

**University of Debrecen  
Faculty of Science and Technology  
Institute of Biology and Ecology**

**HYDROBIOLOGY – WATER QUALITY MANAGEMENT MSC  
PROGRAM**

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## **DEAN'S WELCOME**

Welcome to the Faculty of Science and Technology!

This is an exciting time for you, and I encourage you to take advantage of all that the Faculty of Science and Technology UD offers you during your bachelor's or master's studies. I hope that your time here will be both academically productive and personally rewarding

Being a regional centre for research, development and innovation, our Faculty has always regarded training highly qualified professionals as a priority. Since the establishment of the Faculty in 1949, we have traditionally been teaching and working in all aspects of Science and have been preparing students for the challenges of teaching. Our internationally renowned research teams guarantee that all students gain a high quality of expertise and knowledge. Students can also take part in research and development work, guided by professors with vast international experience.

While proud of our traditions, we seek continuous improvement, keeping in tune with the challenges of the modern age. To meet the demand of the job market for professionals, we offer engineering courses with a strong scientific basis, thus expanding our training spectrum in the field of technology. Based on the fruitful collaboration with our industrial partners, recently, we successfully introduced dual-track training programmes in our constantly evolving engineering courses.

We are committed to providing our students with valuable knowledge and professional work experience, so that they can enter the job market with competitive degrees. To ensure this, we maintain a close relationship with the most important national and international companies. The basis for our network of industrial relationships is in our off-site departments at various companies, through which market participants - future employers - are also included in the development and training of our students.

Prof. dr. Ferenc Kun  
Dean

# UNIVERSITY OF DEBRECEN

**Date of foundation:** 1912 Hungarian Royal University of Sciences, 2000 University of Debrecen

**Legal predecessors:** Debrecen University of Agricultural Sciences; Debrecen Medical University; Wargha István College of Education, Hajdúböszörmény; Kossuth Lajos University of Arts and Sciences

**Number of Faculties at the University of Debrecen:** 13

Faculty of Agricultural and Food Sciences and Environmental Management

Faculty of Child and Special Needs Education

Faculty of Dentistry

Faculty of Economics and Business

Faculty of Engineering

Faculty of Health

Faculty of Humanities

Faculty of Informatics

Faculty of Law

Faculty of Medicine

Faculty of Music

Faculty of Pharmacy

Faculty of Science and Technology

**Number of students at the University of Debrecen:** 32,351

**Full time teachers of the University of Debrecen:** 1,649

206 full university professors and 1,305 lecturers with a PhD.

## **FACULTY OF SCIENCE AND TECHNOLOGY**

The Faculty of Science and Technology is currently one of the largest faculties of the University of Debrecen with about 2,500 students and more than 200 staff members. The Faculty has got 6 institutes: Institute of Biology and Ecology, Institute of Biotechnology, Institute of Chemistry, Institute of Earth Sciences, Institute of Physics and Institute of Mathematics. The Faculty has a very wide scope of education dominated by science and technology (13 Bachelor programs and 14 Master programs), additionally it has a significant variety of teachers' training programs. Our teaching activities are based on a strong academic and industrial background, where highly qualified teachers with a scientific degree involve student in research and development projects as part of their curriculum. We are proud of our scientific excellence and of the application-oriented teaching programs with a strong industrial support. The number of international students of our faculty is continuously growing (currently ~ 810 students). The attractiveness of our education is indicated by the popularity of the Faculty in terms of incoming Erasmus students, as well.

### **THE ORGANIZATIONAL STRUCTURE OF THE FACULTY**

Dean: Prof. Dr. Ferenc Kun, Full Professor

E-mail: [ttkdekan@science.unideb.hu](mailto:ttkdekan@science.unideb.hu)

Vice Dean for Educational Affairs: Prof. Dr. Gábor Kozma, Full Professor

E-mail: [kozma.gabor@science.unideb.hu](mailto:kozma.gabor@science.unideb.hu)

Vice Dean for Scientific Affairs: Prof. Dr. Sándor Kéki, Full Professor

E-mail: [keki.sandor@science.unideb.hu](mailto:keki.sandor@science.unideb.hu)

Consultant on External Relationships: Prof. Dr. Attila Bérczes, Full Professor

E-mail: [berczesa@science.unideb.hu](mailto:berczesa@science.unideb.hu)

Consultant on Talent Management Programme: Prof. dr. Tibor Magura, Full Professor

E-mail: [magura.tibor@science.unideb.hu](mailto:magura.tibor@science.unideb.hu)

Dean's Office

Head of Dean's Office: Mrs. Katalin Kozma-Tóth

E-mail: [toth.katalin@science.unideb.hu](mailto:toth.katalin@science.unideb.hu)

English Program Officer: Mrs. Alexandra Csatóry

Address: 4032 Egyetem tér 1., Chemistry Building, A/101, E-mail: [acsatary@science.unideb.hu](mailto:acsatary@science.unideb.hu)

## DEPARTMENTS OF INSTITUTES OF BIOLOGY AND ECOLOGY

**Department of Hydrobiology** (home page: <http://biology.unideb.hu>)

**4032 Debrecen, Egyetem tér 1, Ecological Building**

Name	Position	E-mail	room
Mr. Prof. Dr. István Grigorszky, PhD, habil	University Professor, Head of Department	<a href="mailto:grigorszky.istvan@science.unideb.hu">grigorszky.istvan@science.unideb.hu</a>	022
Mr. Dr. Sándor Alex Nagy, PhD, habil	Senior Research Fellow	<a href="mailto:nagy.sandor.alex@science.unideb.hu">nagy.sandor.alex@science.unideb.hu</a>	115b
Mr. Dr. István Bácsi, PhD, habil	Associate Professor	<a href="mailto:bacsi.istvan@science.unideb.hu">bacsi.istvan@science.unideb.hu</a>	020
Mr. Dr. László Antal PhD, habil	Associate Professor	<a href="mailto:antal.laszlo@science.unideb.hu">antal.laszlo@science.unideb.hu</a>	116
Mr. Dr. István Gyulai, PhD	Assistant Professor	<a href="mailto:gyulai.istvan@science.unideb.hu">gyulai.istvan@science.unideb.hu</a>	06
Mr. Dr. Imre Somlyai, PhD	Assistant Professor	<a href="mailto:somlyai.imre@science.unideb.hu">somlyai.imre@science.unideb.hu</a>	023
Mr. Dr. Csaba Berta, PhD	Assistant Professor	<a href="mailto:berta.csaba@science.unideb.hu">berta.csaba@science.unideb.hu</a>	120
Mr. Dr. Krisztián Nyeste, PhD	Assistant Professor	<a href="mailto:nyeste.krisztian@science.unideb.hu">nyeste.krisztian@science.unideb.hu</a>	119

**Department of Botany** (<http://biology.unideb.hu>)

**4032 Debrecen, Egyetem tér 1, Life Science Building**

Name	Position	E-mail	room
Mr. Prof. Dr. Gábor Vasas, PhD, habil, DSc	University Professor	<a href="mailto:vasas.gabor@science.unideb.hu">vasas.gabor@science.unideb.hu</a>	1.506

**Department of Ecology** (<http://biology.unideb.hu>)

**4032 Debrecen, Egyetem tér 1, Ecological Building**

Name	Position	E-mail	room
Mr. Prof. Dr. Béla Tóthmérész, PhD, habil, DSc	University Professor	<a href="mailto:tothmerb@gmail.com">tothmerb@gmail.com</a>	112

**Department of Evolutionary Zoology and Human Biology** (<http://biology.unideb.hu>)

**4032 Debrecen, Egyetem tér 1, Life Science Building**

Name	Position	E-mail	room
Mr. Dr. Ádám Lendvai, PhD, habil	Associate Professor	<a href="mailto:lendvai.adam@science.unideb.hu">lendvai.adam@science.unideb.hu</a>	1.207
Mr. Dr. Jácint Tökölyi	Associate Professor	<a href="mailto:tokolyi.jacint@science.unideb.hu">tokolyi.jacint@science.unideb.hu</a>	1.202

**Department of Physical Geography and Geoinformatics** (<http://geogis.unideb.hu>)  
**4032 Debrecen, Egyetem tér 1, Geomathematics Building**

<b>Name</b>	<b>Position</b>	<b>E-mail</b>	<b>room</b>
Mr. Prof. Dr. Szilárd Szabó, PhD, habil, DSc	University Professor, Head of Department	szabo.szilard@science.unideb.hu	2.223

**Department of Civil Engineering** (<https://eng.unideb.hu/hu>)  
**4028 Debrecen, Ótemető utca 2., Faculty of Engineering Building**

<b>Name</b>	<b>Position</b>	<b>E-mail</b>	<b>room</b>
Mrs. Dr. Herta Czédli, PhD	Associate Professor	herta.czedli@eng.unideb.hu	209/c

**Hortobágy National Park Directorate** (<https://www.hnp.hu/en>)  
**4024 Debrecen, Sumen u. 2. Nature Conservation Development Department**

<b>Name</b>	<b>Position</b>	<b>E-mail</b>	<b>room</b>
Ms. Dr. Szilvia Gőri, PhD,	Head of Department, Ecologist	gori.szilvia@hnp.hu	103

## ACADEMIC CALENDAR

General structure of the academic semester (2 semesters/year):

Study period	1 <sup>st</sup> week	Registration*	1 week
	2 <sup>nd</sup> – 15 <sup>th</sup> week	Teaching period	14 weeks
Exam period	directly after the study period	Exams	7 weeks

\*Usually, registration is scheduled for the first week of September in the fall semester, and for the first week of February in the spring semester.

For further information please check the following link:

[https://www.edu.unideb.hu/tartalom/downloads/University\\_Calendars\\_2025\\_26/University\\_calendar\\_2025-2026-Faculty\\_of\\_Science\\_and\\_Technology.pdf](https://www.edu.unideb.hu/tartalom/downloads/University_Calendars_2025_26/University_calendar_2025-2026-Faculty_of_Science_and_Technology.pdf)



# THE HYDROBIOLOGY – WATER QUALITY MANAGEMENT MASTER PROGRAM

## Information about the Program

Name of MSc Program:	Hydrobiology MSc Program
Specialization available:	Water Quality Management
Field, branch:	Science
Qualification:	Hydrobiologist – Water Quality Manager
Mode of attendance:	Full-time
Faculty, Institute:	Faculty of Science and Technology Institute of Biology and Ecology
Head of programme:	Prof. Dr. István Grigorszky, University Professor
Programme coordinator:	Dr. Csaba Berta, Assistant Professor
Duration:	4 semesters
ECTS Credits:	120

### Objectives of the MSc program:

The aim of the Hydrobiology – Water Quality management MSc program is to train professional hydrobiologist who has deep insights the physical, chemical, and ecological aspects and processes of various water types in temperate, tropical and semi-arid regions, as well as interactions throughout the hydrological cycle, and the various hydrological processes and function, and the impact this has on health.

### Professional competences to be acquired

#### A Hydrobiologist – Water Quality Management:

##### a) Knowledge:

- He/she knows the processes in the hydrosphere as well as the methods for exploring, evaluating and managing the connection system of the hydro-spherical processes.
- He/she knows, uses and develops the field- and laboratory practice methods and tools that are used by modern hydrobiology, and for their own work and research.
- He/she possesses the knowledge of theories, paradigms and principles that characterize the hydrobiology science, and knows the possibilities of sustainable use, utilization and preservation of water as an environmental element and resource.
- He/she possesses the knowledge needed to design and carry out hydrobiological research on aquatic and wetland habitats and to conduct various expert activities related to water.

##### b) Abilities:

- He/she has the ability to systematically understand and master the knowledge in the field of hydrobiology, as well as the theoretical and practical knowledge of the field of science and the acquired experience to receive new information, to recognize new phenomena and solve the problems

that arise.

- He/she is capable of recognizing ecological processes in waters, describing water quality, tracking water quality changes, and developing water quality improvement programs.
- He/she is capable of handling complex situations, application the data and knowledge of aquatic and wetland habitats in practice to carry out scientific researches.
- He/she is able to evaluate the effects of water and water changes in an objective, professional way, to perform expert tasks, to collect individual data, to record, to process and to coordinate field and laboratory observations with theoretical knowledge.

**c) Attitude:**

- He/she is open to the identification and analysis of emerging problems, seeking to solve them, synthesizing, communicating, and a positive contacting person.
- He/she is committed to a demanding and quality work, able to continue his/her studies, characterized by a practical managing nature with the acquired knowledge of practical hydrobiology, but also suitable for teamwork.
- He/she is open to new hydrobiological and other scientific research results, to professional co-operation.
- He/she strives to expand the existing scientific knowledge and to further develop methods, actively assisting the emergence of new research directions.

**d) Autonomy and responsibility:**

- He/she has the necessary autonomy to manage small workgroups, to organize their work, and the responsibility to identify development directions.
- In professional and non-professional circumstances, he/she has a responsible opinion on hydrobiological, research ethical and bio-ethical issues. Actively disseminates the results of his/her research field, publishes his/her knowledge even in media, and, if necessary defends his/her professional stands against other trends and representatives of pseudo-sciences.
  - He/she is characterized by initiative and decision-making as well as strong personal responsibility.
- After gaining a professional experience, he/she finds out their place in the field of work, helping his/her colleagues in the conscious, goal-oriented tasks implementation. Consciously builds his/her career and helps his/her colleagues alike.

## **Completion of the MSc Program**

### **The Credit System**

Majors in the Hungarian Education System have generally been instituted and ruled by the Act of Parliament under the Higher Education Act. The higher education system meets the qualifications of the Bologna Process that defines the qualifications in terms of learning outcomes: statements of what students know and can do on completing their degrees. In describing the cycles, the framework uses the European Credit Transfer and Accumulation System (ECTS).

ECTS was developed as an instrument of improving academic recognition throughout the European Universities by means of effective and general mechanisms. ECTS serves as a model of academic recognition, as it provides greater transparency of study programs and student achievement. ECTS in no way regulates the content, structure and/or equivalence of study programs.

Regarding each major the Higher Education Act prescribes which professional fields define a certain training program. It contains the proportion of the subject groups: natural sciences, economics and humanities, subject-related subjects and differentiated field-specific subjects.

During the program students have to complete a total amount of 120 credit points. It means approximately 30 credits per semester. The curriculum contains the list of subjects (with credit points) and the recommended order of completing subjects which takes into account the pre-requisite(s) of each subject. You can find the recommended list of subjects/semesters in chapter “Model Curriculum Hydrobiology – Water Quality Management MSc Program”.

## Model Curriculum of Hydrobiology – Water Quality Management MSc Program

Knowledge elements, lectures and lecturers	semesters				ECTS credit points	evaluation
	1.	2.	3.	4.		
	contact hours, types of teaching (l – lecture, s – seminar, p – practice), credit points					
<b>Basic knowledge elements</b>						
General Hydrobiology <i>István Grigorszky</i>	28 l/4 cr. 14 s/1 cr.				5	exam
Mathematical methods in Hydrobiology <i>Vanda Éva Abriha-Molnár</i>	28 l/4 cr. 14 p/1 cr.				5	exam, mid-semester grade
Hydrology and Geography <i>Szilárd Szabó</i>	28 l/4 cr. 14 p/1 cr.				5	exam, mid-semester grade
Applied Hydrobiology <i>Imre Somlyai</i>		28 l/4 cr. 14 s/1 cr.			5	exam
<b>20</b>						
<b>Core subjects</b>						
Water Chemistry <i>István Bácsi</i>	14 l/2 cr. 28 p/3 cr.				5	exam,
Running Water Ecology <i>Csaba Berta</i>	28 l/4 cr. 14 p/1 cr.				5	exam, mid-semester grade
Standing Water Ecology <i>Csaba Berta</i>	28 l/4 cr. 14 p/1 cr.				5	exam, mid-semester grade
Wetland Ecology <i>Imre Somlyai</i>	28 l/4 cr. 14 p/1 cr.				5	exam, mid-semester grade
Water Resources Management <i>Herta Czédli and Csaba Berta</i>		28 l/4 cr. 14 s/1 cr.			5	exam
<b>25</b>						
<b>Specific scientific knowledge</b>						

Aquatic Toxicology <i>Gábor Vasas and István Bácsi</i>		28 1/4 cr. 14 p/1 cr.			5	exam, mid-semester grade
Paleohydrobiology <i>István Gyulai and Csaba Berta</i>		28 1/4 cr. 14 p/1 cr.			5	exam, mid-semester grade
Water Quality Monitoring <i>István Bácsi and István Gyulai</i>			14 1/3 cr. 14 s/1 cr.		5	exam
European Water Framework Directive <i>Krisztián Nyeste</i>				28 1/4 cr. 14 p/1 cr.	5	exam, mid-semester grade
Nature Conservation <i>Szilvia Góri</i>				28 1/4 cr. 14 p/1 cr.	5	exam, mid-semester grade
Algology <i>István Bácsi</i>		28 1/4 cr. 14 p/1 cr.	5		5	exam, mid-semester grade
<b>25</b>						
<b>Optional courses</b>						
Aquatic Microbiology <i>István Bácsi</i>		14 1/3 cr. 14 p/1 cr.			5	exam, mid-semester grade
Macrophytes <i>István Gyulai</i>		28 1/4 cr. 14 p/1 cr.			5	exam, mid-semester grade
Zooplankton <i>István Gyulai and Csaba Berta</i>		28 1/4 cr. 14 p/1 cr.			5	exam, mid-semester grade
Macroinvertebrates <i>László Antal</i>		28 1/4 cr. 14 p/1 cr.			5	exam, mid-semester grade
Fishes <i>László Antal and Krisztián Nyeste</i>		28 1/4 cr. 14 p/1 cr.			5	exam, mid-semester grade
Research Project Management <i>Ádám Lendvai</i>		28 1/4 cr. 14 p/1 cr.			5	exam, mid-semester grade
Tropical Ecology <i>Alex Sándor Nagy</i>		28 1/4 cr. 14 p/1 cr.			5	exam, mid-semester grade
Fundamentals of Geoinformation Systems <i>Szilárd Szabó</i>		28 1/4 cr. 14 p/1 cr.			5	exam, mid-semester grade

Water pollution <i>Krisztián Nyeste</i>		28 l/4 cr. 14 p/1 cr.		5	exam, mid-semester grade
Aquatic invasions <i>Krisztián Nyeste</i>		28 l/4 cr. 14 p/1 cr.		5	exam, mid-semester grade
Basic information <i>Csaba Berta</i>		14 l/1 cr.		1	sign
Biostatistics <i>Jácint Tökölly</i>		56 lab/3 cr		3	exam
Sampling, Sample treatment and Analytical tests <i>Edina Baranyai</i>		13 l/1 cr 62 lab/4 cr		5	exam, mid-semester grade
<b>Thesis work and consultation</b>					
Thesis writing I.			56 s/5 cr.		5 mid-semester grade
Thesis writing II.				56 s/10 cr.	10 mid-semester grade
					15
<b>Field practice</b>					
Field practice I.		28 s/5 cr.			5 mid-semester grade
					5
<b>Total</b>					<b>120</b>

### *Work and Fire Safety Course*

According to the Rules and Regulations of University of Debrecen a student has to complete the online course for work and fire safety. Registration for the course and completion are necessary for graduation. For MSc students the course is only necessary only if BSc diploma has been awarded outside of the University of Debrecen.

Registration in the Neptun system by the subject: MUNKAVEDELEM

Students have to read an online material until the end to get the signature on Neptun for the completion of the course. The link of the online course is available on webpage of the Faculty.

### *Physical Education*

According to the Rules and Regulations of University of Debrecen a student has to complete Physical Education courses at least in one semester during his/her Master's training. Our University offers a wide range of facilities to complete them. Further information is available from the Sport Centre of the University, its website: <http://sportsci.unideb.hu>.

### *Pre-degree Certification*

A pre-degree certificate is issued by the Faculty after completion of the master's (MSc) program. The pre-degree certificate can be issued if the student has successfully completed the study and exam requirements as set out in the curriculum, the requirements relating to Physical Education as set out in Section 10 in Rules and Regulations – with the exception of preparing thesis – and gained the necessary credit points (120). The pre-degree certificate verifies (without any mention of assessment or grades) that the student has fulfilled all the necessary study and exam requirements defined in the curriculum and the requirements for Physical Education. Students who obtained the pre-degree certificate can submit the thesis and take the final exam.

### *Thesis*

A Thesis is the creative elaboration of a professional task in written form. By solving the task, the student relies on his/her studies using national and international literature under the guidance of an internal and external supervisor (referee). By a completed dissertation and its successful defence an hydrobiologist student certifies that he/she is capable to apply the acquired knowledge in practice and to summarize the completed work and its results in professional way, to solve the tasks related to his/her topic creatively and to complete individual professional work. By preparing and defending a thesis a student who completes the Water Management Master program prove that he/she is capable of the practical applications of the acquired skills, summarizing the work done and its results in a professional way, creatively solving the tasks related to the topic and doing individual professional work.

The requirements of the thesis content, the general aspects of evaluation and the number of credits assigned to the thesis are determined by the requirements of the program. In water management program the credits assigned to the thesis is 15.

The formal requirements of a thesis shall be announced at the same time of task setting up

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by writing. A thesis can be submitted by a student supported solely by the internal supervisor and external referee. The thesis also need to be uploaded into the University of Debrecen Electronic Archive website (<https://dea.lib.unideb.hu/dea/?locale-attribute=en>). If a thesis is evaluated with a fail mark by the referee and the department the student is not allowed to take the final exam and is supposed to prepare a new or modified thesis. The student has to be informed about it. Conditions on resubmitting the thesis are defined by the program coordinator of the particular specialization.

### *Final Exam*

Students having obtained the pre-degree certificate will finish their studies by taking the final exam of Water Management-Hydrobiologist master program. A final exam is the evaluation and control of the knowledge and skills acquired. The candidate has to certify that he/she is able to apply the obtained knowledge in practice. A final exam can be taken after obtaining the pre-degree certificate. A final exam has to be taken in front of the Final Exam Board. If a candidate does not pass his/her final exam by the termination of his/her student status, he/she can take his/her final exam after the termination of the student status on any of the final exam days of the relevant academic year according to existing requirements on the rules of the final exam.

The Final Exam consists of 2 parts on the basis of its curriculum:

According to the prerequisites of taking a final exam:

- compiling all the subjects provided from semester 1 to 4 in the model curriculum, obtaining at least 120 credits including subjects of criterion on the basis of curriculum;
- making and submitting the thesis (2 semesters, 15 credits).

The final exam (oral exam):

Subjects:

- The core material of the final exam (T1)
- Material related to the 'Water Quality Management' specialisation (T2)
- Grade for the thesis (D1) and grade for the thesis defence (D2)

Calculation of a final exam grade (FE) according to this formula:

$$FE = (T1 + T2 + D1 + D2) / 4$$

The requirements of the oral part of the final exam, the agenda of the topics with the indication of their literature are announced by the department during the final week of the study period the latest. The oral part of the final exam is evaluated on a five-point scale by the Final Exam Board. The final grade for the final exam will be decided on by voting in a closed meeting after the final exam. In case of equal votes the committee chair will take the decision. Final exam results will be announced by the committee chair. A note of the final exam will be taken.

### *Retaking failed final exam*

If any parts of the final exam is evaluated with a fail mark according to the existing rules of the university, it can be retaken. The ensuing final exam period is the soonest that the re-sit is allowed. If a thesis is evaluated with a solid fail mark by the supervisor and the referee, the

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graduate is not allowed to take a final exam and a new thesis has to be written. A final exam can be retaken twice on each topic.

#### *Final Exam Board*

Committee chair and members of the committee are selected from the acknowledged internal and external experts of the professional field. Traditionally, it is the chair and in case of his/her absence or indisposition the vice-chair who will be called upon, as well. The committee consists of – besides the chair – at least two members, and questioners as required. The mandate of a Final Exam Board lasts for one year.

#### *Rules and Regulations*

The Academic and Examination Rules and Regulations of the University of Debrecen, which contain the rules to be followed by students, are available at the following link:

<https://www.edu.unideb.hu/p/rules-and-regulations>

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## Diploma

The diploma is an official document decorated with the coat of arms of Hungary which verifies the successful completion of studies in the Hydrobiology – Water Quality Management Master Program. It contains the following data: name of HEI (higher education institution); institutional identification number; serial number of diploma; name of diploma holder; date and place of his/her birth; level of qualification; training program; specialization; mode of attendance; place, day, month and year issued. Furthermore, it has to contain the rector's (or vice-rector's) original signature and the seal of HEI. The University keeps a record of the diplomas issued.

In Hydrobiology – Water Quality Management Master Program the diploma grade is calculated as the average grade of the results of the followings:

- Weighted average of the overall studies at the program (A)
- Average of grades of the thesis and its defense given by the Final Exam Board (B)
- Average of the grades received at the Final Exam for the two subjects (C)

$$\text{Diploma grade} = (A + B + C)/3$$

Classification of the award on the bases of the calculated average:

Excellent	4.81 – 5.00
Very good	4.51 – 4.80
Good	3.51 – 4.50
Satisfactory	2.51 – 3.50
Pass	2.00 – 2.50

## Course Descriptions of Hidrobiology – Water Quality Management MSc Program

<b>Title of course:</b> General Hydrobiology <b>Code:</b> TTHME9104_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: 28 hours - preparation for the exam: 64 hours Total: 120 hours	
<b>Year, semester:</b> 1st year, 1 st semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> Physical and chemical properties of various water types. Geological and morphological characteristics of natural water bodies. Physical characteristics of water areas, such as movements of sea water-waves, tidal phenomena, ocean currents, eddies, water movements in lakes and lagoons. Temperature of natural water bodies. Transparency, light, color and turbidity in sea, standing and running waters. Basic chemical characteristics of natural water. The main mineral elements and compounds, gases, nutrients. Overview of the aquatic life nekton, plankton, pleuston, neuston, periphyton, benthos.). Food chain. Primary production. Biogeography of aquatic organisms.	
<b>Literature</b> 1. Moss, B. (2010): Ecology of Fresh Waters: A View for the Twenty-First Century, Wiley-Blackwell, I 2. Michael J. and Mills D., (1990): Freshwater Ecology: Principles and Applications, Wiley-Blackwell, 3. Levinton J.S., (2010): Marine Biology: International Edition: Function, Biodiversity, Ecology, OUP USA, 4. Kaiser M. J., Attrill M.J., Jennings S., Thomas D.N., Barnes D.K.A, Brierley A.S., HiddinkJ.G, Kaartokallio H, Polunin N.V.C), Raffaelli D.G, (2011): Marine Ecology: Processes, Systems, and Impacts, OUP USA,	
<b>Schedule:</b> <b>Lectures:</b> <i>1<sup>st</sup> week</i> Field of hydrobiology in science and its practical applications. <i>2<sup>nd</sup> week</i> Biological production in water bodies. <i>3<sup>rd</sup> week</i> Basics of nutrient cycles in the waters and energy levels.	

