Course	Semester	Hours	ECTS
Analysis of Single-Cell Sequencing Data	winter/summer	15	1
Anatomy and Embryology of Plants	summer	20	2
Animal Bioacoustics	summer	30	3
Amphibian Ecology and Conservation	summer	30	3
Avian Biology	summer	35	3
Basic Immunology	winter	30	3
Biochemistry	winter/summer	30	3
Biological Invasions	winter/summer	30	3
Butterfly Ecology and Conservation	summer	30	3
Ecology	winter/summer	45	4
Epidemiology	winter/summer	30	3
Evolutionary Psychology	winter/summer	20	2
Experimental Design and Data Analysis for Biologists	winter/summer	30	3
Forensic Biology	winter	30	3
Functional Physiology	winter/summer	30	3
Genetics (Basic)	winter/summer	30	3
Genetics (Advanced)	winter/summer	30	3
Genome analysis methods	winter/summer	15	1
Harmful and Useful Algae and Cyanobacteria	summer	20	2
Hydrobiology	winter/summer	45	4
Introduction to Bioinformatics	winter/summer	15	1
Introduction to Epigenetics	winter/summer	15	1
Introduction to Geographic Information Systems	winter/summer	15	1
Inventory Methods for Ungulates	summer	15	1
Microbiology	summer	45	4
Mimicry, Aposematism, and Other Animal Survival Strategies	summer	30	3
Mechanisms of Evolution	winter/summer	30	3
Molecular Phylogenetics	summer	15	1
Molecular Diagnostics	summer	15	1
Molecular Techniques in Biology	winter/summer	30	3
Natura 2000 Network	summer	10	1
Natural Environment of North East Poland	winter/summer	10	1
Novel Technologies in Wildlife Studies	summer	30	3
Palynology	summer	10	1
Physiological Ecology	winter/summer	30	3
Plant Ageing	winter/summer	10	1
Plant Biology and Ecology	summer	45	4
Plant Physiology	winter/summer	45	4
Plant In Vitro Culture	winter/summer	15	1
Plant-Pathogen Interactions	winter/summer	25	2
Population and Conservation Genetics	winter/summer	30	3
Social Insects	winter/summer	15	1
Soils and Landscape	winter/summer	10	1
Toxicology	winter/summer	30	3
Trends and Methods in Immunobiology	summer	30	3

Water Protection and Restoration	winter	40	4
Research Project	winter/summer	60	10

Course: **Analysis of Single-Cell Sequencing Data**

Course Coordinator: Tomasz Włodarczyk, PhD
Email: t.wlodar@uwb.edu.pl

Language: **English**

Semester: **winter/summer**	Number of hours (total): **15**
ECTS: **1**	*Laboratory: **15**

Substantive content:

Single-cell sequencing technology allows for getting insight into the processes of cell development and differentiation with a resolution that is unattainable using bulk data. In brief, this method consists of disassembling tissue or organs into cells and encapsulating them separately within fluid droplets. Based on the barcode DNA fragments from each droplet, products of the subsequent sequencing can be assigned to individual cells. The technology is widely used in the studies of immune response, carcinogenesis, and organism development. However, dealing with single-cell data raises new problems that should be addressed during data analysis. These are:

Data sparsity (high frequency of dropouts, that is zero data matrix entries which result from some of the mRNA or DNA molecules not being captured during library preparation)

Large datasets (the data is stored in the matrices whose size is the number of cells x number of studied genes)

High data dimensionality (we try to investigate the differences in the expression of many genes simultaneously)

Multimodality (we want to integrate datasets representing different modalities, for example, gene expression and chromatin accessibility – ATACseq).

During the course, students will be guided in performing the analysis using the output from single-cell technology. The analysis includes:

Cell annotation (identification of cell types)

Identification of highly variable genes

Data cleaning and quality control

Data clustering and visualization

This project will be done using the Bioconductor ecosystem, which is being developed under the R environment. Thus, students will be introduced to the basics of using R (if necessary).

Literature:

Amezquita, R.A., Lun, A.T.L., Becht, E. *et al.* Orchestrating single-cell analysis with Bioconductor. *Nat Methods* 17, 137–145 (2020). https://doi.org/10.1038/s41592-019-0654-x

Forms and conditions of credit:

- attendance
- tasks completion

Course: **Anatomy and Embryology of Plants**

Course Coordinator: dr hab. Danuta Drzymulska, prof. UwB
Email: drzym@uwb.edu.pl

Language: English

Semester: **summer**	Number of hours (total): **20**
ECTS: **2**	*Lecture: **5** *Laboratory: **15**

Substantive content:

1. Plant cell characteristics with particular emphasis on typical plant elements such as cell walls, plastids, reserve substances, and calcium oxalate crystals.
2. Anatomical structure of plants: plant tissues (meristems, dermal tissues: epidermis and peridermis, vascular tissues: xylem, phloem and support tissues: parenchyma, chlorenchyma, aerenchyma, collenchyma, sclerenchyma).
3. Anatomical structure of plants: organ system (root, stem, and leaf); organs of primary plant body, organs of secondary growth; modifications of organs).
4. Reproductive structures, male and female gametophytes, and embryogenesis of seed plants: flower, stamens, pistils, ovules, microsporogenesis, megasporogenesis, pollen grains, pollination, fertilization, embryos, endosperm, types of seeds and fruits.

Literature:

1. Barclay G. 2002. Anatomy and morphology of seed plants. https://www.researchgate.net/publication/239937711_Plant_Anatomy
2. Plant anatomy and embryology, Vol. 2, Block 3. 2020. Flower to fertilization. https://egyankosh.ac.in/bitstream/123456789/69530/1/Block-3.pdf
3. Plant anatomy and embryology, Vol. 2, Block 4. 2020. Endosperm and embryo. https://egyankosh.ac.in/bitstream/123456789/69535/1/Block-4.pdf

Forms and conditions of credit:

- attendance on the lectures and labs
- active work at the laboratories: self-preparation of microscopic slides, microscopic observations
- written test – main topics previously presented to students

Course: **Animal Bioacoustics**

Course Coordinator: Krzysztof Deoniziak, PhD
Email: k.deoniziak@uwb.edu.pl

Language: **English**

Semester: **summer**	Number of hours (total): **30** *Lecture: **6** *Laboratory: **6** *Field course: **18**
ECTS: **3**	

Substantive content:

Animal bioacoustics covers all matters related to the production, transmission, and reception of sound in nature, as well as the investigation and use of natural sound by people and the impacts of anthropogenic sounds on animals. The course is divided into lectures and practicals that will focus on methods and data analysis for studying animal sound communication. During lectures, students will be presented with an overview of animal acoustic communication. Practicals aim at giving the students hands-on experience in sound recording, sound analysis, and playback experiments. Using interactive sound analysis software, we will work on acoustic signals produced by birds, amphibians, and insects from Poland and beyond.

