



KAPITAŁ LUDZKI
NARODOWA STRATEGIA SPÓJNOŚCI

Projekt współfinansowany przez
Unię Europejską w ramach
Europejskiego Funduszu
Społecznego

UNIA EUROPEJSKA
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FUNDUSZ SPOŁECZNY



Course title		ECTS code	
Alternative Bio-protection - lecture		13.4.0254	
Name of unit administrating study			
null			
Studies			
faculty	field of study	type	drugiego stopnia
Wydział Oceanografii i Geografii	Marine Biotechnology	form	stacjonarne
		specjalty	wszystkie
		specialization	wszystkie
Teaching staff			
dr hab. Robert Czajkowski, profesor uczelni; dr Alicja Chmielewska; dr hab. Joanna Nakonieczna, profesor uczelni; dr hab. Mariusz Grinholc, profesor uczelni; prof. UG, Sylwia Jafra			
Forms of classes, the realization and number of hours		ECTS credits	
Forms of classes		1	
Lecture		Lecture – 15 h	
The realization of activities		Student's own work – 15 h	
classroom instruction			
Number of hours		TOTAL: 30 h – 1 ECTS	
Lecture: 15 hours			
The academic cycle			
2023/2024 summer semester			
Type of course		Language of instruction	
obligatory		English	
Teaching methods		Form and method of assessment and basic criteria for evaluation or examination requirements	
<ul style="list-style-type: none"> - Innovative teaching/learning methods Problem-based learning - discussion - multimedia-based lecture - problem-focused lecture 		Final evaluation	
		<ul style="list-style-type: none"> - Graded credit - Examination 	
		Assessment methods	
		<ul style="list-style-type: none"> - written exam with open questions - Lecture – written test/examination 	
		The basic criteria for evaluation	
		Lectures: exam: written part (obligatory): test with questions, including open questions. Positive grade if the number of points $\geq 51\%$.	
Method of verifying required learning outcomes			
Exam - knowledge about the topics presented and characterized in the course (KW_04, KK_04)			
Required courses and introductory requirements			
A. Formal requirements			
B. Prerequisites			
Basic knowledge of microbiology, molecular biology, genetics			
Aims of education			
The course will introduce the students to alternative biological control methods used to protect marine organisms from diseases in their natural environment (natural habitats). These methods include promising and novel biological control approaches such as (oral) vaccines, probiotics, bacteriophage therapy, and the application of light and photosensitizers (photodynamic inactivation) to minimize the impact of pathogens. Likewise, students will also be introduced to the issues of social aspects of industrial (marine) food, enzyme, metabolite production, and related risks (KW_04, KK_04).			
Course contents			

Biological control:

- the idea of biological control / biological protection – history, aim, examples
- the concept of biological protection with the focus on marine (natural and artificial) environments

Bacteriophages:

- the discovery of viruses infecting bacteria,
- the use of bacteriophages in therapy (from the past to the future)
- marine environment as a source of valuable bacteriophage isolates and their enzymes
- bacteriophage-centered biological control in (natural and artificial) marine environments

Vaccines:

- the history and significance of vaccinations
- the basics of operation and production of classic and new generation vaccines
- antibacterial and antiviral vaccines
- vaccination of aquatic organisms,
- the role of adjuvants with the focus on adjuvants of marine origin

Photobiology:

- basic biological mechanisms at the molecular level occurring under the influence of light
- demonstration of photobiology's importance for biotechnology, medicine, and connection with other fields and disciplines of science.
- characterization of modern research tools and measurement methods used in photobiology, related fields, and scientific disciplines.

Bibliography of literature

T. W. Fisher & Thomas S. Bellows & L. E. Caltagirone & D. L. Dahlsten & Carl B. Huffaker & G. Gordh "Handbook of Biological Control: Principles and Applications of Biological Control" (Academic Press)

Male, J. Brostoff, D. B. Roth, I. Roitt "Immunology" (Mosby Inc.)

I. M. Hamblin and G. Jori "Medical and Environmental applications (RSC Publishing)

E. Kutter, A. Sulakvelidze "Bacteriophages – biology and application" (CRC Press)

(Also, the students will be provided with appropriate, relevant learning materials (experimental and review publications, book chapters, reports) before the classes.

The learning outcomes (for the field of study and specialization)

KW_04
KK_04

Knowledge

KW_04 Knows and has an in-depth understanding of advanced research methods used in marine biotechnology and related sciences

Skills

Social competence

KK_04 Is willing to assess and understand the risks as well as dilemmas, including ethical dilemmas, related to conducting scientific research and introducing advanced technologies; understands and appreciates the importance of intellectual property; behaves ethically

Contact

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Course title		ECTS code	
Alternative Bio-protection - tutorials		13.4.0255	
Name of unit administrating study			
null			
Studies			
faculty	field of study	type	drugiego stopnia
Wydział Oceanografii i Geografii	Marine Biotechnology	form	stacjonarne
		specjalty	wszystkie
		specialization	wszystkie
Teaching staff			
dr hab. Robert Czajkowski, profesor uczelni; dr Alicja Chmielewska; prof. UG, Sylwia Jafra; dr hab. Joanna Nakonieczna, profesor uczelni; dr hab. Mariusz Grinholc, profesor uczelni			
Forms of classes, the realization and number of hours		ECTS credits	
Forms of classes		1	
Auditorium classes		Seminar (auditorium) classes - 12 h	
The realization of activities		Student's own work – 13 h	
classroom instruction		TOTAL: 20 h – 1 ECTS	
Number of hours			
Auditorium classes: 12 hours			
The academic cycle			
2023/2024 summer semester			
Type of course		Language of instruction	
obligatory		English	
Teaching methods		Form and method of assessment and basic criteria for evaluation or examination requirements	
- Problem-focus lecture		Final evaluation	
Problem-based learning		Graded credit	
Innovative teaching/learning methods		Assessment methods	
Student's own work		- graded course credit based on individual grades obtained during the semester	
- group work		- Tutorials - the final grade is based on partial grades received during the semester for activity during classes and written reports assignments	
		The basic criteria for evaluation	
		Tutorials: tests, written report, activity during laboratories	
Method of verifying required learning outcomes			
Tutorials – knowledge about the methods presented and described in the course (KK_03, KU-01, KU-02)			
Required courses and introductory requirements			
A. Formal requirements			
B. Prerequisites			
Basic knowledge of microbiology, molecular biology, genetics			
Aims of education			
The course will introduce the students to alternative biological control methods used to protect marine organisms from diseases in their natural environment (natural habitats). These methods include promising and novel biological control approaches such as (oral) vaccines, probiotics, bacteriophage therapy, and the application of light and photosensitizers (photodynamic inactivation) to minimize the impact of pathogens. Likewise, students will also be introduced to the issues of social aspects of industrial (marine) food, enzyme, metabolite production, and related risks (KU_01, KU_02, KK_03).			
Course contents			