*4<sup>th</sup> week* Eutrophication and oligotrophication processes.

*5<sup>th</sup> week* Water quality and water merit.

*6<sup>th</sup> week* The hydrological cycle.

*7<sup>th</sup> week* Effects of the quantitative changes in water resources.

*8<sup>th</sup> week* Quality changes in water resources.

*9<sup>th</sup> week* Typology of standing waters.

*10<sup>th</sup> week* Typology of running waters.

*11<sup>th</sup> week* Typology of ground waters and springs.

*12<sup>th</sup> week* Physiognomy and space of living of standing waters.

*13<sup>th</sup> week* Physiognomy and space of living of running waters.

*14<sup>th</sup> week* Zonation and succession.

**Requirements:**

Lecture:

The minimum requirement for the examination is 50% from the midterm and closing tests. Based on the summarized score of the test the grade for the examination is given according to the following table:

Score	Grade
0-49%	fail (1)
50-59%	pass (2)
60-72%	satisfactory (3)
73-84%	good (4)
85-100%	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

**Person responsible for course:** Dr. habil. Istvan Grigorszky, university professor, PhD

**Lecturer:** Dr. habil. István Grigorszky, University professor, PhD

<b>Title of course:</b> General Hydrobiology <b>Code:</b> TTHMG9104_EN	<b>ECTS Credit points:</b> 2
<b>Type of teaching, contact hours</b> - lecture: - - practice: 1 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 14 hours - laboratory: - - home assignment: 16 hours - preparation for the exam: - Total: 30 hours	
<b>Year, semester:</b> 1st year, 1 st semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> Physical and chemical properties of various water types. Geological and morphological characteristics of natural water bodies. Physical characteristics of water areas, such as movements of sea water-waves, tidal phenomena, ocean currents, eddies, water movements in lakes and lagoons. Temperature of natural water bodies. Transparency, light, color and turbidity in sea, standing and running waters. Basic chemical characteristics of natural water. The main mineral elements and compounds, gases, nutrients. Overview of the aquatic life nekton, plankton, pleuston, neuston, periphyton, benthos.). Food chain. Primary production. Biogeography of aquatic organisms.	
<b>Literature</b> 1. Moss, B. (2010): Ecology of Fresh Waters: A View for the Twenty-First Century, Wiley-Blackwell, I 2. Michael J. and Mills D., (1990): Freshwater Ecology: Principles and Applications, Wiley-Blackwell, 3. Levinton J.S., (2010): Marine Biology: International Edition: Function, Biodiversity, Ecology, OUP USA, 4. Kaiser M. J., Attrill M.J., Jennings S., Thomas D.N., Barnes D.K.A, Brierley A.S., HiddinkJ.G, Kaartokallio H, Polunin N.V.C), Raffaelli D.G, (2011): Marine Ecology: Processes, Systems, and Impacts, OUP USA,	
<b>Schedule:</b> <b>Lectures:</b> <i>1<sup>st</sup> week.</i> Presenting further training courses and specializations in hydrobiology. <i>2<sup>nd</sup> week.</i> Producer and demolisher organisms. <i>3<sup>rd</sup> week.</i> Anthropogenic effects in waters. <i>4<sup>th</sup> week.</i> Presentation of eutrophication in a specific example.	

5<sup>th</sup> week. Different land use and their impacts.

6<sup>th</sup> week. El Niño and La Niña.

7<sup>th</sup> week. Demonstration the effects of drought on an example area.

8<sup>th</sup> week. Demonstration the effects of water pollution based on an example.

9<sup>th</sup> week. Introducing the major standing waters of the Earth.

10<sup>th</sup> week. Introducing the major running waters of the Earth.

11<sup>th</sup> week. Problems with the non-renewable water resources of the Earth.

12<sup>th</sup> week. Presentation of the most important living organism groups in standing waters.

13<sup>th</sup> week. Presentation of the most important living organism groups in running waters.

14<sup>th</sup> week. Presentation of the most important macrophytes in waters.

### **Requirements:**

#### Practice:

Participation at classes is compulsory. A student must attend the courses and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

During the semester there is one practical test. It can be completed in the 14<sup>th</sup> week.

The minimum score is 50%. Based on the score of the test, the grade for the test is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-72	satisfactory (3)
73-84	good (4)
85-100	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

**Person responsible for course:** Dr. habil. István Grigorszky, university professor, PhD

**Lecturer:** Dr. habil. István Grigorszky, University professor, PhD

<b>Title of course:</b> Mathematical methods in hydrobiology <b>Code:</b> TTHME9101_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: 28 hours - preparation for the exam: 64 hours Total: 120 hours	
<b>Year, semester:</b> 1st year, 1 st semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> A comprehensive introduction to probability, probability distributions, sampling distributions, basic techniques of statistical inference, analysis of variance, linear regression, inference for categorical variables, and nonparametric statistics. This course is designed to teach the students about a variety of mathematical methods which are used in modelling through their application to solving hydrobiological problems. In the practical part of the course students learn the methods of mathematical methods of data processing and planning of experiment.	
<b>Literature</b> - Venables, W. N. and Ripley, B. D. 2003: Modern Applied Statistics with S. 4th edition. Springer, New York. - Cox D.R., Donnelly C.A. (2011): Principles of Applied Statistics Cambridge University Press - Wasserman L. (2004): All of Statistics: A Concise Course in Statistical Inference, Springer;	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> Introduction to the course. <i>2<sup>nd</sup> week.</i> Basics of model building in science. <i>3<sup>rd</sup> week.</i> Introduction to the programming languages, with special reference to R programming language end environment. <i>4<sup>th</sup> week.</i> Basics of data management. <i>5<sup>th</sup> week.</i> Graphical methods in descriptive statistics. <i>6th week.</i> Basic statistics; statistical distributions. <i>7<sup>th</sup> week.</i> Exam. <i>8<sup>th</sup> week.</i> Sampling, design of experiments. <i>9<sup>th</sup> week.</i> Regression analyses.	

10<sup>th</sup> week. Analysis of variance (ANOVA).

11<sup>th</sup> week. General linear models and generalized linear models.

12<sup>th</sup> week. Multivariate methods: classification.

13<sup>th</sup> week. Multivariate methods: ordination.

14<sup>th</sup> week. Exam.

### **Requirements:**

Participation at classes is compulsory. A student must attend the courses and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

During the semester there are two tests: the mid-term test in the 7th week and the end-term test in the 14th week.

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

-an offered grade:

it may be offered for students if the average grade of the two exams is at least satisfactory (3) and the average of the mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of them.

- in case an offered grade cannot be given, or it is not convenient for the student there is a possibility to have an exam in the exam session.

**Person responsible for course:** Dr. Vanda Éva Abriha-Molnár, assistant professor

**Lecturer:** Dr. Vanda Éva Abriha-Molnár, assistant professor



<b>Title of course:</b> Mathematical Methods in Hydrobiology <b>Code:</b> TTHMG9101_EN	<b>ECTS Credit points: 2</b>
<b>Type of teaching, contact hours</b> - lecture: - - practice: 1 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 14 hours - laboratory: - - home assignment: 16 hours - preparation for the exam: - Total: 30 hours	
<b>Year, semester:</b> 1st year, 1 st semester	
<b>Further courses built on it:</b>	
<b>Topics of course</b> A comprehensive introduction to probability, probability distributions, sampling distributions, basic techniques of statistical inference, analysis of variance, linear regression, inference for categorical variables, and nonparametric statistics. This course is designed to teach the students about a variety of mathematical methods which are used in modelling through their application to solving hydrobiological problems. In the practical part of the course students learn the methods of mathematical methods of data processing and planning of experiment.	
<b>Literature</b> - Venables, W. N. and Ripley, B. D. 2003: Modern Applied Statistics with S. 4th edition. Springer, New York. - Cox D.R., Donnelly C.A. (2011): Principles of Applied Statistics Cambridge University Press - Wasserman L. (2004): All of Statistics: A Concise Course in Statistical Inference, Springer;	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> Practical basic knowledge to the course. <i>2<sup>nd</sup> week.</i> Techniques and tools of model building in science. <i>3<sup>rd</sup> week.</i> Basic usage of the R environment and programming language. <i>4<sup>th</sup> week.</i> Basic methods of data management. <i>5<sup>th</sup> week.</i> Practical usage of graphical methods in descriptive statistics. 6th week Basic statistics and statistical distributions of real data. <i>7<sup>th</sup> week.</i> Exam. <i>8<sup>th</sup> week.</i> Sampling, design of experiments. <i>9<sup>th</sup> week.</i> Analysis of variance (ANOVA) and regression analyses based on R. <i>10<sup>th</sup> week.</i> General linear models and generalized linear models in R. <i>11<sup>th</sup> week.</i> Models of population dynamics and their implementation in R.	

12<sup>th</sup> week. Discrete and continuous models, chaotic dynamics and their programming in R.

13<sup>th</sup> week. Multispecies communities and diversity. R packages to calculate these methods.

14<sup>th</sup> week. Exam.

**Requirements:**

Participation at classes is compulsory. A student must attend the courses and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

During the semester there are two tests: the mid-term test in the 7th week and the end-term test in the 14th week.

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

-an offered grade:

it may be offered for students if the average grade of the two designing tasks is at least satisfactory (3) and the average of the mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of them.

- in case an offered grade cannot be given, or it is not convenient for the student there is a possibility to have an exam in the exam session.

**Person responsible for course:** Dr. Vanda Éva Abriha-Molnár, assistant professor

**Lecturer:** Dr. Vanda Éva Abriha-Molnár, assistant professor

<b>Title of course:</b> Hydrology and Geography <b>Code:</b> TTHME9201_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: 28 hours - preparation for the exam: 64 hours Total: 120 hours	
<b>Year, semester:</b> 1st year, 2nd semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> <p>The course aims to provide detailed information about the physical characteristics of water resources. Students will learn both the surface waters and groundwater specific knowledge including the water cycle from the beginning: forming of precipitation, its spatial and temporal distribution as well the consequences of the inhomogeneous distribution (scarcity and floods and erosion). Surface water characteristics are also important including the network types, catchments, watersheds, shape of catchments. Geomorphology of riverine systems. Subsurface water types (groundwater, aquifer, aquitard, sensitive water resources), groundwater movement and its effect on pollution spreading. In the practical part of the course students learn the methods of the determination of flow direction and the speed of groundwater movement, furthermore, the metrics of the river parameters and a simple method will be introduced to calculate the soil erosion.</p>	
<b>Literature</b> <ol style="list-style-type: none"> <li>1. Han, D. 2010. Concise hydrology, www.BookBooN.com, ISBN 978-87-7681-536-1, 145 p.</li> <li>2. Brutsaert, W. 2005. Hydrology – An introduction. Cambridge University Press, ISBN 9780521824798 618 p.</li> <li>3. Loucks, D.P. and van Beek, E. 2005. Water resources systems planning and management. UNESCO Publishing ISBN 92-3-103998-9, 680 p.  <a href="http://hydrologic.org/BIB/Publ_UNESCO/SR_999_E_2005.pdf">http://hydrologic.org/BIB/Publ_UNESCO/SR_999_E_2005.pdf</a> </li> </ol>	
<b>Schedule:</b> <b>Lectures:</b> <i>1<sup>st</sup> week.</i> Water cycle and water courses of the Earth. <i>2<sup>nd</sup> week.</i> Horizontal and vertical structure of seas. <i>3<sup>rd</sup> week.</i> Geographical distribution of the chemical characteristics, temperature and the ice. <i>4<sup>th</sup> week.</i> Movements of the seas: waves. <i>5<sup>th</sup> week.</i> Movement of the seas: currents, tidal waves.	

6<sup>th</sup> week. Rivers, wells, estuaries.

7<sup>th</sup> week. Catchments, watersheds, morphometrical indices, network-patterns.

8<sup>th</sup> week. Runoff, floods.

9<sup>th</sup> week. Genetical lake types.

10<sup>th</sup> week. Water budget types for lakes.

11<sup>th</sup> week. Geometric and attribute data collection and extraction.

12<sup>th</sup> week. Types of undersurface waters.

13<sup>th</sup> week Remote sensing in hydrology.

14<sup>th</sup> week. Grade-offering exam.

### **Requirements:**

#### Lecture:

The minimum requirement for the examination is 50% from the midterm and closing tests. Based on the summarized score of the test the grade for the examination is given according to the following table:

Score	Grade
0-49%	fail (1)
50-59%	pass (2)
60-72%	satisfactory (3)
73-84%	good (4)
85-100%	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

**Person responsible for course:** Prof. Dr. habil. Szilárd Szabó, university professor, DSc

**Lecturer:** Prof. Dr. habil. Szilárd Szabó, university professor, DSc  
Dr. László Bertalan, assistant professor, PhD

<b>Title of course:</b> Hydrology and Geography <b>Code:</b> TTHMG9201_EN	<b>ECTS Credit points: 2</b>
<b>Type of teaching, contact hours</b> - lecture: - - practice: - - laboratory: 1 hours/week	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: - - laboratory: 14 hours - home assignment: 16 hours - preparation for the exam: - Total: 30 hours	
<b>Year, semester:</b> 1st year, 2nd semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> <p>The course aims to provide detailed information about the physical characteristics of water resources. Students will learn both the surface waters and groundwater specific knowledge including the water cycle from the beginning: forming of precipitation, its spatial and temporal distribution as well the consequences of the inhomogeneous distribution (scarcity and floods and erosion). Surface water characteristics are also important including the network types, catchments, watersheds, shape of catchments. Geomorphology of riverine systems. Subsurface water types (groundwater, aquifer, aquitard, sensitive water resources), groundwater movement and its effect on pollution spreading. In the practical part of the course students learn the methods of the determination of flow direction and the speed of groundwater movement, furthermore, the metrics of the river parameters and a simple method will be introduced to calculate the soil erosion.</p>	
<b>Literature</b> <ol style="list-style-type: none"> <li>1. Han, D. 2010. Concise hydrology, www.BookBooN.com, ISBN 978-87-7681-536-1, 145 p.</li> <li>2. Brutsaert, W. 2005. Hydrology – An introduction. Cambridge University Press, ISBN 9780521824798 618 p.</li> <li>3. Loucks, D.P. and van Beek, E. 2005. Water resources systems planning and management. UNESCO Publishing ISBN 92-3-103998-9, 680 p.  <a href="http://hydrologic.org/BIB/Publ_UNESCO/SR_999_E_2005.pdf">http://hydrologic.org/BIB/Publ_UNESCO/SR_999_E_2005.pdf</a> </li> </ol>	
<b>Schedule:</b> <b>Lectures:</b> <i>1<sup>st</sup> week.</i> Application of geodetic instruments in hydrology I. <i>2<sup>nd</sup> week.</i> Application of geodetic instruments in hydrology II. <i>3<sup>rd</sup> week.</i> Application of geodetic instruments in hydrology III. <i>4<sup>th</sup> week.</i> Field data processing and interpretation for thematic map compositions. <i>5<sup>th</sup> week.</i> Small-scale flume experiments for understanding river morphology I.	

6<sup>th</sup> week. Small-scale flume experiments for understanding river morphology II.

7<sup>th</sup> week. Methods for spatio-temporal analysis of river channel development.

8<sup>th</sup> week. Floodplain management.

9<sup>th</sup> week. Effects of river regulation works; floodplain rehabilitation.

10<sup>th</sup> week. Applied hydrometrics; surface water survey and gauging methodology.

11<sup>th</sup> week. Hydrological time series data analysis.

12<sup>th</sup> week. Digital Elevation Models, Applied GIS methods in hydrology.

13<sup>th</sup> week. Delineation of wetlands based on remote sensing data.

14<sup>th</sup> week. Practical test.

### **Requirements:**

#### Practice:

Participation at classes is compulsory. A student must attend the courses and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

During the semester there is one practical test. It can be completed in the 14<sup>th</sup> week.

The minimum score is 50%. Based on the score of the test, the grade for the test is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-72	satisfactory (3)
73-84	good (4)
85-100	excellent (5)

**Person responsible for course:** Prof. Dr. habil. Szilárd Szabó, university professor, DSc

**Lecturer:** Prof. Dr. habil. Szilárd Szabó, university professor, DSc  
Dr. László Bertalan, assistant professor, PhD

<b>Title of course:</b> Applied Hydrobiology <b>Code:</b> TTHME9210_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: 28 hours - preparation for the exam: 64 hours Total: 120 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> The types of natural water supplies (surface waters and groundwaters) and their main characteristics. Water pollution, waste materials. Technologies for providing drinking water from different water sources. Domestic, industrial and agricultural wastewaters. Wastewater treatment (primary, secondary, tertiary). Biological methods (activated sludge, fixed-film reactors). Treatment of sewage sludge (biogas production, composting). Natural wastewater treatment systems (stabilization ponds, constructed wetlands). Types and function of reservoirs. Fish ponds and fish breeding. Biomanipulation.	
<b>Literature</b> <i>Compulsory:</i> K. Edzwald (2011): Water Quality and Treatment. Handbook of Drinking Water. American Water Works Association, USA ISBN: 9780071630115 J.E. Drinan, F.Spellman (2012): Water and Wastewater Treatment: Guide for the Nonengineering Professional. CRC Press, USA ISBN 9781439854006 R.W. Crites, E.J. Middlebrooks, S.C. Reed (2005): Natural Wastewater Systems, CRC Press, USA ISBN 9780849338045 H. Reinersten, L.A. Dahle, L. Jorgensen 1993: Fish Farming Technology. CRC Press ISBN 9789054103264	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> Surface and underground water resources, their qualitative and quantitative characteristics, the factors determining them. <i>2<sup>nd</sup> week.</i> The definition of drinking water. Drinking water production from groundwater. The characteristics of the river bank filtration and the technology used for purification. Artificial recharge of groundwater. <i>3<sup>rd</sup> week.</i> Drinking water from confined groundwater. The characteristics and treatment technologies	

<p>of the confined groundwater. Arsenic removal methods. Characteristics and use of karstic waters for drinking water supply.</p> <p>4<sup>th</sup> week. Production of drinking water from surface waters. Water extraction methods from standing and running waters, purification characteristics, the applied technological processes.</p> <p>5<sup>th</sup> week. Types of industrial water demand. Procedures for industrial water treatment (membrane technologies, softening, desalting, iron and manganese removal).</p> <p>6<sup>th</sup> week. Biology of drinking water supply systems. The biological features of water withdrawal sites and the drinking water supply network.</p> <p>7<sup>th</sup> week. The definition of wastewater and its types. The technology of domestic wastewater treatment.</p> <p>8<sup>th</sup> week. Biological treatment processes 1. The operation of artificial methods (active sludge and fixed film systems)</p> <p>9<sup>th</sup> week. Biological treatment processes 2. Types of natural methods and their functional characteristics.</p> <p>10<sup>th</sup> week. Characterization and treatment methods of sewage sludge. Biogas production.</p> <p>11<sup>th</sup> week. The hydrobiological effects of heat pollution. Effects of hydromorphological interventions in surface waters.</p> <p>13<sup>th</sup> week. The basics of fish farming, extensive and intensive methods.</p> <p>12<sup>th</sup> week. Future tasks of applied hydrobiology (effects of global warming, biomanipulation, drug residues in water).</p> <p>14<sup>th</sup> week. Consultation or exam.</p>	<p><b>Requirements:</b></p> <p>- <i>for a signature</i></p> <p>Attendance at lectures is recommended, but not compulsory.</p> <p>- <i>for a grade</i></p> <p>The course ends in a written examination. 2 (Pass) grade: 50% of the maximum points available. If the score of any test is below 50%, students can take a retake test.</p> <p>- <i>an offered grade:</i></p> <p>There are at least two tests during the semester, and the offered grade is the average of them.</p>
<p><b>Person responsible for course:</b> Dr. Imre Somlyai, assistant professor, PhD</p>	<p><b>Lecturer:</b> Dr. Imre Somlyai, assistant professor, PhD</p>



<b>Title of course:</b> Applied Hydrobiology <b>Code:</b> TTHMG9210_EN	<b>ECTS Credit points: 2</b>
<b>Type of teaching, contact hours</b> - lecture: - - practice: 1 hours/week - laboratory: -	
<b>Evaluation:</b> signature	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 14 hours/week - laboratory: - - home assignment: 16 hours - preparation for the exam: - Total: 30 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
Comparative assessment of methods used in water and wastewater treatment. Possibilities for controlling operation. Visit the drinking water treatment plant, a sewage treatment plant, a fish farm and a waterworks laboratory.	
<b>Literature</b>	
<i>Compulsory:</i> M.P. Cheremisinoff (2002): Handbook of water and wastewater treatment technologies. Butterworth-Heinemann, USA ISBN 0-7506-7498-9 K. Edzwald (2011): Water Quality and Treatment. Handbook of Drinking Water. American Water Works Association, USA ISBN: 9780071630115 J.E. Drinan, F. Spellman (2012): Water and Wastewater Treatment: Guide for the Nonengineering Professional. CRC Press, USA ISBN 9781439854006	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> Methods of water withdrawal, well types and their operation. <i>2<sup>nd</sup> week.</i> Comparing types of sand filters and their operation. <i>3<sup>rd</sup> week.</i> Applicability of various primary coagulant and the possibilities of increasing the coagulation process. <i>4<sup>th</sup> week.</i> Comparison of using of different disinfectants. Case study. <i>5<sup>th</sup> week.</i> Evaluation of membrane techniques, their applicability in water and wastewater treatment. <i>6<sup>th</sup> week.</i> Comparison of arsenic removal methods. Case study. <i>7<sup>th</sup> week.</i> Investigation of the operation of activated sludge: organic matter load (COD, BOD), N and P forms, sediment sludge, Mohlmann index. <i>8<sup>th</sup> week.</i> Using chemicals in wastewater treatment.	

*9<sup>th</sup> week.* Types of municipal water supply systems and sewer networks.

*10<sup>th</sup> week.* Design and operation of industrial cooling water systems.

*11<sup>th</sup> week.* Options of stormwater treatment.

*13<sup>th</sup> week.* Visit to a drinking water treatment plant and a fish farm.

*12<sup>th</sup> week.* Visit to a wastewater treatment plant and a waterworks lab.

*14<sup>th</sup> week.* Consultation.

**Requirements:**

- for a signature

Participation at practice classes is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. In case of further absences, a medical certificate needs to be presented.

- for a grade

The practice ends with submitting a term paper.

**Person responsible for course:** Dr. Imre Somlyai, assistant professor, PhD

**Lecturer:** Dr. Imre Somlyai, assistant professor, PhD

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<b>Title of course:</b> Water Chemistry <b>Code:</b> TTHME9215_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 1 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: 28 hours - preparation for the exam: 64 hours Total: 120 hours	
<b>Year, semester:</b> 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
The course introduces the chemical and physical properties of water and processes occurring in aqueous media, furthermore, the course discusses the main laws of behavior of aqueous solutions. Basic knowledge: the structure of the water molecule, water phase diagram, different states (consistence, phases) of water will be discussed. Subjects as supercritical state, polarity, and water as solvent will be introduced. Chemical equilibrium and kinetic principles will be introduced for the acid-base reactions, complex formation, precipitation/dissolution, oxidation/reduction reactions, and for dilution processes.	
<b>Literature</b>	
1. Snoeyink VL (2006) Water Chemistry. John Wiley & Sons Inc. 2. Spellman FR (2014) The Science of Water: Concepts and Applications. CRC Press. Stanley EM (2010) Water Chemistry: Green Science and Technology of Nature's Most Renewable Resource. CRC Press.	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> Development of hydrophysics and hydrochemistry. <i>2<sup>nd</sup> week.</i> The structure of the water molecule. General characterization and physical properties of water. <i>3<sup>rd</sup> week.</i> The proportion of water resources on Earth I: Fresh, salty and brackish waters. <i>4<sup>th</sup> week.</i> Proportions of water resources on Earth II .: Surface- and groundwaters. <i>5<sup>th</sup> week.</i> Water cycles. <i>6<sup>th</sup> week.</i> Cold and warm sea currents, the Coriolis force. <i>7<sup>th</sup> week.</i> Methods of measuring the physical parameters of the water, their importance in water management. <i>8<sup>th</sup> week.</i> The chemical properties of water: general laws of dissolution, reactivity of water.	

<p>9<sup>th</sup> week. Water as a solvent: dissolution of gases, cations and anions.</p> <p>10<sup>th</sup> week. Dissociation equilibria in aqueous solutions.</p> <p>11<sup>th</sup> week. The pH of aqueous solutions.</p> <p>12<sup>th</sup> week. Laws of acid-base equilibria.</p> <p>13<sup>th</sup> week. Oxidation -reduction systems, basic knowledge of electrochemistry.</p> <p>14<sup>th</sup> week. Organic substances in the waters, reactions of organic matter: hydrolysis, hydration, dehydration.</p>
<p><b>Requirements:</b></p> <p>- <i>for a signature</i></p> <p>Attendance at lectures is highly recommended, but not compulsory.</p> <p>- <i>for a grade</i></p> <p>During the semester there will be no written tests, there will be an oral exam in the exam period.</p>
<p><b>Person responsible for course:</b> Dr. habil. István Bácsi, associate professor, PhD</p>
<p><b>Lecturer:</b> Dr. habil. István Bácsi, associate professor, PhD</p>

<b>Title of course:</b> Water Chemistry laboratory <b>Code:</b> TTHMG9215_EN	<b>ECTS Credit points: 2</b>
<b>Type of teaching, contact hours</b> - lecture: - - practice: - - laboratory: 2 hours/week	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: - - laboratory: 28 hours - home assignment: 16 hours - preparation for the exam: - Total: 30 hours	
<b>Year, semester:</b> 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
The conditions of water sampling, sample types. Chemical properties of waters, inorganic compounds, and inorganic materials related to eutrophication. Organic substances in water, indicators of organic matter content. Interpretation of water treatment, classification of water treatment methods. Methods for degassing. Methods for removing soluble and floating substances.	
<b>Literature</b>	
1. Snoeyink VL (2006) Water Chemistry. John Wiley & Sons Inc. 2. Spellman FR (2014) The Science of Water: Concepts and Applications. CRC Press. . Stanley EM (2010) Water Chemistry: Green Science and Technology of Nature's Most Renewable Resource. CRC Press.	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> Measurement of depth and transparency. Measurement of water conductivity in different water types. <i>2<sup>nd</sup> week.</i> Instrumental measurement of pH, dissolved oxygen content and saturation in different water types. <i>3<sup>rd</sup> week.</i> Surveying of waterbed section by ultrasonic measuring instrument. <i>4<sup>th</sup> week.</i> The pH. Acidity, alkalinity, water hardness. <i>5<sup>th</sup> week.</i> Methods for determination of dissolved oxygen: classical analytical, electrochemical and optical methods. <i>6<sup>th</sup> week.</i> Measurement of inorganic nutrients I. - Reduced nitrogen forms: ammonium. <i>7<sup>th</sup> week.</i> Measurement of inorganic nutrients II. - Oxidized nitrogen forms: nitrite, nitrate. <i>8<sup>th</sup> week.</i> Measurement of inorganic nutrients III. - Phosphorous forms. <i>9<sup>th</sup> week.</i> Measurement of water nutrition indicators: chlorophyll content.	