Literature:

Bradbury JW, Vehrencamp SL. 2011 Principles of animal communication. Sinauer Associates Inc.
Charif RA, Waack AM, Strickman LM. 2010. Raven Pro 1.4 User's Manual. Cornell Lab of Ornithology.
Ladich F. 2019. Ecology of sound communication in fishes. Fish and Fisheries 20: 552-563
Pijanowski BC, Farina A, Gage SH, Dumyahn SL, Krause BL. 2011. What is soundscape ecology? An introduction and overview of an emerging new science. Landscape Ecology 26:1213-1232
A. Farina. 2014. Soundscape Ecology: Principles, Patterns, Methods and Applications. Springer
Brumm H. 2013. Animal Communication and Noise. Springer
Hedwig B. 2014. Insect hearing and acousitc communication. Springer
Cocroft RB, Gogala M, Hill PSM, Wessel A. 2014. Studying vibrational communication. Springer
Ladich F. 2015. Sound communication in fishes. Springer

Forms and conditions of credit:

- attendance
- active participation

Course: **Amphibian Ecology and Conservation**	
Course Coordinator: Adam Hermaniuk, PhD Email: adamher@uwb.edu.pl	
Language: English	
Semester: **summer**	Number of hours (total):**30** *Seminar: **5** *Field course: **25**
ECTS: **3**	
Substantive content: The course aims to deepen students' knowledge of the biology and ecology of amphibians found in Poland. Students will acquire skills in conducting inventory research methods, identifying threats, and implementing conservation actions to protect these animals. Through participation in active protection projects students will actively contribute to the preservation of amphibian populations during their critical spring migratory cycles within the Podlasie region. Upon completion of the course, students will be equipped with practical knowledge and skills necessary for effective conservation and monitoring of amphibians in their environment. Additionally, the course addresses the impact of roads and traffic on wildlife, particularly focusing on mortality assessment along Carska Road in Biebrza National Park. Topics include the effects of roads on terrestrial animal populations, field methods for evaluating road impacts, identification of killed vertebrates, traffic intensity assessment, and planning road-wildlife mitigation strategies to minimize negative impacts.	
Literature: Dodd CK. 2009. Amphibian ecology and conservation. Oxford University Press. Oxford. https://www.academia.edu/7681373/Dodd_2006_Amphibian_ecology_and_conservation_A_handbook_of_techniques Forman, R. T.T., D. Sperling, J. A. Bissonette, A. P. Clevenger, C. D. Cutshall, V. H. Dale, L. Fahrig, R. France, C. R. Goldman, K. Heanue, J. A. Jones, F. J. Swanson, T. Turrentine, & T. C. Winter. 2003. Road Ecology; Science and Solutions. Island Press, Covelo, CA.	
Forms and conditions of credit: - attendance on the seminar - attendance on the field course - oral presentation and report from the field course	

Course: **Avian Biology**

Course Coordinator: Paweł Brzęk, PhD
Email: brzek@uwb.edu.pl

Language: English

Semester: **summer**	Number of hours (total): **35** *Lecture: **15** *Field course: **20**
ECTS: **3**	

Substantive content:
The lecture presents a summary of avian systematics, anatomy, physiology, behavior, and reproduction. Flight adaptations, as well as similarities and differences between birds and mammals (the only two groups of extant endotherms), will be particularly emphasized. Because birds are a common subject of study in different fields of biology, lectures will frequently refer to more general problems of evolutionary, physiological, and behavioral ecology. The impact of human activity on birds and bird conservation will be also discussed.

1. General overview of modern birds.
2. Definition of species and speciation in birds.
3. Physiology and ecology of birds. Adaptations for flight. Comparison of birds and mammals – the only two groups of extant endotherms.
4. Avian flight: feathers, types of flight.
5. Bird migration and navigation.
6. Avian reproduction: altricial and precocial birds, hatching asynchrony, brood parasites.
7. Human-caused threats to birds, bird conservation.

Field course during the winter semester will take place at Akcja Siemianówka, the biggest inland bird ringing station in Poland localized on the northern edge of Białowieża Forest. During the summer semester, students will visit birding hot spots in the Podlasie region like Biebrza Marshes and Białowieża Primeval Forest and witness the phenomenon of spring bird migration. During the course, students will learn about the methods and activities connected with bird ringing, through the process from handling a bird safely to taking basic measurements, as well as about migrant and resident bird species observed and ringed in NE Poland.

Literature:
Bicudo J. E. P. W., Buttemer W. A., Chappell M. A., Pearson J. T., Bech C. 2010. Ecological and environmental physiology of birds. Oxford University Press.
McNab B.K. 2002. The physiological ecology of vertebrates. Cornell University Press, Ithaca, New York.
Balmer DE, Coiffait L, Clark J, Robinson R. 2008. Bird ringing: a concise guide. British Trust of Ornithology
Busse P, Meissner W, Cofta T. 2015. Bird ringing station manual. De Gruyter
Svensson L. 2010. Collins Bird Guide: The Most Complete Guide to the Birds of Britain and Europe. Harper Collins
Demongin L. 2016. Identification guide to birds in the hand. Beauregard-Vendon

Forms and conditions of credit:
- lecture –attendance and final written test
- field course – attendance and test

Course: **Basic Immunology**

Course Coordinator: Aneta Książek, PhD
Email: anetak@uwb.edu.pl

Language: English

Semester: **winter**	Number of hours (total): **30** *Lecture: **15** *Laboratory: **15**
ECTS: **3**	

Substantive content:

1. Functioning of the immune system.
2. Structure and mechanisms of immunocompetent cells actions. Morphology of immune cells among different groups of organisms (human, birds, mice, fish and amphibians).
3. Non-specific and specific components of an immune response: differences between both types of mechanisms
4. Mechanisms of non-specific immune reactions:
   - assessment of phagocytic blood activity
   - measurement of natural antibodies in blood serum by hemagglutination method
5. Mechanisms of specific immune response. Antigen-antibody reactions: characteristics, conditions and examples of practical utilization:
   - agglutination
   - precipitation.

Literature:

1. Abbas A. K., Lichtman A. H., Pillai S. 2023. Basic Immunology. Functions and Disorders of the Immune System, 7th Edition.
2. Chaplin D.D. 2010. Overview of the immune response. Journal of Allergy and Clinical Immunology. 125(2). doi:10.1016/j.jaci.2009.12.980.
3. Punt J., Stanford S. Jones P. and Owen J.A. 2018. Kuby Immunology. W.H.Freeman & Co Ltd., 8th edition, 944 pp.
4. Susan F. 2022. Antigen-antibody Reactions: An Overview. Immunochemistry & Immunopathology 8. 133.

Forms and conditions of credit:

- attendance on the lecture
- final report from the laboratory

Course: **Biochemistry**

Course Coordinator: dr hab. Andrzej Bajguz, prof. UwB
Email: abajguz@uwb.edu.pl

Language: English

Semester: **winter/summer**	Number of hours (total): **30**
ECTS: **3**	*Lecture: **15** *Laboratory: **15**

Substantive content:
Biological oxygenation, types, energetics, and meaning: oxidative and non-oxidative decarboxylation of pyruvate, tricarboxylic acids cycle, and respiratory chain
Biosynthesis ATP – photosynthetic, oxidative, and substrate phosphorylation
Basic mechanisms of regulation of metabolism
Nucleic acids – their structure, types, and function
Amino acids, peptides, proteins – their structure, types, and functions
Catabolism of proteins, amino acids, and nucleotides: deamination, urea cycle, degradation of purines and pyrimidines
Enzymes, coenzymes, vitamins – their structure, types, biological and metabolic functions
Replication and transcription. Translation and modification of proteins
Saccharides and lipids – their structure, types, and function
Carbohydrate metabolism: glycolysis, gluconeogenesis, and pentose phosphate pathway
Lipids metabolism: biosynthesis and oxidation of fatty acids
Porphyrins – their structure, types, and functions

Literature:
Tymoczko J.L., Berg J.M., Gatto Jr. G.J., Stryer L., Biochemistry. 8th Edition. W. H. Freeman and Company, 2015.
Campbell M.K., Farrell S.O., Biochemistry, Eighth Edition. Cengage Learning, 2015.
Buchanan B.B., Gruissem W., Jones R.L., Biochemistry & Molecular Biology of Plants. John Wiley & Sons, Ltd, 2015.