Biological control:

- the idea of biological control / biological protection – history, aim, examples
- the concept of biological protection with the focus on marine (natural and artificial) environments

Bacteriophages:

- the discovery of viruses infecting bacteria,
- the use of bacteriophages in therapy (from the past to the future)
- marine environment as a source of valuable bacteriophage isolates and their enzymes
- bacteriophage-centered biological control in (natural and artificial) marine environments

Vaccines:

- the history and significance of vaccinations
- the basics of operation and production of classic and new generation vaccines
- antibacterial and antiviral vaccines
- vaccination of aquatic organisms,
- the role of adjuvants with the focus on adjuvants of marine origin

Photobiology:

- basic biological mechanisms at the molecular level occurring under the influence of light
- demonstration of photobiology's importance for biotechnology, medicine, and connection with other fields and disciplines of science.
- characterization of modern research tools and measurement methods used in photobiology, related fields, and scientific disciplines.

Bibliography of literature

T. W. Fisher & Thomas S. Bellows & L. E. Caltagirone & D. L. Dahlsten & Carl B. Huffaker & G. Gordh "Handbook of Biological Control: Principles and Applications of Biological Control" (Academic Press)
 Male, J. Brostoff, D. B. Roth, I. Roitt "Immunology" (Mosby Inc.)
 I. M. Hamblin and G. Jori "Medical and Environmental applications (RSC Publishing)
 E. Kutter, A. Sulakvelidze "Bacteriophages – biology and application" (CRC Press)
 (Also, the students will be provided with appropriate, relevant learning materials (experimental and review publications, book chapters, reports) before the classes.

The learning outcomes (for the field of study and specialization)

KU_01
 KU_02
 KK_03

Knowledge

Skills

KU_01 Can plan and conduct research in the laboratory and at sea and document activities and results; can use laboratory devices under the supervision of the tutor; applies the principles of occupational health and safety
 KU_02 Can collect and interpret empirical data; uses statistical methods and IT tools in data analysis; formulates conclusions based on empirical data

Social competence

KK_03 Is ready to apply the principles of occupational health and safety, in particular working in the laboratory and at sea; is ready to be responsible for his safety and that of others, and to recognize threats and take appropriate actions

Contact

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Course title		ECTS code	
Blue biotechnology industry - tutorials		13.4.0272	
Name of unit administrating study			
Faculty of Management			
Studies			
faculty	field of study	type	wszystkie
Wydział Oceanografii i Geografii	Marine Biotechnology	form	wszystkie
		specjalty	wszystkie
		specialization	wszystkie
Teaching staff			
dr Anna Dziadkiewicz; dr n. med. Justyna Pawłowska; dr Marek Kołatka			
Forms of classes, the realization and number of hours		ECTS credits	
Forms of classes		3	
Auditorium classes		Classes – 30 h	
The realization of activities		Student's own work 45	
classroom instruction		TOTAL 75 – 3 ECTS	
Number of hours			
Auditorium classes: 30 hours			
The academic cycle			
2023/2024 summer semester			
Type of course		Language of instruction	
obligatory		English	
Teaching methods		Form and method of assessment and basic criteria for evaluation or examination requirements	
<ul style="list-style-type: none"> - seminar lecture - critical incident (case) analysis - multimedia-based lecture 		Final evaluation	
		Graded credit	
		Assessment methods	
		<ul style="list-style-type: none"> - test - written exam with open questions - written exam (test) - written exam (long written answer/problem solving) 	
		The basic criteria for evaluation	
		Correct answer to 50% of the questions given by the examiner during the exam.	
Method of verifying required learning outcomes			
Learning outcomes (KW_02_Bt; KW_05; KU_03; KK_02) - Method of verification (Written tests of theoretical knowledge).			
Required courses and introductory requirements			
A. Formal requirements B. Prerequisites			
Aims of education			
<p>During the lecture, students learn the basic issues related to the protection of intellectual property. The aims of the lecture are: to obtain knowledge theoretical and practical skills in the field of intellectual property protection, increase in creativity and innovation, and awareness legal students.</p> <p>The industrial biotechnology industry is a growth area, attracting more and more young people who see this industry as a career opportunity. That's why education in how to run and manage a business, as well as a team, plays a key role. The "Management" module will include education in soft skills (communication skills, teamwork, marketing and PR) and project and process management skills.</p>			
Course contents			
<ol style="list-style-type: none"> 1. The concept of intangible goods and intellectual property 2. Classification of intangible goods 			

- 3. Copyright - the basis - the subject of copyright, copyright holders
- 6. Solutions of industrial property law (inventions, utility models, industrial designs, topographies of integrated circuits, designs rationalization)
- 7. Inventions in the field of pharmacy and biotechnology - specificity of the subject and protection
- 8. Communication Skills in biotechnology industry
- 9. Problem Solving in organization
- 10. Project and Process Management
- 11. Introduction to marketing and PR
- 12. Ethics aspects in science and business

Bibliography of literature

Indicated by the teachers

The learning outcomes (for the field of study and specialization)

KW_02_Bt
KW_05
KU_03
KK_02

Knowledge

KW_02_Bt He has advanced knowledge of the possibilities of biotechnological use of marine resources
KW_05 Has knowledge in the field of social sciences and humanities helpful in entrepreneurship and effective functioning in society, as a person, citizen, employee, employer. Understands the principles of responsibility in driving scientific research.

