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Siberian Federal University

ENVIRONMENTAL BIOMONITORING

GUIDELINES FOR STUDENTS' INDEPENDENT STUDIES

Krasnoyarsk
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SUNRAISE

СИБИРСКИЙ ФЕДЕРАЛЬНЫЙ УНИВЕРСИТЕТ | SIBERIAN FEDERAL UNIVERSITY

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ENVIRONMENTAL BIOMONITORING. Guidelines for students' independent studies. Textbook [Text] / comp . NV Pakharkova, TL Shashkova. - Krasnoyarsk: SFU Press , 2020. – 28 p.

Assessment of existing and possible future environmental impact to quality of soil, water and air has become very actual. Two fundamentally different approaches are used for this purpose: the physical- chemical and biological. This methodical Tutorial provides guidelines for students' independent studies on the subject "ENVIRONMENTAL BIOMONITORING".

Designed for university teachers and students of Master Degree Program «Environmental Monitoring».

GUIDELINES FOR STUDENTS' INDEPENDENT STUDIES

№	*Independent /Project work*	Workload Credits (hours)
1	Independent familiarization with some of the key concepts, tools and methods as presented in the literature Theoretical course study	0,5 (18)
2	Essay	0,5 (18)

Modules and sections of discipline	**Topics for independent work, (hours)**
Module 1. The principles of organization of biological monitoring	Methods for studying living organisms proposed for the integrated assessment of habitat quality in the framework of biomonitoring (5)
Module 2. Bioindication and bioassay in the Environmental Assessment	Planning of lichenoindication research (4)
	Methods of sampling and sample preparation recommended for ecotoxicological analysis of water, soil and waste (5)
	Hydro-chemical characteristics of the water and their significance for the biological monitoring of water bodies. Problems of regional regulation of water quality. (4)

Essays themes are provided for students at the 2nd and defended at the 5-10th weeks of the course study according to the curriculum of in-class activities and independent work (of the discipline "Biomonitoring of Environment"

Testing system

During the semester, students' progress is tested in different ways. Tests are divided into sections according to themes and modules of the discipline. Final form of control is an exam in the end of the term.

TOPICS FOR INDEPENDENT WORK

TOPIC 1. METHODS FOR STUDYING LIVING ORGANISMS PROPOSED FOR THE INTEGRATED ASSESSMENT OF HABITAT QUALITY IN THE FRAMEWORK OF BIOMONITORING

For practical purposes, you should know how reliable and efficient a particular indicator, so it was proposed to characterize the indicators under the two indices - reliability and relevance.

The accuracy - is the degree of conjugation of the indicator with the indicator object. Considered absolutely reliable indicator of which 100% of the indicating corresponds to an object. To calculate the reliability of taking a certain number of reference sites, where there is necessarily an indicator. Among them there are, where the indicator is found together with the object indicating. The percentage of these sites and areas with display, but without indicating the object is a quantitative indicator of the reliability of the indicator.

If the pairing is more than 90%, and the reliability of more than 9, the indicator is considered to be reliable. Satisfactory indicator will be if contingency is 75 - 90%, and the reliability is in the range of 3 - 9 doubtful indicator is considered when the contingency is 60 - 75%, and the confidence index is 1.5 – 3.

In assessing the level of pollution ecosystems usually use different criteria, the most common of which are characteristics of the species composition, species abundance and living condition of individuals belonging to the community. These two criteria are closely linked, because the comparison communities only on the composition of the existing types without reference to their abundance is

approximate, reconnaissance evaluation. For an objective comparison of the two sites in the same biotope using different codes.

For bio-indication of air pollution or soil used Jaccard coefficient, defined as the number of species common to the two sites, expressed as a percentage of the total number of species. Another well-known coefficient is the name of the community Sorensen, however, was first proposed Chekanovsky. An important requirement in conducting comparative assessments of biocenosis is the use of statistical tests, so the number of repetitions of the compared sites and the value of space should be defined by statistical criteria.