Forms and conditions of credit:
- final report and pass test from the laboratory
- attendance at the lab and lecture
- written exam (lecture part)

Course: **Biological Invasions**	
Course Coordinator: Edyta Jermakowicz, PhD Email: edytabot@uwb.edu.pl	
Language: English	
Semester: **winter/summer**	Number of hours (total): **30** *Lecture: **10** *Laboratory/field course: **20**
ECTS: **3**	
Substantive content: Principles of invasion biology and ecology – terminology and definitions, mode and source of introduction, ecology. History of plants and animals' migration. Theories and concepts of invasion biology. Factors (natural and anthropogenic) influencing spread and establishment of alien species. Survey of the most dangerous plant and fungi invaders and their biology and ecology. Survey of the most dangerous animal invaders and their biology and ecology. Ecological and economic impact of biological invasions. Management of biological invasions.	
Literature: Tokarska-Guzik B. 2005. The establishment and spread of alien plant species (kenophytes) in the flora of Poland. Uniwersytet Śląski, Katowice. Elton C.S. 1958. The Ecology of Invasions by Animals and Plants. More references will be proposed during course.	
Forms and conditions of credit: - attendance on the lecture - attendance and active participation in the field course - final report from the laboratory and field course	

Course: **Butterfly Ecology and Conservation**	
Course Coordinator: Marcin Sielezniew, Professor UwB Email: marcins@uwb.edu.pl	
Language: English	
Semester: **summer**	Number of hours (total): **30** *Lecture: **10** *Field course: **20**
ECTS: **3**	

Substantive content:
Butterflies are a model group in the ecology and conservation of insects. The lectures aim to familiarize students with the diversity and ecology of butterflies in Poland with special reference to Large Blue butterflies whose larvae are social parasites of red ants. Participation in field courses will give an opportunity to visit some selected sites interesting because of the butterfly fauna as well as overall biodiversity and also to know the research methodology.
Butterflies and moths: classification, systematics and evolution of Lepidoptera;
Morphology, anatomy, and development;
Wing coloration, camouflage, aposematism, mimicry;
Behavior: thermoregulation, territoriality, courtship;
Life histories: oviposition, host plants, aphytophagy, myrmecophily, natural enemies;
Dispersal abilities, population structure, migrations;
Butterfly diversity in NE Poland on the background of national and European fauna;
Methods of butterfly studies and monitoring (e.g. mark-release-recapture, transect counts);
Natural and anthropogenic threats for butterfly fauna (including the impact of climate change);
Conservation management: examples from Poland and Europe.

Literature:
Settele J, Shreeve T, Konvička M, Van Dyck H (eds) (2009) Ecology of butterflies in Europe. CUP, Cambridge.
Van Swaay C, Cuttelod A, Collins S, Maes D, Lopez Munguira M, Šašić M, Settele J, Verovnik R, Verstrael T, Warren M, Wiemers M, Wynhof I (2010) European red list of butterflies. Publications Office of the European Union, Luxembourg.
Selected journal articles.

Forms and conditions of credit:
- presence at lectures
- final report from the field course

Course: **Ecology**

Course Coordinator: Paweł Brzęk, PhD
Email: brzek@uwb.edu.pl

Language: English

Semester: **winter/summer**	Number of hours (total): **45**
ECTS: **4**	*Lecture: **30** *Laboratory/field course: **15**

Substantive content:
The course presents the biosphere as the effect of natural selection acting over millions of years under specific conditions on Earth and discusses several ecological and behavioral phenomena from an evolutionary perspective. Particular emphasis is placed on examples of evolutionary processes observed under natural conditions, as well as on the effect of anthropic pressure on conditions and life on Earth.

1. Definition of ecology, problems studied by ecology, scientific methods applied in ecology.
2. Biosphere: Earth as habitat for life.
3. Energy flow and matter cycles in the biosphere; productivity and decomposition.
4. Ecosystems, ecological succession. Ecological processes shaping dynamics of communities.
5. Basic trophic interactions (predation, competition, parasitism).
6. Population – spatial structure, demography, growth, and survival patterns.
7. Macroecology (ecogeographical rules, species-area relationship, biodiversity, extinctions).
8. Climate change: causes and effects.
9. Selection in the wild, factors maintaining genetic variation in the wild, epigenetic variation.
10. Adaptation and evolutionary constraint.
11. Evolution of life history traits, evolutionary trade-offs.
12. Sexual selection, mating systems.
13. Evolution of altruism and selfishness (kin selection, eusociality, other forms of altruism, parent-offspring conflict, sibling competition).
14. Optimization of foraging strategy.
15. Evolutionary ecology of Homo sapiens.

During laboratory exercises, students learn models of problems taught during lectures and analyze sample results (e.g. population structure and growth, trophic interactions, optimization of foraging strategy), and (if opportunity allows) participate in field ecological projects.

Literature:
Wilmer P., Stone G., Johnston I. 2005. Environmental physiology of animals. Oxford: Blackwell Science.
Moss B. 2001. Ecology of fresh waters. Blackwell Science, 557 pp.

Forms and conditions of credit:
- lectures: attendance; final written test.
- laboratory and field course: attendance; final written test (labs) or report (field).

Course: **Epidemiology**	
Course Coordinator: Agata Banaszek, PhD Email: banaszek@uwb.edu.pl	
Language: **English**	
Semester: **winter/summer**	Number of hours: 30 *Lecture: 15 *Laboratory: 15
ECTS: **3**	
Substantive content: Definition, scope, and uses of epidemiology. The historical context (the epidemic of cholera in London) and achievements in epidemiology (for example the eradication of smallpox) The definition of health and disease. Measuring the frequency of the disease, and the population at risk. Incidence and prevalence. Mortality, death rates, and morbidity. Infant and maternal mortality rates as measures of civilization development Types of epidemiological studies. Observational and experimental epidemiology. Potential errors in epidemiological studies. Ecological fallacy. Mass vaccination for polio (Heine-Medina) How to establish a cause of disease. Causation in epidemiology. The concept of cause. Correlation is not causation, false ideas about cause Epidemiology and prevention. Four levels of prevention primordial, primary, secondary, and tertiary prevention. Screening tests. The obligatory screening test for newborns in Poland – the example of phenylketonuria Epidemiology of infectious diseases. Chain of infection. Epidemic and endemic diseases. The history of large epidemics and how they influenced the history of societies (Black Death in Europe). The investigation and control of epidemics Clinical epidemiology. The definition of normality – what is normal? The diagnostic tests and their value. Solving the cases of epidemic diseases – the cases of bioterrorism, infectious diseases or food poisoning	
Literature: Bonita R, Beaglehole R and Kjellstrom T. 2006. Basic Epidemiology, 2nd edition WHO, pdf available online Ahrens W. and Pigeot I (eds). 2014. Handbook of Epidemiology, 2nd edition Springer, pdf available online The articles recommended by the course instructor	
Forms and conditions of credit: - attendance in the lectures and labs - work evaluation at the laboratories – solving problems and tasks - written exam – short questions previously presented to students	

Course: **Evolutionary Psychology**	
Course Coordinator: Julita Sadowska, PhD Email: julita.sadowska@uwb.edu.pl	
Language: English	
Semester: **winter/summer**	Number of hours (total): **20**
ECTS: **2**	*Lecture: **20**
Substantive content: The course is an introduction to the discipline of evolutionary psychology. The lecture will cover topics such as: - Basics of evolutionary psychology and evolution - Biology of attraction - Mate choice, female and male strategies - Communication, verbal, non-verbal cues - Emotion - Evolution and role of aggression - Altruism and altruistic behavior in related and non-related individuals	
Literature: Evolutionary Psychology. The New Science of the Mind. David M. Buss. Taylor & Francis. 2019.	
Forms and conditions of credit: - attendance - final test	