<p>10<sup>th</sup> week. The most important metal ions in water: the classical analytical measurement possibilities of iron and manganese.</p> <p>11<sup>th</sup> week. Methods for measuring the organic matter content of waters I: measurement of chemical oxygen demand.</p> <p>12<sup>th</sup> week. Methods for measuring the organic matter content of water II: compiling experiments to determine the biological oxygen demand.</p> <p>13<sup>th</sup> week. Methods for measuring the organic matter content of water III: biological oxygen demand. Definition of BOD7.</p> <p>14<sup>th</sup> week. Consultation.</p>
<p><b>Requirements:</b></p> <p>- <i>for a signature</i></p> <p>Participation at laboratory practices is compulsory. A student must attend the laboratory practices and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.</p> <p>- <i>for a grade</i></p> <p>During the semester there will be short written tests on every practice, reports should be prepared after every topic. The final grade will be the average of the grades of written tests and reports.</p>
<p><b>Person responsible for course:</b> Dr. habil. István Bácsi, associate professor, PhD</p>
<p><b>Lecturer:</b> Dr. habil. István Bácsi, associate professor, PhD</p>

<b>Title of course:</b> Running Water Ecology <b>Code:</b> TTHME9205_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: 28 hours - preparation for the exam: 64 hours Total: 120 hours	
<b>Year, semester:</b> 1st year, 1 st semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> <p>This course will introduce students to major conceptual themes in ecology of running waters. . Our goals for this course are to gain an understanding of major physical and biological features of streams and rivers; the range of diversity of running waters around the world; fundamental processes producing patterns of riverine structure and function and critical issues associated with the conservation and management of streams and their biota.</p> <p>We will study the functional aspects of running waters and its ecological state by comparing natural and human impacted running water types. In the field, we will measure the running water types structure and discharge, sample organisms, and determine water chemistry and the ecological state on the basis of biological, chemical and hydro-morphological characteristics. In the lab, we will identify selected organisms and will learn about adaptation mechanism as regards nutrition, life cycles and resistance to water current.</p>	
<b>Literature</b> <ol style="list-style-type: none"> <li>4. Allan J.D. Castillo M.M., (2011) Stream Ecology: Structure and function of running waters, Springer Netherlands,</li> <li>5. Michael J. and Mills D., (1990): Freshwater Ecology: Principles and Applications, Wiley-Blackwell,</li> <li>6. Giller P.S. (1999): The Biology of Streams and Rivers (Biology of Habitats), Oxford University Press, USA,</li> <li>7. APHA (2012): Standard Methods for the Examination of Water and Wastewater, Clearway Logistics Phase 1a;</li> </ol>	
<b>Schedule:</b> <b>Lectures:</b> <i>1<sup>st</sup> week.</i> Water resources and water cycle. <i>2<sup>nd</sup> week.</i> The streamflow system.	

3<sup>rd</sup> week. Zonation of watercourses.

4<sup>th</sup> week. Water temperature and dissolved oxygen.

5<sup>th</sup> week. The sedimentation process.

6<sup>th</sup> week. Organic matter processing.

7<sup>th</sup> week. River continuum concept, guilds.

8<sup>th</sup> week. Ecological zonation of streams.

9<sup>th</sup> week. Floodplain landforms.

10<sup>th</sup> week. Typology of springs and running waters.

11<sup>th</sup> week. Succession patterns of fish populations.

12<sup>th</sup> week. Main streams of the Carpathian Basin: River Danube.

13<sup>th</sup> week. Main streams of the Carpathian Basin: River Tisza.

14<sup>th</sup> week. Grade-offering exam.

### **Requirements:**

#### Lecture:

The minimum requirement for the examination is 50% from the midterm and closing tests. Based on the summarized score of the test the grade for the examination is given according to the following table:

Score	Grade
0-49%	fail (1)
50-59%	pass (2)
60-72%	satisfactory (3)
73-84%	good (4)
85-100%	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

**Person responsible for course:** Dr. Csaba Berta, assistant professor, PhD

**Lecturer:** Dr. Csaba Berta, assistant professor, PhD



<b>Title of course:</b> Running Water Ecology <b>Code:</b> TTHMG9205_EN	<b>ECTS Credit points: 2</b>
<b>Type of teaching, contact hours</b> - lecture: - - practice: 1 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 14 hours - laboratory: - - home assignment: 16 hours - preparation for the exam: - Total: 30 hours	
<b>Year, semester:</b> 1st year, 1 st semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> <p>This course will introduce students to major conceptual themes in ecology of running waters. . Our goals for this course are to gain an understanding of major physical and biological features of streams and rivers; the range of diversity of running waters around the world; fundamental processes producing patterns of riverine structure and function and critical issues associated with the conservation and management of streams and their biota.</p> <p>We will study the functional aspects of running waters and its ecological state by comparing natural and human impacted running water types. In the field, we will measure the running water types structure and discharge, sample organisms, and determine water chemistry and the ecological state on the basis of biological, chemical and hydro-morphological characteristics. In the lab, we will identify selected organisms and will learn about adaptation mechanism as regards nutrition, life cycles and resistance to water current.</p>	
<b>Literature</b> 8. Allan J.D. Castillo M.M., (2011) Stream Ecology: Structure and function of running waters, Springer Netherlands, 9. Michael J. and Mills D., (1990): Freshwater Ecology: Principles and Applications, Wiley-Blackwell, 10. Giller P.S. (1999): The Biology of Streams and Rivers (Biology of Habitats), Oxford University Press, USA, 11. APHA (2012): Standard Methods for the Examination of Water and Wastewater, Clearway Logistics Phase 1a;	
<b>Schedule:</b> <b>Lectures:</b> <i>1<sup>st</sup> week.</i> Physical and chemical attributes of water. <i>2<sup>nd</sup> week.</i> Order of streamflows.	

3<sup>rd</sup> week. Riverbed geology, bedload transport and substrate.

4<sup>th</sup> week. Measuring dissolve oxygen, flow rate, and current speed.

5<sup>th</sup> week. Mountain stream, piedmont river, river plain.

6<sup>th</sup> week. Autochthonous and allochthonous sources of nutrients.

7<sup>th</sup> week. Functional feeding groups (shredders, grazers, collectors, predators).

8<sup>th</sup> week. Space of living.

9<sup>th</sup> week. Oxbow lake, chute, backswamps.

10<sup>th</sup> week. The small streams: rivulet, brooke, rill.

11<sup>th</sup> week. Typical fish species of the zonations.

12<sup>th</sup> week. Presentations I.: the major streams of the students own country.

13<sup>th</sup> week. Presentations II.: the major streams of the students own country or other main tributaries of Danube.

14<sup>th</sup> week. Grade-offering exam.

### **Requirements:**

#### Practice:

Participation at classes is compulsory. A student must attend the courses and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

During the semester there is one practical test. It can be completed in the 14<sup>th</sup> week.

The minimum score is 50%. Based on the score of the test, the grade for the test is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-72	satisfactory (3)
73-84	good (4)
85-100	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

**Person responsible for course:** Dr. Csaba Berta, assistant professor, PhD

**Lecturer:** Dr. Csaba Berta, assistant professor, PhD

<b>Title of course:</b> Standing Water Ecology <b>Code:</b> TTHME9204_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: 28 hours - preparation for the exam: 64 hours Total: 120 hours	
<b>Year, semester:</b> 1st year, 1 st semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> <p>The primary objective of this course is to allow the students to become familiar with the scope of standing water ecology and to master its basic facts, principles, concept and fundamental processes. The course explores the structure and function of standing water types, including physical, chemical and biological controls of productivity and species composition of aquatic plants and animals and effects of pollution on organisms and water quality. The laboratory emphasizes modern, hands-on techniques for answering fundamental and applied questions. During the practise/field work the students will learn the qualitative and quantitative techniques for studying lakes, ponds and various standing water types. During the laboratory work the students will identify various aquatic organisms and will learn about adaptation mechanism as regards nutrition, life cycles.</p>	
<b>Literature</b> <ol style="list-style-type: none"> <li>1. Kalff J (2001): Limnology. Benjamin and Cummings.</li> <li>2. Williams D. D. (2001): The Ecology of Temporary Waters. Blackburn Pr.</li> <li>3. Belgrano A., Ulanowicz R. E., Scharler U. M., Dunne J. (2005): Aquatic Food Webs: An Ecosystem Approach, Oxford University Press,</li> <li>4. Burk A. R. (2005): Progress In Aquatic Ecosystems Research. Nova Science Pub Inc.</li> </ol>	
<b>Schedule:</b> <b>Lectures:</b> <i>1<sup>st</sup> week.</i> Limnology, Water cycle, habitats, water yields. <i>2<sup>nd</sup> week.</i> The vertical segmentation of a standing water. <i>3<sup>rd</sup> week.</i> Standing water typology. <i>4<sup>th</sup> week.</i> Space of living and physiognomy.	

5<sup>th</sup> week. Eutrophication (trophy and trophity).

6<sup>th</sup> week. Halobity.

7<sup>th</sup> week. Saprobity .

8<sup>th</sup> week. Toxicity.

9<sup>th</sup> week. Physical parameters of standing waters.

10<sup>th</sup> week. Chemical parameters of standing waters.

11<sup>th</sup> week. Fish communities of standing waters.

12<sup>th</sup> week. Macroinvertebrates of standing waters.

13<sup>th</sup> week. Saline lakes and reservoirs, Lake Balaton “hungarian sea”.

14<sup>th</sup> week. Grade-offering exam.

### **Requirements:**

#### Lecture:

The minimum requirement for the examination is 50% from the midterm and closing tests. Based on the summarized score of the test the grade for the examination is given according to the following table:

Score	Grade
0-49%	fail (1)
50-59%	pass (2)
60-72%	satisfactory (3)
73-84%	good (4)
85-100%	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

**Person responsible for course:** Dr. Csaba Berta, assistant professor, PhD

**Lecturer:** Dr. Csaba Berta, assistant professor, PhD

<b>Title of course:</b> Standing Water Ecology <b>Code:</b> TTHMG9204_EN	<b>ECTS Credit points: 2</b>
<b>Type of teaching, contact hours</b> - lecture: - - practice: 1 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 0 hours - practice: 14 hours - laboratory: 0hours - home assignment: 20 hours - preparation for the exam: 30 hours Total: 64 hours	
<b>Year, semester:</b> 1st year, 1 st semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> <p>The primary objective of this course is to allow the students to become familiar with the scope of standing water ecology and to master its basic facts, principles, concept and fundamental processes. The course explores the structure and function of standing water types, including physical, chemical and biological controls of productivity and species composition of aquatic plants and animals and effects of pollution on organisms and water quality. The laboratory emphasizes modern, hands-on techniques for answering fundamental and applied questions. During the practise/field work the students will learn the qualitative and quantitative techniques for studying lakes, ponds and various standing water types. During the laboratory work the students will identify various aquatic organisms and will learn about adaptation mechanism as regards nutrition, life cycles.</p>	
<b>Literature</b> <ol style="list-style-type: none"> <li>1. Kalff J (2001): Limnology. Benjamin and Cummings.</li> <li>2. Williams D. D. (2001): The Ecology of Temporary Waters. Blackburn Pr.</li> <li>3. Belgrano A., Ulanowicz R. E., Scharler U. M., Dunne J. (2005): Aquatic Food Webs: An Ecosystem Approach, Oxford University Press,</li> <li>4. Burk A. R. (2005): Progress In Aquatic Ecosystems Research. Nova Science Pub Inc.</li> <li>5. Padisák, J (2005): Általános limnológia, ELTE Eötvös Kiadó.</li> </ol>	
<b>Schedule:</b> <b>Lectures:</b> <i>1<sup>st</sup> week.</i> Division of the different habitats and water yields. All the student's need to recognize 10 different habitat and water yield, in case of an example. <i>2<sup>nd</sup> week.</i> Have to distinguish the different parts of the water body. Discussion about their functions.	

*3<sup>rd</sup> week.* Division of the Hungarian standing water types. Every student needs to differentiate 10 water body.

*4<sup>th</sup> week.* Space of living and their main organisms.

*5<sup>th</sup> week.* Isolation of the different types of eutrophication and their main consequences. All the students need to discuss about the trophic.

*6<sup>th</sup> week.* Categorization of an example water body based on halobity.

*7<sup>th</sup> week.* Categorization of an example water body based on saprobity.

*8<sup>th</sup> week.* Categorization of an example water body based on toxicity.

*9<sup>th</sup> week.* Analyzing water bodies with data series. Monomictic, dimictic, polymictic, oligomictic, amictic lakes.

*10<sup>th</sup> week.* Measurement of different chemical parameter of a standing water.

*11<sup>th</sup> week.* Analyses of characteristic fish groups of standing water based on data series and their water quality aspects.

*12<sup>th</sup> week.* Analyses of typical macroinvertebrates community of standing waters based on data series and their water quality aspects.

*13<sup>th</sup> week.* Investigation of the physical, chemical and biological characteristics that characterize the different water quality status of water bodies.

*14<sup>th</sup> week.* Grade-offering exam.

### **Requirements:**

#### Practice:

Participation at classes is compulsory. A student must attend the courses and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

During the semester there is one practical test. It can be completed in the 14<sup>th</sup> week.

The minimum score is 50%. Based on the score of the test, the grade for the test is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-72	satisfactory (3)
73-84	good (4)
85-100	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

**Person responsible for course:** Dr. Csaba Berta, assistant professor, PhD

**Lecturer:** Dr. Csaba Berta, assistant professor, PhD

<b>Title of course:</b> Wetland ecology <b>Code:</b> TTHME9216_EN	<b>ECTS Credit points: 3</b>
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: 28 hours - preparation for the exam: 64 hours Total: 120 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> <p>Students will be provided with state-of-the-art basic knowledge of wetland flora and fauna and ecology. The course emphasizes wetlands functions and values in an ecosystem perspective. Both saltwater and freshwater wetlands will be addressed in the course. The relationship of wetlands to adjacent terrestrial and deep water habitats, along with wetlands succession and dynamics will be discussed.</p> <p>This course provides instruction in the following topics: wetland hydrology; wetland vegetation; major faunal populations associated with wetlands; wetland plant and animal communities, ecosystem relationships, and dynamic processes; wetland classification systems, principles of wetlands ecology and dynamics; evaluation of wetland functions; overview of wetland development, restoration, and constructed wetlands.</p>	
<b>Literature</b> <i>Compulsory:</i> <ol style="list-style-type: none"> <li>1. Mitsch, W.J., J.G. Gosselink, C.J. Anderson and L. Zhang. (2009): Wetland Ecosystems, John Wiley &amp; Son, Inc., New York.</li> <li>2. Wright, W. and J. Gosselink (2007): Wetlands, John Wiley &amp; Sons, Inc.</li> <li>3. Keddy P.A. (2010): Wetland Ecology Principles and Conservation, Cambridge University Press</li> </ol>	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> Definition of wetland. Wetland functions: hydrologic processes, water quality improvement, wildlife habitat. Productivity of wetlands. <i>2<sup>nd</sup> week.</i> Classification of wetland systems. Freshwater and coastal wetlands. <i>3<sup>rd</sup> week.</i> Formation, chemistry, and biology of wetland soils. Soil forming factors. Features of hydric soils, horizonization. Types of wetland soils.	

4 <sup>th</sup> week.	Organic vs inorganic soils. Redox reactions, carbon , phosphorous, sulfur and nitrogen transformations in the wetland soils.
5 <sup>th</sup> week.	Soil communities in wetlands, their importance in the formation and change of the soils. Biological indicator species and assemblages.
6 <sup>th</sup> week.	Vegetation and fauna of wetlands. The most important species and taxa.
7 <sup>th</sup> week.	Adaptations of plants to wetland environments: structural adaptations (aerenchyma, adventitious roots, stem elongation, lenticels, pneumatophores), physiological adaptations (anaerobic respiration, malate production, carnivorous nutrition).
8 <sup>th</sup> week.	Adaptation of animals to wetland environment. Adaptation to salt stress (osmoregulation) and anoxia. Necton adaptations. Estuarine-dependent life cycles. Importance of wetlands in the bird migration.
9 <sup>th</sup> week.	Wetlands as ecosystems. Trophic structures. Features of bio-geochemical cycles. Carbon cycle.
10 <sup>th</sup> week.	Nitrogen cycle (fixation, ammonification, immobilization, nitrification and denitrification). Phosphorus and sulphur cycles.
11 <sup>th</sup> week.	Primer and seconder production in wetlands. Productivity of different types of wetlands.
12 <sup>th</sup> week.	The Ramsar Convention on Wetlands. Key features of the Ramsar Convention.
13 <sup>th</sup> week.	Wetland and landscape. Restoration of wetlands. Constructed wetlands
14 <sup>th</sup> week.	Consultation or exam

#### **Requirements:**

##### *- for a signature*

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. In case of further absences, a medical certificate needs to be presented.

##### *- for a grade*

The course ends in an written **examination**. 2 (Pass) Grade: 50% of the maximum points available. If the score of any test is below 50%, students can take a retake test.

##### *-an offered grade:*

There are at least two test during the semester, and the offered grade is the average of them.

**Person responsible for course:** Dr. Imre Somlyai, assistant professor, PhD

**Lecturer:** Dr. Imre Somlyai, assistant professor, PhD



<b>Title of course:</b> Wetland ecology <b>Code:</b> TTHMG9216_EN	<b>ECTS Credit points: 2</b>
<b>Type of teaching, contact hours</b> - lecture: - - practice: 1 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 14 hours - laboratory: - - home assignment: 16 hours - preparation for the exam: - Total: 30 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> <p>Students will be provided with state-of-the-art basic knowledge of wetland flora and fauna and ecology. The course emphasizes wetlands functions and values in an ecosystem perspective. Both saltwater and freshwater wetlands will be addressed in the course. The relationship of wetlands to adjacent terrestrial and deep water habitats, along with wetlands succession and dynamics will be discussed.</p> <p>This course provides instruction in the following topics: wetland hydrology; wetland vegetation; major faunal populations associated with wetlands; wetland plant and animal communities, ecosystem relationships, and dynamic processes; wetland classification systems, principles of wetlands ecology and dynamics; evaluation of wetland functions; overview of wetland development, restoration, and constructed wetlands.</p>	
<b>Literature</b> <i>Compulsory:</i> 1. Mitsch, W.J., J.G. Gosselink, C.J. Anderson and L. Zhang. (2009): Wetland Ecosystems, John Wiley & Son, Inc., New York. 2. Wright, W. and J. Gosselink (2007): Wetlands, John Wiley & Sons, Inc. 3. Keddy P.A. (2010): Wetland Ecology Principles and Conservation, Cambridge University Press	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> Importance of hydrologic processes (recharging and discharging wetlands). Importance of water quality improvement. <i>2<sup>nd</sup> week.</i> Discussing wetland types of student's country. <i>3<sup>rd</sup> week.</i> Methods for analysis of soil structure and physical characteristics. The importance of soil gas content. <i>4<sup>th</sup> week.</i> Methods for analysis of soil chemical characteristics.	

<p>5<sup>th</sup> week. Methods for investigating of soil fauna and flora.</p> <p>6<sup>th</sup> week. Showing the most important plant and animal taxa according to the wetland types.</p> <p>7<sup>th</sup> week. Presentation of structural and physiological adaptations of plants.</p> <p>8<sup>th</sup> week. Definition of osmosis. Mechanisms of osmoregulation. Conformers and regulators.</p> <p>9<sup>th</sup> week. Trophic structures of different wetland types. General features of bio-geochemical cycles.</p> <p>Energy flow in the ecosystems.</p> <p>10<sup>th</sup> week. Adaptation of plants and animal to low nitrogen content.</p> <p>11<sup>th</sup> week. Primary and secondary production in wetlands. Productivity of different types of wetlands.</p> <p>12<sup>th</sup> week. The Ramsar Convention on Wetlands. Key features of the Ramsar Convention.</p> <p>13<sup>th</sup> week. Wetland and landscape. Restoration of wetlands. Constructed wetlands</p> <p>14<sup>th</sup> week. Consultation</p>
<p><b>Requirements:</b></p> <p>- <i>for a signature</i></p> <p>Participation at <b>practice classes</b> is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. In case of further absences, a medical certificate needs to be presented.</p> <p>- <i>for a grade</i></p> <p>The course ends in an written <b>examination</b>. 2 (Pass) Grade: 50% of the maximum points available. If the score of any test is below 50%, students can take a retake test.</p> <p>- <i>an offered grade:</i></p> <p>There are at least two test during the semester, and the offered grade is the average of them.</p>
<p><b>Person responsible for course:</b> Dr. Imre Somlyai, assistant professor, PhD</p>
<p><b>Lecturer:</b> Dr. Imre Somlyai, assistant professor, PhD</p>

<b>Title of course:</b> Water Resource Management <b>Code:</b> TTHME9213_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: 28 hours - preparation for the exam: 64 hours Total: 120 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> <p>The course aims to enhance understanding of the multi-scale interconnections between water management, environmental and socioeconomic issues. In particular, it considers multidisciplinary approaches to water management problems. Students will learn the basic concepts of hydrology and water resource, like water properties, hydrological cycle, sources of water and water balance calculation, impacts of population, urbanization, agriculture and climate change on water. Also, to explore the linkages between water and human health.</p> <p>Examples and case studies will be used to illustrate the water management, drawing on perspectives from both the natural and social sciences. Topics will be covered through lectures from a range of contributors, investigation of case-studies and small group work.</p>	
<b>Literature</b> <ol style="list-style-type: none"> <li>1. Loucks D. P., van Beek E., Stedinger J. R., Dijkman J. P.M., Villars M. T. (2005): Water Resources Systems Planning and Management: An Introduction to Methods, Models and Applications. UNESCO Paris,</li> <li>2. Hussey K. (2011): Water Resources Planning and Management. Cambridge University Press</li> <li>3. Wurbs R. (2013): Water Resources Planning and Management. InTech</li> </ol>	
<b>Schedule:</b> <b>Lectures:</b> <i>1<sup>st</sup> week.</i> Basics of water management. Its specializations, water balance and damage prevention. <i>2<sup>nd</sup> week.</i> Wastewater management and global water scarcity. Ground waters, aquifer protection. <i>3<sup>rd</sup> week.</i> The purpose, significance and conditions of irrigation. <i>4<sup>th</sup> week.</i> Water Framework Directive <i>5<sup>th</sup> week.</i> Erosion, slopes, harmful water surplus. <i>6<sup>th</sup> week.</i> Natural disasters	

7<sup>th</sup> week. Surface waters

8<sup>th</sup> week. Water and climate change: challenges for the 21st century - Problems and Solutions. Role of engineering in sustainable water management

9<sup>th</sup> week. Managing Floods – Dams, Mobile Dams; Mobile flood walls; Strategies for Managing Sea Level Rise; Barriers

10<sup>th</sup> week. Flood Risk Reduction; Managing Risk

11<sup>th</sup> week. Sediments; Processes and Modelling Assumptions; Sedimentation, Bed Shear Stress

12<sup>th</sup> week. Urban Water Systems: Drinking Water, Wastewater, Urban Drainage

13<sup>th</sup> week. Lakes and Reservoirs; Downstream Characteristics

14<sup>th</sup> week. Hydroelectric Power Production

**Requirements:**

Lecture:

The minimum requirement for the examination is 50% from the midterm and closing tests. Based on the summarized score of the test the grade for the examination is given according to the following table:

Score	Grade
0-49%	fail (1)
50-59%	pass (2)
60-72%	satisfactory (3)
73-84%	good (4)
85-100%	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

**Person responsible for course:** Dr. Herta Czédli, associate professor, PhD

**Lecturer:** Dr. Herta Czédli, associate professor, PhD, Dr. Csaba Berta, assistant professor, PhD

<b>Title of course:</b> Water Resource Management <b>Code:</b> TTHMG9213_EN	<b>ECTS Credit points: 2</b>
<b>Type of teaching, contact hours</b> - lecture: - - practice: 1 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 14 hours - laboratory: - - home assignment: 16 hours - preparation for the exam: - Total: 30 hours	
<b>Year, semester:</b> 1st year, 2nd semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> <p>The course aims to enhance understanding of the multi-scale interconnections between water management, environmental and socioeconomic issues. In particular, it considers multidisciplinary approaches to water management problems. Students will learn the basic concepts of hydrology and water resource, like water properties, hydrological cycle, sources of water and water balance calculation, impacts of population, urbanization, agriculture and climate change on water. Also, to explore the linkages between water and human health.</p> <p>Examples and case studies will be used to illustrate the water management, drawing on perspectives from both the natural and social sciences. Topics will be covered through lectures from a range of contributors, investigation of case-studies and small group work.</p>	
<b>Literature</b> <ol style="list-style-type: none"> <li>1. Loucks D. P., van Beek E., Stedinger J. R., Dijkman J. P.M., Villars M. T. (2005): Water Resources Systems Planning and Management: An Introduction to Methods, Models and Applications. UNESCO Paris,</li> <li>2. Hussey K. (2011): Water Resources Planning and Management. Cambridge University Press</li> <li>3. Wurbs R. (2013): Water Resources Planning and Management. InTech</li> </ol>	
<b>Schedule:</b> <b>Lectures:</b> <i>1<sup>st</sup> week.</i> The practical usage of Salamin Pál's water equation for the calculation of the water balance. <i>2<sup>nd</sup> week.</i> Calculation of quantitative water supply in global scale based on data series. <i>3<sup>rd</sup> week</i> Practice-oriented insight for the different irrigation systems. <i>4<sup>th</sup> week.</i> All of the students must categorize an example water body in case of the EU Water Framework Directive.	