Skills

KU_03 Is able to fluently use and critically analyze the available scientific information; on their basis and on the basis of his own work, can prepare and present an oral presentation and / or a written study covering detailed issues in the field of marine biotechnology, using scientific language, including specialist terminology and conceptual apparatus; has the ability to conduct discussions

Social competence

KK_02 Is ready to effectively plan and organize his own work and team work, in particular work in the laboratory and at sea; is ready to plan his individual career and act in an entrepreneurial manner

Contact

anna.dziadkiewicz@ug.edu.pl



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Course title		ECTS code	
Reproductive biotechnology - lecture		13.8.1329	
Name of unit administrating study			
null			
Studies			
faculty	field of study	type	drugiego stopnia
Wydział Oceanografii i Geografii	Marine Biotechnology	form	stacjonarne
		specjalty	wszystkie
		specialization	wszystkie
Teaching staff			
prof. UG, dr hab. Konrad Ocalewicz; dr Agnieszka Bernat-Wójtowska			
Forms of classes, the realization and number of hours		ECTS credits	
Forms of classes		2	
Lecture		Classes requiring the direct participation of an academic teacher:	
The realization of activities		ECTS credits: 1,5	
classroom instruction		Number of hours: 37 h:	
Number of hours		-lectures: 30 h	
Lecture: 30 hours		-consultations with teacher: 5 h	
		-exam : 2 h	
		Student's own work:	
		ECTS credits: 0,5	
		Number of hours: 20 h	
		-preparation for the exam: 20 h	
		TOTAL: 57	
The academic cycle			
2023/2024 summer semester			
Type of course		Language of instruction	
obligatory		English	
Teaching methods		Form and method of assessment and basic criteria for evaluation or examination requirements	
multimedia-based lecture		Final evaluation	
		Examination	
		Assessment methods	
		- two mid-semester tests (open questions)	
		- written exam with open questions	
		The basic criteria for evaluation	
		A prerequisite for taking the exam is a positive (min 51%) passing of two mid-term tests and positive grade from the laboratory practical classes. The exam includes the content indicated in the syllabus in the "Program content" field. Written exam (first term) consists of short open questions and at least one task- solving question. Correction exam is oral exam with 3 randomly drawn by student questions. The grading system and marks are in accordance with the University Regulations.	
Method of verifying required learning outcomes			

expected learning outcome	multimedia-based lecture
	Knowledge
KW_02	exam
	Skills
KU_01	exam
	Competences
KK_04	exam

Required courses and introductory requirements

A. Formal requirements

none

B. Prerequisites

none

Aims of education

The overall aim of the subject is to provide students with in-depth knowledge and advances in reproductive technologies in marine and freshwater vertebrates together with practical aspects and biotechniques used in the reproductive biotechnology. The student will gain knowledge and practical skills about the tools used for assisted reproduction in fish and in aquacultures, and its usage and links with other fields and disciplines of science, e.g. developmental biology, molecular biology, genetic engineering.

Course contents

A. Lectures

- A1: Embryogenesis of fish and marine invertebrates. Maternal to zygotic transition.
- A2: Gametogenesis in fish – spermatozoa and eggs/ova.
- A3: Quality of gametes and short- and long-term gamete storage/preservation of spermatozoa.
- A4: Molecular and physiological aspects of fertilization.
- A5: Genetic and environmental sex determination.
- A6: Gonadal differentiation and sexual maturation.
- A7: Hormonal and environmental control of sexual maturation.
- A8: Induced androgenesis, gynogenesis and polyploidization.
- A9: Transgenesis in invertebrates and vertebrates.
- A10: Genome editing from morpholino to CRISPR.
- A11: Chimerism and primordial germ cell transplantation.
- A12: Production of all-female and all-male fish.
- A13: Interspecies hybridization.
- A14: Production of clonal and isogenic fish lines.
- A15: Stem cells and their applications in reproductive biology

Bibliography of literature

A.1. used during the lectures

- Wang H. et al. 2018. Sex control in aquaculture. Wiley-Blackwell.
 - Pandian T.J, Koteeswaran R. 1998. Ploidy induction and sex control in fish. Hydrobiologia 384, 167-243.
 - Piferrer F. et al. Polyploid fish and shellfish: production, biology and application to aquaculture for performance improvement and genetic containment.
 - Okoli A.S. et al. 2021. Sustainable use of CRISPR/Cas in fish aquaculture: the biosafety perspective. Transgenic Research 31: 1-21.
 - Overturf K. 2007. Molecular research in Aquaculture. Wiley-Blackwell
 - Dunham R.2004. Aquaculture and Fisheries Biotechnology. Genetic approach. CABI Publishing.
 - John Liu. 2007. Aquaculture Genome Technologies. Wiley-Blackwell
 - De Siqueira-Silva et al. 2018. Biotechnology applied to fish reproduction: tools for conservation. Fish Physiology and Biochemistry 44, 1469-1485.
 - Zwierzchowski L (red). 1997. Biotechnologia zwierząt. Wyd. Naukowe PWN..
 - Demska-Zakęś K. 2008. Innowacyjne techniki oceny biologicznej i ochrony cennych gatunków ryb hodowlanych i raków. Wydawnictwo IRŚ.
- A.2. studied independently by the student

Instrukcje do ćwiczeń przygotowane przez prowadzącego zajęcia.

Marek Maleszewski. Ćwiczenia z biologii rozwoju zwierząt.

Hwa Jin Y et al. 2021. Surrogate broodstock to enhance biotechnology research and applications in aquaculture. *Aquaculture Advances* 49(2021)107756

Scientific papers from field of gene/genome engineering published recently in specialized journals.

The learning outcomes (for the field of study and specialization)

P6/7U_W, P6/7U_WG KW_02

P6/7U_U, P6/7U_UW, P6/7U_UO KU_01

P6/7U_K, P6/7U_KK, P6/7U_KR KK_04

Knowledge

KW_02 Possesses a broad knowledge and understanding concerning reproduction of aquatic vertebrates and reproductive technologies used for their breeding under control conditions.

Skills

KU_01 Has the ability to plan and carry out research on fish reproduction and gamete biotechnology in the laboratory, document the experiments and their results; can draw conclusions based on the results obtained during the laboratory activities.

Social competence

KK_04 Has an ability to evaluate and understand dilemmas and ethical threats related to research focusing on the biotechnology of reproduction and modern reproductive techniques.