To assess the levels of ecosystem's pollution can be used different indices of species diversity. Better are those diversity indices that do not depend on the size of the sample, show the relative importance of species in the community and are dimensionless. Typically use the Shannon index (Shannon-Wiener) H '. Diversity H 'Shannon-Wiener mathematically characterizes two parameters cenosis - the number of species and the uniformity of their population (number of individuals or their quantitative proportion).

Book in English:

Biomonitoring: General and Applied Aspects on Regional and Global Scales / C. A. Burga, A. Kratochwil ISBN: 978-90-481-5621-4 (Print) 978-94-015-9686-2 (Online)

http://link.springer.com/book/10.1007/978-94-015-9686-2

Books in Russian:

1. Биологический контроль окружающей среды: биоиндикация и биотестирование [Текст]: учеб. пособие для вузов /О.П.Мелехова [и др.]; под ред.О.П.Мелеховой и Е.И.Егоровой. – М.: Издательский центр «Академия», 2007. – 288 с.

2. Е.И. Егорова, В.И. Белолипецкая. Биотестирование и биоиндикация окружающей среды. Учебное пособие по курсу «Биотестирование». Обнинск: ИАТЭ, 2000 г. - 84 с.

Test your knowledge:

1) How is the degree of conjugation of the indicator with the indicator object?
2) For what values of proximity and confidence Bioindication is impossible?
3) In what cases, we can use in biomonitoring index Shannon-Wiener?
4) What are the similarities and differences between the coefficient of Jaccard and index of biotic dispersion Sorensen?

TOPIC 2. PLANNING OF LICHENOINDICATION RESEARCH

Lichenoindication is a method of determining the degree of atmospheric pollution using lichens as bio-indicator organisms. Lichenoindication method enables integrated assessment of air pollution of sufficiently large areas (from a town neighborhoods to a country size), zoning them according to the degree of air pollution.

Depending on the habitat of lichens are divided into the following ecological groups: epigeic (on the soil), saxicolous(on the rocks), epiphytic (on the bark of trees), epixylic (for debarked wood), epiphyllous (on the leaves of evergreens).Lichens are very sensitive to pollutants, due to the peculiarities of their morphophysiology: photobiont vulnerability, lack of protective covers, the lack of isolation, lack of ability to regulate gas and water exchange, requirements to acidity of the substrate, etc

Results of lichenoindication mapping of territory depend on the specific tasks and competent collection of the test material. For this purpose, you can use both directions of the method: passive and active (transplant) lichenoindication.

The general plan of research during lichenoindication mapping the territory:

1: Determination of species diversity and relative abundance of lichens;

2 Study of the structure of lichen groups, features of the distribution of certain types of lichens, projective cover, etc.;

3 Ranking of these species in the degree of sensitivity to air pollution.

4 Evaluating mathematical indices;

5 Experiments on transplantation lichenoindication.

At lichenoindication study of the effect of industrial enterprises on the environment necessary to consider the specifics of the substances that make up the waste products, the height of the chimneys, the operating mode of the enterprise, and etc.. Very important characteristic meteorological conditions, particularly in the case of short-term studies of transplant methods lichenoindication.

For studying of big territory more convenient to keep a record of several informative lichen species with well-studied ecological features.

Book in English:

Protocols in Lichenology. Culturing, Biochemistry, Ecophysiology and Use in Biomonitoring / Ilse C. Kranner, Richard P. Beckett, Ajit K. Varma ISBN:978-3-642-56359-1(Online) http://link.springer.com/book/10.1007/978-3-642-56359-1

Books in Russian:

1. Биологический контроль окружающей среды: биоиндикация и биотестирование [Текст]: учеб. пособие для вузов /О.П.Мелехова [и др.]; под ред.О.П.Мелеховой и Е.И.Егоровой. – М.: Издательский центр «Академия», 2007. – 288 с.

2. Бязров Л.Г. Лишайники в экологическом мониторинге / М.: Научный мир, 2002. - 336 с.