Course: **Experimental Design and Data Analysis for Biologists**	
Course Coordinator: Piotr Jadwiszczak, PhD Email: piotrj@uwb.edu.pl	
Language: English	
Semester: **winter/summer**	Number of hours (total): **30** *Seminar: **15** *Laboratory: **15**
ECTS: **3**	
This course aims to familiarize students with the steps of the Scientific Method and selected techniques of statistical data analysis. Students will learn about the role and correct hypothesis formulation in research, experimental design, and research planning with a particular focus on ecological/ecophysiological studies (including the definition of a sample, correct sample unit identification and collection methods, types of data, replications, and pseudoreplication, techniques of taking notes). Discussed topics also include data processing and ethical issues in science and scientific writing/publications (data manipulation, plagiarism, authorship issues, duplicate or concurrent publications, conflicts of interest, fraud, animal use, and local law). Students will also learn about Fisher's and Neyman-Pearson's approaches to the verification of statistical hypotheses, selected parametric and randomization tests, Monte Carlo simulations, and elements of Bayesian methodology (Bayes' rule in practice).	
Literature: Lampert, W., Sommer, U. 2007. Limnoecology. Oxford University Press. Quinn, G.P., Keough, M.J. 2002. Experimental design and data analysis for biologists. Cambridge University Press. Sand-Jensen, K. 2007. How to write consistently boring scientific literature. Oikos, 116: 723 – 727. Hurlbert, Stuart H., 1984, Pseudo-replication and the design of ecological field experiments, Ecological Monographs, 54:187-211.	
Forms and conditions of credit: - 100% attendance - participation in discussion during classes - student project: students design a study/project in accordance with the scientific method - passing a short test on selected statistical methods	

Course: **Forensic Biology**	
Course Coordinator: Ada Wróblewska, PhD Email: adabot@uwb.edu.pl	
Language: English	
Semester: **winter**	Number of hours (total): **30** *Lecture: **5** *Laboratory: **25**
ECTS: **3**	

The aim of the course is to reveal the history of forensic research with the usage of biological traces and the interpretation of the obtained DNA and RNA results in forensic cases. Molecular markers and techniques used in forensic laboratories will be presented. Students will learn about the collection of biological trial and their preservation, DNA / RNA extraction, and analysis methods depending on the type of sample and the expected results. Controversial cases in forensics will be described and explained.

During the laboratory students will learn basic descriptions of 1) forensic entomology and 2) forensic botany. The forensic entomology defines the interactions between insects as evidence and the legal system. Students will acquire knowledge of how to identify the different arthropod taxa of significance in the decomposition process and will get familiar with the life cycles of the various species involved in decomposition, the patterns of decomposition of a human body under different conditions, the differences in the development of arthropods related to the presence of drugs and/or toxins in tissues and the role of the forensic entomologist in the moral and legal systems of our society.

In the second part of the laboratories, students will acquire knowledge and develop skills in forensic botany and its methodology. During laboratory sessions, the student will learn how various disciplines of botany, especially plant morphology, and anatomy, as well as plant ecology, provide evidential materials in a case and lead from discovering a botanical trace to establishing its connection with the circumstances of the event. The student becomes familiar with the procedures for collecting and preserving botanical traces and their further analysis.

Literature:

1. R. Li 2015. Forensic biology. CRC Press, Taylor & Francis Group.
2. Forensic Science International: Genetics, Journal of Applied Genetics, Archiwum Medycyny Sądowej i Kryminologii, Investigative
Genetics, Nature Reviews, itp.
3. Gennard D. 2012. Forensic Entomology: An Introduction, 2nd Edition.
Wiley-Blackwell.
4. Lappas N, Lappas C. 2015. Forensic Toxicology. Adacemid Press.Gennard Dorothy. 2012. Forensic entomology: an introduction. Wiley-Blackwell

Forms and conditions of credit:

- attendance on the lecture
- attendance and active participation in the laboratories
- exam

Course: **Functional Physiology**	
Course Coordinator: Sebastian Maciak, PhD, Email: maciaks@uwb.edu.pl	
Language: English	
Semester: **winter/summer**	Number of hours (total): **30** *Lecture: **15** *Laboratory: **15**
ECTS: **3**	
Substantive content: DNA content and cell size variation. The impact of cell size and cell division rate on the physiological properties of an organism and variation in the metabolic rates; Basal Metabolic Rate is a fundamental trait of all living organisms. Metabolic rate measurements. Closed respirometry; Experiments with artificial selection as a model system; The main genes involved in the regulation of cellular metabolism. Metabolic signaling pathways; Cellular aerobic pathways and formation of reactive oxygen species (ROS); Oxidative stress and examples for dietary interventions; The structure and function of different types of cells. The basis for animal histology. Histological slides preparation; Basic microscopy techniques. Cell size measurements; Animal cell growth and cell division rate; Evolution of cell size is a key factor in developing nowadays maladies such as metabolic syndrome, diabetes, or cancer; Peto's paradox and general methods of cancer prevention; The evolutionary context of carcinogenesis and its possible contribution to the understanding of mechanisms of cancer initiation; The use of animal models in cancer and diabetes research; The clinical aspect of the physiological studies and trends in the individualization of metabolic disease therapies;	
Literature: Schmidt-Nielsen K. 1997. Animal Physiology. Adaptation and environment. 5th eds. Cambridge University Press Moyes Ch.D., Schulte P.M. 2016. Principles of Animal Physiology 3rd eds. Pearson Education.	
Forms and conditions of credit: - attendance at the lecture - final report from the laboratory	

Course: **Genetics (Basic)**	
Course Coordinator: Agata Banaszek, PhD Email: banaszek@uwb.edu.pl	
Language: English	
Semester: **winter/summer**	Number of hours (total): **30** *Lecture: **15** *Laboratory: **15**
ECTS: **3**	
Substantive content: Information for students – if you are not familiar with the basic laws of inheritance or just have a problem understanding them, this subject is for you. If you already have basic genetics choose rather the advanced-level 1. Basic laws of inheritance (Mendel laws). The structure and behavior of chromosomes during mitosis and meiosis. 2. The inheritance of linked genes. Linkage and mapping. Genetic variation. 3. Sex inheritance and sex linkage. Lyon hypothesis. Sex chromosomes and sex reversal. 4. Quantitative traits. The relationship between genotype and phenotype. Twin studies. Human skin Color and the Genetic Mechanisms of inheritance 5. DNA structure and the flow of genetic information in the cell. The genetic code. Molecular basis of point mutations. Types of point mutations and their effects on proteins. Metabolic blocks and diseases. 6. Chromosomal mutations, types, and examples. The mutations on chromosome number and structure. Human aneuploidy. Polyploidy in the evolution of cultivated plants.	
Literature: Griffiths, Wessler, Lewontin et al. 2000. An Introduction to genetic analysis. Freeman, USA. Elseth G. D., Baumgardner K. D. 1984. Genetics. Addison-Wesley Publishing Company, USA.	
Forms and conditions of credit: - attendance on the lectures and labs - work evaluation at the laboratories – solving genetic problems and tasks - written exam – short questions previously presented to students	

