sludge wastewater treatment plants have a primary settling tank and others do not. Explain why a primary settling tank is not always built.

Biotechnology of wastes

9. What are the properties of waste for biological treatment?
10. How is waste prepared for biological treatment?
11. Discuss the methods of biological waste treatment
12. Explain the waste composting process.
13. What makes a landfill an anaerobic biological reactor?

Bioremediation of soil

14. What is the role of water (soil moisture) in soil bioremediation?
15. What is the role and importance of organic matter (humus) in the soil?
16. List and discuss the mechanisms of heavy metals removal by microorganisms.
17. Describe the role of soil organisms and the processes they induce.
18. Discuss the general assumptions of bioremediation methods for soil contaminated with heavy metals.
19. Discuss the assumptions of soil bioremediation. List the methods of soil bioremediation contaminated with petroleum products.

Instrumental analysis

20. What is UV / VIS spectroscopy. On any example, discuss the possibilities of its application.
21. Beer-Lambert law - application and deviations from this law (when they can occur - give an example).
22. Describe the basic elements of the structure, principle of operation and application of the total organic carbon analyzer (on any example).
23. What is IR spectroscopy and how can it be applied in practice (on any example)?
24. What is high performance liquid chromatography (HPLC) and what is it used for?