3. Шкараба Е.М., Селиванов А.Е. Использование лишайников в качестве индикаторов загрязнения окружающей среды: Учебное пособие. - Пермь. Изд. ПГПУ, 2001.

4. Трасс Х.Х. Трансплантационные методы лихеноиндикации / Х.Х. Трасс // Проблемы экологического мониторинга и моделирования экосистем: Т. 8. - Л.: Гидрометеоиздат, 1985. - С. 140-144.

Test your knowledge:

1 Suggest a set of measures lichenoindication explore the surrounding area of the industrial enterprise.

2 What specific factors should be considered when planning lichenoindication research in the area of industrial enterprises?

3 What the variants of passive lichenoindication techniques can be used in large-scale studies?

TOPIC 3. METHODS OF SAMPLING AND SAMPLE PREPARATION RECOMMENDED FOR ECOTOXICOLOGICAL ANALYSIS OF WATER, SOIL AND WASTE

Sampling, storage and transportation should be carry out correctly, to obtain reliable information on the composition of the test sample. Therefore it is recommended to entrust the sampling procedure specialist in this field. In the case of self-reliant sampling is necessary to follow the rules that are prescribed in the state standards.

Sampling is a crucial moment in the research of state of the natural environment. The slightest deviation from the recommended methods or inaccuracy in sampling leads to large errors, or the utter uselessness of the results of measurements. Therefore, it is necessary to strictly follow all the provisions of guidelines and guidelines developed for the sampling, storage and transport of samples to the laboratory and sample preparation for analysis.

Storage of samples is complicated by the problem of loss contained in these materials due to adsorption on the walls of vessels, as well as the destruction in solvents and on the surfaces of the carrier under the influence of oxygen, light and other environmental factors. Oxidation and reduction processes, biochemical processes involving bacteria and other biological objects living in it, as well as the physical and physico-chemical processes of sorption, sedimentation occur in the water. Since the dissolved oxygen can be consumed for oxidation of organic substances and accordingly the organoleptic properties of water such as odor, taste, color, turbidity may vary.

Some elements (iron, aluminum, copper, cadmium, manganese, chromium, zinc, phosphates, etc.) and their compounds have the ability to easy adsorb onto the walls of vessels.

On the other hand, a number of trace elements (boron, silicon, sodium, potassium, etc.) may leach out of glass (particularly dark) or plastic bottles. These processes are sometimes quite significant impact on the deterioration of the reliability and accuracy of the subsequent analysis, however, this group of technological procedures of storage and stabilizing samples for eco-analytical control is essential.

Application of field express methods of analysis "*in situ*" helps to avoid many of the complications related to changes in the state of samples analyzed, but it is not always possible. Therefore, it is necessary to have an understanding of the processes taking place in the media during the storage of samples, as well as to know the rules for its correct implementation.

Books in English:

Biomonitoring of Water and Waste Water / Anju Agrawal, Krishna Gopal ISBN: 978-81-322-0864-8 (Online)

http://link.springer.com/book/10.1007/978-81-322-0864-8

Biomonitoring: General and Applied Aspects on Regional and Global Scales / C. A. Burga, A. Kratochwil ISBN: 978-90-481-5621-4 (Print) 978-94-015-9686-2 (Online)

http://link.springer.com/book/10.1007/978-94-015-9686-2

Books in Russian:

1. ГОСТ Р 51592-2000: Вода. Общие требования к отбору проб
2. ГОСТ Р 51593-2000 Вода питьевая. Отбор проб
3. ГОСТ 17.1.5.05-85 Охрана природы. Гидросфера. Общие требования к отбору проб поверхностных и морских вод, льда и атмосферных осадков

4. ГОСТ 17.1.5.04-81 Охрана природы. Гидросфера. Приборы и устройства для отбора, первичной обработки и хранения проб природных вод. Общие технические условия

5. НВН 33-5.3.01-85 Инструкция по отбору проб для анализа сточных вод.