Course: **Genetics (Advanced)**	
Course Coordinator: Agata Banaszek, PhD Email: banaszek@uwb.edu.pl	
Language: English	
Semester: **winter/summer**	Number of hours (total): **30** *Lecture: **15** *Laboratory: **15**
ECTS: **3**	
Substantive content: Information for students – you need to have a good understanding of basic laws of inheritance and mutations to cope with this subject. If not choose Basic Genetics 1. The structure of genomes – nuclear, mitochondrial, chloroplast 2. Methods for molecular genetic research – molecular markers. PCR and DNA sequencing 3. Methods for gene activity research, microarrays. Gene silencing 4. Epigenetics in contrast to classical genetics. Types of epigenetic changes 5. Cancer as the effect of mutations, epigenetic changes, and environmental factors 6. Ecogenetics – the interaction between genotype and environmental factors. The explanation of why some people have a higher risk of particular diseases 7. Genetic engineering and biotechnology, gene therapies, genetic testing, GMO, cloning.	
Literature: 1. Paro R., Santoro R. Wutz A., Grossniklaus U. 2011. Introduction to epigenetics. Learning materials in biosciences, open-access 2. Griffiths, Wessler, Lewontin et al. 2000. An Introduction to genetic analysis. Freeman, USA. 3. Elseth G. D., Baumgardner K. D. 1984. Genetics. Addison-Wesley Publishing Company, USA. 4. Costa L. Eaton K. 2006. Gene-environment interaction: fundamentals of ecogenetics. Wiley	
Forms and conditions of credit: - attendance on the lectures and labs - work evaluation at the laboratories – solving genetic problems and tasks - written exam – short questions previously presented to students	

Course: **Genome analysis methods**

Course Coordinator: Maciej Matosiuk, PhD
E-mail: m.matosiuk@uwb.edu.pl

Language: **English**

Semester: **winter/summer**	Number of hours: **15**
ECTS: **1**	*Lecture: **15**

Substantive content:

Inherited component of organismal variability - the genome, became the focal point of research, as many of genetic variants can directly affect fitness and health of individuals. Genomes can also elucidate the evolutionary history of many taxonomic groups. The main goal of the course is to introduce students to:

1. Genome architecture in prokaryotes and eukaryotes along with organelles (mitochondria and plastids) and the story behind their acquisition.
2. Standard techniques used for genome sequencing projects (i.e. Human Genome Project) during the emergence of Genomics.
3. Methods used for assessment of genome size and genome mapping (genetic and physical), including cutting-edge optical mapping.
4. Second and third generation of sequencing (sequencing by synthesis, SMRT and nanopore sequencing) and their modifications, used currently for throughput scRNA analyses (10x Chromium).
5. Methods of genome analysis at various levels of organization (TADs, chromatine interactions, open chromatine, transciption factor bindng, epigenetic modifications and gene expression).
6. Comparative genomics and genome evolution.

Literature:

1. Brown TA 2018. Genomes, 4th Edition. Garland Science, Taylor & Francis Group, LCC.
Scientific papers from: Nature, Science, Genome Research, PNAS, Molecular Biology and Evolution, Current Biology.

Forms and conditions of credit:

1. Attendance.

Course: **Harmful and Useful Algae and Cyanobacteria**	
Course Coordinator: Magdalena Grabowska, Professor UwB Email: magra@uwb.edu.pl	
Language: English	
Semester: **summer**	Number of hours (total): **20** *Lecture: **6** *Laboratory: **4** *Field course: 10
ECTS: **2**	
Substantive content: Toxic algae and cyanobacteria in freshwater and marine ecosystems. Types of toxins and their effect on other organisms and water quality. Methods of detection of toxins. Regulation on Cyanotoxins in Legislation. Influence of strongly eutrophic Siemianówka dam reservoir on lowland Narew River. Role of algae and cyanobacteria in human life and economy. Algal and cyanobacterial indicators in the assessment of aquatic ecosystems. Cyanobacteria and algae as a source of bioactive metabolites: potential application in biotechnology, pharmacy, and economy.	
Literature: Burchardt L. (ed.) 2014. Key to Identification of Phytoplankton Species in Lakes and Rivers. Guide for Laboratory Classes and Field Research Chorus I. & Welker M. 2021. Toxic cyanobacteria in water - Second edition. A guide to their public health consequences, monitoring, and management. CRC Press, London Grabowska M., Mazur-Marzec H. 2011. The effect of cyanobacterial blooms in the Siemianówka Dam Reservoir on the phytoplankton structure in the Narew River. Oceanological and Hydrobiological Studies 40:19-26 Lange-Bertalot H., Hofmann G., Werum M., Cantonati M., 2017. Freshwater Benthic Diatoms od Central Europe: Over 800 Common Species Used in Ecological Assessment, Koeltz Botanical Books Overlingė D, Toruńska-Sitarz A, Cegłowska M, Błaszczyk A, Szubert K, Pilkaitytė R, Mazur-Marzec H, 2021. Phytoplankton of the Curonian Lagoon as a New Interesting Source for Bioactive Natural Products. Special Impact on Cyanobacterial Metabolites. Biomolecules 11:1139	
Forms and conditions of credit: - attendance and discussion during lectures and laboratory and field courses - final report from the laboratory and field courses	

Course: **Hydrobiology**

Course Coordinator: prof. dr hab. Andrzej Górniak
Email: hydra@uwb.edu.pl

Language: English

Semester: **winter/summer**	Number of hours (total): **45** *Lecture: **15** *Laboratory: **20** *Field course: **10**
ECTS: **4**	

Substantive content:
1. Water resources and different types of freshwater ecosystems.
2. Physical and chemical water properties. Nutrient cycle and organic matter.
3. Vertical gradient of environmental factors in lake ecosystems.
4. Lake trophic status - Carlson's Trophic State Index.
5. Eutrophication: reasons and consequences.
6. Water quality assessment methods.
7. Lake habitats (pelagic, littoral, bentos) and sub-habitats (neuston, periphyton, psammon, etc.)
8. Taxonomy and ecology of freshwater algae and cyanobacteria.
9. Taxonomy and ecology of freshwater zooplankton (Crustacea, Rotifera).
10. Macrobenthos and macrophytes.
11. Biotic and abiotic factors affecting seasonal and spatial distribution of freshwater communities.
12. Alien and invasive species in freshwater ecosystems.
13. Lake restoration and biomanipulation methods.

Literature:
1. Moss B. 2001. Ecology of freshwaters. Blackwell Science, 557 pp.
2. Lampert, W., Sommer, U. 2007. Limnoecology. Oxford University Press.
3. Moss B. 2017. Ponds and small lakes: Microorganisms and freshwater ecology.
4. Dodds W.K, Whiles M.R. 2011. Freshwater ecology: concepts and environmental applications of limnology.
5. Burchardt L. (ed.) 2014. Key to Identification of Phytoplankton Species in Lakes and Rivers. Guide for Laboratory Classes and Field Research
6. Błędzki, L.A., Rybak, J.I., 2016. Freshwater crustacean zooplankton of Europe. Springer, Berlin, 918 pp.