5<sup>th</sup> week. Wischmeier-Smith soil loss factor calculation under different regions of the world (usage of data series).

6<sup>th</sup> week. Students task: find those natural disasters that are caused by water directly and has a connected affect to their own country.

7<sup>th</sup> week. The assessment of the characteristics of surface waters mainly focusing on the water supply systems. Make of a comprehensive study.

8<sup>th</sup> week. The Resource Types, their Uses and Pressure

9<sup>th</sup> week. The Governance of Common Goods. Between the State and the Marketplace

10<sup>th</sup> week. Case study I: Community Water Management in Europe

11<sup>th</sup> week. Case study II: Community Water Management in North-America

12<sup>th</sup> week. Case study III: Community Water Management in Latin America

13<sup>th</sup> week. Case study IV: Community Water Management in Africa

14<sup>th</sup> week. Case study V: Community Water Management in Asia

### **Requirements:**

#### Lecture:

The minimum requirement for the examination is 50% from the midterm and closing tests. Based on the summarized score of the test the grade for the examination is given according to the following table:

Score	Grade
0-49%	fail (1)
50-59%	pass (2)
60-72%	satisfactory (3)
73-84%	good (4)
85-100%	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

**Person responsible for course:** Dr. Herta Czédli, associate professor, PhD

**Lecturer:** Dr. Herta Czédli, associate professor, PhD, Dr. Csaba Berta, assistant professor, PhD

<b>Title of course:</b> Aquatic Toxicology <b>Code:</b> TTHME9207_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: 28 hours - preparation for the exam: 64 hours Total: 120 hours	
<b>Year, semester:</b> 1 <sup>th</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> <p>The discipline of aquatic toxicology aims to study the mode and mechanisms of entry of these pollutants into the aquatic ecosystem. Also elucidate the potential impacts, hazards and risks. Investigate the health of individual organisms and the community structures they inhabit. The complexity of the effluents in aquatic systems presents a number of challenges to the toxicologist. The course will discuss some of the different chemical and biological pollutants and these analytical strategies that have been used for water quality assessment and will discuss some of their strengths and limitations in terms of being able to accurately quantify the various physico/chemical species of the pollutant. The course will also discuss the interpretational complexities resulting from synergistic and antagonistic effects between chemicals.</p>	
<b>Literature</b> <ol style="list-style-type: none"> <li>1. Mikko Nikinmaa (2014) An Introduction to Aquatic Toxicology. Elsevier: USA</li> <li>2. Ernest Hodgson (Editor) (2010) A Textbook of Modern Toxicology, 4th Edition. John Wiley &amp; Sons, Inc.: USA</li> <li>3. <a href="http://www.oecd.org/env/ehs/testing/more-about-oecd-test-guidelines.htm">http://www.oecd.org/env/ehs/testing/more-about-oecd-test-guidelines.htm</a></li> </ol>	
<b>Schedule:</b> <p><i>1<sup>st</sup> week.</i> Introduction to toxicology: the history, disciplines and main principles (hazard, risk, exposure, tolerance, toxicity, toxicity end points, threshold, adverse effect, dose) are discussed in this section.</p> <p><i>2<sup>nd</sup> week.</i> The values determined in ecotoxicology: EC/ED, IC/ID, LC/LD, NOEL, NOEC, NOAEL, NOAEC, LOEL, LOEC, LOAEL, maximum allowable concentration (MAC), maximum tolerated dose (MTD). The dose-effect and dose-response relationships are explained through an example. Bioelimination and biodegradation processes.</p>	

3 <sup>rd</sup> week.	Correlation among bioconcentration, bioaccumulation and biomagnification. Persistence, examples for persistent inorganic/organic pollutants.
4 <sup>th</sup> week.	Governmental agencies of regulatory toxicology as well as biological indicators, biomarkers, and biological monitoring are discussed. Processes of ecological risk assessment: problem formulation, analysis, risk characterization, risk management, data acquisition and monitoring.
5 <sup>th</sup> week.	Toxicokinetics of aquatic pollutants: toxicokinetic compartment models, quantitative structure- activity relationship (QSAR). Uptake, distribution, metabolism and excretion of compounds.
6 <sup>th</sup> week.	Bioavailability: the characteristics of pharmacological and environmental bioavailability. Abiotic and biotic factors. Octanol/water coefficient ( $K_{ow}$ ).
7 <sup>th</sup> week.	Biotransformation of organic compounds, the principles of detoxification: phase I and phase II enzymes. Complex formation of metals with metallothioneins and phytochelatin.
8 <sup>th</sup> week.	Application of genomics (microarray, qPCR), proteomics (2D GE, MS) and metabolomics (NMR, MS). Genotoxicity, carcinogenesis, teratogenicity, neurotoxicity, effects on reproduction and behaviour, oxidative stress.
9 <sup>th</sup> week.	Toxicity bioassays, tests according to OECD guidelines. Acute and chronic testing. Growth inhibition (algal, plant) tests, Daphnia acute immobilisation and reproduction tests, Fish embryo acute toxicity (FET) tests, Microtox. Microcosm and mesocosm model ecosystems. Factors in test designing: selecting test species, environment (salinity, pH, temperature, O <sub>2</sub> ).
10 <sup>th</sup> week.	Eutrophication: factors and consequences. Harmful algal blooms, cyanotoxins and other cyanobacterial secondary metabolites. Control of algal blooms, biomanipulation by the alteration of food web.
11 <sup>th</sup> week.	Inorganic pollutants in water and sediment: metals - copper, lead, mercury, cadmium, chromium, arsenic, zinc, aluminium, iron. Organometallic compounds. The main sources and adverse effects on aquatic species are discussed.
12 <sup>th</sup> week.	Organic pollutants in water and sediment: oil, pesticides (herbicides, insecticides, fungicides), endocrine-disruptors (detergents, personal hygiene compounds, human and veterinary drugs), paper and pulp-mill wastewater, halogenated organic compounds (PCBs, dioxin, PBBs, TBBPA), PAH, ionic liquids, nanomaterials, nano and microplastics. The main sources and adverse effects on aquatic species are discussed.
13 <sup>th</sup> week.	Wastewater treatment processes: primary, secondary and tertiary treatment. Disinfection steps for generating household water. Sludge treatment (anaerobic, aerobic processes). Phytoremediation. Constructed wetlands: ecological role of plants, microorganisms and animals used in CWs.
14 <sup>th</sup> week.	Presentations of the students. Overview and summary of semester.



**Requirements:**

- *for a signature*

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up any practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments of the course to each practice class. Active participation is evaluated by the teacher in every class. If a student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.

Students have to submit all the two designing tasks as scheduled minimum on a sufficient level.

During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 15th week. Students have to sit for the tests

- for a grade

The course ends in an examination. Based on the average of the grades of the designing tasks and the examination, the exam grade is calculated as an average of them:

- the average grade of the two designing tasks

- the result of the examination

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
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0-59	fail (1)
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60-69	pass (2)
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70-79	satisfactory (3)
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80-89	good (4)
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90-100	excellent (5)
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If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

-an offered grade:

it may be offered for students if the average grade of the two designing tasks is at least satisfactory (3) and the average of the mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of them.

**Person responsible for course:** Prof. Dr. habil. Gábor Vasas, university professor, Dsc

**Lecturer:** Prof. Dr. habil. Gábor Vasas, university professor, Dsc

<b>Title of course:</b> Aquatic Toxicology laboratory practice <b>Code:</b> TTHML9207_EN	<b>ECTS Credit points: 2</b>
<b>Type of teaching, contact hours</b> - lecture: - - practice: - - laboratory: 1 hours/week	
<b>Evaluation:</b> mid-semester grade grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: - - laboratory: 14 hours - home assignment: 16 hours - preparation for the exam: - Total: 30 hours	
<b>Year, semester:</b> 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> Testing potential water contaminants using ecotoxicological tests: algae test, seedling test, Daphnia test. The effect of the toxic substance on growth, physiological processes (nutrition, movement / behavior). Calculation of EC <sub>50</sub> and LD <sub>50</sub> . Possibilities for detection of contaminants: classical or instrumental analytical methods. Evaluation of toxicological tests, toxicology based risk assessment. Possibilities to remove toxic substances.	
<b>Literature</b> 1. Gary M. Rand (1995): Fundamentals Of Aquatic Toxicology: Effects, Environmental Fate And Risk Assessment, ISBN: 1560320915 / 9781560320913 2. Mikko Nikinmaa (2014) An Introduction to Aquatic Toxicology ISBN: 978-0-12-411574-3 3. Ernest Hodgson (2004) A Textbook of Modern Toxicology, Third Edition ISBN: 9780471265085	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> Testing potential water pollutants by algae test I: testing systems with different algae. Sampling, determining initial density in cultures. <i>2<sup>nd</sup> week.</i> Testing potential water pollutants by algae test II: measurement of growth, establishment of growth inhibition, calculation of EC <sub>50</sub> . <i>3<sup>rd</sup> week.</i> Testing potential water pollutants by algae test III: studying the impact of the potential pollutant on algae biomass and organic matter production. <i>4<sup>th</sup> week.</i> Testing potential water pollutants by algae test IV: studying the effect of potential pollutant on nutrient uptake (phosphate, nitrate) of algae.	

5 <sup>th</sup> week.	Testing potential water pollutants by seedling test I: assembling of test systems with seedlings.
6 <sup>th</sup> week.	Testing potential water pollutants by seedling test II: calculation of germination percentage and the extent of growth inhibition.
7 <sup>th</sup> week.	Testing potential water pollutants by Daphnia test I: assembling of test systems with daphnids.
8 <sup>th</sup> week.	Testing potential water pollutants by Daphnia test II: observation of immobility or mortality. Calculation of LD <sub>50</sub> .
9 <sup>th</sup> week.	Evaluation of toxicological tests, toxicology based risk assessment.
10 <sup>th</sup> week.	Toxic component analysis I: classical analytical methods to test toxic substances (metals, inorganic micro-pollutants).
11 <sup>th</sup> week.	Toxic component analysis II: instrumental analytical methods for determination of toxic substances.
12 <sup>th</sup> week.	Possibilities to remove toxic materials I: mechanical methods.
13 <sup>th</sup> week.	Possibilities to remove toxic materials II: physico-chemical methods.
14 <sup>th</sup> week.	Possibilities to remove toxic materials I: biological methods.
<b>Requirements:</b> - <i>for a signature</i> Participation at laboratory practices is compulsory. A student must attend the laboratory practices and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. - <i>for a grade</i> During the semester there will be short written tests on every practice, reports should be prepared after every topic. The final grade will be the average of the grades of written tests and reports.	
<b>Person responsible for course:</b> Dr. habil. István Bácsi, associate professor, PhD	
<b>Lecturer:</b> Dr. habil. István Bácsi, associate professor, PhD	

<b>Title of course:</b> Paleohydrobiology <b>Code:</b> TTHME9211_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> <ul style="list-style-type: none"> <li>- lecture: 2 hours/week</li> <li>- practice: -</li> <li>- laboratory: -</li> </ul>	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> <ul style="list-style-type: none"> <li>- lecture: 28 hours</li> <li>- practice: -</li> <li>- laboratory: -</li> <li>- home assignment: 28 hours</li> <li>- preparation for the exam: 64 hours</li> </ul> Total: 120 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b>	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> <p>This course will introduce the students to analyses the relationships between zooplankton remains and an ancient lake history. Sampling and data collections methods, problems and solutions. Sediment collecting and analysing. Laboratory methods using for analyses different lake sediments. Geochemical analyses. Dating using <sup>137</sup>Cs, <sup>210</sup>Pb and radiokarbon methods. Subfossil remains responses to climate changes. Verification of lake level changes using subfossil remains. Effects of environmental pollutions in diversity and abundance. Problems of bioturbations. Statistical analyses of results.</p>	
<b>Literature</b> <p><i>Compulsory:</i></p> <ol style="list-style-type: none"> <li>1. Binford, M. W., Deevey, E. S. 1983: Paleolimnology: An Historical Perspective on Lacustrine Ecosystems. Ann. Rev. Ecol. Syst. 14: 255-286.</li> <li>2. Bjorn, E. Berglund (ed.) 2003: Handbook of Holocene Palaeoecology and Palaeohydrology. The Blackburn Press, 869 pp.</li> <li>3. Last, W.M. and Smol, J.P. (eds) 2001: Tracking Environmental Change Using Lake Sediments</li> <li>4. Volume 1 Basin analysis, coring and chronological techniques</li> <li>5. Smol, J.P., Birks, H.J.B., Last, W.M. (eds) 2001: Tracking Environmental Change Using Lake Sediments - Volume 4 Zoological indicators</li> </ol>	
<b>Schedule:</b> <p><i>1<sup>st</sup> week.</i> What is paleolimnology? Paleo and neoecology. Aims of Hungarian and International researches.</p> <p><i>2<sup>nd</sup> week.</i> Main objects of paleohydrobiology. Differences of methods in stagnant and running waters.</p> <p><i>3<sup>rd</sup> week.</i> Sediment sampling methods. Soft and hard sediment catchers. Sample size and physical parameters of a sediment column.</p>	

4<sup>th</sup> week. Dating: radiocarbon and cesium dating. Dendrocronology, pollen and spore analysing.

5<sup>th</sup> week. Subfossil remains in sediments I. Algees plant remains and fungis.

6<sup>th</sup> week. Subfossil remains in sediments II. Molluscs, amoebas, ostracods and fishes.

7<sup>th</sup> week. Subfossil remains in sediments III. Rotifers and Cladocerans.

8<sup>th</sup> week. Effects of climate change and antropogenic impacts in paleolimnology.

9<sup>th</sup> week. Verify the climate change using stabile isotopes, geochemistry as a paleolimnology method.

10<sup>th</sup> week. Importance of paleolimnology in environmental protection.

11<sup>th</sup> week. Sediment sampling, soil deposit and soil erosion. Effects of a river flood.

12<sup>th</sup> week. Statistical methods in paleolimnology. Main component analysing. Non-metric multidimensional scaling. canonical correspondence analysis.

13<sup>th</sup> week. Demonstration of environmental pollution. Heavy metals in sediments.

14<sup>th</sup> week. Case-studies.

### Requirements:

- *for a signature*

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up any practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments of the course to each practice class. Active participation is evaluated by the teacher in every class. If a student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.

Students have to **submit all the two designing tasks** as scheduled minimum on a sufficient level.

During the semester there are two tests: the mid-term test in the 8<sup>th</sup> week and the end-term test in the 15<sup>th</sup> week. Students have to sit for the tests

- *for a grade*

The course ends in an **examination**. Based on the average of the grades of the designing tasks and the examination, the exam grade is calculated as an average of them:

- the average grade of the two designing tasks
- the result of the examination

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

- |   |        |                  |
|---|--------|------------------|
| - | Score  | Grade            |
| - | 0-59   | fail (1)         |
| - | 60-69  | pass (2)         |
| - | 70-79  | satisfactory (3) |
| - | 80-89  | good (4)         |
| - | 90-100 | excellent (5)    |
- If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.
  - -an offered grade:
  - it may be offered for students if the average grade of the two designing tasks is at least satisfactory

- |  |
|--|
| - (3) and the average of the mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of them. |
| <b>Person responsible for course:</b> Dr. István Gyulai, assistant professor, PhD  |
| <b>Lecturer:</b> Dr. István Gyulai, assistant professor, PhD; Dr. Csaba Berta, assistant professor, PhD                          |

<b>Title of course:</b> Paleohydrobiology <b>Code:</b> TTHMG9211_EN	<b>ECTS Credit points: 2</b>
<b>Type of teaching, contact hours</b> - lecture: - - practice: 1 - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 14 hours - practice: - - laboratory: - - home assignment: 16 hours - preparation for the exam: Total: 30 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b>	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> This course will introduce the students to analyses the relationships between zooplankton remains and an ancient lake history. Sampling and data collections methods, problems and solutions. Sediment collecting and analysing. Laboratory methods using for analyses different lake sediments. Geochemical analyses. Dating using <sup>137</sup> Cs, <sup>210</sup> Pb and radiokarbon methods. Subfossil remains responses to climate changes. Verification of lake level changes using subfossil remains. Effects of environmental pollutions in diversity and abundance. Problems of bioturbations. Statistical analyses of results.	
<b>Literature</b> <i>Compulsory:</i> 1. Andrew, S. Cohen 2003: Paleolimnology: The History and Evolution of Lake Systems. Oxford University Press, 528 pp. 2. Binford, M. W., Deevey, E. S. 1983: Paleolimnology: An Historical Perspective on Lacustrine Ecosystems. Ann. Rev. Ecol. Syst. 14: 255-286. 3. Bjorn, E. Berglund (ed.) 2003: Handbook of Holocene Palaeoecology and Palaeohydrology. The Blackburn Press, 869 pp. 4. Last, W.M. and Smol, J.P. (eds) 2001: Tracking Environmental Change Using Lake Sediments 5. Volume 1 Basin analysis, coring and chronological techniques 6. Smol, J.P., Birks, H.J.B., Last, W.M. (eds) 2001: Tracking Environmental Change Using Lake Sediments - Volume 4 Zoological indicators	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> Soft sediment sampling using Hargrave type sampler and gravity corer. <i>2<sup>nd</sup> week.</i> Core sampling using Kajak and Russian type samplers. <i>3<sup>rd</sup> week.</i> Slicing of a soft sediment column.	

4<sup>th</sup> week. Slicing of a hard long sediment column.

5<sup>th</sup> week. Loss of ignition method for determining organic material content.

6<sup>th</sup> week. Loss of ignition method for determining carbonate content.

7<sup>th</sup> week. Destruction of organic material content using Potassium Hydroxide.

8<sup>th</sup> week. Destruction of carbonate content using Hydrogen Chloride.

9<sup>th</sup> week. Exploration of Cladoceran remains in sediments.

10<sup>th</sup> week. Exploration of macroscopic invertebrates remains in sediments.

11<sup>th</sup> week. Sediment exploration for geochemical measurements.

12<sup>th</sup> week. Microscopic session I. Cladoceran remains analysing.

13<sup>th</sup> week. Microscopic session II. macroscopic invertebrates remains analysing.

14<sup>th</sup> week. Case-studies of reconstructions using microscopic remains.

### Requirements:

*- for a signature*

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up any practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments of the course to each practice class. Active participation is evaluated by the teacher in every class. If a student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.

Students have to **submit all the two designing tasks** as scheduled minimum on a sufficient level.

During the semester there are two tests: the mid-term test in the 8<sup>th</sup> week and the end-term test in the 15<sup>th</sup> week. Students have to sit for the tests

*- for a grade*

The course ends in an **examination**. Based on the average of the grades of the designing tasks and the examination, the exam grade is calculated as an average of them:

- the average grade of the two designing tasks
- the result of the examination

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

- | - | Score   | Grade            |
|---|---|------------------|
| - | 0-59  | fail (1)         |
| - | 60-69   | pass (2)         |
| - | 70-79   | satisfactory (3) |
| - | 80-89   | good (4)         |
| - | 90-100  | excellent (5)    |
| - | If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS. |                  |
| - | -an offered grade:  |                  |
| - | it may be offered for students if the average grade of the two designing tasks is at least satisfactory                                       |                  |
| - | (3) and the average of the mid-term and end-term tests is at least satisfactory (3). The  |                  |



offered grade is the average of them.

**Person responsible for course:** Dr. István Gyulai, assistant professor, PhD

**Lecturer:** Dr. István Gyulai, assistant professor, PhD; Dr. Csaba Berta, assistant professor, PhD

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<b>Title of course:</b> Water Quality Monitoring <b>Code:</b> TTHME9212_EN	<b>ECTS Credit points: 3</b>
<b>Type of teaching, contact hours</b> - lecture: 1 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: 28 hours - preparation for the exam: 64 hours Total: 120 hours	
<b>Year, semester:</b> 3 <sup>rd</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> During the course the participant should be able to understand and apply: (i) concepts of water quality and pollution processes in various standing and running water types; (ii) apply the different steps of the monitoring cycle in rivers and lakes; (iii) the basic concepts of groundwater quality and monitoring; (iv) apply common statistical techniques for water quality data evaluation; (v) design sustainable freshwater quality monitoring and assessment programmes under specified conditions; (vi) the entire thought process that underlies the planning of an environmental monitoring effort and receive systematic planning tools, templates, checklists, labor and budget spreadsheets for use in any future monitoring work.	
<b>Literature</b> 1. Bartram J. and Ballance Water Quality Monitoring (1996): A practical guide to the design and implementation of freshwater quality studies and monitoring programmes. United Nations Environment Programme. 2. Ward, R.C., Loftis J. C., Graham B. (2003) Design of Water Quality Monitoring Systems. John Wiley and Sons. 3. Nilgun B., HarmanciogluO., Fistikoglu S.D., Ozkul Vijay Singh M.N., Alpaslan (1999): Water Quality Monitoring Network Design. Springer-Science, Business Media	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> Water qualification as a claim and need. The concept of quality and goodness. The history of water qualification: international and national overview. <i>2<sup>nd</sup> week.</i> The ecological indication, indicators. The ethological and ecological sides of the ecological water quality. <i>3<sup>rd</sup> week.</i> The main types of studies on the basis of the ecological water qualification (taxonomic and occurrence characteristics, coexistential relations, associations).	

4 <sup>th</sup> week.	Characteristics of biological and ecological based quality assessments. Survey, surveillance and monitoring.
5 <sup>th</sup> week.	Assessment of water bodies from nature conservation and environmental protection point of views. Three-phase workflow for status assessment (status survey, status evaluation, status qualification). Main time, equipment, cost and expertise features of the three work phases.
6 <sup>th</sup> week.	European Union (EU) Water Framework Directive (WFD). Internal regulation, policy building and application of the EU. The basic objectives of WFD.
7 <sup>th</sup> week.	Obligations of EU member states in relation to surface and groundwater bodies. Separation of natural, highly modified and artificial water bodies.
8 <sup>th</sup> week.	Interpretation of the ecological status / potential for the WFD. Determination of the ecological state / potential and the reference state and the meaning of maximum ecological potential.
9 <sup>th</sup> week.	Interpretation of the chemical status for the WFD. Determining the chemical state, the factors and indicators preferred by the WFD. Classification of ecological status / potential and chemical state.
10 <sup>th</sup> week.	Organism groups preferred by the WFD I: Phytoplankton sampling criteria, sample storage, preparation and data evaluation methods.
11 <sup>th</sup> week.	Organism groups preferred by the WFD II: Phytobenthone sampling criteria, sample storage, preparation and data evaluation methods.
12 <sup>th</sup> week.	Organism groups preferred by the WFD III: Sampling methods for macroscopic aquatic invertebrate fauna, sample and data processing.
13 <sup>th</sup> week.	Organism groups preferred by the WFD IV: Sampling methods for fish fauna, sample and data processing.
14 <sup>th</sup> week.	Coordination of chemical and different biological results, practical questions of qualification.
<b>Requirements:</b> - <i>for a signature</i> Attendance at lectures is highly recommended, but not compulsory. - <i>for a grade</i> During the semester there will be no written tests, there will be an oral exam in the exam period.	
<b>Person responsible for course:</b> Dr. habil. István Bácsi, associate professor, PhD	
<b>Lecturer:</b> Dr. habil. István Bácsi, associate professor, PhD; Dr. István Gyulai, assistant professor, PhD	

<b>Title of course:</b> Water Quality Monitoring <b>Code:</b> TTHMG9212_EN	<b>ECTS Credit points: 2</b>
<b>Type of teaching, contact hours</b> - lecture: - - practice: - - laboratory: 1 hours/week	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: - - laboratory: 14 hours - home assignment: 16 hours - preparation for the practices: - Total: 30 hours	
<b>Year, semester:</b> 3 <sup>rd</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> During the practice the students gain experience in the methods of measuring physical and chemical parameters important in water qualification, they will know the methods of sampling and sample processing, gain insights into the qualification of data obtained from sample processing and to the quality of the given water body.	
<b>Literature</b> 1. Bartram J. and Ballance Water Quality Monitoring (1996): A practical guide to the design and implementation of freshwater quality studies and monitoring programmes. United Nations Environment Programme. 2. Ward, R.C., Loftis J. C., Graham B. (2003) Design of Water Quality Monitoring Systems. John Wiley and Sons. 3. Nilgun B., Harmancioglu O., Fistikoglu S.D., Ozkul Vijay Singh M.N., Alpaslan (1999): Water Quality Monitoring Network Design. Springer-Science, Business Media	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> Measurement of physical and chemical parameters of water samples (using different types of multimeters). <i>2<sup>nd</sup> week.</i> Measurement of chemical parameters of a water sample in laboratory I (chloride, calcium, magnesium). <i>3<sup>rd</sup> week.</i> Measurement of chemical parameters of a water sample in laboratory II (alkalinity, acidity). <i>4<sup>th</sup> week.</i> Measurement of chemical parameters of a water sample in laboratory III (iron and manganese).	