6. ГОСТ 12071-84: Грунты. Отбор, упаковка, транспортирование и хранение образцов

7. ГОСТ 27753.1-88 Грунты тепличные. Методы отбора проб

8. ГОСТ 17.4.3.01-83 ОХРАНА ПРИРОДЫ. Почвы. Общие требования к отбору проб

9. ГОСТ 17.4.4.02-84 Охрана природы. Почвы. Методы отбора и подготовки проб для химического, бактериологического, гельминтологического анализа

10. ГОСТ 28192-89 - Отходы цветных металлов и сплавов. Методы отбора, подготовки проб и методы испытаний

11. ПНД Ф 12.1:2:2.2:2.3.2-03 Отбор проб почв, Грунтов, осадков биологических очистных сооружений, шламов промышленных сточных вод, донных отложений искусственно созданных водоемов, прудов-накопителей и гидрохимических сооружений / Методические рекомендации допущены для целей государственного экологического контроля.

12. ПНД Ф 14.1:2:4.12-06 16.1:2.3.3.9-06 Методика определения токсичности водных вытяжек из почв, осадков сточных вод и отходов, питьевой, сточной, природной воды по смертности тест-объекта Daphnia magna Straus [Текст]: метод. Пособие / Ю.С. Григорьев, Т.Л. Шашкова. - Москва, 2006. - 44 с.

13. А.Г. Муравьев Руководство по определению показателей качества воды полевыми методами http://www.anchem.ru/literature/books/muraviev/content.asp

14. Отбор проб воды и их консервация. http://www.anchem.ru/literature/books/muraviev/014.asp

15. Технология и средства контроля загрязнения окружающей среды http://ecodelo.org/taxonomy/term/455

16. Якунина, И.В. Методы и приборы контроля окружающей среды. Экологический мониторинг: учебное пособие / И.В. Якунина, Н.С. Попов. Тамбов: Изд-во Тамб. гос. техн. ун-та, 2009. – 188 с.

Test your knowledge:

1. What devices are used for sampling sediment, surface water, ice, precipitation?
2. How to store and transport water samples?
3. How to store and transport soil samples?
4. How to take samples of contaminated soil?
5. How to prepare soil samples for analysis?
6. What is the procedure of sample preparation for biological analysis of waste?

TOPIC 4. HYDRO-CHEMICAL CHARACTERISTICS OF THE WATER AND THEIR SIGNIFICANCE FOR THE BIOLOGICAL MONITORING OF WATER BODIES. PROBLEMS OF REGIONAL REGULATION OF WATER QUALITY.

Various natural waters can be very different from each other. Parameters such as the depth of the water, flow rate, acid-base properties of water, turbidity, oxygen and temperature conditions, the amount of dissolved organic matter, nitrogen and phosphorus compounds, and many other effects on aquatic flora and fauna. All of these parameters are influenced by both anthropogenic stress, and the natural processes that occur in water bodies.

Formation of chemical composition of natural waters is determined by two groups of factors:

- *direct factors* - those that directly affect the water (that is, the effect of substances that can enrich the water with dissolved compounds, or, conversely, to

allocate them from the water): the composition of rocks, living organisms, human activities;

- *indirect factors* that determine the conditions in which the interaction of substances with water takes place: climate, topography, hydrology, vegetation, hydrological and hydrodynamic conditions etc.

Factors that determine the chemical composition of natural waters should be divided into the following groups according to the nature of its effects:

- physical and geographical (relief, climate, weathering, soil cover);
- geological (rocks composition, the tectonic structure, hydrogeological conditions);
- physico-chemical (chemical properties of elements, acid-base and redox conditions, a mixture of water and cation exchange);
- biological (activity of plants and living organisms);
- anthropogenic (all factors associated with human activity).

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http://link.springer.com/book/10.1007/978-94-015-9686-2

Books in Russian:

1. Брагинский, Л.П. К методике токсикологического эксперимента с тяжелыми металлами на гидробионтах / Л.П. Брагинский, П.Н. Линник // Гидробиол. журн. – 2003. - Т. 39. - № 1. - С. 92-104.