Forms and conditions of credit:
- attendance on the lecture, laboratory and field courses
- reports from the laboratory and field course

Course: **Introduction to Bioinformatics**	
Course Coordinator: Maciej Matosiuk, PhD Email: m.matosiuk@uwb.edu.pl	
Language: English	
Semester: **winter/summer**	Number of hours (total): **15** *Laboratory: **15**
ECTS: **1**	
Substantive content: The main goal of the course is to prepare students for efficient work in unix (Linux) environment using command line tools. Students will also learn easy ways to automatize their multiple-task work with simple scripts, even on remote servers. A large part of the course will focus on practical manipulation of text files including pattern recognition as an easy guide to prepare input files for multiple applications. 1. Introduction to Linux: GUI, documentation, file system organization, command structure in terminal. (2 hours) 2. Terminal commands every user should know. Build-in text editors (gedit, nano). Useful operators. How to connect and work on remote servers. (3 hours) 3. How to work with text files: an easy way to identification of complex patterns and their modification/replacement with powerful language of regular expressions (regex). (4 hours) 4. How to create and execute a bash script. Further automatization of scripts using loops (for, while, until). (4 hours) 5. Main molecular biology databases. (2 hours)	
Literature: 1. Haddock SHD, Dunn 2010. Practical computing for Biologist. Oxford University Press.	
Forms and conditions of credit: - attendance - practical skill test on remote server	

Course: **Introduction to Epigenetics**	
Course Coordinator: Julita Sadowska, PhD Email: julita.sadowska@uwb.edu.pl	
Language: English	
Semester: **winter/summer**	Number of hours (total): **15**
ECTS: **1**	*Lecture: **15**
Substantive content: The course serves as an introduction to the field of epigenetics. Science has been studying how genetic information encoded in DNA is inherited for over 60 years, with the Human Genome Project being a culminating point. HGP was supposed to map and reveal the entire human genome sequence allowing us to identify all possible genes. The next "post-genome" challenge however was understanding how information encompassed in the DNA code enables specific proteins to be produced and what regulatory mechanisms play what role in that. It quickly turned out that not everything made sense in the light of classical genetics: these were what we call examples of epigenetic regulation mechanisms.	
Literature: Genomes. T.A. Brown. 2018. Garland Science. Epigenetics. Lyle Armstrong. 2014. Garland Publishing. Additional reading: Identically different. When you can change your genes. Tim Spector. 2012. Weidenfeld&Nicolson. The epigenetics revolution. How modern biology is rewriting our understanding of genetics, disease, and inheritance. Nessa Carey. 2011. Icon.	
Forms and conditions of credit: - attendance - final test	

<table>
<tr><td colspan="2">Course: Introduction to Geographic Information Systems</td></tr>
<tr><td colspan="2">Course Coordinator: Paweł Mirski, PhD
Email: p.mirski@uwb.edu.pl</td></tr>
<tr><td colspan="2">Language: English</td></tr>
<tr><td>Semester: winter/summer</td><td rowspan="2">Number of hours (total): 15
*Laboratory: 15</td></tr>
<tr><td>ECTS: 1</td></tr>
<tr><td colspan="2">Substantive content:
Spatial data in GIS: vector and raster models
Geographic projections in GIS
Data visualization: symbolization, labeling
Thematic maps
Digitalization and vector map editing
Geoprocessing tools
Introduction to Spatial Analysis</td></tr>
<tr><td colspan="2">Literature:
Wilson JP Fotheringham SA 2008. The Handbook of Geographic Information Science. Blackwell Publishing Ltd</td></tr>
<tr><td colspan="2">Forms and conditions of credit:
- attendance
- active participation</td></tr>
</table>

<table>
<tr><td colspan="2">Course: Inventory Methods for Ungulates</td></tr>
<tr><td colspan="2">Course Coordinator: prof. dr hab. Mirosław Ratkiewicz
Email: ermi@uwb.edu.pl</td></tr>
<tr><td colspan="2">Language: English</td></tr>
<tr><td>Semester: summer</td><td rowspan="2">Number of hours (total): 15
*Lecture: 4
*Field course: 11</td></tr>
<tr><td>ECTS: 1</td></tr>
<tr><td colspan="2">Substantive content:
The rules of research in the field.
Identification, collection and preservation of biological traces left by different species of mammals in the field.
Analysis of the collected data - estimating density of the large mammals (boar, moose, red deer, roe deer, wolf).
Observation of the large mammals interacting with their environments.
Practical application of traditional and modern methods in the field study of wild mammals.</td></tr>
<tr><td colspan="2">Literature:
Jędrzejewski W., Sidarowicz W. (2010). The art of animal tracking. ZBS PAN.
Rezendes P. (1999). Tracking and the Art of Seeing: How to Read Animal Tracks and Sign. HarperCollins Publishers, Inc., New York.</td></tr>
<tr><td colspan="2">Forms and conditions of credit:
- presence on all field research
- field course report</td></tr>
</table>

Course: **Microbiology**	
Course Coordinator: Marek Bartoszewicz, PhD Email: mbartosz@uwb.edu.pl	
Language: English	
Semester: **summer** ECTS: **4**	Number of hours (total): **45** *Laboratory: **45**
Substantive content: Basics of microscopy. Light microscope, fluorescence microscope, phase contrast microscope. The application of microscopes in microbiology. Simple staining. Types of dyes. Preparation technique of preparations. Microscopic observations. Gram staining. Complex staining of mycobacteria and endospores of bacilli. Microbiological media. Techniques of sterilization and disinfection. Autoclave, Pasteur's oven, microwave sterilizer Isolation of bacteria from environmental samples. Culture and growth of bacteria. Purification of bacterial cultures. Bacteria enumeration techniques. Test I Biochemical tests (e.g. API) Antibiotics and bacterial resistance. Susceptibility testing (disc diffusion tests, gradient strips) Gram-positive aerobic bacteria. Gram-negative bacteria Anaerobes (e.g. *Clostridium* spp.) Basics of virology (phage typing, cell cultures) Test II	
Literature: Angela Edwards, Beatrix Fahnert, Greg Pryor, Anthony Strelkauskas, Jennifer Strelkauskas (2015) Microbiology: A Clinical Approach. Garland Science. Gerard J. Tortora, Berdell R. Funke, Christine L. Case, Derek Weber, Warner Bair GE (2020) Microbiology: An Introduction (13th Edition). Pearson Education.	
Forms and conditions of credit: To pass the subject Microbiology, you must pass two tests and attend lab classes (one absence is allowed).	

Course: **Mimicry, Aposematism, and Other Animal Survival Strategies**	
Course Coordinator: Marta Skowron Volponi, PhD Email: m.skowronvolponi@uwb.edu.pl	
Language: English	
Semester: **summer**	Number of hours (total): **30** *Lecture: **10** *Field course: **15** *Laboratory: **5**
ECTS: **3**	
Substantive content: How to survive an encounter with a predator? The course includes a theoretical overview of the diversity of animal survival strategies, from camouflage, through aposematism to mimicry on various sensory levels – morphological, behavioural, acoustical and chemical resemblances that species have developed to increase their chances of living through dangerous confrontations. During the field course students will have the opportunity to observe examples of deceit in the natural world and learn experimental techniques that allow to verify the effectiveness of animal strategies in confrontation with predators. Students will be encouraged to develop and discuss their own research ideas inspired by field encounters with wildlife. An introduction to the analysis of behavioural experiments in Boris software will be carried out during laboratories.	
Literature: Donald L.J. Quicke (2017) Mimicry, Crypsis, Masquerade and Other Adaptive Resemblances: The Ecology and Evolution of Adaptive Resemblance**.** Blackwell Pub Graeme D. Ruxton, William L. Allen, Thomas N. Sherratt, Michael P. Speed (2018 or 2005) Avoiding Attack: The Evolutionary Ecology of Crypsis, Aposematism, and Mimicry. OUP Oxford Olivier Friard & Marco Gamba. User guide of BORIS the Behavioral Observation Research Interactive Software. Version 8.23. Available online. Selected journal articles.	
Forms and conditions of credit: - presence at lectures - active participation in the field course - mini written experimental procedure proposal (prepared in pairs) addressing a chosen research question	