Contact

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Course title		ECTS code	
Reproductive biotechnology - laboratory		13.8.1328	
Name of unit administrating study			
null			
Studies			
faculty	field of study	type	drugiego stopnia
Wydział Oceanografii i Geografii	Marine Biotechnology	form	stacjonarne
		specjalty	wszystkie
		specialization	wszystkie
Teaching staff			
prof. UG, dr hab. Konrad Ocalewicz; dr Agnieszka Bernat-Wójtowska			
Forms of classes, the realization and number of hours		ECTS credits	
Forms of classes		2	
Laboratory classes		Classes requiring the direct participation of an academic teacher:	
The realization of activities		ECTS: 1,5	
classroom instruction		number of hours: 35 h	
Number of hours		-laboratories: 20 h	
Laboratory classes: 20 hours		-consultations with teacher: 10 h	
		-participation in colloquia: 5 h	
		Student's own work:	
		ECTS: 0.5	
		number of hours: 20 h	
		-preparation for lab work and tests: 20 h	
		TOTAL: 55	
The academic cycle			
2023/2024 summer semester			
Type of course		Language of instruction	
obligatory		English	
Teaching methods		Form and method of assessment and basic criteria for evaluation or examination requirements	
conducting experiments		Final evaluation	
		Graded credit	
		Assessment methods	
		- writing reports after finishing each laboratory topic (total 3 writing reports), entry test for each laboratory topic (total 3 entry tests)	
		- ssignment work – conducting research and presenting results	
		- graded course credit based on individual grades obtained during the semester	
		The basic criteria for evaluation	
		Determination of the grade is based on partial grades received during the practical course in laboratory from 4 learning outcomesKW_03, KU-01, KK_04. The grading system and marks are in accordance with the University Regulations.	
Method of verifying required learning outcomes			

expected learning outcome	conducting experiments
	Knowledge
W_1 [KW_03_Og/Bt]	report, test
	Skills
U_1 [KU_01_Og/Bt]	report, test
	Competences
K_1 [KK_04]	report, tes

Required courses and introductory requirements

A. Formal requirements

none

B. Prerequisites

none

Aims of education

The overall aim of the subject is to provide students with in-depth knowledge and advances in reproductive technologies in marine and freshwater vertebrates together with practical aspects and biotechniques used in the reproductive biotechnology. The student will gain knowledge and practical skills about the tools used for assisted reproduction in fish and in aquacultures, and its usage and links with other fields and disciplines of science, e.g. developmental biology, molecular biology, genetic engineering.

Course contents

Laboratories will cover practical aspects of modern reproductive biotechnology techniques in marine organisms and will be divided in 3 major experimental blocks:

1. Assessment of egg and sperm quality and oocytes developmental stage; storage of gametes, cryopreservation of spermatozoa.
 2. in vitro fertilization and assessment of developmental embryo stage after fertilization.
 3. Induced gynogenesis and production of triploid fish embryos with application of UV irradiation for sperm inactivation and temperature shock for poliploidization.
- Evaluation of ploidy level: karyotyping of diploid and triploid fish embryos.

Bibliography of literature

A.1. used during the class

Zwierzchowski L. (red). 1997. Biotechnologia zwierząt. Wyd. Naukowe PWN..

Demska-Zakęś K. 2008. Innowacyjne techniki oceny biologicznej i ochrony cennych gatunków ryb hodowlanych i raków. Wydawnictwo IRŚ.

A.2. studied independently by the student

Protocols and instructions.

Marek Maleszewski. Ćwiczenia z biologii rozwoju zwierząt.

Hwa Jin Y et al. 2021. Surrogate broodstock to enhance biotechnology research and applications in aquaculture. Aquaculture Advances 49(2021)107756

Scientific papers from field of gene/genome engineering published recently in specialized journals.

The learning outcomes (for the field of study and specialization)

P6/7U_W, P6/7U_WG W_1 [KW_03_Og/Bt]
P6/7U_U, P6/7U_UW, P6/7U_UO U_1 [KU_01_Og/Bt]
P6/7U_K, P6/7U_KK, P6/7U_KR K_1 [KK_04]

Knowledge

W_1 [KW_03_Og/Bt] - knows and understands complex biological issues related to fish reproduction on the molecular level, understands their importance for the organism, marine environment and marine biotechnology(B1-3).

Skills

U_1 [KU_01_Og/Bt] Has the ability to plan and carry out research on fish reproduction and gamete biotechnology in the laboratory, document the experiments and their results; can draw conclusions based on the results obtained during the laboratory activities.

Social competence

KK_04 Has an ability to evaluate and understand dilemmas and ethical threats related to research focusing on the biotechnology of reproduction and modern

	reproductive techniques.
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Contact

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Course title		ECTS code	
Marine pharmacology - tutorials		13.8.1330	
Name of unit administrating study			
null			
Studies			
faculty	field of study	type	drugiego stopnia
Wydział Oceanografii i Geografii	Marine Biotechnology	form	stacjonarne
		specjalty	wszystkie
		specialization	wszystkie
Teaching staff			
prof. dr hab. Hanna Mazur-Marzec; dr Alicja Chmielewska			
Forms of classes, the realization and number of hours		ECTS credits	
Forms of classes		2	
Auditorium classes		ECTS credits - 2	
The realization of activities		Tutorials - 20 h	
classroom instruction		Student's own work - 30 h	
Number of hours		Consultations - 5 h	
Auditorium classes: 20 hours		TOTAL 55 h	
The academic cycle			
2023/2024 summer semester			
Type of course		Language of instruction	
obligatory		English	
Teaching methods		Form and method of assessment and basic criteria for evaluation or examination requirements	
<ul style="list-style-type: none"> - multimedia-based lecture - text analysis and discussion 		Final evaluation	
		Graded credit	
		Assessment methods	
		<ul style="list-style-type: none"> - (mid-term / end-term) test - assignment work – project or presentation - oral course credit 	
		The basic criteria for evaluation	
		<p>Written part (obligatory): test with questions, including open questions Positive grade if the number of points $\geq 51\%$. For students having between 41% and 50% the oral examination is obligatory. Students with the number of points $\leq 41\%$ do not pass the final test;</p> <p>Oral part (obligatory for students having between 41% and 50% from the written part and facultative for students with $\geq 51\%$): discussion on three problems related to the topic, selected by the teacher;</p>	
Method of verifying required learning outcomes			

Learning outcomes	Text analysis	Lecture with presentation
	Knowledge	
KW_02	Written report	Written/oral test
KW_04	Written report	Written/oral test
	Competences	
KK_04		Contribution to group discussion/test

Required courses and introductory requirements

- A. Formal requirements
- B. Prerequisites

Aims of education

Acquisition by students' knowledge on pharmaceutical potential of marine bioproducts and technologies used to evaluate their drugability, including bioassays applied at the research stage as well as the pre-clinical and clinical trials (KW-02; KW_04).
Acquisition by students' understanding of threats and ethical dilemmas related to in vivo assays (KK_04)

Course contents

Principles of development of marine bioproducts as potential drugs. Rationale, advantages and disadvantages of different in vitro assays, cell-culture assays, organoids and model organisms. Purpose and stages of pre-clinical and clinical trials. Examples of drugs developed from marine bioproducts.