5 <sup>th</sup> week. Measurement of inorganic nutrient content of water samples I: Nitrogen forms (ammonium, nitrite, and nitrate).
6 <sup>th</sup> week. Measurement of inorganic nutrient content of water samples II: phosphorous; chlorophyll-content as an indicator of inorganic nutrient richness.
7 <sup>th</sup> week. Qualification of the sampled water body using the parameters measured up to now based on Biological Water Quality Assessment and Hungarian Standard MSZ 12749.
8 <sup>th</sup> week. Qualification of the sampled water body using the parameters measured up to now according to EU WFD.
9 <sup>th</sup> week. Qualification of a given water body based on phytoplankton and phytobenthos data according to EU WFD.
10 <sup>th</sup> week. Qualification of a given water body based on macrophyte data according to EU WFD.
11 <sup>th</sup> week. Qualification of a given water body based on macroinvertebrate data according to EU WFD.
12 <sup>th</sup> week. Qualification of a given water body based on fish data according to EU WFD.
13 <sup>th</sup> week. Comparing the different water qualification systems, discussing the phenomena behind the differences in quality results.
14 <sup>th</sup> week. Consultation.
<p><b>Requirements:</b></p> <p><i>- for a signature</i></p> <p>Participation at laboratory practices is compulsory. A student must attend the laboratory practices and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.</p> <p><i>- for a grade</i></p> <p>During the semester there will be short written tests on every practice, reports should be prepared after every topic. The final grade will be the average of the grades of written tests and reports.</p>
<b>Person responsible for course:</b> Dr. habil. István Bácsi, associate professor, PhD
<p><b>Lecturer:</b> Dr. habil. István Bácsi, associate professor, PhD ;</p> <p>Dr. István Gyulai, assistant professor, PhD</p>

<b>Title of course:</b> European Water Framework Directive <b>Code:</b> TTHME9218_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: 28 hours - preparation for the exam: 64 hours Total: 120 hours	
<b>Year, semester:</b> 2nd year, 2nd semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> This course will introduce the students to monitoring and assessment in the context of the Water Framework Directive. The course focused on the monitoring obligations and most recent assessment criteria of chemical and ecological status in the context of the water framework directive 2000/60/EC. Emerging topics such as the water quality indicators, ecological status assessment of surface waters and the water reuse in the EU. To acquaint participants with the principles and techniques used in fresh water quality description, monitoring and assessment.	
<b>Literature</b> 1. Kaika, M. (2003). The Water Framework Directive: A New Directive for a Changing Social, Political and Economic European Framework. European Planning Studies, 11 (3). 2. The Water Framework Directive 2000/60/EK 3. Furse M.T, Hering D., Brabec K., Buffagni A., Sandin L., Verdonchot P.F.M. (eds), (2006) The Ecological Status of European Rivers. Hydrobiologia 566. Kluvier. 4. European Environmental Bureau RSPB and Pond Conservation. 2006. European Environmental NGO Technical Review of the Water Framework Directive Intercalibration Process. <a href="http://www.eeb.org/activities/water/200609-NGO-review-WFD-Intercalibration.pdf">http://www.eeb.org/activities/water/200609-NGO-review-WFD-Intercalibration.pdf</a>	
<b>Schedule:</b> <b>Lectures:</b> <i>1<sup>st</sup> week.</i> Introduce the qualification systems of water bodies. <i>2<sup>nd</sup> week.</i> Description and characterization of types of surface water bodies. <i>3<sup>rd</sup> week.</i> Theoretical basics of the EU Water Framework Directive. <i>4<sup>th</sup> week.</i> Introduce the cornerstones of creation, relevance and priority of the EU Water Framework Directive. <i>5<sup>th</sup> week.</i> Interpretation of the stated goals and definitions.	

*6<sup>th</sup> week.* General aspects of the EU Water Framework Directive.

*7<sup>th</sup> week.* Hydrogeology, physical, physicochemical and chemical aspects of the EU Water Framework Directive.

*8<sup>th</sup> week.* Process of the reference conditions for different types of surface water bodies.

*9<sup>th</sup> week.* Detail of the elements of water quality for classification of ecological status.

*10<sup>th</sup> week.* Impacts of human activities on groundwater.

*11<sup>th</sup> week.* Monitoring of the status of surface and ground waters.

*12<sup>th</sup> week.* Monitoring of the status of protected water bodies.

*13<sup>th</sup> week.* Responsibilities of the government administration with commitment of EU Water Framework Directive and their interests of environmental and nature conservation.

*14<sup>th</sup> week.* Grade-offering exam.

### **Requirements:**

#### Lecture:

The minimum requirement for the examination is 50% from the midterm and closing tests. Based on the summarized score of the test the grade for the examination is given according to the following table:

Score	Grade
0-49%	fail (1)
50-59%	pass (2)
60-72%	satisfactory (3)
73-84%	good (4)
85-100%	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

**Person responsible for course:** Dr. Krisztián Nyeste, assistant professor, PhD

**Lecturer:** Dr. Krisztián Nyeste, assistant professor, PhD

<b>Title of course:</b> European Water Framework Directive <b>Code:</b> TTHMG9218_EN	<b>ECTS Credit points:</b> 2
<b>Type of teaching, contact hours</b> - lecture: - - practice: 1 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 14 hours - laboratory: - - home assignment: 16 hours - preparation for the exam: - Total: 30 hours	
<b>Year, semester:</b> 2nd year, 2nd semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> This course will introduce the students to monitoring and assessment in the context of the Water Framework Directive. The course focused on the monitoring obligations and most recent assessment criteria of chemical and ecological status in the context of the water framework directive 2000/60/EC. Emerging topics such as the water quality indicators, ecological status assessment of surface waters and the water reuse in the EU. To acquaint participants with the principles and techniques used in fresh water quality description, monitoring and assessment.	
<b>Literature</b> 1. Kaika, M. (2003). The Water Framework Directive: A New Directive for a Changing Social, Political and Economic European Framework. European Planning Studies, 11 (3). 2. The Water Framework Directive 2000/60/EK 3. Furse M.T, Hering D., Brabec K., Buffagni A., Sandin L., Verdonchot P.F.M. (eds), (2006) The Ecological Status of European Rivers. Hydrobiologia 566. Kluvier. 4. European Environmental Bureau RSPB and Pond Conservation. 2006. European Environmental NGO Technical Review of the Water Framework Directive Intercalibration Process. <a href="http://www.eeb.org/activities/water/200609-NGO-review-WFD-Intercalibration.pdf">http://www.eeb.org/activities/water/200609-NGO-review-WFD-Intercalibration.pdf</a>	
<b>Schedule:</b> <b>Lectures:</b> <i>1<sup>st</sup> week.</i> Hydrogeology and hydromorphology. <i>2<sup>nd</sup> week.</i> Water physics and chemistry. <i>3<sup>rd</sup> week.</i> Presentation about phytoplankton. <i>4<sup>th</sup> week.</i> Presentation about phytobenthos. <i>5<sup>th</sup> week.</i> Presentation about macrophytes. <i>6<sup>th</sup> week.</i> Presentation about macroinvertebrates.	



7<sup>th</sup> week. Presentation about fishes.

8<sup>th</sup> week. Field measurement methods.

9<sup>th</sup> week. Laboratory measurement methods.

10<sup>th</sup> week. Applicability of toxicology.

11<sup>th</sup> week. Usage of microscope.

12<sup>th</sup> week. Sample processing and evaluation of results I.

13<sup>th</sup> week. Sample processing and evaluation of results II.

14<sup>th</sup> week. Grade-offering exam.

### **Requirements:**

#### Practice:

Participation at classes is compulsory. A student must attend the courses and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

During the semester there is one practical test. It can be completed in the 14<sup>th</sup> week.

The minimum score is 50%. Based on the score of the test, the grade for the test is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-72	satisfactory (3)
73-84	good (4)
85-100	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

**Person responsible for course:** Dr. Krisztián Nyeste, assistant professor, PhD

**Lecturer:** Dr. Krisztián Nyeste, assistant professor, PhD

<b>Title of course:</b> Nature Conservation <b>Code:</b> TTHME9217_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 - practice: - - laboratory: - - home assignment: 28 hours - preparation for the practices: 64 hours Total: 120 hours	
<b>Year, semester:</b> 3 <sup>rd</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> This course is designed to provide students a broad, interdisciplinary background for developing their understanding of environmental and resource problems and what sustainable solutions are needed to solve them. It also provides a solid foundation for the development of critical thinking skills. The program is designed to ensure that graduates possess broad-based, integrated knowledge of how local and global ecological systems work as well as an understanding of the interdependency between people and the environment. Topics include current issues, management techniques, a history of the conservation movement in the Europe and some countries all over the world as well as underlying principles of environmental conservation.	
<b>Literature</b> 1. Alexander M. (2013): Management Planning for Nature Conservation: A Theoretical Basis & Practical Guide. Springer-Science, Business Media 2. Forbes S., Kendle T. (1997) Urban Nature Conservation: Landscape Management in the Urban Countryside. Thompson Professional.	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> Preparation, training and outcome requirements, thematics and schedule, selected bibliography, aims and tasks of the course. <i>2<sup>nd</sup> week.</i> Ecological background of nature conservation, background sciences. Connection of nature conservation, landscape protection and environmental protection, interdisciplinary connections. <i>3<sup>rd</sup> week.</i> Development and history of conservation ecology, its place among biological sciences. Hierarchy of supra-individual systems, spatial and temporal patterns. <i>4<sup>th</sup> week.</i> Ecological methods in nature conservation, landscape protection and environmental protection. Basics in conservation biology. Principles of nature conservation management,	

<p>management practice methods.</p> <p><i>5<sup>th</sup> week.</i> History and development of nature conservation. Early years, preservation of natural resources. From the first idea of conservation till the establishment of the first national park. Evolution of the national institution of nature conservation from the first law on forests.</p> <p><i>6<sup>th</sup> week.</i> Nature conservation becoming independent. Establishment of the National Conservation Committee. The role of science, forestry and social initiatives (ornithology) in the development of nature conservation.</p> <p><i>7<sup>th</sup> week.</i> The development of the modern nature conservation from the establishment of the first national park until the 1984 Act on nature conservation. Development of the network of national parks in Hungary, international background of the development.</p> <p><i>8<sup>th</sup> week.</i> Legal instruments in nature protection, development until nowadays. Nature protection categories. International conventions.</p> <p><i>9<sup>th</sup> week.</i> The nature conservation strategy of the European Union. EU Birds Directive and Habitats Directive. The Natura 2000 network and its regulations in Hungary.</p> <p><i>10<sup>th</sup> week.</i> Practice of nature conservation management, I. Preservation, conservation, rehabilitation, reconstruction and creation. The role of the natural disturbance processes in the maintenance of the biological diversity. Fragmentation and mosaic structures. Migration and natural re-population processes.</p> <p><i>11<sup>th</sup> week.</i> Practice of nature conservation management, II. Wetland habitats, wetland management and restoration.</p> <p><i>12<sup>th</sup> week.</i> The significance of the landscape-scale approach in the nowadays nature conservation practice. Landscape-scale habitat restoration and reconstruction programmes.</p> <p><i>13<sup>th</sup> week.</i> Land-use and nature conservation conflicts. Nature conservation issues concerning agriculture areas.</p> <p><i>14<sup>th</sup> week.</i> Assessment.</p>	<p><b>Requirements:</b></p> <p><i>- for a signature</i></p> <p>Participation at laboratory practices is compulsory. A student must attend the laboratory practices and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.</p> <p><i>- for a grade</i></p> <p>During the semester there will be short written tests on every practice, reports should be prepared after every topic. The final grade will be the average of the grades of written tests and reports.</p> <p><b>Person responsible for course:</b> Szilvai Gőri, ecologist</p> <p><b>Lecturer:</b> Szilvai Gőri, ecologist</p>
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<b>Title of course:</b> Nature Conservation <b>Code:</b> TTHMG9217_EN	<b>ECTS Credit points: 2</b>
<b>Type of teaching, contact hours</b> - lecture: - - practice: 1 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 14 hours - laboratory: - - home assignment: 16 hours - preparation for the practices: - Total: 30 hours	
<b>Year, semester:</b> 3 <sup>rd</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> The students understand the principle of international agreements that evolve with the development of environmental protection. Familiar with the main international conventions and their causes and inefficiency. Understand the main contexts, directions, some of the basic common features of the environmental protection conventions, aspects of domestic international tasks.	
<b>Literature</b> 1. Alexander M. (2013): Management Planning for Nature Conservation: A Theoretical Basis & Practical Guide. Springer-Science, Business Media 2. Forbes S., Kendle T. (1997) Urban Nature Conservation: Landscape Management in the Urban Countryside. Thompson Professional. 3. Kratochwil A. (1999): Biodiversity in ecosystems: principles and case studies of different complexity level. Springer-Science, Business Media 4. Primack, R. B. (1993): Essentials of Conservation Biology. Sinauer Associates, Sunderland, Massachusetts. 5. Shrader-Frechette, K. S., and McCoy, E. D. (1993): Method in ecology. Strategies for Conservation. Cambridge University Press, Cambridge, UK	
<b>Schedule:</b> <i>1<sup>st</sup>-7<sup>th</sup> weeks.</i> wetland habitats; types, threats, nature conservation management, rehabilitation; field work in the Hortobágy National Park. <i>8<sup>th</sup>-14<sup>th</sup> weeks.</i> grassland habitats; types, threats, nature conservation management and land use; field work in the Hortobágy National Park.	
<b>Requirements:</b> <i>- for a signature</i> Participation at laboratory practices is compulsory. A student must attend the laboratory practices and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.	

- *for a grade*

During the semester there will be short written tests on every practice, reports should be prepared after every topic. The final grade will be the average of the grades of written tests and reports.

**Person responsible for course:** Szilvai Góri, ecologist

**Lecturer:** Szilvai Góri, ecologist

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<b>Title of course:</b> Aquatic Microbiology <b>Code:</b> TTHME9301_EN	<b>ECTS Credit points: 3</b>
<b>Type of teaching, contact hours</b> - lecture: 1 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 14 hours - practice: - - laboratory: - - home assignment: 28 hours - preparation for the exam: 64 hours Total: 120 hours	
<b>Year, semester:</b> Facultative from 2 <sup>nd</sup> to 4 <sup>th</sup> semester	
<b>Its prerequisite(s):</b> General Hydrobiology; Water Chemistry	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> The course gives an overview of the organization, taxonomy (morphology, DNA and RNA based classification), evolution and ecology of bacteria and heterothrophic eukaryotes (protozoa and fungus-like organisms) from hydrobiological point of view. Activity of prokaryotic and heterothrophic eukaryotic microorganisms will be discussed on the basis of their role in nutrient cycles. The course shows the interactions among bacteria and between bacteria and eukaryotic microorganisms, deals with their roles in the life of aquatic habitats, furthermore, it introduces the formation and functions of biofilms.	
<b>Literature</b> 1. Allison DG, Gilbert PL, Lappin-Scott HM, Wilson M (2000) Community Structure and co-operation in biofilms. Cambridge University Press, Cambridge, ISBN: 0-521- 79302- 5. 2. Sigee DC (2005) Freshwater Microbiology. John Wiley & Sons Inc., ISBN: 0-471-48529- 2 3. Hausmann, K., Hülsmann, N., Radek, R. (2003) Protistology. E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart, ISBN: 3-510-65208-8 3. Patterson DJ (1996) Free-living Freshwater Protozoa: A Color Guide. Manson Publishing Ltd., ISBN-10: 1874545405; ISBN-13: 978-1874545408 4. Cai L, Hyde KD, Tsui CKM (2014) Freshwater Fungi and Fungal-like Organisms. Walter de Greuter GmbH, Berlin/Boston, ISBN: 978-3-11-033345-9	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> Classification of life forms, status of microorganisms. The main groups of microorganisms, their phylogenetic relationships. <i>2<sup>nd</sup> week.</i> The structure of the prokaryotic cell, its components: "nucleus", cytoplasm, ribosomes, plasmids, membrane, cell wall, flagellae, pili, seath. <i>3<sup>rd</sup> week.</i> The most important nutrient cycle and ecological groups of bacteria, the main characteristics of their occurrence.	

4 <sup>th</sup> week.	Influence of environmental factors on bacteria: temperature, pH, oxidation-reduction potential and oxygen, pressure, salt concentration, light and radiation effects - phototoxicity, phototropism, chemical composition of the environment - chemotaxis.
5th week.	The formation and structure of biofilm. Interactions of bacterial populations.
6th week.	Structure of eukaryotic cell, its components: Membranes, membrane systems; microfilaments, microtubules; centrioles and basal body; micro bodies; contractile vacuoles; extrusomes. The endosymbiont theory. The nucleus. The emergence of sexual reproduction.
7th week.	Movement types among protozoans. Amoboid movement. The structure and function of the flagella and the cilia. Behavior movements. The nutrition of protozoans. Types of food intake: pinocytosis, phagocytosis. The path of the diet taken in the cell. Dietary preferences.
8th week.	Impact of environmental factors on protozoans. Distribution, settling. Cyst formation and reactivation. Habitats of protozoans. Open water and protozoan plankton. Soil and moss protozoans. Special associations. Interactions of protozoans.
9th week.	Practical significance of protozoans. Protozoans as water quality indicators. The role of protozoans in wastewater treatment.
10th week.	Definition of the term "fungi". An overview of the structure of the eukaryotic fungus-like organisms.
11th week.	Evolution of fungi in aquatic environments. Impact of environmental factors on growth, tolerance of extreme environmental conditions.
12th week.	Organic nutrient-degrading communities of fungi - saprophytic fungi. Parasitic fungi: parasites of aquatic photosynthetic organisms (algae, plants) and animals.
13th week.	The ecological role of fungi in lentic ecosystems. Fungal communities in watercourses. Mycorrhiza in aquatic habitats.
14th week.	Consultation.
<b>Requirements:</b> - <i>for a signature</i> Attendance at lectures is highly recommended, but not compulsory. - <i>for a grade</i> During the semester there will be no written tests, there will be an oral exam in the exam period.	
<b>Person responsible for course:</b> Dr. habil. István Bácsi, associate professor, PhD	
<b>Lecturer:</b> Dr. habil. István Bácsi, associate professor, PhD	

<b>Title of course:</b> Aquatic Microbiology <b>Code:</b> TTHMG9301_EN	<b>ECTS Credit points: 2</b>
<b>Type of teaching, contact hours</b> - lecture: - - practice: 1 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 14 hours - laboratory: - - home assignment: 16 hours - preparation for the exam: - Total: 30 hours	
<b>Year, semester:</b> Facultative from 2 <sup>nd</sup> to 4 <sup>th</sup> semester	
<b>Its prerequisite(s):</b> General Hydrobiology; Water Chemistry	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> The course gives an overview of the organization, taxonomy (morphology, DNA and RNA based classification), evolution and ecology of bacteria and heterothrophic eukaryotes (protozoa and fungus-like organisms) from hydrobiological point of view. The main taxons, their main representatives and their ecological role in aquatic habitats.	
<b>Literature</b> 1. Allison DG, Gilbert PL, Lappin-Scott HM, Wilson M (2000) Community Structure and co-operation in biofilms. Cambridge University Press, Cambridge, ISBN: 0-521- 79302- 5. 2. Sigee DC (2005) Freshwater Microbiology. John Wiley & Sons Inc., ISBN: 0-471-48529- 2 3. Hausmann, K., Hülsmann, N., Radek, R. (2003) Protistology. E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart, ISBN: 3-510-65208-8 3. Patterson DJ (1996) Free-living Freshwater Protozoa: A Color Guide. Manson Publishing Ltd., ISBN-10: 1874545405; ISBN-13: 978-1874545408 4. Cai L, Hyde KD, Tsui CKM (2014) Freshwater Fungi and Fungal-like Organisms. Walter de Greuter GmbH, Berlin/Boston, ISBN: 978-3-11-033345-9	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> The history of classification of bacteria, the basis for the modern taxonomy of bacteria. <i>2<sup>nd</sup> week.</i> Photosynthetic bacteria: Halobacteria, purple and green bacteria, cyanobacteria. <i>3<sup>rd</sup> week.</i> Chemolitotrophic bacteria: Bacteria involved in the cycles of nitrogen and sulfur and / or transformation of metals. <i>4<sup>th</sup> week.</i> Saprophytic bacteria. <i>5<sup>th</sup> week.</i> The formation and structure of biofilm. Interactions of bacterial populations. <i>6<sup>th</sup> week.</i> The history of the classification of eukaryotes, including the Protists. A general overview of the modern filogenetic system of Protists, with particular reference to groups of	



<p>protozoans.</p> <p>7<sup>th</sup> week. The flagellated protozoans and the traditional and modern system of sporozoans and their ecological significance.</p> <p>8<sup>th</sup> week. The main groups of ciliates and their ecological significance.</p> <p>9<sup>th</sup> week. Position of eukaryotic fungus-like organisms and true fungi in the system of living organisms.</p> <p>10<sup>th</sup> week. The slime molds: cellular slime molds (Acrasiomycota, Dictyosteliomycota), real slime molds (Mixomycota) and parasitic slime molds (Plasmodiophoromycota).</p> <p>11<sup>th</sup> week. "Phycomycetes": characteristics of the groups Hyphochytridiomycota, Labyrinthulomycota and Oomycota, their main representatives.</p> <p>12<sup>th</sup> week. Water molds (Chytridiomycota) and zygosporic fungi (Zygomycota).</p> <p>13<sup>th</sup> week. Major groups of sac fungi (Ascomycota) and basidiosporic fungi (Basidiomycota) with special regard to their representatives in wetland habitats.</p> <p>14<sup>th</sup> week. Consultation.</p>
<p><b>Requirements:</b></p> <p>- <i>for a signature</i></p> <p>Participation at practices is compulsory. A student must attend the practices and may not miss more than three times during the semester. In case a student does so, the subject will not be signed, and the student must repeat the course.</p> <p>- <i>for a grade</i></p> <p>During the semester there will be three short written tests. Additionally, every student must prepare a short (10-15 min) presentation in each topic. The final grade will be the average of the grades of written tests and presentations.</p>
<p><b>Person responsible for course:</b> Dr. habil. István Bácsi, associate professor, PhD</p>
<p><b>Lecturer:</b> Dr. habil. István Bácsi, associate professor, PhD</p>

<b>Title of course:</b> Algology <b>Code:</b> TTHME9305_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 1 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 14 hours - practice: - - laboratory: - - home assignment: 28 hours - preparation for the exam: 64 hours Total: 120 hours	
<b>Year, semester:</b> Facultative from 2 <sup>nd</sup> to 4 <sup>th</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> Course provides a comprehensive overview of classical and contemporary aspects of freshwater algae biology and ecology and takes full advantage of excellent range of aquatic habitats to provide an introduction to their recognition, identification and ecology. Emphasis will be placed on the use of the microscope and taxonomic keys for the identification to generic and species level and their ecological importance.	
<b>Literature</b> 1. John D. M., Whitton B. A., Bro A. J. 2002: The Freshwater Algal Flora of the British Isles – An Identification Guide to Freshwater and Terrestrial Algae. Cambridge University Press. 2. Lee R. E. 1999: Phycology. – Unicersity Press, Cambridge. 3. Van den Hoek C., Mann D. G., Jahns H. M. 1995: Algae, An introduction to phycology. – Unicersity Press, Cambridge.	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> “Definition” of algae. The difference between the prokaryotic and eukaryotic oxygen-producing photosynthetic organisms. Origin of the chloroplast. <i>2<sup>nd</sup> week.</i> Structure of algae by cell number and morphology. Asexual and sexual reproduction of algae, alternations of generations. <i>3<sup>rd</sup> week.</i> The basics of classification of eukaryotic algae - types of flagellae and cell division. <i>4<sup>th</sup> week.</i> Nutrients, nutrition. Nutritional strategies of eukaryotic algae. <i>5<sup>th</sup> week.</i> Habitats, algal communities - phytobenthos, phytoplankton. <i>6<sup>th</sup> week.</i> Vertical structure of phytoplankton communities.	

<p>7<sup>th</sup> week. Possibilities of functional grouping of photosynthetic organisms.</p> <p>8<sup>th</sup> week. Interactions of algal populations.</p> <p>9<sup>th</sup> week. The effects of diurnal cycle, weekly and monthly environmental periods on algal communities. Plankton Ecology Group model of phytoplankton succession.</p> <p>10<sup>th</sup> week. Phytoplankton based ecological status assessment.</p> <p>11<sup>th</sup> week. Phytobenthos based ecological status assessment.</p> <p>12<sup>th</sup> week. Biotechnological significance of algae I: Bioremediation, wastewater treatment.</p> <p>13<sup>th</sup> week. The biotechnological significance of algae II: From the use of the entire biomass to high-value biomolecules.</p> <p>14<sup>th</sup> week. Consultation.</p>
<p><b>Requirements:</b></p> <p>- <i>for a signature</i></p> <p>Attendance at lectures is highly recommended, but not compulsory.</p> <p>- <i>for a grade</i></p> <p>During the semester there will be no written tests, there will be an oral exam in the exam period.</p>
<p><b>Person responsible for course:</b> Dr. habil. István Bácsi, associate professor, PhD</p>
<p><b>Lecturer:</b> Dr. habil. István Bácsi, associate professor, PhD</p>

<b>Title of course:</b> Algology seminar <b>Code:</b> TTHMG9305_EN	<b>ECTS Credit points: 2</b>
<b>Type of teaching, contact hours</b> - lecture: - - practice: 1 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 14 hours - laboratory: - - home assignment: 16 hours - preparation for the exam: - Total: 30 hours	
<b>Year, semester:</b> Facultative from 2 <sup>nd</sup> to 4 <sup>th</sup> semester	
<b>Its prerequisite(s):</b> General Hydrobiology; Water Chemistry	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> The course gives an overview of the organization, taxonomy (morphology, DNA and RNA based classification), evolution and ecology of cyanobacteria and eukaryotic algae. The main taxons, their main representatives and their ecological role in aquatic habitats.	
<b>Literature</b> 1. John D. M., Whitton B. A., Bro A. J. 2002: The Freshwater Algal Flora of the British Isles – An Identification Guide to Freshwater and Terrestrial Algae. Cambridge University Press. 2. Lee R. E. 1999: Phycology. – Unicersity Press, Cambridge. 3. Van den Hoek C., Mann D. G., Jahns H. M. 1995: Algae, An introduction to phycology. – Unicersity Press, Cambridge.	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> Prokaryotic "algae": the phylum Cyanobacteria I: members of the previously integrated order of Chroococcales and the order Pleurocapsales. <i>2<sup>nd</sup> week.</i> Prokaryotic "algae": the phylum Cyanobacteria II: the orders Oscillatoriales and Nostocales). <i>3<sup>rd</sup> week.</i> Prokaryotic "algae": the phylum Cyanobacteria III: the previously independent order Stigonematales members of the previously separated phylum Chloroxybacteria. <i>4<sup>th</sup> week.</i> Glaucophytes and the red algae (Rhodophyta). <i>5<sup>th</sup> week.</i> Heterokonts: The phylum Ocrophyta (earlier Heterokontophyta) I: Chrysophyceae and Xanthophyceae.	