Course: **Mechanisms of Evolution**	
Course Coordinator: Agnieszka Bona, PhD	
Language: English	
Semester: **winter/summer**	Number of hours (total): **30**
ECTS: **3**	*Laboratory: **30**
Substantive content: Sources of variation. Methods for determining variation in populations. Assumptions of Hardy-Weinberg equilibrium. Genetic drift and its consequences in small and large populations. Bottleneck and founder effect. Natural selection: directional, stabilizing, disruptive and apostatic selection. Kin selection and altruism. How do new species arise? The process and modes of speciation. Species concepts and limitations in their use. Human evolution: fossil records and molecular evidence.	
Literature: Antón SC, Potts R, Aiello LC. 2014. Evolution of early Homo: An integrated biological perspective. *Science*, 345(6192). Futuyma DJ. 2005. Evolution. Sinauer, Sunderland USA. Ridley M. 2004. Evolution. Blackwell Publishing Sobel JM, Chen GF, Watt LR, Schemske DW. 2010. The biology of speciation. *Evolution: International Journal of organic evolution*, *64*(2), 295-315.	
Forms and conditions of credit: - attendance - active participation in laboratory work - test	

Course: **Molecular Phylogenetics**	
Course Coordinator: Mirosław Ratkiewicz, PhD Email: ermi@uwb.edu.pl	
Language: English	
Semester: **summer**	Number of hours (total): **15** *Lecture: **7** *Laboratory: **8**
ECTS: **1**	
Substantive content: Molecular phylogeny may reveal real genetic relationships between taxa at intra and inter-specific levels. It usually uses homologous, aligned DNA or protein sequences and different phylogenetic approaches to construct the phylogenetic tree, test it statistically, and present it in a form that is readable and interpretable to the reader. During the course, students will learn about all the important rules, stages, and methods that are used in molecular phylogenetics and will know what we have learned from this approach so far. • Students will also learn how to construct phylogenetic trees using different methods with the help of MEGAXI software from DNA and/or protein sequences and test them as evolutionary hypotheses by bootstrap approach. Students will also learn how to construct phylogenetic networks and test for selection and neutral evolution.	
Literature: Hall, B. G. (2013). Building phylogenetic trees from molecular data with MEGA. Molecular biology and evolution, 30(5), 1229-1235. https://www.megasoftware.net/ https://www.megasoftware.net/docs	
Forms and conditions of credit: - attendance in laboratory and lectures - simple, practical test for skills gained on using MEGAXI software or higher.	

Course: **Molecular Diagnostics**	
Course Coordinator: Mirosław Ratkiewicz, PhD Other: Dr Magdalena Czajkowska Email: ermi@uwb.edu.pl, magdacz@uwb.edu.pl	
Language: English	
Semester: **summer**	Number of hours (total): **15** *Lecture: **6** *Laboratory: **9**
ECTS: **1**	
Substantive content: Molecular diagnostics in a scientific sense means the identification of any organism (from viruses to mammals) and the detection of its genetic or genomic variants. The main goal from a medical perspective is to precisely detect different pathogens, genetic disorders, and tumor DNA/ RNA for diagnosis, prognosis, and monitoring response to therapy. As a connection of laboratory medicine, genetic/genomic knowledge, and technology Molecular diagnostics provides the accurate diagnosis. During the course, students will get an overview of the field of molecular diagnostics and different, modern molecular diagnostic methods. Students will also learn about the role of GWAS (genome-wide association studies), candidate gene approach, and others in surveys of complex diseases, pharmacogenetics, and nutrigenetics. During the laboratory work students will perform simple molecular diagnostic tests using PCR and DNA sequencing approaches. Students will also get familiar with the possibilities provided by the GTR (Genetic Testing Registry) online platform that belongs to NCBI.	
Literature: https://www.sciencedirect.com/topics/medicine-and-dentistry/molecular-diagnostics https://www.jmdjournal.org/ https://www.ncbi.nlm.nih.gov/gtr/	
Forms and conditions of credit: - attendance in laboratory and lectures - simple, practical test of choice (A,B, C or D) on the knowledge gained during the course.	

Course: **Molecular Techniques in Biology**	
Course coordinator: Magdalena Czajkowska, PhD Email: magdacz@uwb.edu.pl	
Language: English	
Semester: **winter/summer**	Number of hours (total): **30** *Lecture: **10** *Laboratory: **20**
ECTS: **3**	
Substantive content: Main rules of work in Molecular Biology Laboratory Practice of pipetting DNA extraction Gel electrophoresis Molecular species identification: PCR – amplification of *cyt b* gene Clean-up of PCR products Sequencing reaction Purification of sequencing reaction products with the ExTerminator kit (A&A Biotechnology) Separation of sequencing products on a 3130 Genetic Analyzer (Applied Biosystems) NCBI website and BLAST tool DNA sampling (invasive and noninvasive) (L) Principles and methods of DNA isolation (L) Primer design and PCR setup and types (L) Genetic methods based on fragment length polymorphism (L) Genetic techniques based on DNA sequencing, including Next Generation Sequencing (L)	
Literature: Carson S., Miller H.B., Witherow D.S. Molecular Biology Techniques: A Classroom Laboratory Manual, 3rd ed. 2012. Elsevier. Tagu D., Moussard C. Techniques for Molecular Biology. 2006. CRC Press. Ream W., Field K.G., Molecular Biology Techniques: An intensive Laboratory Course. 1999. Academic Press. Elsevier. Allison L.A. Fundamental Molecular Biology, 2ed. 2012. Wiley-Blackwell. Freeland J.R. Molecular ecology. 2011. Wiley-Blackwell. Avise J.C. Molecular Markers, Natural History, and Evolution. 2004. Sinauer, Sunderland, MA. Avise, J.C. (ed.). 2010. Molecular Ecology and Evolution: the Organismal Side. World Scientific Publishing, Singapore	
Forms and conditions of credit: - attendance on the lecture - active participation in laboratory work.	

Course: **Natura 2000 Network**	
Course Coordinator: prof. dr hab. Andrzej Górniak Email: hydra@uwb.edu.pl	
Language: English	
Semester: **summer**	Number of hours (total):**10** *Field course: **10**
ECTS: **1**	
Substantive content: During the course, students will be introduced to current EU Directives for habitats and species protection. During the fieldwork at Natura 2000 sites in the Podlasie region, students on the base of their observations will identify species and habitats important for the EU and will define the threats to these habitats and species to identify non-compliance farming on Natura 2000 sites. Students will assess the impact of various forms of human activity on the functioning of the area and indicate their proposal management of the area of Natura 2000.	
Literature: Borre, Jeroen Vanden, et al. "Integrating remote sensing in Natura 2000 habitat monitoring: Prospects on the way forward." Journal for Nature Conservation 19.2 (2011): 116-125. Söderman, Tara. "Natura 2000 appropriate assessment: Shortcomings and improvements in Finnish practice." Environmental Impact Assessment Review 29.2 (2009): 79-86.	
Forms and conditions of credit: - participation in fieldwork and - report from field course	

Course: **Natural Environment of North East Poland**	
Course Coordinator: prof. Andrzej Górniak Email: hydra@uwb.edu.pl	
Language: English	
Semester: **winter/summer**	Number of hours (total): **10** *Lecture: **10**
ECTS: **1**	
Substantive content: NE Poland in the geologic map of Europe. Effects of Pleistocene glaciation on relief, sediments, and water net. Relict permafrost in NE Poland. Neotectonic activity and lakes location and Kraton hydrogeology. Pleistocene, artesian groundwaters basin. Features of the climate of NE Poland, climatic types in the Koeppen climate classification, continentalism advancement, and the recent global changes effects. River hydrology, typology of rivers and their regimes. Artificial forms of surface water- Augustów Canal, Great Masurian Lakes System, specificity of Siemianówka Reservoir, small retention ponds. Water quality and ecological state of freshwaters in NE Poland. Effects of melioration on water cycle in catchments.	
Literature: McCann T. (2008), The geology of Central Europe: Volume 1: Precambrian and Palaeozoic; Volume. 2: Mesozoic and Cenozoic. Geological Society of London. Tockner et al. [ed.] 2009. Rivers of Europe. Elsevier, Amsterdam. 700 pp. Website of the Polish Geological Institute: http://www.pgi.gov.pl; webpages in English related to regional geology, resources, and geotourism in Poland	
Forms and conditions of credit: - active participation in the course - presentations from themes offered by instructor	