Bibliography of literature

Schumacher Alexander, Hinder Markus, Gassmann Oliver, 2016. Value Creation in the Pharmaceutical Industry: The Critical Path to Innovation, Wiley-VCH, ISBN-10: 3527339132; ISBN-13:
Graham Patric., 2018. An Introduction to medicinal chemistry. Oxford University Press, UK, ISBN: 9780198796589
Selected articles from scientific journals, e.g.: Marine Drugs (MDPI), Marine Biotechnology (Springer)

The learning outcomes (for the field of study and specialization)

- KW_02
- KW_04
- KK_04

Knowledge

KW_02 The student will possess knowledge about the possible pharmaceutical application of marine natural products. The student will be able to describe the stages of the process of development of marine bioproducts as potential medicinal products, including product isolation, in-vitro assays, preclinical and clinical trials. The student will give and describe examples of marine products successfully developed as therapeutics.
KW_04 The student will understand and will be able to describe the principles of advanced methods used to evaluate pharmaceutical potential of marine natural products, including toxicity, enzymatic, stability and activity assays, mammalian cell cultures, organoid cultures, nematode C. elegans, animal models and different stages of clinical trials.

Skills

Social competence

KK_04 The student will be able to discuss and evaluate the hazards and ethic dilemmas connected with the development of marine products as bio-pharmaceuticals, including the hazards and ethical considerations of pre-clinical and clinical trials.

Contact

hanna.mazur-marzec@ug.edu.pl



KAPITAŁ LUDZKI
NARODOWA STRATEGIA SPÓJNOŚCI

Projekt współfinansowany przez
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Course title		ECTS code	
Marine pharmacology - laboratory		13.8.1331	
Name of unit administrating study			
null			
Studies			
faculty	field of study	type	drugiego stopnia
Wydział Oceanografii i Geografii	Marine Biotechnology	form	stacjonarne
		specjalty	wszystkie
		specialization	wszystkie
Teaching staff			
prof. dr hab. Hanna Mazur-Marzec; dr Alicja Chmielewska			
Forms of classes, the realization and number of hours		ECTS credits	
Forms of classes		3	
Laboratory classes		ECTS credits: 3	
The realization of activities		Laboratory classes: 45 h	
classroom instruction		Consultations: 5 h	
Number of hours		Student's own work: 30 h	
Laboratory classes: 45 hours		TOTAL: 80 h	
The academic cycle			
2023/2024 summer semester			
Type of course		Language of instruction	
obligatory		English	
Teaching methods		Form and method of assessment and basic criteria for evaluation or examination requirements	
conducting experiments		Final evaluation	
		Graded credit	
		Assessment methods	
		- (mid-term / end-term) test	
		- graded course credit based on individual grades obtained during the semester	
		- oral course credit	
		The basic criteria for evaluation	
		Activity of the student will be evaluated by partial grades, including evaluation of planning, performing and understanding of specific experiments, tests and work safety	
		Written report will be evaluated in terms of data documentation, analysis and interpretation, graphic and statistical representation, use of scientific terminology	
Method of verifying required learning outcomes			

Learning outcomes	Laboratory experiments/tests
	Knowledge
KW_04	test, report, activity during laboratory classes
	Skills
KU_01	report, activity during laboratory classes
	Competences
KK_04	test

Required courses and introductory requirements**A. Formal requirements****B. Prerequisites****Aims of education**

Acquisition by students' knowledge on pharmaceutical potential of marine bioproducts and technologies used to evaluate their drugability, including bioassays applied at the research stage as well as the pre-clinical and clinical trials (KW_04, KU_01).

Acquisition by students' understanding of threats and ethical dilemmas related to in vivo assays (KK_04)

Course contents

In vitro assessment of cytotoxic activity, enzymatic assays, antimicrobial activity, quorum quenching, assessment of drug stability under physiological conditions, selected ADME assays, effect on cytochrome P450 enzymes, from discovery to commercialization, principles of mammalian cell culture, principles of work with a model organism – *C. elegans*, antiviral activity of marine bioproducts

Bibliography of literature

Schumacher Alexander, Hinder Markus, Gassmann Oliver, 2016. Value Creation in the Pharmaceutical Industry: The Critical Path to Innovation, Wiley-VCH, ISBN-10: 3527339132; ISBN-13:

Graham Patric., 2018. An Introduction to medicinal chemistry. Oxford University Press, UK, ISBN: 9780198796589

The learning outcomes (for the field of study and specialization)

KW_04

KU_01

KK_04

Knowledge

KW_04 The student will understand and will be able to describe the principles of advanced methods used to evaluate pharmaceutical potential of marine natural products, including toxicity, enzymatic, stability and activity assays, mammalian cell cultures, organoid cultures, nematode *C. elegans*, animal models and different stages of clinical trials.

Skills

KU_01 - The student will be able to use equipment and materials in the biochemistry and cell culture laboratory. The student will be able to design and safely perform basic assays evaluating marine bioproducts as potential drugs and experiments with model organisms and microorganisms. The students will be able to document the procedures and results in a form of written report.

Social competence

KK_04 The student will be able to discuss and evaluate the hazards and ethic dilemmas connected with the development of marine products as bio-pharmaceuticals, including the hazards and ethical considerations of pre-clinical and clinical trials.

Contact

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Course title		ECTS code	
Cosmeceuticals and nutraceuticals_Tutorials		13.4.0264	
Name of unit administrating study			
null			
Studies			
faculty	field of study	type	drugiego stopnia
Wydział Oceanografii i Geografii	Marine Biotechnology	form	stacjonarne
		specjalty	wszystkie
		specialization	wszystkie
Teaching staff			
prof. dr hab. Bogdan Banecki; Katarzyna Gruzewska; dr Leszek Kadziński; dr Robert Łyżeń			
Forms of classes, the realization and number of hours		ECTS credits	
Forms of classes		1	
Auditorium classes		Auditorium: 1	
The realization of activities		Classes – 15 h	
classroom instruction		Student's own work 10 h	
Number of hours			
Auditorium classes: 15 hours			
The academic cycle			
2023/2024 summer semester			
Type of course		Language of instruction	
obligatory		English	
Teaching methods		Form and method of assessment and basic criteria for evaluation or examination requirements	
<ul style="list-style-type: none"> - critical incident (case) analysis - discussion of the presented issues - individual consultation with the teacher - discussion - group work 		Final evaluation	
		Graded credit	
		Assessment methods	
		<ul style="list-style-type: none"> - (mid-term / end-term) test - reports - tests - assignment work – project or presentation 	
		The basic criteria for evaluation	
		The form of getting credit is the correct performance of the research tasks indicated in the syllabus in the field "Program content" and the submission of a written report (it is possible to submit an electronic report).	
Method of verifying required learning outcomes			
Learning outcomes (KW_02_Bt) - Method of verification (Written tests of theoretical knowledge, the so-called "entries").			
Learning outcomes (KU_03) - Method of verification (Assessment of the reports).			
Required courses and introductory requirements			
A. Formal requirements			
B. Prerequisites			
Knowledge of the basics of operation of biophysical apparatus: UV-VIS spectrometer, gas and liquid chromatograph, mass spectrometry. Knowledge of the basic processes of molecular biology, biotechnology, microbiology. Ability to use laboratory equipment.			
Aims of education			
The aim of the course is to familiarize the student with the practical aspects of marine biotechnology and practical familiarization of the student with the methods used in development and quality control laboratories used in the development of dietary supplements and medicinal products. During the course, the student will learn about biotechnological processes and modern analytical techniques used in accredited laboratories and in the pharmaceutical and cosmetic industries. During the course, students will gain knowledge on the acquisition and practical use of active substances			