<p>6<sup>th</sup> week. Heterokonts: The phylum Ocrophyta (earlier Heterokontophyta) II: the brown algae (Phaeophyceae) and others (Eustigmatophyceae, Raphidophyceae, Dictyochophyceae).</p> <p>7<sup>th</sup> week. Diatoms (Bacillariophyta).</p> <p>8<sup>th</sup> week. Haptophytes or “golden algae” and cryptophytes (Haptophyta and Cryptophyta).</p> <p>9<sup>th</sup> week. Dinoflagellates (Miozoa, earlier Dinophyta).</p> <p>10<sup>th</sup> week. Euglenids and “green amoebas”: the phyla Euglenozoa (earlier Euglenophyta) and Chlorarachniophyta.</p> <p>11<sup>th</sup> week. Green algae I (Chlorophyta / Chlorodendrophyceae, Chlorophyceae).</p> <p>12<sup>th</sup> week. Green algae II (Chlorophyta / Ulvophyceae: Cladophorales, Bryopsidales).</p> <p>13<sup>th</sup> week. Green algae III (Chlorophyta / Ulvophyceae: Dasycladales, Trentepohliales).</p> <p>14<sup>th</sup> week. Green algae characterized by conjugation: the phylum Conjugatophyta.</p>
<p><b>Requirements:</b></p> <p>- <i>for a signature</i></p> <p>Participation at practices is compulsory. A student must attend the practices and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.</p> <p>- <i>for a grade</i></p> <p>During the semester there will be three short written tests. Additionally, every student has to prepare a short (10-15 min) presentation in a given topic. The final grade will be the average of the grades of written tests and presentations.</p>
<p><b>Person responsible for course:</b> Dr. habil. István Bácsi, associate professor, PhD</p>
<p><b>Lecturer:</b> Dr. habil. István Bácsi, associate professor, PhD</p>

<b>Title of course:</b> Macrophytes <b>Code:</b> TTHME9304_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: 28 hours - preparation for the exam: 64 hours Total: 120 hours	
<b>Year, semester:</b> Facultative from 2 <sup>nd</sup> to 4 <sup>th</sup> semester	
<b>Its prerequisite(s):</b>	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
The goals of this course are: to learn the basic taxonomy of common aquatic plants; to become familiar with the habitats where aquatic plants are commonly found; to understand the functioning of nutrient cycles in aquatic systems; become familiar with control and management of aquatic plants in perturbed and man-made ecosystems, become familiar with aquatic nuisance plant species and their role in the environment.	
<b>Literature</b>	
<i>Compulsory:</i> 1. Casper, S.J., Krausch, H-D. 1981: Pteridophyta und Anthophyta, 2. Teil. Süßwasserflora von Mitteleuropa, Band 24. VEB Gustav Fischer Verlag, Jena, Germany, 2. Bornette G., Puijalon S. (2009):Macrophytes: Ecology of Aquatic Plants. Wiley Online Press. 3. Caffrey, J.M., Dutartre, A., Haury, J., Murphy, K.M., Wade, P.M. (2006): Macrophytes in Aquatic Ecosystems: From Biology to Management. Springer. 4. Cook, C.D.K., Gut, B.J., Rix, E.M., Schneller, J. 1974: Water Plants of the World. A Manual for the Identification of the Genera of Freshwater Macrophytes. 576 pp., ISBN: 90-6193-024-3 5. Jeppesen, E.; Sondergaard, M.; Sondergaard, M.; Christofferson, K. (eds.) 1997: The Structuring Role of Submerged Macrophytes in Lakes. Series: Ecological Studies, Vol. 131. 452 pp., ISBN: 0-387-98284-1	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> Definition of water macrophytes. Taxonomy of water plants. <i>2<sup>nd</sup> week.</i> Form of life categories of water plants. <i>3<sup>rd</sup> week.</i> Emerged macrophytes.	

4<sup>th</sup> week. Submerged macrophytes.

5<sup>th</sup> week. Floating leaf macrophytes.

6<sup>th</sup> week. Floating macrophytes.

7<sup>th</sup> week. Life in open water, characteristic algae species.

8<sup>th</sup> week. Habitat types of shorelines.

9<sup>th</sup> week. Characteristic plant species of floodplains and swamps.

10<sup>th</sup> week. Characteristic plant species of marshlands.

11<sup>th</sup> week. Macrophytes as a biological indicators of European Water Framework Directives.

12<sup>th</sup> week. Macrophytes like stress specific indicators.

13<sup>th</sup> week. Macrophytes as a part of ecological state.

14<sup>th</sup> week. Using geoinformatics methods to analyzing macrophytes coverages.

### Requirements:

*- for a signature*

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up any practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments of the course to each practice class. Active participation is evaluated by the teacher in every class. If a student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.

Students have to **submit all the two designing tasks** as scheduled minimum on a sufficient level.

During the semester there are two tests: the mid-term test in the 8<sup>th</sup> week and the end-term test in the 15<sup>th</sup> week. Students have to sit for the tests

*- for a grade*

The course ends in an **examination**. Based on the average of the grades of the designing tasks and the examination, the exam grade is calculated as an average of them:

- the average grade of the two designing tasks
- the result of the examination

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

*-an offered grade:*

it may be offered for students if the average grade of the two designing tasks is at least satisfactory (3) and the average of the mid-term and end-term tests is at least satisfactory (3). The offered grade

is the average of them.
<b>Person responsible for course:</b> Dr. István Gyulai assistant professor, PhD
<b>Lecturer:</b> Dr. István Gyulai assistant professor, PhD



<b>Title of course:</b> Macrophytes <b>Code:</b> TTHMG9304_EN	<b>ECTS Credit points:</b> 2
<b>Type of teaching, contact hours</b> - lecture: - - practice: 1 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 14 hours - laboratory: - - home assignment: 16 hours - preparation for the exam: - Total: 30 hours	
<b>Year, semester:</b> Facultative from 2 <sup>nd</sup> to 4 <sup>th</sup> semester	
<b>Its prerequisite(s):</b>	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
The practice part will focus on to get a practice on identification of various macrophyte specie and use this knowledge for ecosystem study. During the short field trips to local wetlands we improve the knowledge, and familiarization with field instruments and water quality measurments based on macrophyte species.	
<b>Literature</b>	
<i>Compulsory:</i> 1. Casper, S.J., Krausch, H-D. 1981: Pteridophyta und Anthophyta, 2. Teil. Süßwasserflora von Mitteleuropa, Band 24. VEB Gustav Fischer Verlag, Jena, Germany, 2. Bornette G., Puijalon S. (2009):Macrophytes: Ecology of Aquatic Plants. Wiley Online Press. 3. Caffrey, J.M., Dutartre, A., Haury, J., Murphy, K.M., Wade, P.M. (2006): Macrophytes in Aquatic Ecosystems: From Biology to Management. Springer. 4. Cook, C.D.K., Gut, B.J., Rix, E.M., Schneller, J. 1974: Water Plants of the World. A Manual for the Identification of the Genera of Freshwater Macrophytes. 576 pp., ISBN: 90-6193-024-3 5. Jeppesen, E.; Sondergaard, M.; Sondergaard, M.; Christofferson, K. (eds.) 1997: The Structuring Role of Submerged Macrophytes in Lakes. Series: Ecological Studies, Vol. 131. 452 pp., ISBN: 0-387-98284-1	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> Collecting of emerged macrophytes. <i>2<sup>nd</sup> week.</i> Identification of merged macrophytes. <i>3<sup>rd</sup> week.</i> Collecting of submerged macrophytes. <i>4<sup>th</sup> week.</i> Identification of submerged macrophytes. <i>5<sup>th</sup> week.</i> Collecting of floating leaf macrophytes. <i>6<sup>th</sup> week.</i> Identification of floating leaf macrophytes.	

7<sup>th</sup> week. Collecting of floating macrophytes.

8<sup>th</sup> week. Identification of floating macrophytes.

9<sup>th</sup> week. Taxonomy of swamp macrophytes.

10<sup>th</sup> week. Taxonomy of marshland macrophytes.

11<sup>th</sup> week. Characteristic macrophytes of an oligotrophic lake.

12<sup>th</sup> week. Characteristic macrophytes of a mesotrophic lake.

13<sup>th</sup> week. Characteristic macrophytes of a eutrophic lake.

14<sup>th</sup> week. Monitoring of water plants using macrophytes habitat categories.

### Requirements:

- *for a signature*

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up any practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments of the course to each practice class. Active participation is evaluated by the teacher in every class. If a student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.

Students have to **submit all the two designing tasks** as scheduled minimum on a sufficient level.

During the semester there are two tests: the mid-term test in the 8<sup>th</sup> week and the end-term test in the 15<sup>th</sup> week. Students have to sit for the tests

- *for a grade*

The course ends in an **examination**. Based on the average of the grades of the designing tasks and the examination, the exam grade is calculated as an average of them:

- the average grade of the two designing tasks
- the result of the examination

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

- *an offered grade:*

it may be offered for students if the average grade of the two designing tasks is at least satisfactory (3) and the average of the mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of them.

**Person responsible for course:** Dr. István Gyulai assistant professor, PhD

**Lecturer:** Dr. István Gyulai assistant professor, PhD

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<b>Title of course:</b> Zooplankton <b>Code:</b> TTHME9403_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: 28 hours - preparation for the exam: 64 hours Total: 120 hours	
<b>Year, semester:</b> Facultative from 2 <sup>nd</sup> to 4 <sup>th</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> Zooplankton importance. Structure of freshwater and marine zooplankton. Main systematic groups. Ecology of zooplankton (feeding, life cycle, habitat, behavior). Zooplankton and water quality. Zooplankton and fish interaction. Zooplankton methodology, collection and identification. Indicator and test organisms. Habitat attachment of zooplankton. Using planctonic and littoral cladocera species for reconstruction lake-level changes.	
<b>Literature</b> <i>Compulsory:</i> 1. G. E. Likens (2010): Plankton of Inland Waters. Academic Press ISBN 9780123819949 2. I.M. Suthers, D. Rissik (2009): Plankton. A guide to their ecology and monitoring for water quality. CSIRO Publishing, Australia 3. M. Omori (1992): Methods in Marine Zooplankton Ecology. Krieger Pub. Co. ISBN-10: 0894646532 4. R.P. Harris, P.H. Wiebe, J. Lenz, H.R. Skjoldal, M. Huntley (2000): ICES Zooplankton Methodology Manual. Academic Press ISBN 0-12-327645-4	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> The members of the zooplankton community, their taxonomic classification, their lifestyle, their occurrence in aquatic ecosystems. <i>2<sup>nd</sup> week.</i> The role of zooplankton in aquatic food web and in material cycle. <i>3<sup>rd</sup> week.</i> Study of zooplankton: aspects of representative sampling, collection methods, tools, sample preservation, transport, storage. <i>4<sup>th</sup> week.</i> Species identification, major anatomical characteristics, typical sex and seasonal morphological differences. <i>5<sup>th</sup> week.</i> Ecology of zooplankton species, indicator species, common species, rare species.	

<p>6<sup>th</sup> week. Investigation and monitoring of zooplankton community: quantitative characteristics (number of individuals, biomass).</p> <p>7<sup>th</sup> week. Investigation and monitoring zooplankton community: quality characteristics (species composition, dominance, diversity, functional groups), evaluation of results.</p> <p>8<sup>th</sup> week. The importance of zooplankton organisms: water qualification and fish farming aspects.</p> <p>9<sup>th</sup> week. Laboratory breeding and application of zooplankton organisms in ecotoxicology.</p> <p>10<sup>th</sup> week. Planktonic crustaceans (Cladocera, Copepoda) in freshwaters.</p> <p>11<sup>th</sup> week. Characteristics of marine zooplankton.</p> <p>13<sup>th</sup> week. Zooplankton researches - case studies.</p> <p>12<sup>th</sup> week. The impact of climate change on zooplankton.</p> <p>14<sup>th</sup> week. Consultation or exam.</p>
<p><b>Requirements:</b></p> <p>- <i>for a signature</i></p> <p>Attendance at lectures is recommended, but not compulsory.</p> <p>- <i>for a grade</i></p> <p>The lecture ends with a written examination. 2 (Pass) Grade: 50% of the maximum points available. If the score of any test is below 50%, students can take a retake test.</p> <p>- <i>an offered grade:</i></p> <p>There are at least two tests during the semester, and the offered grade is the average of them.</p>
<p><b>Person responsible for course:</b> Dr. Csaba Berta, assistant professor, PhD</p>
<p><b>Lecturer:</b> Dr. Csaba Berta, assistant professor, PhD; Dr. István Gyulai, assistant professor, PhD</p>

<b>Title of course:</b> Zooplankton <b>Code:</b> TTHMG9403_EN	<b>ECTS Credit points: 2</b>
<b>Type of teaching, contact hours</b> - lecture: - - practice: 1 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 14 hours - laboratory: - - home assignment: 16 hours - preparation for the exam: - Total: 120 hours	
<b>Year, semester:</b> Facultative from 2 <sup>nd</sup> to 4 <sup>th</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
The target is to know the main zooplankton groups (Rotatoria, Cladocera, Copepoda), methods of preparation, identification of animals using a microscope.	
<b>Literature</b>	
<i>Compulsory:</i> 1. J. Moore 2006: An Introduction to the Invertebrates. Cambridge University Press. ISBN: 9780521674065 2. M Suthers, D. Rissi 2009: Plankton - A Guide to their Ecology and Monitoring for Water Quality. CSIRO ISBN: 9780643090583 3. Bledzki, L.A., Rybak, J.I. 2016: Freshwater Crustacean Zooplankton of Europe. Springer International Publishing, Switzerland ISBN 978-3-319-29871-9	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> Recognizing the main taxonomic groups of zooplankton. <i>2<sup>nd</sup> week.</i> Characteristics and major genera of the Monogononta class (Rotatoria). <i>3<sup>rd</sup> week.</i> Identification of features required to determine the rotifers' species, preparation of mastax. <i>4<sup>th</sup> week.</i> Identification of rotifer species I. <i>5<sup>th</sup> week.</i> Identification of rotifer species II. <i>6<sup>th</sup> week.</i> The most important genera of Cladocera. <i>7<sup>th</sup> week.</i> Identification of features required to determine the cladocerans' species, preparation methods. <i>8<sup>th</sup> week.</i> Identification of cladoceran species I. <i>9<sup>th</sup> week.</i> Identification of cladoceran species II <i>10<sup>th</sup> week.</i> Separation of the three orders of Copepoda, the recognition of the most important species.	

11<sup>th</sup> week. Preparation of the 5th toracic leg of cyclopoid copepods, identification of species.

12<sup>th</sup> week. Breeding of *Daphnia magna* in laboratory.

13<sup>th</sup> week. Evaluation of results of zooplankton investigations on the basis of given species lists.

14<sup>th</sup> week. Consultation.

**Requirements:**

- *for a signature*

Participation at practice classes is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. In case of further absences, a medical certificate needs to be presented.

- *for a grade*

The practice ends with submitting a term paper.

**Person responsible for course:** Dr. Csaba Berta, assistant professor, PhD

**Lecturer:** Dr. Csaba Berta, assistant professor, PhD;

Dr. István Gyulai, assistant professor, PhD

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<b>Title of course:</b> Macroinvertebrates <b>Code:</b> TTHME9302_EN	<b>ECTS Credit points: 3</b>
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: 28 hours - preparation for the exam: 64 hours Total: 120 hours	
<b>Year, semester:</b> Facultative from 2 <sup>nd</sup> to 4 <sup>th</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> This course presents practices and concepts of using macroinvertebrates to monitor the environmental health or integrity of freshwater ecosystems. <b>The course objectives are to know and describe:</b> (i) the body plan and the life history strategies of macroinvertebrate taxa; (ii) habits and trophic group types; (iii) macroinvertebrate patterns of abundance based on physical and chemical habitat templates. Discuss effect of impairment on assemblage composition. Correctly use a variety of sampling gears. Use proper collecting, labeling, and preservation techniques and correctly identify specimens by following methods demonstrated in the course..	
<b>Literature</b> <i>Compulsory:</i> <ol style="list-style-type: none"> <li>1. Voshell J. R (2002): A Guide to Common Freshwater Invertebrates of North America, McDonald and Woodward Publishing Company;</li> <li>2. Peckarsky B. (1990): Freshwater Macroinvertebrates of Northeastern North America, Cornell University Press</li> <li>3. <u>Lancaster J.</u> and <u>Downes B. J.</u> (2013) :Aquatic Entomology, Oxford University Press</li> <li>4. Hynes, H.B.N. (1970): The Ecology of Running Waters, Liverpool Uneversity Press</li> </ol>	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> Types of aquatic macroinvertebrates: sessile, hemisessile and vagile species. Biophages and hylophages, filters, breakers, collectors, scrapers. Phytophag, carnivor and omnivor species. <i>2<sup>nd</sup> week.</i> Body plan, activities, nutrion and reproduction of sponges and cnidarians. The most important freshwater and marine taxa. <i>3<sup>rd</sup> week.</i> Body plan and life-styles of flatworms. Waterbound parasitic faltworms (weeds and gallbladder) and their life-styles. Their importance pf flatworms in freshwater and seas.	



<p>Kamptozoans.</p> <p>4<sup>th</sup> week. Annelid worms: body plan and life-style. Free living and parasitic taxa. Rotifers and bryozoans.</p> <p>5<sup>th</sup> week. Molluscs: body plan and life style. Snails, bivalves and cephalopods and their importance in the water animal assemblages.</p> <p>6<sup>th</sup> week. General body structure of arthropods. Body plan of macroscopic crustaceans. The most important freshwater and marine taxa. Invasive species.</p> <p>7<sup>th</sup> week. Body plan of bugs. The most important taxa living on surface of water, or in the water. Characterization of families of caddyflies.</p> <p>8<sup>th</sup> week. Separation of myflies and dragonflies at family level. Their importance in the water animal assemblages. The most important taxa</p> <p>9<sup>th</sup> week. General body structure of the beetles. Separation of water and water-bound beetles at family level. The most important taxa.</p> <p>10<sup>th</sup> week. General body structure of dipterans. Separation of dipteran larvae at family level.</p> <p>11<sup>th</sup> week. Macroinvertebrate assemblages of lacustrine, pelagic and littoral. Trophic relationships.</p> <p>12<sup>th</sup> week. Macroinvertebrate assemblages of benthic, stygian and littoral. Trophic relationships.</p> <p>13<sup>th</sup> week. Macroinvertebrate assemblages of springs and watercourses. Adaptations to running water.</p> <p>14<sup>th</sup> week. Presentation of the most important methods used to collect aquatic macroinvertebrates. Labeling, and preservation techniques.</p>
<p><b>Requirements:</b></p> <p>- <i>for a signature</i></p> <p>Attendance at <b>lectures</b> is recommended, but not compulsory.</p> <p>Participation at <b>practice classes</b> is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. In case of further absences, a medical certificate needs to be presented.</p> <p>- <i>for a grade</i></p> <p>The course ends in an written <b>examination</b>. 2 (Pass) Grade: 50% of the maximum points available. If the score of any test is below 50%, students can take a retake test.</p> <p>- <i>an offered grade:</i></p> <p>There are at least two test during the semester, and the offered grade is the average of them.</p>
<p><b>Person responsible for course:</b> Dr. habil. László Antal, associate professor, PhD</p>
<p><b>Lecturer:</b> Dr. habil. László Antal, associate professor, PhD</p>

<b>Title of course:</b> Macroinvertebrates <b>Code:</b> TTHMG9302_EN	<b>ECTS Credit points: 2</b>
<b>Type of teaching, contact hours</b> - lecture: - practice: 1 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - practice: 14 hours - laboratory: - - home assignment: 16 hours - preparation for the exam: - hours Total: 30 hours	
<b>Year, semester:</b> Facultative from 2 <sup>nd</sup> to 4 <sup>th</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> This course presents practices and concepts of using macroinvertebrates to monitor the environmental health or integrity of freshwater ecosystems. <b>The course objectives are to know and describe:</b> (i) the body plan and the life history strategies of macroinvertebrate taxa; (ii) habits and trophic group types; (iii) macroinvertebrate patterns of abundance based on physical and chemical habitat templates. Discuss effect of impairment on assemblage composition. Correctly use a variety of sampling gears. Use proper collecting, labeling, and preservation techniques and correctly identify specimens by following methods demonstrated in the course..	
<b>Literature</b> <i>Compulsory:</i> <ol style="list-style-type: none"> <li>1. Voshell J. R (2002): A Guide to Common Freshwater Invertebrates of North America, McDonald and Woodward Publishing Company;</li> <li>2. Peckarsky B. (1990): Freshwater Macroinvertebrates of Northeastern North America, Cornell University Press</li> <li>3. <u>Lancaster J.</u> and <u>Downes B. J.</u> (2013) :Aquatic Entomology, Oxford University Press</li> <li>4. Hynes, H.B.N. (1970): The Ecology of Running Waters, Liverpool Uneversity Press</li> </ol>	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> Types of aquatic macroinvertebrates: sessile, hemisessile and vagile species. Biophages and hylophages, filters, breakers, collectors, scrapers. Phytophag, carnivor and omnivor species. <i>2<sup>nd</sup> week.</i> Presentation the most important taxa and species of sponges and cnidarians living in freshwater and marine. <i>3<sup>rd</sup> week.</i> Presentation the most important taxa and species of flatworms living in freshwater and marine habitats. Medical importance of parasitic flatworms.	

<p>4<sup>th</sup> week. Presentation the most important taxa and species of annelids living in freshwater and marine</p> <p>The most important rotifer and bryozoan species.</p> <p>5<sup>th</sup> week. Presentation the most important taxa and species of molluscs living in freshwater and marine adaptation to waving. Invasive species in the freshwaters.</p> <p>6<sup>th</sup> week. The most important representatives of the macroscopic crabs. Invasive species in the freshwater habitats.</p> <p>7<sup>th</sup> week. Presentation the bug species living on surface of water, or in the water. Presentation of caddyflies larvae and imagoes.</p> <p>8<sup>th</sup> week. The most important taxa of myflies and dragonflies. Presentation the larvae and imagoes.</p> <p>9<sup>th</sup> week. The most important taxa of beetles living in freshwaters.</p> <p>10<sup>th</sup> week. Presentation the most important taxa and species of dipterans living in freshwater.</p> <p>11<sup>th</sup> week. Macroinvertebrate assemblages of facial, pelagial and fital. Trophic relationships.</p> <p>12<sup>th</sup> week. Macroinvertebrate assemblages of bental, stigal és freatal. Trophic relationships.</p> <p>13<sup>th</sup> week. Macroinvertebrate assemblages of springs and watercourses. Adaptations to running water.</p> <p>14<sup>th</sup> week. Presentation of the most important methods used to collect aquatic macroinvertebrates. Labeling, and preservation techniques.</p>
<p><b>Requirements:</b></p> <p>- <i>for a signature</i></p> <p>Participation at <b>practice classes</b> is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. In case of further absences, a medical certificate needs to be presented.</p> <p>- <i>for a grade</i></p> <p>The course ends in an written <b>examination</b>. 2 (Pass) Grade: 50% of the maximum points available. If the score of any test is below 50%, students can take a retake test.</p> <p>- <i>an offered grade:</i></p> <p>There are at least two test during the semester, and the offered grade is the average of them.</p>
<p><b>Person responsible for course:</b> Dr. habil. László Antal, associate professor, PhD</p>
<p><b>Lecturer:</b> Dr. habil. László Antal, associate professor, PhD</p>

<b>Title of course:</b> Fishes <b>Code:</b> TTHME9306_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: 28 hours - preparation for the exam: 64 hours Total: 120 hours	
<b>Year, semester:</b> Facultative from 2 <sup>nd</sup> to 4 <sup>th</sup> semester	
<b>Its prerequisite(s):</b> TTHME9104_EN	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> This is an comprehensive subject about fishes: Taxonomy; Evolution; Organization; Morphological and meristic characters; Anatomy; Freshwater Fish fauna; Reproductive biology; Ecology; Diet; Diseases; Conservation biology; Migration; Fisheries management; Biomanipulation.	
<b>Literature</b> <i>Compulsory:</i> 1. Nelson, J.S., 2006. Fishes of the World. 4th Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, ISBN: 978-0-471-25031-9  2. <i>Recommended:</i> 3. Cowx, I.G., 2002. Management and Ecology of Lake and Reservoir Fisheries. Wiley-Blackwell, ISBN: 978-0852382837 4. Kottelat, M., Freyhof, J., 2007. Handbook of European Freshwater Fishes. Publications Kottelat, Cornol, Switzerland. ISBN: 9782839902984 5. Leppäkoski, E., Gollasch, S., Olenin, S., (Eds.), 2010. Invasive Aquatic Species of Europe. Distribution, Impacts and Management. Springer, ISBN: 978-9048161119. 6. Lucas, M., Baras, E., 2001. Migration of Freshwater Fishes. Wiley-Blackwell, ISBN: 978-0632057542 7. Scheffer, M. 2004. Ecology of Shallow Lakes. DeAngelis DL, Manly BFJ. Springer, ISBN 978- 1-4020-2306-4	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> Taxonomy of Fishes. <i>2<sup>nd</sup> week.</i> Evolution of Fishes. <i>3<sup>rd</sup> week.</i> Anatomy of Fishes. <i>4<sup>th</sup> week.</i> Organization of Fishes.	

5<sup>th</sup> week. Morphological and meristic characters of Fishes.

6<sup>th</sup> week. Freshwater Fish fauna.

7<sup>th</sup> week. Reproductive biology of Fishes.

8<sup>th</sup> week. Ecology of Fishes.

9<sup>th</sup> week. Diet of Fishes.

10<sup>th</sup> week. Diseases of Fishes .

11<sup>th</sup> week. Conservation biology.

12<sup>th</sup> week. Migration of Fishes .

13<sup>th</sup> week. Fisheries management.

14<sup>th</sup> week. Biomanipulation.

### **Requirements:**

- *for a signature*

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up any practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor. Active participation is evaluated by the teacher in every class. If a student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.

- *for a grade*

- The course ends in an **examination**.