2. Булгаков, Н.Г. Индикация состояния природных экосистем и нормирование факторов окружающей среды. Обзор существующих подходов. / Н.Г. Булгаков // Успехи современной биологии. - 2002. – Т. 122. - №2. – С.115-135.

3. Григорьев Ю.С., Власова Е.С., Шашкова Т.Л. Биодоступность загрязняющих веществ в водных объектах и проблема регионального нормирования. // Материалы III Всероссийской конференции по водной токсикологии, посвященной памяти Б.А. Флерова, «Антропогенное влияние на водные организмы и экосистемы», конференции по гидроэкологии «Критерии оценки качества вод и методы нормирования антропогенных нагрузок». Часть 3. – Борок, 2008. – стр. 168-171.

4. Гидрохимические показатели состояния окружающей среды (Текст): справочные материалы / под ред. Т.В. Гусевой. – М.: ФОРУМ: ИНФРА-М, 2007. – 192 с.

5. Моисеенко, Т.И. Рассеянные элементы в поверхностных водах суши: Технофильность, биоаккумуляция и экотоксикология (Текст): науч. изд. / Т.И. Моисеенко, Л.П. Кудрявцева, Н.А. Гашкина. – Ин-т вод. Проблем РАН. – М.: Наука, 2006. – 261 с.

6. Озёра и другие водоёмы. всё о гидрологии суши. http://ozero.com/

7. Филенко, О.Ф. Биологические методы в контроле качества окружающей среды / О.Ф. Филенко // Экологические системы и приборы. - 2007. - № 6. – С. 18-20.

Test your knowledge:

1. What does determine the composition of natural waters?
2. Why is the background level of chemicals in the water different in different regions?
3. What is the significance description of the hydro-chemical properties of the water body for biological analysis?
4. Why does the same concentration of the pollutant in a sample of water from different water bodies cause a variety of toxic effects on the test organism?

Additional information can be found at the following sites:

General issues of biomonitoring

1. http://www.green.unibel.by/greenphone/monitoring.htm

2. http://www.bioassay.narod.ru/biot.htm
3. http://kspu.kaluga.ru/biomon/direction/vidbio.htm

Biomonitoring of soil pollution

4. http://www.eco-edu.spb.ru/help/341.html
5. http://www.eco-edu.spb.ru/help/349.html
6. http://www.green.unibel.by/greenphone/monitoring.htm
7. http://www.nsu.ru/community/nature/books/Obr3-4/15.htm
8. http://www.bioassay.narod.ru/biot.htm
9. http://webcenter.ru/~duckweed/index.htm
10. http://www.nsu.ru/community/nature/books/Obr3-4/14.htm
11. http://www.nsu.ru/community/nature/books/Obr3-4/15.htm
12. http://www.green.unibel.by/greenphone/monitoring.htm
13. http://soils.usda.gov/sqi/kit2.html
14. http://www.bionet.schule.de/schulen/novaky/living_water/en/soilqual.htm

Biomonitoring of air pollution

15. http://ib.komisc.ru/t/ru/ir/vt/02-57/06.html
16. http://www.nsu.ru/community/nature/books/Obr3-4/13.htm
17. http://www.eco-edu.spb.ru/help/323.html
18. http://www.green.unibel.by/greenphone/monitoring.htm
19. http://www.nsu.ru/community/nature/books/Obr3-4/14.htm
20. http://www.epa.gov/epahome/Standards.html
21. http://ecolu-%20info.unige.ch/~haurie/mutate/Mutate_final/Lectures/Lect_2_4_4/lect_2_4_4.htm
22. http://www.dnr.state.oh.us/forestry/health/lichen/lichenstudy.htm

Biomonitoring of water pollution

23. http://herba.msu.ru/algae/3.html
24. http://www.green.unibel.by/greenphone/monitoring.htm
25. http://webcenter.ru/~duckweed/index.htm