from marine organisms for the needs of the pharmaceutical and cosmetic industries (KW_02_Bt). In addition, the student will acquire the skills necessary for laboratory work (KK_03), learn the basic techniques and research tools necessary in marine biotechnology. The classes will also enable individual planning of experiments, contact with the equipment and methods that they will meet in future work. Particular emphasis is placed on issues related to the use of marine organisms or substances derived from them, and teamwork.

Course contents

These exercises are designed to familiarize students with the process of creating medicinal or cosmetic products using the potential of marine organisms from the design stage, development of analytical methods, through formulation development, method validation to quality control of finished products.

- extraction of a natural active compound of marine origin
- development and validation of an analytical method for determining the content of an active substance from material of marine origin
- release kinetics of marine active substance from solid drug form
- research on the diffusion of an active substance of marine origin from transdermal forms of pharmaceutical and cosmetic products
- extraction and testing of the properties of collagen obtained from marine organisms
- familiarization with the functioning of the company producing pharmaceutical or cosmetics products. Students will have the opportunity to familiarize themselves with research and development department.

Bibliography of literature

Indicated by the teachers

The learning outcomes (for the field of study and specialization)

KW_02_Bt
KU_03

Knowledge

KW_02_Bt He has advanced knowledge of the possibilities of biotechnological use of marine resources

Skills

KU_03 Is able to fluently use and critically analyze the available scientific information; on their basis and on the basis of his own work, can prepare and present an oral presentation and / or a written study covering detailed issues in the field of marine biotechnology, using scientific language, including specialist terminology and conceptual apparatus; has the ability to conduct discussions

Social competence

Contact

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Course title		ECTS code	
Copy Cosmeceuticals and nutraceuticals laboratory		13.4.0265	
Name of unit administrating study			
null			
Studies			
faculty	field of study	type	drugiego stopnia
Wydział Oceanografii i Geografii	Marine Biotechnology	form	stacjonarne
		specjalty	wszystkie
		specialization	wszystkie
Teaching staff			
prof. dr hab. Bogdan Banecki; dr Robert Łyżeń; Katarzyna Gruzewska; dr Leszek Kadziński			
Forms of classes, the realization and number of hours		ECTS credits	
Forms of classes		1	
Auditorium classes		Laboratory classes: 1	
The realization of activities		Classes – 15 h	
classroom instruction		Student's own work 10 h	
Number of hours			
Auditorium classes: 15 hours			
The academic cycle			
2023/2024 summer semester			
Type of course		Language of instruction	
obligatory		English	
Teaching methods		Form and method of assessment and basic criteria for evaluation or examination requirements	
<ul style="list-style-type: none"> - - discussion of the results of experiments - individual consultation with the teacher - conducting experiments - discussion - group work 		Final evaluation	
		Graded credit	
		Assessment methods	
		<ul style="list-style-type: none"> - Tests Lab Report - graded course credit based on individual grades obtained during the semester 	
		The basic criteria for evaluation	

Theoretical preparation for exercises, i.e. basic knowledge of the topic being implemented, is assessed on the basis of the so-called "entrance tickets" written / oral from each exercise.

During each test, the knowledge of the principles of construction and operation of devices and apparatus is assessed, as well as their selection in order to obtain correct readings. The ability to recognize and solve problems arising during the exercise is assessed, as well as the correct interpretation and understanding of the results obtained. The precision of the research is assessed, as well as the ability to cooperate in pairs (each pair of students performs a separate exercise) and individual work during the preparation and documentation of the analysis (written report).

During the exercises, the correct application of the obligatory laboratory procedures is assessed.

The final grade for laboratory exercises is derived on the basis of partial grades according to the following rules: 25% of the final grade is the average grade from six tests of theoretical knowledge (so-called "entries"); 50% of the final grade is a partial grade from the practical implementation of the experiment; 25% of the final grade is a partial grade from the report containing the results, their analysis, interpretations and final conclusions.

Method of verifying required learning outcomes

Learning outcomes (KW_02_Bt) - Method of verification (Written tests of theoretical knowledge, the so-called "entries").

Learning outcomes (KU_01_Og/Bt) - Method of verification (Assessment of the reports).

Required courses and introductory requirements

A. Formal requirements

B. Prerequisites

Knowledge of the basics of operation of biophysical apparatus: UV-VIS spectrometer, gas and liquid chromatograph, mass spectrometry. Knowledge of the basic processes of molecular biology, biotechnology, microbiology. Ability to use laboratory equipment.

Aims of education

The aim of the course is to familiarize the student with the practical aspects of marine biotechnology and practical familiarization of the student with the methods used in development and quality control laboratories used in the development of dietary supplements and medicinal products. During the course, the student will learn about biotechnological processes and modern analytical techniques used in accredited laboratories and in the pharmaceutical and cosmetic industries. During the course, students will gain knowledge on the acquisition and practical use of active substances from marine organisms for the needs of the pharmaceutical and cosmetic industries (KW_02_Bt). In addition, the student will acquire the skills necessary for laboratory work (KK_03), learn the basic techniques and research tools necessary in marine biotechnology. The classes will also enable individual planning of experiments, contact with the equipment and methods that they will meet in future work. Particular emphasis is placed on issues related to the use of marine organisms or substances derived from them, and teamwork.

Course contents

These exercises are designed to familiarize students with the process of creating medicinal or cosmetic products using the potential of marine organisms from the design stage, development of analytical methods, through formulation development, method validation to quality control of finished products.