The course ends in an examination. The minimum requirement for the test and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

**Person responsible for course:** Dr. László Antal associate professor, PhD

**Lecturer:** Dr. László Antal, associate professor, PhD

Dr. Krisztián Nyeste, assistant professor, PhD

<b>Title of course:</b> Fishes <b>Code:</b> TTHMG9306_EN	<b>ECTS Credit points:</b> 2
<b>Type of teaching, contact hours</b> <ul style="list-style-type: none"> <li>- lecture: -</li> <li>- practice: 1 hours/week</li> <li>- laboratory: -</li> </ul>	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> <ul style="list-style-type: none"> <li>- lecture: -</li> <li>- practice: 14 hours</li> <li>- laboratory: -</li> <li>- home assignment: 16 hours</li> <li>- preparation for the exam: -</li> </ul> Total: 120 hours	
<b>Year, semester:</b> Facultative from 2 <sup>nd</sup> to 4 <sup>th</sup> semester	
<b>Its prerequisite(s):</b> TTHME9104_EN	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> The aim of the course is to the students enable to identifying the most important characteristics of fishes. The students be able to independently determine the various fish species whether they are in field conditions or from photographs. They have the ability to apply decoding keys individually, to be able to test the most important morphometric and meristine features.	
<b>Literature</b> <i>Compulsory:</i> <ol style="list-style-type: none"> <li>1. Nelson, J.S., 2006. Fishes of the World. 4th Edition, John Wiley &amp; Sons, Inc., Hoboken, New Jersey, ISBN: 978-0-471-25031-9</li> </ol> <i>Recommended:</i> <ol style="list-style-type: none"> <li>1. Cowx, I.G., 2002. Management and Ecology of Lake and Reservoir Fisheries. Wiley-Blackwell, ISBN: 978-0852382837</li> <li>2. Kottelat, M., Freyhof, J., 2007. Handbook of European Freshwater Fishes. Publications Kottelat, Cornol, Switzerland. ISBN: 9782839902984</li> <li>3. Leppäkoski, E., Gollasch, S., Olenin, S., (Eds.), 2010. Invasive Aquatic Species of Europe. Distribution, Impacts and Management. Springer, ISBN: 978-9048161119.</li> <li>4. Lucas, M., Baras, E., 2001. Migration of Freshwater Fishes. Wiley-Blackwell, ISBN: 978-0632057542</li> <li>5. Scheffer, M. 2004. Ecology of Shallow Lakes. DeAngelis DL, Manly BFJ. Springer, ISBN 978-1-4020-2306-4</li> </ol>	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> Taxonomic practice I. (principles) . <i>2<sup>nd</sup> week.</i> Taxonomic practice II. (predatory fishes).	

3<sup>rd</sup> week. Taxonomic practice III. (not predatory fishes).

4<sup>th</sup> week. Anatomical practice I.

5<sup>th</sup> week. Anatomical practice II .

6<sup>th</sup> week. Fish diseases practice (ectoparasites).

7<sup>th</sup> week. Fish diseases practice (endoparasites).

8<sup>th</sup> week. Natural nutrients I.

9<sup>th</sup> week. Natural nutrients II.

10<sup>th</sup> week. Industrial nutrition I.

11<sup>th</sup> week. Industrial nutrition II.

12<sup>th</sup> week. Research fishing methods .

13<sup>th</sup> week. Industrial fishing methods I.

14<sup>th</sup> week. Industrial fishing methods II.

### **Requirements:**

- *for a signature*

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up any practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor. Active participation is evaluated by the teacher in every class. If a student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.

- *for a grade*

The course ends in an **examination**.

The course ends in an examination. The minimum requirement for the test and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

**Person responsible for course:** Dr. László Antal, associate professor, PhD

**Lecturer:** Dr. László Antal, associate professor, PhD

Dr. Krisztián Nyeste, assistant professor, PhD

<b>Title of course:</b> Research project management <b>Code:</b> TTHME9418_EN	<b>ECTS Credit points: 3</b>
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: 28 hours - preparation for the exam: 64 hours Total: 120 hours	
<b>Year, semester:</b> Facultative from 2 <sup>nd</sup> to 4 <sup>th</sup> semester	
<b>Its prerequisite(s):</b>	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> Basics of project planning: the research question, surveying the literature, setting the research hypotheses. Choosing study species, area and methodology. Principles of data collecting: design of sampling, experimental and observational studies, basics of statistical design and analyses. Writing up: structure of scientific communications (talks, posters and papers), the publishing machinery. Writing grant proposals.	
<b>Literature</b> <i>Compulsory:</i> course material  <i>Recommended:</i> <ol style="list-style-type: none"> <li>1. Paul D. Leedy, Jeanne E. Ormrod : Practical Research: Planning and Design (11th Edition). Prentice Hall, 2015.</li> <li>2. Crawley, Michael J. Statistics : an introduction using R / Michael J. Crawley. Second edition. Wiley. 2015.</li> <li>3. William R. Shadish, Thomas D. Cook, Donald T. Campbell: Experimental and Quasi-Experimental Designs for Generalized Causal Inference. Wadsworth Publishing 2001.</li> <li>4. John W. Creswell: Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 4th Edition. SAGE Publications Inc, 2013.</li> <li>5. Joshua Schimel . Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded? Oxford University Press 2011.</li> </ol>	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> The scientific method. Generating hypotheses and drawing predictions.	



2<sup>nd</sup> week. Approaching a new scientific question. How to survey the literature.

3<sup>rd</sup> week. Choosing study subjects, area and methodology

4<sup>th</sup> week. Principles of data collection: sampling designs, difference between experimental and observational studies.

5<sup>th</sup> week. Controlling for confounders. Spurious correlations.

6<sup>th</sup> week. Experimental protocols. Randomization, standardization, the importance of a control group. Blinding.

7<sup>th</sup> week. Experimental protocols. Randomized block design, Latin square, factorial design.

8<sup>th</sup> week. Analysing collected data - 1. Continuous variables.

9<sup>th</sup> week. Analysing collected data – 2. Comparing groups.

10<sup>th</sup> week. Analysing collected data – 3. Other methods.

11<sup>th</sup> week. Organizing research data. Data structures and reproducible research.

12<sup>th</sup> week. Writing up: structure of scientific communications (talks, posters and papers).

13<sup>th</sup> week. Publishing: from manuscript submission to peer review.

14<sup>th</sup> week. Writing grant proposals.

### Requirements:

- *for a signature*

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up any practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor.

During the semester there are two tests: the mid-term test in the 8<sup>th</sup> week and the end-term test in the 15<sup>th</sup> week. Students have to sit for the tests

- *for a grade*

The course ends in an **examination**. Based on the average of the grades of the designing tasks and the examination, the exam grade is calculated as an average of them:

- the average grade of home assignments
- the result of the examination

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

- *an offered grade:*

it may be offered for students if the average grade of the two designing tasks is at least satisfactory

(3) and the average of the mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of them.

**Person responsible for course:** Dr. habil. Ádám Z. Lendvai, associate professor, PhD

**Lecturer:** Dr. habil. Ádám Z. Lendvai, associate professor, PhD

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<b>Title of course:</b> Research Project Management <b>Code:</b> TTHMG9418_EN	<b>ECTS Credit points:</b> 2
<b>Type of teaching, contact hours</b> - lecture: - - practice: 1 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 14 hours - laboratory: - - home assignment: 16 hours - preparation for the exam: - Total: 30 hours	
<b>Year, semester:</b> Facultative from 2 <sup>nd</sup> to 4 <sup>th</sup> semester	
<b>Its prerequisite(s):</b>	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> Basics of project planning: the research question, surveying the literature, setting the research hypotheses. Choosing study species, area and methodology. Principles of data collecting: design of sampling, experimental and observational studies, basics of statistical design and analyses. Writing up: structure of scientific communications (talks, posters and papers), the publishing machinery. Writing grant proposals.	
<b>Literature</b> <i>Compulsory:</i> 1. course material  <i>Recommended:</i> 1. Paul D. Leedy, Jeanne E. Ormrod : Practical Research: Planning and Design (11th Edition). Prentice Hall, 2015. 2. Crawley, Michael J. Statistics : an introduction using R / Michael J. Crawley. Second edition. Wiley. 2015. 3. William R. Shadish, Thomas D. Cook, Donald T. Campbell: Experimental and Quasi-Experimental Designs for Generalized Causal Inference. Wadsworth Publishing 2001. 4. John W. Creswell: Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 4th Edition. SAGE Publications Inc, 2013. 6. Joshua Schimel . Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded? Oxford University Press 2011.	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> Generating hypotheses and drawing predictions in everyday life questions.	

2<sup>nd</sup> week. Looking up papers with specific criteria.

3<sup>rd</sup> week. Practical aspects of study subject selection.

4<sup>th</sup> week. Full random and stratified random sampling.

5<sup>th</sup> week. Do storks bring babies? Investigating causation in correlational data sets.

6<sup>th</sup> week. Designing a placebo-controlled randomized double-blind study.

7<sup>th</sup> week. Experimental protocols. Randomized block design, Latin square, factorial design.

8<sup>th</sup> week. Correlations, linear regression.

9<sup>th</sup> week. T-test, Parametric and non-parametric analysis of variance.

10<sup>th</sup> week. Ordination and cluster analysis.

11<sup>th</sup> week. Organizing research data. Data structures and reproducible research.

12<sup>th</sup> week. How to make a good (and a bad) talk. How to write a research paper.

13<sup>th</sup> week. Submitting a manuscript. Perform a peer review.

14<sup>th</sup> week. Writing grant proposals.

#### **Requirements:**

*- for a signature*

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up any practice with another group.

During the semester there are two tests: the mid-term test in the 8<sup>th</sup> week and the end-term test in the 15<sup>th</sup> week. Students have to sit for the tests

*- for a grade*

The course ends in an **examination**. Based on the average of the grades of the designing tasks and the examination, the exam grade is calculated as an average of them:

- the average grade of home assignments
- the result of the examination

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

*-an offered grade:*

it may be offered for students if the average grade of the two designing tasks is at least satisfactory (3) and the average of the mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of them.

**Person responsible for course:** Dr. habil. Ádám Z. Lendvai, associate professor, PhD

**Lecturer:** Dr. habil. Ádám Z. Lendvai, associate professor, PhD

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<b>Title of course:</b> Tropical Ecology <b>Code:</b> TTHME9406_EN	<b>ECTS Credit points: 3</b>
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: 28 hours - preparation for the exam: 64 hours Total: 120 hours	
<b>Year, semester:</b> Facultative from 2 <sup>nd</sup> to 4 <sup>th</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> <p>This course will provide students with a general overview of tropical ecology. Students will gain insight about basic ecological concepts and be able to explore a variety of ecosystems, their animals and the multiple and complex ecological interactions that can be found in these areas. Brazil is a tropical country with an immensely rich biodiversity and for this reason a very representative area to these studies. Emphasis will be given to the study of the ecosystems found in Brazil, but others will be discussed as well. The course objectives is: become acquainted with the concepts and issues addressed to tropical ecology; learn the characteristics of the major tropical ecosystems on earth; observe different ecosystems and seek examples of important interactions. Students become familiar with the biodiversity of the tropics; understand the importance of the balance and the harmony among different types of tropical ecosystems; understand the natural and human made impacts on natural ecosystems in tropical area; comprehend the importance of conservation and management of natural systems.</p>	
<b>Literature</b> 1. Michael, G., Mirian, L. C., Efrem, G. F. (1998): Rio Negro, rich life in poor water – SPB Academic Publishing bv, Hague, Netherland, 2. Wilhelm, F. (1987): Hydrogeographie, Braunschweig, 3. John Kricher (2011): Tropical Ecology. Princeton University Press, 4. Montagnini, F., Carl F. J. (2005): Tropical Forest Ecology (The Basis for Conservation and Management)	
<b>Schedule:</b> <b>Lectures:</b> <i>1<sup>st</sup> week.</i> The tropics and their location on Earth. <i>2<sup>nd</sup> week.</i> Characterization of white, black and transparent waters of tropical watercourses. <i>3<sup>rd</sup> week.</i> Oligotrophy in tropical waters.	

*4<sup>th</sup> week.* Problems of water load and water pollution in the tropics.

*5<sup>th</sup> week.* Tropical watercourses in the savannah belt.

*6<sup>th</sup> week.* Characteristics of topical standing waters.

*7<sup>th</sup> week.* Interaction between tropical watercourses and the oceans.

*8<sup>th</sup> week.* The littoral region of the tropical seas.

*9<sup>th</sup> week.* The wildlife of the Pantanal.

*10<sup>th</sup> week.* The ecological features of Pantanal.

*11<sup>th</sup> week.* Harmonization of nature conservation, recreation and economic interests on tropics.

*12<sup>th</sup> week.* Water system of the Amazonas River.

*13<sup>th</sup> week.* The wildlife of the Amazonas.

*14<sup>th</sup> week.* Amazonas as a natural value and as an economic potential.

### **Requirements:**

#### Lecture:

The minimum requirement for the examination is 50% from the midterm and closing tests. Based on the summarized score of the test the grade for the examination is given according to the following table:

Score	Grade
0-49%	fail (1)
50-59%	pass (2)
60-72%	satisfactory (3)
73-84%	good (4)
85-100%	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

**Person responsible for course:** Dr. habil. Alex Sándor Nagy, Senior Research Fellow, PhD

**Lecturer:** Dr. habil. Alex Sándor Nagy, Senior Research Fellow, PhD

<b>Title of course:</b> Tropical Ecology <b>Code:</b> TTHMG9406_EN	<b>ECTS Credit points: 2</b>
<b>Type of teaching, contact hours</b> - lecture: - - practice: 1 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: 14 hours - laboratory: - - home assignment: 16 hours - preparation for the exam: - Total: 30 hours	
<b>Year, semester:</b> Facultative from 2 <sup>nd</sup> to 4 <sup>th</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> <p>This course will provide students with a general overview of tropical ecology. Students will gain insight about basic ecological concepts and be able to explore a variety of ecosystems, their animals and the multiple and complex ecological interactions that can be found in these areas. Brazil is a tropical country with an immensely rich biodiversity and for this reason a very representative area to these studies. Emphasis will be given to the study of the ecosystems found in Brazil, but others will be discussed as well. The course objectives is: become acquainted with the concepts and issues addressed to tropical ecology; learn the characteristics of the major tropical ecosystems on earth; observe different ecosystems and seek examples of important interactions. Students become familiar with the biodiversity of the tropics; understand the importance of the balance and the harmony among different types of tropical ecosystems; understand the natural and human made impacts on natural ecosystems in tropical area; comprehend the importance of conservation and management of natural systems.</p>	
<b>Literature</b> <ol style="list-style-type: none"> <li>1. Michael, G., Mirian, L. C., Efrem, G. F. (1998): Rio Negro, rich life in poor water – SPB Academic Publishing bv, Hague, Netherland,</li> <li>2. Wilhelm, F. (1987): Hydrogeographie, Braunschweig,</li> <li>3. John Kricher (2011): Tropical Ecology. Princeton University Press,</li> <li>4. Montagnini, F., Carl F. J. (2005): Tropical Forest Ecology (The Basis for Conservation and Management)</li> </ol>	
<b>Schedule:</b> <b>Lectures:</b> <i>1<sup>st</sup> week.</i> Modelling an example tropical territory based on data series. <i>2<sup>nd</sup> week.</i> All of the students' needs to demonstrate a freely chosen tropical watercourse. <i>3<sup>rd</sup> week.</i> Comparing the different types of trophy, focusing on the oligotrophy.	



*4<sup>th</sup> week.* Group discussion about the advantages and disadvantages of water-load and pollution.

*5<sup>th</sup> week.* Modelling the effects of water courses in the savannah belt using data series.

*6<sup>th</sup> week.* Comparing the tropical standing water bodies to temperate water bodies.

*7<sup>th</sup> week.* The students' needs to find different interaction between water courses and the ocean around the Earth (just in tropical region).

*8<sup>th</sup> week.* Mapping the needs of those non-living and living creatures that have a connection to the littoral region of the tropical seas.

*9<sup>th</sup> week.* Grouping the wildlife of the Pantanal, based on literature.

*10<sup>th</sup> week.* Unravel the secrets behind the ecological functions of the Pantanal.

*11<sup>th</sup> week.* Based on literature, every student has to make a presentation about the different usage of the tropical region.

*12<sup>th</sup> week.* Making a model about the main tributaries of the Amazonas River, and connecting it to different hypothesis about the possible water polluting sources.

*13<sup>th</sup> week.* Indicating all the major flora and fauna of the Amazonas River (from microscopic to giant) based on literature and own knowledge.

*14<sup>th</sup> week.* Group discussion about whether the main function of the Amazonas River is nature conservation (living, space of living, etc.) or the economy (power plants, fishing, etc.).

### **Requirements:**

#### Practice:

Participation at classes is compulsory. A student must attend the courses and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

During the semester there is one practical test. It can be completed in the 14<sup>th</sup> week.

The minimum score is 50%. Based on the score of the test, the grade for the test is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-72	satisfactory (3)
73-84	good (4)
85-100	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

**Person responsible for course:** Dr. habil. Alex Sándor Nagy, Senior Research Fellow, PhD

**Lecturer:** Dr. habil. Alex Sándor Nagy, Senior Research Fellow, PhD

<b>Title of course:</b> Fundamentals of Geoinformation Systems for Water Management <b>Code:</b> TTHME9203_EN	<b>ECTS Credit points: 3</b>
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: - - laboratory: - - home assignment: 28 hours - preparation for the exam: 64 hours Total: 120 hours	
<b>Year, semester:</b> Facultative from 2 <sup>nd</sup> to 4 <sup>th</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> Definition, function, types and content of the information systems. Geotagged information. Geoinformatics and spatial information systems. Elements of geoinformation systems. Vector and raster data models. Development of geospatial systems (cadastres, military, topography and thematic maps). Dimensions and specifications of geospatial systems; application possibilities, levels and system planning. Steps of geospatial model building. Model requirements and characteristics. Theoretical models, entities, connection types. Logical models, object characteristics, thematic and geometrical dimensions. Geometric basic shapes, scale- and resolution-dependency. Vector, raster and hybrid systems. Vector-raster and raster-vector transformation. Topological models, geometric connections of objects. Point, line and polygon topology. Data types, attributes, metadata, sampling. Geometric and attribute data collection and extraction. Theory of visual interpretation of remotely sensed data. Raster data processing techniques.	
<b>Literature</b> 1. Huisman, O., de By, R.A. 2009. Principles of Geographic Information Systems. ITC Educational Textbook Series, No. 1., <a href="https://webapps.itc.utwente.nl/librarywww/papers_2009/general/PrinciplesGIS.pdf">https://webapps.itc.utwente.nl/librarywww/papers_2009/general/PrinciplesGIS.pdf</a> 2. de Smith, M.J., Goodchild, M.F., Longley, P.A. 2018. Geospatial Analysis. 6 <sup>th</sup> Edition online: <a href="http://www.spatialanalysisonline.com/HTML/index.html">http://www.spatialanalysisonline.com/HTML/index.html</a> 3. Graser, A. 2016. Learning QGIS, PACKT Publishing, ISBN-13: 978-1785880339	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> Definition, function, types and content of the information systems. Geotagged information. Geoinformatics and spatial information systems.	

*2<sup>nd</sup> week.* Elements of geoinformation systems. Vector and raster data models.

*3<sup>rd</sup> week.* Development of geospatial systems (cadasters, military, topography and thematic maps).

*4<sup>th</sup> week.* Dimensions and specifications of geospatial systems; application possibilities, levels and system planning.

*5<sup>th</sup> week.* Steps of geospatial model building. Model requirements and characteristics. Theoretical models, entities, connection types.

*6<sup>th</sup> week.* Logical models, object characteristics, thematic and geometrical dimensions. Geometric basic shapes, scale- and resolution-dependency.

*7<sup>th</sup> week.* Midterm exam (test).

*8<sup>th</sup> week.* Vector, raster and hybrid systems. Vector-raster and raster-vector transformation.

*9<sup>th</sup> week.* Topological models, geometric connections of objects. Point, line and polygon topology.

*10<sup>th</sup> week.* Data types, attributes, metadata, sampling.

*11<sup>th</sup> week.* Geometric and attribute data collection and extraction.

*12<sup>th</sup> week.* Theory of visual interpretation of remotely sensed data.

*13<sup>th</sup> week.* Raster data processing techniques.

*14<sup>th</sup> week.* Obligatory test, semester closing.

#### **Requirements:**

The minimum requirement for the examination is 50% from the midterm and closing tests. Based on the summarized score of the test the grade for the examination is given according to the following table:

Score	Grade
0-49%	fail (1)
50-59%	pass (2)
60-72%	satisfactory (3)
73-84%	good (4)
85-100%	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

**Person responsible for course:** Prof. Dr. habil. Szilárd Szabó, university professor, DSc

**Lecturer:** Prof. Dr. habil. Szilárd Szabó, university professor, DSc ;  
Dr. László Bertalan, assistant professor, PhD

<b>Title of course:</b> Fundamentals of Geoinformation Systems for Water Management <b>Code:</b> TTHMG9203_EN	<b>ECTS Credit points: 2</b>
<b>Type of teaching, contact hours</b> - lecture: - - practice: - - laboratory: 1 hours/week	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: - - laboratory: 14 hours - home assignment: 16 hours - preparation for the exam: - Total: 30 hours	
<b>Year, semester:</b> Facultative from 2 <sup>nd</sup> to 4 <sup>th</sup> semester	
<b>Its prerequisite(s):</b> -	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
The course aims to provide detailed information about the basics of geoinformatics (GIS). Data models (vector and raster) are the first steps to learn and the students learn a GIS software. The main focus is on the capability of field data collection, i.e. to understand the background of positioning systems such as GPS devices, total stations and their accuracy. Aerial photos, orthophotographs and satellite images are also important topics of this course especially from the aspect of water detection, mapping and analysis.	
<b>Literature</b>	
1. QGIS Training Manual - <a href="https://docs.qgis.org/2.8/en/docs/training_manual/">https://docs.qgis.org/2.8/en/docs/training_manual/</a> 2. Sutton, T., Dassau, O., Sutton, M. 2009. A gentle introduction in GIS, <a href="https://docs.qgis.org/2.8/en/docs/gentle_gis_introduction/index.html">https://docs.qgis.org/2.8/en/docs/gentle_gis_introduction/index.html</a> 3. Graser, A. 2016. Learning QGIS, PACKT Publishing, ISBN-13: 978-1785880339	
<b>Schedule:</b> <i>1<sup>st</sup> week.</i> Introduction to GIS and the QGIS software environment. <i>2<sup>nd</sup> week.</i> Maps and projections - practice <i>3<sup>rd</sup> week.</i> Basic operations, layer management, table management. <i>4<sup>th</sup> week.</i> Creation of point objects. <i>5<sup>th</sup> week.</i> Creation of line objects. <i>6<sup>th</sup> week.</i> Creation of polygon objects. <i>7<sup>th</sup> week.</i> Thematic maps. <i>8<sup>th</sup> week.</i> Summary, practice. <i>9<sup>th</sup> week.</i> Query by attribute data.	

*10<sup>th</sup> week.* Basics of raster data, aerial and satellite images.

*11<sup>th</sup> week.* Visual interpretation of remotely sensed data

*12<sup>th</sup> week.* Hybrid data visualization and analysis.

*13<sup>th</sup> week.* Test. Offered grading.

*14<sup>th</sup> week.* Obligatory test, semester closing.

### **Requirements:**

Participation at classes is compulsory. A student must attend the courses and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

During the semester there is one practical test. It can be completed in the 13<sup>th</sup> or 14<sup>th</sup> week.

The minimum score is 50%. Based on the score of the test, the grade for the test is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-72	satisfactory (3)
73-84	good (4)
85-100	excellent (5)

-an offered grade:

it may be offered for students if the test written in the 13<sup>th</sup> week is at least satisfactory (3).

- in case an offered grade cannot be given, or it is not convenient for the student there is a possibility to repeat in the last week

**Person responsible for course:** Prof. Dr. Szilard Szabó, university professor, DSc

**Lecturer:** Prof. Dr. Szilárd Szabó, university professor, DSc ;  
Dr. László Bertalan, assistant professor, PhD

<b>Title of course:</b> Aquatic invasions <b>Code:</b> TTHME9424_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> - lecture: 2 hours/week - practice: – - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 28 hours - practice: – - laboratory: - - home assignment: 20 hours - preparation for the exam: 10 hours Total: 48 hours	
<b>Year, semester:</b> 1 <sup>st</sup> and 2 <sup>nd</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> –	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> This is a comprehensive subject about aquatic invasions: Terms of aquatic invasions, alien species, invasive species. Invasive routes and vectors. Spontaneous and semi-spontaneous spreading, introducing of alien invasive species. Success of the invasion. Spreading ecology of invasive species. Ecological effects, risk assessment and management of invasions. Analysis of invasion success, and the role of natural enemies. Resistance of native communities against biological invasions. Protection and prevention against invasive species. Most common invasive species in Europe and in Hungary. Case studies.	
<b>Literature</b> <i>Compulsory:</i> 1. Nentwig, W., 2008. Biological Invasions. Springer-Verlag Berlin and Heidelberg GmbH & Co. KG. <i>Recommended:</i> 1. Lockwood, J.L. 2013. Invasion Ecology. John Wiley and Sons Ltd. 2. Cowx, I.G., 2002. Management and Ecology of Lake and Reservoir Fisheries. Wiley-Blackwell, ISBN: 978-0852382837 3. Leppäkoski, E., Gollasch, S., Olenin, S., (Eds.), 2010. Invasive Aquatic Species of Europe. Distribution, Impacts and Management. Springer, ISBN: 978-9048161119.	
<b>Course objective/intended learning outcomes</b> <b>a) Knowledge</b> - He/she fundamentally knows risks and ecological features of biological invasions of freshwater habitats. - He/she expansively knows the main properties of aquatic invasions. <b>b) Abilities</b> - He/she is able to plan for protection and prevention of ecological effects of invasive species. <b>c) Attitude</b> - He/she is open to learn and accept professional improvement and innovation in his/her	

profession.

- He/she makes a decision in complex and unexpected decision cases by completely taking into account legal and ethical norms.

**d) Autonomy and responsibility**

- Even in unexpected decision-making situations he/she is capable of considering complex, fundamental questions from his/her professional field.

He/she is open to critical remarks which are professionally well-founded.

**Schedule:**

*1<sup>st</sup> week.* Introduction to invasion ecology.

*2<sup>nd</sup> week.* Transport vectors and pathways.

*3<sup>rd</sup> week.* Trend in numbers of invaders.

*4<sup>th</sup> week.* Propagules.

*5<sup>th</sup> week.* Disturbance.

*6<sup>th</sup> week.* Establishment success: the influence of biotic interactions.