26. http://www.eco-edu.spb.ru/help/332.html
27. http://www.bioassay.narod.ru/biot.htm
28. http://www.edu.yar.ru/russian/misc/eco_page/bioind/princip/osn.html
29. http://phm.bio.msu.ru/groups/ibs2.html
30. http://www.mobot.org/jwcross/duckweed/
31. http://www.epa.gov/epahome/Standards.html
32. http://usacehr.detrick.army.mil/aeam/Methods/Fish_Bio/default.asp
33. http://www.urbanfischer.de/journals/baecol/baecol.htm
34. http://www.mermayde.nl/mosselmonitor.html
35. http://www.aces.edu/waterquality/articles/0103001/0103001.htm.
36. http://community.middlebury.edu/~trombula/PaCE%20Site/BI140Web/2000.Projects/MRInverts/MRInverts_index.html

Test questions

1. Toxicity is …

a) property of chemicals to damage or have lethal effects on living organisms;
b) the degree of change in the probability or rate of adverse effects occurrence at a certain degree of change of substance concentration
c) those adverse effects that result from the interaction of organisms, harmful substances and environmental conditions
d) the value inverse to quantity of toxicant at a time

2. _____ is a method of investigation in which the quality of an environment and factors acting alone or in combination with others, are estimated by the survival rate, the state and behavior of organisms that are placed purposefully in this environment

3. Vital functions or toxicity criteria describing response of test object to the damaging effects of the environment are_____

4. Any change of index of vital activity or body functions upon exposure of toxicants is called _____

5. Test object is …

a) an object of the environment, selected for analysis of toxicity in laboratory conditions
b) an organism that is used for assessing the toxicity of chemicals, water and sewage, soil, sediments, feed, etc.
c) a function of an organism used in the bioassay as a response to the damaging effects of the environment
d) a complex of living organisms cultured in the laboratory and used for bioassay

6. Toxicity Criterion – it is …

a) qualitative change of test functions of an organism, based on which a conclusion of the toxicity of environment object is made
b) a reliable quantitative value of the test parameter (test function), based on which a conclusion of the toxicity of environment object is made
c) a parameter of test organism, change of which gives a reliable answer about the toxicity of a test sample

7. Correlate test organisms according to their location in the trophic chain of the aquatic ecosystem

1. organisms at the first trophic level	a) Bivalves
2. organisms at the second trophic level	b) Chlorella
3. organisms at the third trophic level	C) The guppy
	d) Lemna minor
	e) Daphnia
	f) Paramecium caudatum
	g) Rainbow trout

8. _____are bioassays of new generation, based on the process of test-organisms leaving a resting stage

a) biosensors
b) biomarkers
c) toxcyst tests
D) toxkit microbiotests

9. Bioassay as a method for evaluation of aquatic toxicity is used:

a) to obtain a forecast of changes in water bodies, which are under regular human impact
b) to control accidental discharges of highly toxic wastewater
c) to control toxic waste water given to biological type of treatment plants in order to prevent infiltration of hazardous substances to the biocenosis of activated sludge
d) to determine the composition and properties of potential water pollutants
E) to make environmental assessment of new materials, clean technologies, projects of sewage treatment plants, etc.

10. For determination the class of waste hazard original sample should be diluted in the following series of multiplicity:

a) 1, 2, 4, 8, 16 times
b) 1, 3, 9, 27, 81 times
c) 1, 5, 25, 125, 625 times
d) 1, 10, 100, 1000, 10000 times

11. Bioassays designed to detect long-term effects of toxicants are _____

a) acute
b) temporary
c) stationary

d) chronic

12. Requirements to biotests:

a) sensitivity

b) variety of responses

c) speed of response

d) clear response to external influences

e) promptness

13. Problems that are solved by water systems bioassay:

a) determination of the optimal water temperature

b) detection of the degree and nature of water toxicity with the help of hydrobionts

