



MODERN DEVELOPMENT OF BIOTECHNOLOGIES OF WASTEWATER TREATMENT AND BIOENERGY Syllabus

Details of the discipline

Level of higher education	<i>Third (educational and scientific)</i>
Branch of knowledge	<i>16 Chemical and bioengineering</i>
Specialty	<i>163 Biomedical Engineering</i>
Educational program	<i>Biotechnology</i>
Discipline status	<i>Selective</i>
Form of study	<i>Extramural studies</i>
Year of preparation, semester	<i>2nd year, autumn semester</i>
The scope of discipline	<i>5 credits</i>
Semester control / control measures	<i>Exam / modular test</i>
Lessons schedule	<i>Lectures: 6 hour; practical classes: 2 hour / according to the schedule</i>
Language of teaching	<i>Ukrainian</i>
Information about course leader / teachers	<i>Lecturer: Associate Professor Kateryna Shchurska, shchurska.kateryna@lll.kpi.ua, @shchurska (telegram) Seminars: Associate Professor Kateryna Shchurska, shchurska.kateryna@lll.kpi.ua, @shchurska (telegram)</i>
Course placement	<i>Google classroom course code qxzcla3</i>

Curriculum of the discipline

1. Description of the discipline, its purpose, subject of study and learning outcomes

Description of the discipline.

The purpose of the discipline. The aim of the course is to form in students of the degree of Doctor of Philosophy the ability to master the areas of application of biotechnology of waste processing and combating environmental pollution, as well as the use of bioenergy technologies for energy and biofuels.

Subject of academic discipline: modern biotechnologies of waste processing (domestic, industrial, agricultural) and technologies of production and use of biofuels

Program learning outcomes.

- be able to determine the negative impact of waste of various origins on the environment;

- know the main traditional and alternative methods of waste disposal and ways to obtain valuable products from them;
- know the biotechnology of biogas production by anaerobic digestion of organic waste;
- have an idea of the directions of biotechnological processing of hazardous waste; know the methods of biological wastewater treatment;
- know the technology of obtaining liquid and solid biofuels.

2. Prerequisites and postrequisites of the discipline (place in the structural and logical scheme of education according to the relevant educational program)

Prerequisites: have basic knowledge of ecology, biotechnology, methods of analysis, renewable energy, biology, chemistry, level of English language proficiency not lower than A2.

Post-requisites: knowledge obtained on the basis of this course, graduates of the degree of Doctor of Philosophy are used in choosing the topic of scientific work, conducting research on the structure and properties of biological objects, as well as in research work in laboratories and research institutes.

3. The content of the discipline

Section 1. MODERN DEVELOPMENT OF BIOTECHNOLOGIES OF DOMESTIC WASTEWATER TREATMENT

Section 2. MODERN DEVELOPMENT OF BIOTECHNOLOGIES OF INDUSTRIAL WASTEWATER TREATMENT

Section 3. MODERN DEVELOPMENT AND TECHNOLOGIES OF BIOENERGY

4. Training materials and resources

Basic literature:

1. Magram S. F. Worldwide solid waste recycling strategies: A review. Indian Journal of Science and Technology. 2011.Vol. 4 No. 6. P. 692 – 702.
2. Hussein I. Abdel-Shafy, Mona S.M. Mansour Solid waste issue: Sources, composition, disposal, recycling, and valorization. Egyptian Journal of Petroleum. 2018. Volume 27, Issue 4, P. 1275-1290.
3. Tchobanoglous G., Kreith F. Handbook of Solid Waste Management 2nd Edition.– McGraw-Hill Education, 2002. – 834 p.
4. Bio-based fertilizers: A practical approach towards circular economy / K.Chojnackaa. K. Moustakasb, A. Witek-Krowiakc – Bioresource Technology 2020. - 295, P. 1- 9.
5. Sperling M. Basic Principles of Wastewater Treatment. IWA Publishing. 2007. 200 p.
6. Developing Integrated Solid Waste Management Plan. Training Manual. Vol. 4: ISWM Plan. 2009. 176 p.
7. Prasad, Shiv & Rathore, Dheeraj & Singh, Anoop. (2017). Recent Advances in Biogas Production. Chemical Engineering & Process Techniques. 3. 1038..
8. Wang, L.K., Pereira, N.C., Hung, Y.-T., Shamma, N.K. Biological Treatment Processes Volume 8.: Humana Press., 2009. –836 p.