*7<sup>th</sup> week.* Modeling the geographical spread of invasive species.

*8<sup>th</sup> week.* Ecological processes and the spread of non-native species.

*9<sup>th</sup> week.* Ecological impacts of invasive species.

*10<sup>th</sup> week.* Impact synthesis.

*11<sup>th</sup> week.* Evolution of invaders.

*12<sup>th</sup> week.* Predicting and Preventing Invasion.

*13<sup>th</sup> week.* eradication and Control of Invaders.

*14<sup>th</sup> week.* Global Climate Change and Invasive Species.

**Requirements:**

- *for a signature*

Attendance at **lectures** is recommended, but not compulsory.

- *for a grade*

- The course ends in an **examination**.

The course ends in an examination. The minimum requirement for the test and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

**Person responsible for course:** Dr. Krisztián Nyeste, assistant professor, PhD

**Lecturer:** Dr. Krisztián Nyeste, assistant professor, PhD

<b>Title of course:</b> Aquatic invasions <b>Code:</b> TTHMG9424_EN	<b>ECTS Credit points:</b> 2
<b>Type of teaching, contact hours</b> - lecture: – - practice: 1 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - practice: 14 hours - laboratory: - - home assignment: 16 hours - preparation for the exam: - hours Total: 30 hours	
<b>Year, semester:</b> 1 <sup>st</sup> and 2 <sup>nd</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> –	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> During the practice the subjects of the main lectures are presented in case studies: Terms of aquatic invasions, alien species, invasive species. Invasive routes and vectors. Spontaneous and semi-spontaneous spreading, introducing of alien invasive species. Success of the invasion. Spreading ecology of invasive species. Ecological effects, risk assessment and management of invasions. Analysis of invasion success, and the role of natural enemies. Resistance of native communities against biological invasions. Protection and prevention against invasive species. Most common invasive species in Europe and in Hungary.	
<b>Literature</b> <i>Compulsory:</i> 1. Nentwig, W., 2008. Biological Invasions. Springer-Verlag Berlin and Heidelberg GmbH & Co. KG. <i>Recommended:</i> 1. Lockwood, J.L. 2013. Invasion Ecology. John Wiley and Sons Ltd. 2. Cowx, I.G., 2002. Management and Ecology of Lake and Reservoir Fisheries. Wiley-Blackwell, ISBN: 978-0852382837 3. Leppäkoski, E., Gollasch, S., Olenin, S., (Eds.), 2010. Invasive Aquatic Species of Europe. Distribution, Impacts and Management. Springer, ISBN: 978-9048161119.	
<b>Course objective/intended learning outcomes</b> <b>a) Knowledge</b> - He/she fundamentally knows risks and ecological features of biological invasions of freshwater habitats. - He/she expansively knows the main properties of aquatic invasions. <b>b) Abilities</b> - He/she is able to plan for protection and prevention of ecological effects of invasive species. <b>d) Attitude</b> - He/she is open to learn and accept professional improvement and innovation in his/her	



profession.

- He/she makes a decision in complex and unexpected decision cases by completely taking into account legal and ethical norms.

**d) Autonomy and responsibility**

- Even in unexpected decision-making situations he/she is capable of considering complex, fundamental questions from his/her professional field.

He/she is open to critical remarks which are professionally well-founded.

**Schedule:**

*1<sup>st</sup> week.* Introduction to invasion ecology – practice, case studies

*2<sup>nd</sup> week.* Transport vectors and pathways – practice, case studies.

*3<sup>rd</sup> week.* Trend in numbers of invaders – practice, case studies.

*4<sup>th</sup> week.* Propagules – practice, case studies.

*5<sup>th</sup> week.* Disturbance – practice, case studies.

*6<sup>th</sup> week.* Establishment success: the influence of biotic interactions – practice, case studies.

*7<sup>th</sup> week.* Modeling the geographical spread of invasive species – practice, case studies.

*8<sup>th</sup> week.* Ecological processes and the spread of non-native species – practice, case studies.

*9<sup>th</sup> week.* Ecological impacts of invasive species – practice, case studies.

*10<sup>th</sup> week.* Impact synthesis – practice, case studies.

*11<sup>th</sup> week.* Evolution of invaders – practice, case studies.

*12<sup>th</sup> week.* Predicting and Preventing Invasion – practice, case studies.

*13<sup>th</sup> week.* eradication and Control of Invaders – practice, case studies.

*14<sup>th</sup> week.* Global Climate Change and Invasive Species – practice, case studies.

**Requirements:**

Practice:

Participation at classes is compulsory. A student must attend the courses and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

During the semester there is one practical test. It can be completed in the 14<sup>th</sup> week.

The minimum score is 50%. Based on the score of the test, the grade for the test is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-72	satisfactory (3)
73-84	good (4)
85-100	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

**Person responsible for course:** Dr. Krisztián Nyeste, assistant professor, PhD

**Lecturer:** Dr. Krisztián Nyeste, assistant professor, PhD

<b>Title of course:</b> Water pollution <b>Code:</b> TTHME9425_EN	<b>ECTS Credit points:</b> 3
<b>Type of teaching, contact hours</b> <ul style="list-style-type: none"> <li>- lecture: 2 hours/week</li> <li>- practice: –</li> <li>- laboratory: -</li> </ul>	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> <ul style="list-style-type: none"> <li>- lecture: 28 hours</li> <li>- practice: –</li> <li>- laboratory: -</li> <li>- home assignment: 20 hours</li> <li>- preparation for the exam: 10 hours</li> </ul> Total: 48 hours	
<b>Year, semester:</b> 1 <sup>st</sup> and 2 <sup>nd</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> –	
<b>Further courses built on it:</b> -	
<b>Topics of course</b> This is a comprehensive subject about water pollution: Main terms of aquatic pollution. Pollution, contamination. Main types of pollution and contamination of ground water and surface water. Main sources of pollutions. Effects of pollutions on the aquatic assemblages. Bioaccumulation and biomagnification. Bioindication, using of bioindicator species for investigation and risk assessment. Endangered status, vulnerability of aquatic organisms, biomonitoring. Tools of the water quality management and protection. Hungarian and international case studies.	
<b>Literature</b> 1. Nentwig, W., 2008. Biological Invasions. Springer-Verlag Berlin and Heidelberg GmbH & Co. KG. <i>Recommended:</i> <ol style="list-style-type: none"> <li>1. Lockwood, J.L. 2013. Invasion Ecology. John Wiley and Sons Ltd.</li> <li>2. Cowx, I.G., 2002. Management and Ecology of Lake and Reservoir Fisheries. Wiley-Blackwell, ISBN: 978-0852382837</li> <li>3. Leppäkoski, E., Gollasch, S., Olenin, S., (Eds.), 2010. Invasive Aquatic Species of Europe. Distribution, Impacts and Management. Springer, ISBN: 978-9048161119.</li> </ol>	
<b>Course objective/intended learning outcomes</b> <b>a) Knowledge</b> <ul style="list-style-type: none"> <li>- He/she fundamentally knows the main properties of water pollution.</li> <li>- He/she expansively knows the impacts and prevention of water pollution.</li> </ul> <b>b) Abilities</b> <ul style="list-style-type: none"> <li>- He/she is able to plan for investigation, protection, and prevention of water pollution.</li> </ul> <b>c) Attitude</b> <ul style="list-style-type: none"> <li>- He/she is open to learn and accept professional improvement and innovation in his/her profession.</li> <li>- He/she makes a decision in complex and unexpected decision cases by completely taking into account legal and ethical norms.</li> </ul> <b>d) Autonomy and responsibility</b>	

- Even in unexpected decision-making situations he/she can consider complex, fundamental questions from his/her professional field.

He/she is open to critical remarks which are professionally well-founded.

**Schedule:**

*1<sup>st</sup> week.* Definitions and classification of environmental pollution.

*2<sup>nd</sup> week.* Sources and transport of pollutants.

*3<sup>rd</sup> week.* Fresh and marine water pollutants.

*4<sup>th</sup> week.* Consequences of sewage pollution: treatment, disposal and impacts.

*5<sup>th</sup> week.* Nutrients and eutrophication.

*6<sup>th</sup> week.* Oil pollution in the marine environment.

*7<sup>th</sup> week.* Biological pollutants.

*8<sup>th</sup> week.* Plastics as pollutants.

*9<sup>th</sup> week.* Metals as pollutants.

*10<sup>th</sup> week.* Monitoring of aquatic contaminations.

*11<sup>th</sup> week.* Bioindicator species.

*12<sup>th</sup> week.* Case studies I.

*13<sup>th</sup> week.* Case studies II.

*14<sup>th</sup> week.* Summary and conclusions, revision and feedback.

**Requirements:**

*- for a signature*

Attendance at **lectures** is recommended, but not compulsory.

*- for a grade*

The course ends in an **examination**.

The course ends in an examination. The minimum requirement for the test and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

**Person responsible for course:** Dr. Krisztián Nyeste, assistant professor, PhD

**Lecturer:** Dr. Krisztián Nyeste, assistant professor, PhD

<b>Title of course:</b> Water pollution <b>Code:</b> TTHMG9425_EN	<b>ECTS Credit points:</b> 2
<b>Type of teaching, contact hours</b> - lecture: – - practice: 1 hours/week - laboratory: -	
<b>Evaluation:</b> mid-semester grade	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - practice: 14 hours - laboratory: - - home assignment: 16 hours - preparation for the exam: - hours Total: 30 hours	
<b>Year, semester:</b> 1 <sup>st</sup> and 2 <sup>nd</sup> year, 1 <sup>st</sup> semester	
<b>Its prerequisite(s):</b> –	
<b>Further courses built on it:</b> -	
<b>Topics of course</b>	
During the practice the subjects of the main lectures are presented in case studies: Pollution, contamination. Main types of pollution and contamination of ground water and surface water. Main sources of pollutions. Effects of pollutions on the aquatic assemblages. Bioaccumulation and biomagnification. Bioindication, using of bioindicator species for investigation and risk assessment. Endangered status, vulnerability of aquatic organisms, biomonitoring. Tools of the water quality management and protection. Hungarian and international case studies.	
<b>Literature</b>	
1. Nentwig, W., 2008. Biological Invasions. Springer-Verlag Berlin and Heidelberg GmbH & Co. KG. <i>Recommended:</i> 1. Lockwood, J.L. 2013. Invasion Ecology. John Wiley and Sons Ltd. 2. Cowx, I.G., 2002. Management and Ecology of Lake and Reservoir Fisheries. Wiley-Blackwell, ISBN: 978-0852382837 3. Leppäkoski, E., Gollasch, S., Olenin, S., (Eds.), 2010. Invasive Aquatic Species of Europe. Distribution, Impacts and Management. Springer, ISBN: 978-9048161119.	
<b>Course objective/intended learning outcomes</b>	
<b>a) Knowledge</b>	
- He/she fundamentally knows the main properties of water pollution. - He/she expansively knows the impacts and prevention of water pollution.	
<b>b) Abilities</b>	
- He/she is able to plan for investigation, protection, and prevention of water pollution.	
<b>d) Attitude</b>	
- He/she is open to learn and accept professional improvement and innovation in his/her profession. - He/she makes a decision in complex and unexpected decision cases by completely taking into account legal and ethical norms.	
<b>d) Autonomy and responsibility</b>	

- Even in unexpected decision-making situations he/she can consider complex, fundamental questions from his/her professional field.

He/she is open to critical remarks which are professionally well-founded.

**Schedule:**

*1<sup>st</sup> week.* Definitions and classification of environmental pollution. – Practice, case studies

*2<sup>nd</sup> week.* Sources and transport of pollutants. – Practice, case studies

*3<sup>rd</sup> week.* Fresh and marine water pollutants. – Practice, case studies

*4<sup>th</sup> week.* Consequences of sewage pollution: treatment, disposal and impacts. – Practice, case studies

*5<sup>th</sup> week.* Nutrients and eutrophication. – Practice, case studies

*6<sup>th</sup> week.* Oil pollution in the marine environment. – Practice, case studies

*7<sup>th</sup> week.* Biological pollutants. – Practice, case studies

*8<sup>th</sup> week.* Plastics as pollutants. – Practice, case studies

*9<sup>th</sup> week.* Metals as pollutants. – Practice, case studies

*10<sup>th</sup> week.* Monitoring of aquatic contaminations. – Practice, case studies

*11<sup>th</sup> week.* Bioindicator species. – Practice, case studies

*12<sup>th</sup> week.* Case studies I.

*13<sup>th</sup> week.* Case studies II.

*14<sup>th</sup> week.* Summary and conclusions, revision and feedback.

**Requirements:**

Practice:

Participation at classes is compulsory. A student must attend the courses and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

During the semester there is one practical test. It can be completed in the 14<sup>th</sup> week.

The minimum score is 50%. Based on the score of the test, the grade for the test is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-72	satisfactory (3)
73-84	good (4)
85-100	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

**Person responsible for course:** Dr. Krisztián Nyeste, assistant professor, PhD

**Lecturer:** Dr. Krisztián Nyeste, assistant professor, PhD

<b>Title of course:</b> Biostatistics <b>Code:</b> TTBML0300_EN	<b>ECTS Credit points: 3</b>
<b>Type of teaching, contact hours</b> - lecture: 0 hours/week - practice: 0 hours/week - laboratory: 3 hours/week	
<b>Evaluation: written exam</b>	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 0 hours - practice: 0 hours - laboratory: 42 hours - home assignment: 0 hours - preparation for the exam: 40 hours Total: 82 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b>	
<b>Further courses built on it:</b>	
<b>Topics of course</b> Introduction to the R Statistical Environment. Data handling. Descriptive statistics. Statistical hypotheses. Statistical tests on group means. Non-parametric statistics. Statistical tests for variances and distributions. Analysis of variance. Testing the relationships between continuous variables. Linear regression and correlation. Analysis of covariance. Multivariate statistical models. Model selection. Checking model assumptions. Generalized Linear Models. Linear Mixed models. Principal Components Analysis.	
<b>Literature</b> Sokal RR. & Rohlf FJ. 1981. Biometry. W.H. Freeman, New York.	
<b>Course objective/intended learning outcomes</b> <b>a) knowledge</b> <ul style="list-style-type: none"> <li>knows the fundamental statistical principles, statistical tests, multivariate statistical methods, and their usage</li> </ul> <b>b) abilities</b> <ul style="list-style-type: none"> <li>able to plan data collection of simple biological experiments</li> <li>able to prepare his/her data for data analysis</li> <li>able to perform simple statistical tests</li> <li>able to interpret the results of statistical tests</li> </ul> <b>c) attitude</b> <ul style="list-style-type: none"> <li>committed to reliable and precise work</li> <li>strives to improve his/her problem-solving ability</li> <li>open to learn more about other scientific fields</li> </ul> <b>d) autonomy and responsibility</b>	

- has the necessary self-determination to perform data analysis of simple experiments alone

### **Schedule:**

*1<sup>st</sup> week*

Introduction to the R Statistical Environment.

*2<sup>nd</sup> week*

Data handling.

*3<sup>rd</sup> week*

Descriptive statistics.

*4<sup>th</sup> week*

Statistical hypotheses. Statistical tests on group means.

*5<sup>th</sup> week*

Non-parametric statistics. Statistical tests for variances and distributions.

*6<sup>th</sup> week*

Analysis of variance.

*7<sup>th</sup> week*

Testing the relationships between continuous variables. Linear regression and correlation.

*8<sup>th</sup> week*

Analysis of covariance.

*9<sup>th</sup> week*

Multivariate statistical models.

*10<sup>th</sup> week*

Model selection.

*11<sup>th</sup> week*

Checking model assumptions.

*12<sup>th</sup> week*

Generalized Linear Models.

*13<sup>th</sup> week*

Linear Mixed models.

*14<sup>th</sup> week*

Principal Components Analysis.

### **Requirements:**

Participation at the classes is compulsory. A student may not miss more than three lectures during the semester. In case a student does so, the subject will not be signed and the student must repeat the course.

The minimum requirement for the exam 60%. Grades are given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
<b>90-100</b>	<b>excellent (5)</b>

<b>Person responsible for course: Mr. Dr. Jácint Tökölyi, associate professor, PhD</b>
<b>Lecturer: Mr. Dr. Jácint Tökölyi, associate professor, PhD</b>



<b>Title of course:</b> Sampling, Sample treatment and Analytical tests <b>Code:</b> TTKBE0514_EN	<b>ECTS Credit points:</b> 1
<b>Type of teaching, contact hours</b> - lecture: 1 hours/week - practice: - - laboratory: -	
<b>Evaluation:</b> exam	
<b>Workload (estimated), divided into contact hours:</b> - lecture: 14 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 16 hours Total: 30 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b>	
<b>Further courses built on it:</b>	
<b>Topics of course</b> <p>The aim of the course is to introduce the sampling methods generally applied in environmental chemistry. The most important techniques for sampling soil, sediment, surface and underground water, gases, biotic and abiotic biological indicators, biological tissues and fluids, rocks and metal alloys will be discussed. All the relevant and most important pre-treatment techniques will be overviewed which are necessary to get rid of the matrix components prior to the quantitative and qualitative determination of organic and inorganic analytes (such as extraction and dilution techniques, atmospheric and microwave digestion, acidic and basic reactions under high pressure etc.). Sampling and sample pre-treatment methods will be discussed which are used for speciation analysis, for organometallic compounds and biomolecules.</p>	
<b>Literature</b> <p><i>Compulsory:</i>          -Fundamentals of environmental sampling and analysis by Chunlong Zhang (ISBN: 978-0-471-71097-4)  <i>Recommended:</i>          - N.T. Crosby, I. Patel: General principles of good sampling practice, RSC,1995          - S. Mitra: Sample Preparation Techniques in Analytical Chemistry, Wiley, 2003.          - Sampling for Environmental Data Generation; P. Grieco and R. Trattner, SciTech Publishers, Matawan, NJ 1990.          -<a href="https://web.njit.edu/~kebbekus/analysis/SAMPLING.htm">https://web.njit.edu/~kebbekus/analysis/SAMPLING.htm</a></p>	
<b>Schedule:</b> The lecture will be held in the first half of the semester, 2 hours/week <i>1<sup>st</sup> week</i> The grouping of environmental samples, sample types. The thematic classification of the most commonly measured components from environmental samples. The basic rules of sampling and the general description of sampling techniques. <i>2<sup>nd</sup> week</i>	

General statistical aspects of sampling. Liquid sampling: surface and underground water, rivers and streams. Solid sampling of metals, alloys and rocks. General guidelines, homogenization methods.

*3<sup>rd</sup> week*

Sampling from gases at atmospheric and high pressure. Direct sampling of solid materials from gaseous substances: aerosols and particulate matter (PM 10, PM 2.5). Adsorption and absorption techniques to selectively gain compounds from gaseous state, gas filtration. Sampling of soil, sediment and biological tissues.

*4<sup>th</sup> week*

Introduction to basic sample pre-treatment methods: homogenisation and drying of solid substances, circumstances affecting the solubility of the analyte. Storage, preservation and dissolving methods. Extraction techniques.

*5<sup>th</sup> week*

Reactions to eliminate the matrix and mobilize the compounds to be determined: dry and wet digestion methods, ignition, digestion at atmospheric pressure, microwave assisted sample pre-treatment. Digestion under acidic and basic conditions, most commonly applied reagents and pieces of equipment.

*6<sup>th</sup> week*

General introduction to the sampling and sample pre-treatment carried out for speciation analysis and organometallic substances, as well as biomolecules. Elemental speciation.

*7<sup>th</sup> week*

Sample preparation of biological indicators and biological tissues, fluids. Exact examples of a complex sampling and sample pre-treatment process, discussing the steps of tasks to be carried out. Review and consultation possibility.

**Requirements:**

*- for a signature*

Attendance at **lectures** is recommended, but not compulsory. However, students attending 5 out of the 7 occasions will have the opportunity to write a written test after the last lecture: if it is successful **a grade will be offered** in the electronic system which can be accepted or denied by the student.

*- for a grade*

The course ends in an **examination**. The students will either successfully fulfil the requirements to write the written test for an offered grade or take an oral exam in the examination period.

The minimum requirement for the passing mark in the written test and the examination respectively is 50%. For the written test to gain the offered grade the following table will be applied to calculate the result:

Score	Grade
0-49	fail (1)
50-65	pass (2)
66-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of the written test is below 50, students can take the oral exam in the examination period which is the same for those students not visiting the lectures regularly. The exam is in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

*-for an offered grade*

Please see above highlighted with bold characters.

<b>Person responsible for course:</b> Dr. Edina Baranyai, assistant professor, PhD
<b>Lecturer:</b> Dr. Edina Baranyai, assistant professor, PhD

<b>Title of course:</b> Sampling, Sample treatment and analytical tests <b>Code:</b> TTKBL0514_EN	<b>ECTS Credit points:</b> 4
<b>Type of teaching, contact hours</b> - lecture: - - practice: - - laboratory: 4 hours/week	
<b>Evaluation:</b> mid-semester grade based on laboratory manual and written test	
<b>Workload (estimated), divided into contact hours:</b> - lecture: - - practice: - - laboratory: 56 hours - home assignment: 64 hours - preparation for the exam: - Total: 120 hours	
<b>Year, semester:</b> 1 <sup>st</sup> year, 2 <sup>nd</sup> semester	
<b>Its prerequisite(s):</b>	
<b>Further courses built on it:</b>	
<b>Topics of course</b>	
During the laboratory practice, the complex environmental assessment of a fishing lake will be carried out. Taken plant, water, soil and sediment samples will be analysed with the studied methods for the most important inorganic contaminants: chemical oxygen demand, cations and anions affecting halobity, dissolved oxygen, oxygen saturation, pH, conductivity, elemental composition. Both on site techniques, as well as classical and instrumental methods will be applied.	
<b>Literature</b>	
<i>Compulsory:</i> - Fundamentals of environmental sampling and analysis by Chunlong Zhang (ISBN: 978-0-471-71097-4) - University syllabus of environmental analysis (available at the Department's home page of inorg.unideb.hu) <i>Recommended:</i> - Sampling for Environmental Data Generation; P. Grieco and R. Trattner, SciTech Publishers, Matawan, NJ 1990. - <a href="https://web.njit.edu/~kebbekus/analysis/SAMPLING.htm">https://web.njit.edu/~kebbekus/analysis/SAMPLING.htm</a>	
<b>Schedule:</b> The third occasion will be a whole day (8 hours) of sampling at a fishing lake which therefore equals with two practical occasions (2*4 hours). <i>1<sup>st</sup> week</i> Introduction to the general laboratory safety rules highlighting the safety considerations of on-site field study. Overview of the laboratory and on-site pieces of equipment and instruments. <i>2<sup>nd</sup> week</i> Introduction to the fishing lake to be sampled. The sample types to be taken and the compounds to be measured will be discussed, the analytical methods to be applied for the quantitative analysis will be chosen. Students will build up the sampling plan, make a map, indicate the sampling points and collect all the sampling tools from the laboratory which will be necessary to carry out the sampling and on-site measurements.	

*3<sup>rd</sup> week (2\* 4 hours)*

A full day trip to the fishing lake where the collection of surface water, sediment, soil and plant samples will be carried out. On site measurements of water pH and electric conductivity, temperature, preservation of samples for elemental analysis as well as the titration for dissolved oxygen and chemical oxygen demand will be carried out. Samples will be then taken to the laboratory for further measurements.

*4<sup>th</sup> week*

Determination of cation (macro and micro elements) concentration of the surface water samples by microwave plasma atomic emission spectrometry (MP-AES). Dilution of standard solutions and calibration required for the quantitative measurements.

*5<sup>th</sup> week*

Determination of the anion concentration affecting halobity from surface water samples by classical analytical and instrumental methods: carbonate and hydrogen carbonate ion by acid-base titration, chloride ion by argentometric titration and sulphate ion by spectrophotometric analysis.

*6<sup>th</sup> week*

Grinding and drying of soil samples, homogenization. Determination of the moisture content and organic matter content of soil samples and preparing them for elemental analysis by microwave assisted wet digestion at elevated pressure.

*7<sup>th</sup> week*

The elemental analysis of soil samples by microwave plasma atomic emission spectrometry (MP-AES). Dilution of standard solutions and calibration required for the quantitative measurements.

*8<sup>th</sup> week*

Grinding and drying of plant samples, homogenization. Determination of the moisture content of plant samples and preparing them for elemental analysis by conventional wet digestion at atmospheric pressure.

*9<sup>th</sup> week*

The elemental analysis of plant samples by microwave plasma atomic emission spectrometry (MP-AES). Dilution of standard solutions and calibration required for the quantitative measurements.

*10<sup>th</sup> week*

Cutting, grinding and drying of sediment samples, homogenization. Determination of the moisture content and organic matter content of sediment samples and preparing them for elemental analysis by microwave assisted wet digestion at elevated pressure.

*11<sup>th</sup> week*

The elemental analysis of sediment samples by microwave plasma atomic emission spectrometry (MP-AES). Dilution of standard solutions and calibration required for the quantitative measurements.

*12<sup>th</sup> week*

Evaluation of the gained results – calculating the final concentration results from the primer data of samples.

*13<sup>th</sup> week*

Written test regarding the field and laboratory work of sampling, sample pre-treatment and analysis of important environmental factors. Discussion of statistical analysis for the final evaluation and interpretation of the gained data. Finishing the laboratory manuals to be handled in. Washing up all the sample containers and pieces of equipment.

**Requirements:**

*- for a signature*

Attendance at **both the field study and laboratory practices are obligatory**. Maximum one occasion can be missed but only along with a medical certificate. The written test must be above

20% to get a signature, otherwise the student will receive a signature denied and must take the course again in the next semester.

*- for a grade*

The course ends in a written test. The minimum requirement for the passing mark in the written test is 50%. For calculating the grade of the test the following table will be applied:

Score	Grade
0-49	fail (1)
50-65	pass (2)
66-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of the written test is below 50, students can take one final exam in the examination period, which will be similar to the written test. The exam is in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Students will also handle in an electronic laboratory manual interpreting the overall results of the complex environmental assessment of the fishing lake. Grade will be given to this laboratory manual as well.

Final grade will be formed by taking the average of the results of the written test (or exam) and the laboratory manual.

*-for an offered grade*

no grade will be offered

**Person responsible for course:** Dr. Edina Baranyai, assistant professor, PhD

**Lecturer:** Dr. Edina Baranyai, assistant professor, PhD