c) assessment of potential water hazards to aquatic and other organisms

d) finding a good water-salt balance

14. Reasons for selecting phototrophic organisms as test objects for water bioassay. It is:

a) the primary level of the food chain in bodies of water

b) the main target of the toxic anthropogenic effects

c) the ability to accurate identification of species

d) lack of protective integuments

e) high sensitivity to the effects of heavy metals

15. Fluorescence on the basis of which at the department ecotoxicology and microbiology of SFU developed and patented a method of estimating toxic chemicals, using thermophilic strain of microalgae *Chlorella vulgaris* bejer as a test object is …

a) variable

b) fast

c) delayed

d) spontaneous

16. Indicators, which usually characterize mortality (or survival) as toxicity criteria - ....

a) LC_{50}

b) CL_{50}

c) 50_{LC}

d) 50_{LC}

17. Invertebrate animals, most often used in bioassay of water pollution are ...

a) daphnia

b) *Dytiscidae*

c) water strider

d) mosquito larvae

18. Death of what percent of daphnia is a criterion of acute toxicity, provided that of death rate does not exceed 10% - ...

a) 30%

b) 40%

c) 50%

d) 50% and more

19. Food types of crustaceans, which play the main role in trophodynamics - ...

a) predators

b) parasites

c) filter feeders

d) scavengers

20. Apparatuses used for filter feeding animals*:*

a) means for making a flow of water through the filter and release of filtered water

b) filtration apparatus, retaining the particles suspended in water

c) Apparatuses for collecting the filtered food from the filter and transporting it to the oral aperture

d) an analogue of teeth for chewing food

e) are different in structure of bristles

21. Consequences of reduction of number of filter feeders in the water:

a) fish poisoning

b) the death of algae

c) disorder of food chains

d) water pollution by organic substances

22. Culture test organism the crustacean of which have similar levels of resistance to toxic substances, get mature, and make genetic homogeneity brood simultaneously are called _____.

23. Factors that affects the degree of heavy metals toxicity in the water:

a) concentration and duration of exposure

b) the number of live organisms in the water body

c) water pH

d) hardness of water

e) water temperature

24. Type of interaction in most cases polluters (chemicals) act - ...

a) synergy

b) antagonism

c) summation

d) neutralism

25. Sequence of response phase of living aquatic ecosystem to chemical exposure:

a) depression

b) indifference

c) death

d) stimulation

26. Algae cultures recommended for bioassay of fresh water environment:

a) Selenastrum capricornutum

b) Scenodesmus quadrangula

c) Phaeodactylum tricornutum

d) Chlorella vulgaris

e) Skeletonema costatum

27. Type of water bodies with abundant organic substances is called - ...

a) oligotrophic

b) mesotrophic

c) eutrophic

d) dystrophic

28. Most developed system of evaluation of water pollution degree by indicator organisms is the system of _____

29. Combined effect of factors the result of which exceeds the effect of each component and the sum of their individual effects - _____.

30. Environmental monitoring includes the following activities:

a) systematic observations of the state of ecosystems and human impact on it

b) analysis and generalization of measured data

c) assessment of the changes

d) the calculation of current payments

e) forecast of the consequences

31. Locations of compliance of control of limits of emissions to the atmosphere:

a) directly at the place of emission

b) in a suburban area

c) at selected control points (posts) checking actual air pollution

d) in mostly densely populated areas

32. Three categories of monitoring stations by the degree of organization:

a) stationary

b) walking

c) routing

d) mobile

33. Legally acceptable level of environmental pollution by chemicals determines the is called _____

34. _____ are foreign substance founds within living organisms which have with toxic properties

a) xenobiotics

b) thiol toxins

c) superecotoxicants

d) ecotoxicants

35. _____ is visible luminescence of living organisms resulting from their life processes and conditioned by enzymatic oxidation of a special ingredients

36. Organisms which often cause luminescence of multicellular organisms (crustaceans, insects, fish, etc.) - ...

a) symbiotic bacteria

b) protozoa

c) algae

d) viruses

37. Source of energy for bioluminescence - ...

a) physical processes

b) radiation from the sun

c) shortwave radiation

d) chemical reaction

38. Compliance of processes and their sources:

1) Bioluminescence	a) occurs upon electronic excitation of molecules of chlorophyll that absorb UV light and then emit a photon
2) Fluorescence	b) radiation of living organisms in the UV part of the spectrum
	c) the visible luminescence of living organisms associated with of life processes