9. Dahiya A. *Bioenergy* 1st Edition Biomass to Biofuels /– Elsevier, 2014. – 670 p.
10. Singh A., Dheeraj R. *Biohydrogen Production: Sustainability of Current Technology and Future Perspective*. – Springer India, 2017. – 320 p.
11. Wu Y., Zhao F., Liu S., etc. *Bioenergy production and environmental impacts* [Electronic resource]: <https://link.springer.com/article/10.1186/s40562-018-0114-y>
12. Popp J. *The effect of bioenergy expansion: Food, energy, and environment* / J. Popp, Z. Lakner, M. Harangi-Rákos, M. Fáric // *Renewable and Sustainable Energy Reviews*. – 2014. – V. 32. – P. 559-578.
13. *Bioenergy and environment*/ edited by J. Pasztor, L. A. Kristoferson. – Oxford: Westview Press. – 419 p.
14. REMAP – 2030. *Prospects for the development of renewable energy in Ukraine until 2030* / International Renewable Energy Agency IRENA. - 2015. - 57 pages. - Electron. dan. - Access mode: <http://irena.org/remap>.
15. Piet Lens (2011) *Biofilms for environmental biotechnology in support of*
16. *Sustainable development: A report*, Virulence, 2:5, 490-489, DOI: 10.4161/viru.2.5.17758.

Information resources

1. Scientific and Technical Center "Biomass" // Access mode: <http://biomass.kiev.ua/> -
2. UkrNCEM [Electronic resource] // Access mode: <http://www.sea.gov.ua>.
3. Regulatory framework [Electronic resource] // Access mode: <http://zakon.rada.gov.ua>.
4. Ukrecoresursy [Electronic resource] // Access mode: <http://uecr.gov.ua/>
5. Bioenergy Association of Ukraine [Electronic resource] // Access mode: <http://www.uabio.org/>

Educational content

5. Methods of mastering the discipline (educational component)

5.1. Lectures

№ з/п	The title of the lecture topic and a list of key issues
Section 1. MODERN DEVELOPMENT OF BIOTECHNOLOGIES OF DOMESTIC WASTEWATER TREATMENT	
1.	Waste, their classification. Regulatory framework for waste management. Biotechnology of household waste processing Literature: 1-3.
2.	Modern development of biotechnologies of industrial wastewater treatment Biotechnology processing of organic waste from the food industry. Biological leaching of metals from waste. Biotechnology of processing of organic waste of agriculture. Biological treatment of industrial emissions into the atmosphere Literature: 3 - 7.

3.	Modern development and technologies of bioenergy. Bioenergy as a component of the energy field. Biomass as a raw material for bioenergy production. Modern biotechnologies of biofuel production Literature: 9 – 13.
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5.2. Seminars

№ з/п	The name of the topic of the lesson and a list of main questions	Number of aud. hours
1.	Use of biofilms in ecological biotechnologies Literature: 15.	2

6. Independent student work

№	The name of the topic submitted for self-study	Number of hours
1.	Waste sorting at the level of consumers (population). <i>Literature: 1, 2</i>	3
2.	Mechanisms of biological transformation of organic compounds of waste. <i>Literature: 2, 3.</i>	4
3.	Waste of industrial enterprises and their utilization. <i>Literature: 4</i>	4
4.	The state of bioleaching. <i>Literature: 5, 6, 8</i>	6
5.	Enzymatic removal of biofilms <i>Literature: 15.</i>	6
6.	Cleaning of industrial emissions in scrubbers. <i>Literature: 3.</i>	6
7.	Successful examples of bioenergy projects in the world. <i>Literature: 13, 14.</i>	6
8.	Problems of development of third generation biofuels. <i>Literature: 11 - 13.</i>	6
9.	Technological features of cellulases application in cellulose bioconversion processes <i>Literature: 11 – 13.</i>	5