- extraction of a natural active compound of marine origin
- development and validation of an analytical method for determining the content of an active substance from material of marine origin
- release kinetics of marine active substance from solid drug form
- research on the diffusion of an active substance of marine origin from transdermal forms of pharmaceutical and cosmetic products
- extraction and testing of the properties of collagen obtained from marine organisms
- familiarization with the functioning of the company producing pharmaceutical or cosmetics products. Students will have the opportunity to familiarize themselves with research and development department.

Bibliography of literature

Indicated by the teachers

The learning outcomes (for the field of study and specialization)

KW_02_Bt
KU_03

Knowledge

KW_02_Bt He has advanced knowledge of the possibilities of biotechnological use of marine resources

Skills

KU_03 Is able to fluently use and critically analyze the available scientific information; on their basis and on the basis of his own work, can prepare and present an oral presentation and / or a written study covering detailed issues in the

	field of marine biotechnology, using scientific language, including specialist terminology and conceptual apparatus; has the ability to conduct discussions
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	Social competence
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Contact

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Course title		ECTS code	
Apprenticeship		13.8.1418	
Name of unit administrating study			
null			
Studies			
faculty	field of study	type	drugiego stopnia
Wydział Oceanografii i Geografii	Marine Biotechnology	form	stacjonarne
		specjalty	wszystkie
		specialization	wszystkie
Teaching staff			
prof. dr hab. Hanna Mazur-Marzec			
Forms of classes, the realization and number of hours		ECTS credits	
Forms of classes		2	
Workshops		ECTS credits - 2	
The realization of activities		Apprenticeship - 30 h	
classes outside UG premises, classroom instruction		Consultations- 5 h	
Number of hours		Student's own work - 15 h	
Workshops: 30 hours			
The academic cycle			
2023/2024 summer semester			
Type of course		Language of instruction	
obligatory		- Polish in 50.00%	
		- English in 50.00%	
Teaching methods		Form and method of assessment and basic criteria for evaluation or examination requirements	
<ul style="list-style-type: none"> - conducting experiments - designing experiments - discussion - problem solving - project-based method (research, implementation, practical project) 		Final evaluation	
		Graded credit	
		Assessment methods	
		<ul style="list-style-type: none"> - assignment work – completing a specific practical assignment - graded course credit based on individual grades obtained during the semester 	
		The basic criteria for evaluation	
		Student's performance during the apprenticeship	
Method of verifying required learning outcomes			

Learning outcomes	Apprenticeship
	Knowledge
KW_05	The reference of practical placement supervisor, apprenticeship records
	Skills
KU_01	The reference of practical placement supervisor, apprenticeship records
	Competences
KK_03	The reference of practical placement supervisor, apprenticeship records

Required courses and introductory requirements

A. Formal requirements

B. Prerequisites

Aims of education

Aquisition of practical knowledge about functioning of companies and laboratories from biotechnology sector. Getting familiar with methods applied in these institutions.

Course contents

The work obligations and duties are defined by apprenticeship supervisor.

Bibliography of literature

The references suggested by the practical placement supervisor

The learning outcomes (for the field of study and specialization)

KW_05
KU_01
KK_03

Knowledge

KW_05 Student acquired knowledge about specific aspects of professional work at different positions.

Skills

KU_01 Student acquired practice in specific methods used in laboratories and companies working in the biotechnology sector.

Social competence

KK_03 Student is ready to make plan of his work and perform it in a safe way.

Contact

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Course title		ECTS code	
Pro-seminar - research papers		13.8.1364	
Name of unit administrating study			
null			
Studies			
faculty	field of study	type	drugiego stopnia
Wydział Oceanografii i Geografii	Marine Biotechnology	form	stacjonarne
		specjalty	wszystkie
		specialization	wszystkie
Teaching staff			
prof. dr hab. Hanna Mazur-Marzec; dr Dorota Pomorska			
Forms of classes, the realization and number of hours		ECTS credits	
Forms of classes		4	
Proseminar		ECTC credits 2	
The realization of activities		Classes 30 h	
classroom instruction		Consultations 5 h	
Number of hours		Student's own work 65	
Proseminar: 30 hours		TOTAL 100 h; 4 ECTS	
The academic cycle			
2023/2024 summer semester			
Type of course		Language of instruction	
obligatory		English	
Teaching methods		Form and method of assessment and basic criteria for evaluation or examination requirements	
<ul style="list-style-type: none"> - discussion - group work - text analysis and discussion 		Final evaluation	
		Graded credit	
		Assessment methods	
		<ul style="list-style-type: none"> - assignment work – project or presentation - graded course credit based on individual grades obtained during the semester 	
		The basic criteria for evaluation	
		Each of the learning outcomes will be assessed. Students must obtain at least a satisfactory grade for every assessed learning outcome. The assessment will be based on observation and a short test verifying the acquisition of the assumed learning outcomes.	
Method of verifying required learning outcomes			
Learning outcome	text analysis	Discussion	Group work
	Knowledge		
KW_02	Test/presentation	activity of students during classes	
	Skills		
KU_03	presentation/short review	contribution of student to group discussion	
	Competences		KK_01
Required courses and introductory requirements			
A. Formal requirements			
B. Prerequisites			