39. A chemical element, which initiates releases of energy during hydrolysis of ATP required to activate luciferase system is called - ...

a. hydrogen

b. nitrogen

c. oxygen

d. fluorine

40. The luminescence intensity_____when samples with toxic compounds are introduced into the reaction mixture

a. increases

b. remains unchanged

c. decreases

d. first increases, then decreases

41. Toxic compounds of heavy metals - ...

a. xenobiotics

b. thiol toxins

c. superecotoxicants

d. ecotoxicants

42. The wavelength at which organisms containing chlorophyll mostly emit - ...

a. 690 nm

b. 670 nm

c. 630 nm

d. 600 nm

43. The amount of energy spent on processes of growth of individuals in a stressful environment in comparison with the optimal one ...

a. is always lower

b. is always higher

c. is equally

d. varies

44. Relate the type of pollutants to the result of the effect on humans:

1) mutagens	a) cause malformations in embryos and growing organisms
2) fibrogens	b) induce allergic reactions: itching,

asthma and others

3) allergens

c) induce benign tumors

d) change information of generative and somatic cells

45. Embryotoxic effect of substances - ...

a. early embryonic death

b. genetically fixed mutations resulting from adverse effects on chromosomes of generative cell

c. the occurrence of deformities as a result of violations of embryonic development

d. neoplasm of cells

46. Result of the impact of pollutants on cellular and subcellular levels of biomonitoring:

a. change of cell size

b. disturbance of physiological processes in cells

c. accumulation of hazardous substances

d. changes in concentration and activity of macromolecules

e. cell division

f. violation of membranes

47. Pigment changes that occur in plant cells under pollution:

a. increase the amount of carotenoids

b. increase the chlorophyll content

c. reduce the ratio of chlorophyll a / chlorophyll b

d. reduce chlorophyll content

48. The concentration of soluble protein in the cell under pollution...

a. decreases

b. first decreases and then increases

c. first increases and then decreases

d. increases

49. Criteria of plants used for bioindication at organism level:

a. change the color of leaves

b. necrosis

c. gene changes

d. defoliation

e. changes in vitality

f. changes in fertility

50. _____ - is pale leaf color between the veins

51. Changes of leaves of deciduous trees observed when soil is saline by chlorides - ...

a. yellowing of the plots

b. silver coloring

c. redness associated with the accumulation of anthocyanin

d. browning or getting bronze

52. Types of necrosis formed on tobacco exposed to ozone - ...

a dotted and spotted

b) interveinal

c) edge

d) apical

53. Types necrosis formed under the influence of sulfur dioxide gas - ...

a) point and spotted

b) interveinal

c) edge

d) apical

54. Groups of animals the most often used for bioindication:

a) mammals

b) insects

c) molluscs

d) birds

55. _____ - is the detection and determination of biologically and environmentally significant anthropogenic load based on reactions of living organisms and their communities

56. Organisms or communities of organisms, vital functions of which are so closely correlated with certain environmental factors that may be used to assess them, are called _____.

57. Sensitivity of ecosystem components to the toxic effects of pollutants (rate them from maximum sensitivity to minimum):

a) forest herbs

b) ants

c) the population of mammals

d) lichens

58. Features typical for plants in areas with high concentrations of the gaseous emissions:

a) reduction of the root system

b) main axes of shoots are creeping

c) closely spaced narrow leaves

d) a small plant height

e) good storage ability

59. Basic criteria used for test organism selection:

a) the ability of species to inhabit only certain places

b) sensitivity to pollution

c) widespread distribution of the species

d) a narrow range of conditions favorable for vital functions of the species

e) a specific response to certain types of pollution

f) a short life cycle

g) easily detectable response (test function)

h) simple cultivation in laboratory

i) long life of the organism