№	The name of the topic submitted for self-study	Number of hours
10.	Remediation of soils contaminated with industrial waste <i>Literature: 1, 2,</i>	6
11.	Biotechnology of hazardous waste management, including toxic, radioactive <i>Literature: 4, 6.</i>	6
12.	Utilization of industrial wastewater sludge. <i>Literature: 1, 4.</i>	6
13.	Mechanism of integrated waste management <i>Literature: 1, 2.</i>	6
14.	Selection of special stamps of microorganisms capable of destruction of synthetic polymers <i>Literature: 8</i>	6
15.	Phytoremediation measures at closed landfills SHW <i>Literature: 1, 4.</i>	4
16.	Biotransformation of biological substances in the body of the landfill. <i>Literature: 2, 3.</i>	4
17.	Wastes of woodworking enterprises and methods of their processing. <i>Literature: 14</i>	4
18.	Ecological aspects of bioethanol production (methods of alcohol bard processing). <i>Literature: 12,</i>	4
19.	Technological features of the biodiesel production process using microalgae. <i>Literature: 5, 6</i>	4
20.	Photobionics - the creation of artificial systems of biohydrogen. <i>Literature: 4, 11</i>	4
21.	Search for new technological solutions and biological agents to overcome the problems of bioenergy. <i>Literature: 8</i>	4
22.	The use of ash from incinerators in industry.	4

№	The name of the topic submitted for self-study	Number of hours
	<i>Literature: 4, 5</i>	
23.	Modular control work	4
24.	Preparation for the exam	30

Policy and control

7. Policy of academic discipline (educational component)

The system of requirements for students:

- attending lectures and practical classes is a mandatory component of studying the material;
- at the lecture the teacher uses his own presentation material; uses the class on the platform G suite for education to teach the material of the current lecture, additional information, protocols of laboratory work, guidelines for tasks and more;
- the student makes a report at a seminar using presentation materials, after the report answers questions from the audience and the teacher;
- writing a modular test takes place in a seminar without the use of aids (mobile phones, tablets, etc.);
- incentive points are awarded for participation in competitions for environmental work, preparation of reviews of scientific papers or speeches at conferences with reports on the subject of the discipline. The number of encouraged points is not more than 10.

Unacceptable in educational activities for students are:

1) Plagiarism - intentional or deliberate publication (publication), in whole or in part, of another's work (text or ideas) under the name of a person who is not the author of this work, without proper registration of references.

2) Fraud, namely:

- falsification or fabrication of information, scientific results and their subsequent use in academic work;
- forgery of signatures in documents (record books, laboratory protocols, abstracts);
- use of prohibited auxiliary materials or technical means (cheat sheets, headphones, telephones, tablets, etc.) during control measures;
- references to literary sources that were not used in the work;
- write-off when drawing up any type of control;
- passing the procedures of knowledge control by fictitious persons.

3) Unauthorized cooperation, namely:

- providing assistance for the commission of an act of academic dishonesty - intentional or deliberate assistance or attempt to assist another to commit an act of academic dishonesty;

- acquisition from other persons or organizations with the subsequent submission as own results of educational and scientific activity (reports, abstracts, control).

4) Offering or receiving improper remuneration when evaluating the results of success, performance of educational or research tasks.

5) The use of family or business ties to obtain a positive or higher rating in the preparation of any kind of final control or benefits in the work.

8. Types of control and rating system of assessment of learning outcomes (RSO)

Ongoing control: MCR and seminar report.

Calendar control: to be conducted twice a semester as monitoring of the current state of fulfillment of the force requirement.

Semester control: exam.

Conditions for admission to the semester control: minimum positive grade for MCR and semester rating more than 40 points.

The student's rating in the discipline consists of points that the student receives for:

1) Writing 1 MCR - 40 points

2) Report at the seminar - 20 points

3) Exam - 40 points

Scoring criteria:

2.1. Execution of modular control work (MCR):

Each version of the MCR contains 8 questions with 5 points each.

Complete and correct answer to the question - 5 points,

The answer contains certain inaccuracies, small errors in the explanation - 4 points;

The answer contains significant inaccuracies or is incomplete - 0-3 points.

2.2. Доповідь на семінарському занятті:

The evaluation of the report consists of the following main parts:

Disclosure of the topic - 10 points,

The answer to the question - 6 points,

Making a presentation for the report - 4 points.

At the end of the semester, **the condition for admission to the exam** is the student's semester rating ≥ 40 .