Aims of education	
<p>Acquisition by students of knowledge concerning current biotechnological scientific problems. (KW_02)</p> <p>Acquisition of the ability to prepare and give in English a short oral presentation, using scientific language, including specialist terminology and notional apparatus suitable for the conducted research, and to participate in a discussion (KU_03)</p> <p>Acquisition of the ability to critically assess own knowledge and constantly improve it (KK_01)</p>	
Course contents	
The course covers issues concerning different aspects of biotechnology, with special focus on marine biotechnology, presented in the recent research papers	
Bibliography of literature	
Course tutor selects annually a set of papers as the subject of the seminar	
The learning outcomes (for the field of study and specialization) KW_02 KU_03 KK_01	Knowledge KW_02 Possesses knowledge in the field of selected issues currently discussed in biotechnological, with special focus on marine biotechnology, as well as literature and problems concerning related scientific areas and disciplines
	Skills KU_03 Reads with understanding scientific literature and simple reviews in the fields of science and scientific disciplines connected with marine biotechnology; can prepare a short written review and an oral presentation in English (using scientific language), concerning particular issues of marine biotechnology and related scientific areas and disciplines, has an ability to participate in a discussion
	Social competence KK_01- Has an ability to critically assess his own knowledge on marine biotechnology and is willing to constantly improve and update it.
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Course title		ECTS code	
Research cruise II		13.8.1337	
Name of unit administrating study			
null			
Studies			
faculty	field of study	type	drugiego stopnia
Wydział Oceanografii i Geografii	Marine Biotechnology	form	stacjonarne
		specjalty	wszystkie
		specialization	wszystkie
Teaching staff			
prof. dr hab. Hanna Mazur-Marzec; mgr Robert Konkel			
Forms of classes, the realization and number of hours		ECTS credits	
Forms of classes		1	
Field classes		ECTS credits - 1 ECTS	
The realization of activities		Field work - 8 h	
classes outside UG premises		Consultations - 4 h	
Number of hours		Student's own work - 8 h	
Field classes: 8 hours		TOTAL - 20 h	
The academic cycle			
2023/2024 summer semester			
Type of course		Language of instruction	
obligatory		English	
Teaching methods		Form and method of assessment and basic criteria for evaluation or examination requirements	
- conducting experiments		Final evaluation	
- group work		Graded credit	
		Assessment methods	
		perform experiment and present a report	
		The basic criteria for evaluation	
		The quality of work done by the student before and during the cruise as well as the content of the report will be assessed.	
		Students must obtain at least a satisfactory grade for every assessed learning outcome.	
Method of verifying required learning outcomes			
Learning outcomes	Group work	Experimental work	
		Knowledge	
KW_01	Report		
		Skills	
KU_01	Student's activity before and during the cruise		
		Competences	
KK_03	Student's activity before and during the cruise		
Required courses and introductory requirements			
A. Formal requirements			
B. Prerequisites			
Aims of education			
- Acquisition by students of knowledge about the marine resources (KW_01)			

<ul style="list-style-type: none"> - Acquisition the ability to plan and perform field studies, especially marine sample collection and preservation (KU_01) - Acquisition by student the ability to carry out experiments at sea according to safety regulations (KK_03) 	
Course contents Organisation of the research cruise, sampling, preservation of biological material, sample analysis.	
Bibliography of literature Manuals of instruments and other equipment used on board the research vessels	
The learning outcomes (for the field of study and specialization) KW_01 KU_01 KK_03	Knowledge KW_01 Student possesses knowledge on the diversity of marine resources
	Skills KU_01 Student possess the ability to use instruments and equipment used on research vessel for sampling and measurements
	Social competence KK_03 - Student has an ability to work on board the research vessel in line with safety regulations
Contact hanna.mazur-marzec@ug.edu.pl	


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Course title		ECTS code	
Statistics in marine biotechnology - laboratory		13.8.1370	
Name of unit administrating study			
null			
Studies			
faculty	field of study	type	drugiego stopnia
Wydział Oceanografii i Geografii	Marine Biotechnology	form	stacjonarne
		specjalty	wszystkie
		specialization	wszystkie
Teaching staff			
dr hab. Agata Weydmann-Zwolicka, profesor uczelni			
Forms of classes, the realization and number of hours		ECTS credits	
Forms of classes		2	
Auditorium classes		2 ECTS	
The realization of activities		classes: 20 hours,	
classroom instruction, online classes		consultations: 5 hours,	
Number of hours		student's own work: 25 hours	
Auditorium classes: 20 hours		TOTAL 50 h – 2 ECTS	
The academic cycle			
2023/2024 summer semester			
Type of course		Language of instruction	
obligatory		English	
Teaching methods		Form and method of assessment and basic criteria for evaluation or examination requirements	
<ul style="list-style-type: none"> - group work - multimedia-based lecture - problem solving - project-based method (research, implementation, practical project) 		Final evaluation	
		Graded credit	
		Assessment methods	
		<ul style="list-style-type: none"> - (mid-term / end-term) test - assignment work – completing a specific practical assignment 	
		The basic criteria for evaluation	
		The evaluation covers the content indicated in the syllabus field "Course contents." The student must obtain a grade of at least sufficient from each assessed learning effect, nad be present during classes. The final (passing) grade is a percentage indicator included in the UG Studies Regulations.	
Method of verifying required learning outcomes			

expected educational outcomes	Discussion	Problem solving, Data analysis
	Knowledge	
KW_04	Observation of laboratory work.	Completion of credit work - completion of specified practical work. Weighted average of partial grades. Test
	Skills	
KU_02	Observation of laboratory work.	Completion of credit work - completion of specified practical work. Weighted average of partial grades. Test
	Competences	
KK_01	Observation of laboratory work.	

Required courses and introductory requirements

A. Formal requirements

B. Prerequisites

Basic computer skills; Basics of statistics

Aims of education

At the end of the course Students will be able to:

- Plan scientific research and design experiments
- Collect data and prepare basic data bases
- Apply proper statistical methods and computer tools for data analysis
- Explain differences between different data transformations; correlation and regression; analysis of similarity and analysis of variance
- Discuss possible errors occurring at different steps of research projects and experiments
- Present scientific data

Course contents

- Introduction to statistics: basic terminology, steps of statistical research, measuring scales
- Data collection, manipulation, preparation and transformation; Experimental design
- Introduction to the methods of PRIMER
- Resemblance: similarities, dissimilarities and distances; Correlation and regression
- Clustering methods
- Ordination and Multi-dimensional scaling
- Analysis of Similarity (ANOSIM) and Analysis of Variance (ANOVA)
- Analyzing environmental variables and linking assemblage to environment
- Biodiversity measures and tests
- Presentation of scientific data

Bibliography of literature

- Clarke, K.R., Gorley, R.N. (2015) PRIMER v7: User Manual/Tutorial. PRIMER-E: Plymouth
- Clarke, K.R., Gorley, R.N., Somerfield, P.J., Warwick, R.M. (2014) Change in marine communities: an approach to statistical analysis and interpretation, 3rd edition. PRIMER-E: Plymouth
- Ruxton G.D., Colegrave N. Experimental design (2016) Experimental Design for the Life Sciences, 4th edition. Oxford University Press
- Set of up-to-date scientific papers selected by the teaching staff

The learning outcomes (for the field of study and specialization)

- KW_04
- KU_02
- KK_01

Knowledge

KW_04 Knows and understands research methods used in biotechnology and connected sciences

Skills

KU_02 Can collect and interpret empirical data on the biodiversity of marine organisms; applies statistical methods and computer tools in data analysis; formulates conclusions based on empirical data.

Social competence

KK_01 Is ready to critically evaluate their knowledge and constantly improve and update it, as well as to raise qualifications in the field of marine biotechnology

Contact

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