If after writing the exam the student's rating is ≥ 60 , **the grade is set according to the table.**

Table of correspondence of rating points to grades on the university scale:

<i>Scores</i>	<i>Rating</i>
100-95	Perfectly
94-85	Very good
84-75	Good
74-65	Satisfactorily
64-60	Enough

Less than 60	Unsatisfactorily
Admission conditions are not met	Not allowed

9. Additional information on the discipline (educational component)

- the list of theoretical questions that are submitted for semester control (exam) is given in Annex 1;
- At the beginning of the semester, the teacher analyzes the existing distance learning courses on the subject of the discipline and offers students to take the appropriate free courses. After the student receives a certificate of successful completion of distance or online courses on the subject, the teacher closes the relevant part of the course (laboratory or lectures).

List of questions for the exam

1. Bioenergy as a component of the energy sector
2. Biological treatment of industrial emissions into the atmosphere.
3. Biomass for the production of first generation bioenergy (sugar, grain and oilseeds). Biomass for the production of second generation bioenergy (agricultural, industrial, commercial and municipal organic waste). Biomass for the production of third generation bioenergy (micro and macro algae).
4. Biomass as a raw material for bioenergy production.
5. Bioreactors and biofilters for gas purification.
6. Biotechnology of bioethanol, biodiesel, biomethane, biohydrogen production. Use of biocatalytic processes in bioenergy technologies.
7. Biotechnology of processing of organic waste of agriculture.
8. Biotechnology processing of organic waste from the food industry.
9. Biotechnology of household waste processing.
10. Biochemical bases of microbial destruction of organic substrates. The composition of microorganisms and their transforming activity in the processing of manure and waste.
11. Types of composting. Basic requirements for raw materials for compost.
12. Growing larvae of synanthropic flies.
13. Waste of industrial enterprises of Kyiv, their utilization.
14. Livestock waste and their utilization. Features of yeast cultivation on livestock waste. Obtaining feed and food digestibility.
15. Wastes from the food industry (alcohol, leather, meat, brewing, wine, dairy). Features of chemical composition of waste. Methods of their processing.
16. Waste, their classification.
17. Application of genetic engineering for bioenergy crops.
18. Classification of emissions of enterprises by physical state and quantity of the substance.
19. Mechanisms of biological transformation of organic compounds of waste.
20. Regulatory framework for waste management in Ukraine.
21. Optimal conditions and equipment for composting. Groups of living organisms involved in composting processes.
22. The main types of waste disposal and related environmental problems. Filtrate and methods of its processing. Degassing of solid waste.
23. Basic definitions and terms of types of bioenergy resources. The main trends in the state, development of the world energy sector and its component - bioenergy.
24. Prospects for growing and using energy crops in Ukraine.
25. Prospects for the use of plant and animal waste in agriculture for energy production.
26. The main requirements for the selection of equipment are the effect of cleaning emissions into the atmosphere.

27. Features of production and application of enzymes of cellulolytic complex in bioconversion of cellulose-containing raw materials in energy.
28. Cleaning of industrial emissions in scrubbers.
29. Concepts: waste, waste management, waste disposal, waste processing. Classification of waste by type of formation (in the CIS, EU) according to the hygienic principle. Properties of solid waste.
30. The problem of agricultural waste disposal.
31. Industrial composting (types, parameters, schemes, principle of operation). Field composting (scheme, parameters, principle of operation)
32. Waste sorting at the level of consumers (population).
33. The state of bioleaching in Ukraine.
34. Current state and prospects of bioleaching development. General characteristics of bacteria capable of oxidizing sulfides of iron, zinc, tin, cadmium, etc. Formation of metal sulfates.
35. Modern biotechnology of biofuel production
36. Technologies for extraction of metals from wastewater from ore mining plants, ore dumps, "tails".
37. Technological features of cellulase application in cellulose bioconversion processes
38. Successful examples of bioenergy projects in Ukraine.

Work program of the discipline (syllabus):

Compiled by prof. Department of Ecobiotechnology and Bioenergy, Ph.D., prof. Kuzminsky Eugene Vasilyevich

Approved by the Department of Ecobiotechnology and Bioenergy (Minutes № 12 of 12.05.2020)

Agreed by the Methodical Commission of the faculty (protocol № 10 from 26.06.2020)