Course: **Novel Technologies in Wildlife Studies**	
Course Coordinator: Paweł Mirski, PhD Email: p.mirski@uwb.edu.pl	
Language: English	
Semester: **summer**	Number of hours (total): **30** *Field course: **30**
ECTS: **3**	
Substantive content: Novel technologies in wildlife studies will be presented during the field-working course Field classes will contain short theoretic introductions to each topic and equipment handling Topics raised and the field course: The use of trail cameras in fauna monitoring and behavioral studies GPS logging devices to use in movement ecology studies Thermovision for night monitoring of fauna UAV images in bird breeding surveys	
Literature: Silvy NJ. 2020. The Wildlife Techniques Manual: Volume 1: Research. Johns Hopkins University Press Optional articles provided by the Course Coordinator	
Forms and conditions of credit: - attendance - active participation	

Course: **Palynology**

Course Coordinator: Magdalena Fiłoc, PhD
Email: m.filoc@uwb.edu.pl

Language: English

Semester: **summer**	Number of hours (total): **10** *Laboratory: **8** *Field course: **2**
ECTS: **1**	

Substantive content:
The laboratory is devoted to discussing the method of pollen analysis - a universal research tool used, among others, in palaeobotanical and paleoclimatic research, but also archeology, and beekeeping. The analysis is based on the qualitative and quantitative analysis (visual classification) of the composition of sporomorphs (pollen and/or spore) that are in honey and also preserved in the fossils state in lakes and peat bogs.
The laboratory will cover learning the making of the maceration of the samples and their microscopic analysis. Pollen for classes will come from the harvested plants during fieldwork and from honeys and lakes.

Literature:
Beug HJ 2004. Leitfaden der Pollenbestimmung für Mitteleuropa und angrenzende Gebiete. München: Pfeil.
Di Pasquale G, Salignon M, Le Conte Y, Belzunces LP, Decourtye A, et al. 2013. Influence of Pollen Nutrition on Honey Bee Health: Do Pollen Quality and Diversity Matter?. PLOS ONE 8(8): e72016. https://doi.org/10.1371/journal.pone.0072016
https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0072016
Kupryjanowicz M., Nalepka D., Pidek I.A., Walanus A., Balwierz Z., Bińka K., Fiłoc M., Granoszewski W., Kołaczek P., Majecka A., Malkiewicz M., Nita M., Noryśkiewicz B., Winter H., The east-west migration of trees during the Eemian Interglacial registered on isopollen maps of Poland, Quaternary International 2017, http://dx.doi.org/10.1016/j.quaint.2017.08.034
https://www.sciencedirect.com/science/article/pii/S1040618216302154
W. Margielewski, M. Krąpiec, M. Kupryjanowicz, M. Fiłoc, K. Buczek, R. Stachowicz-Rybka, A. Obidowicz, A. Pociecha, E. Szychowska-Krąpiec, D. Sala, A. Klimek, Bog pine dendrochronology related to peat stratigraphy: Palaeoenvironmental changes reflected in peatland deposits since the Late Glacial (case study of the Imszar raised bog, Northeastern Poland), Quaternary International 2022, 613, 61-80, DOI: 10.1016/j.quaint.2021.11.007 https://www.sciencedirect.com/science/article/pii/S1040618221005486

Forms and conditions of credit:
- attendance

Course: **Physiological Ecology**

Course Coordinator: Paweł Brzęk, PhD
Email: brzek@uwb.edu.pl

Language: English

Semester: **winter/summer**	Number of hours (total): **30**
ECTS: **3**	*Lecture: **30**

Substantive content:
The main goal of the course is to present the physiological traits and features of animals as an evolutionary adaptation to challenges posed by environmental conditions (including anthropogenic effects). Both variation and evolution of physiological traits will be particularly emphasized.

1. What is 'physiological ecology'?
2. Natural variation of physiological traits and their importance for fitness under natural conditions.
3. Research methods used in physiological ecology, particularly artificial selection.
4. Energy metabolism of animals under natural conditions, its limits, and importance for fitness. Scaling of metabolic rate.
5. Ecto- and endotherms. Thermal heterogeneity, thermal sensitivity, and thermoregulation among different groups of organisms.
6. Examples of thermal adaptation and acclimation.
7. Living in the extremes: coping and molecular mechanisms
8. Effects of anthropogenic temperature change on animals.
9. Evolutionary physiology of the digestive system.
10. Gas exchange in animals. Adaptation to life at high altitudes and for diving.
11. Physiology of locomotion in animals.
12. Water and salt physiology of animals living in different habitats.
13. Nervous system and senses: intelligence, memory, and learning as an adaptation to the environment.
12. Physiology of aging in the wild.

Literature:
Angilletta, M.J. Jr. 2009. Thermal Adaptation*:* A Theoretical and Empirical Synthesis. Oxford University Press.
Hayes, J.P., Garland, T. Jr. 1995. The evolution of endothermy: testing the aerobic capacity model. Evolution, 49: 836 – 847.
Hill R., Wyse G., Anderson M. 2004. Animal physiology. Sinauer Associates, Sunderland, USA.
Karasov W.H., Martinez del Rio C. 2007. Physiological ecology. Princeton University Press, Princeton, USA.
McNab B.K. 2002. The physiological ecology of vertebrates. Cornell University Press, Ithaca, New York.

Forms and conditions of credit:
- lecture attendance
- final written test

Course: **Plant Aging**	
Course Coordinator: Violetta Macioszek, PhD Email: v.macioszek@uwb.edu.pl	
Language: English	
Semester: **winter/summer**	Number of hours (total): **10** *Lecture: **10**
ECTS: 1	
Substantive content: Plant aging processes substantially differ from animal senescence due to the plant cell-specific features. However, plant biogerontology is a new modern area of plant biology that has recently been highly investigated. The lecture will focus on mechanisms of the plant aging process on molecular physiological levels with special attention on aging in model plants and age-dependent plant resilience against abiotic and biotic stresses e.g. green islands formation in response to pathogen and light-induced senescence. 1. Definition and testing of plant aging 2. Initiation of plant aging 3. Plant cell aging and programmed cell death 4. Arabidopsis and crop models of leaf aging 5. Age-dependent plant resilience against stresses	
Literature: Review and original papers from various scientific journals e.g. Popov V.N., Syromyatnikov M.Yu., Franceschi C., Moskalev A.A., Krutovsky K.V. Genetic mechanisms of aging in plants: What can we learn from them? Ageing Research Reviews 2022, 77, 101601. Rankenberg T., Geldhof B., van Veen H., Holsteens K., Van de Poel B., Sasidharan R. Age-Dependent Abiotic Stress Resilience in Plants. Trends in Plant Science 2021, 26 (7), 692-705.	
Forms and conditions of credit: - attendance	

Course: **Plant Biology and Ecology**

Course Coordinator: Izabela Tałałaj, PhD
Email: izagry@uwb.edu.pl

Language: English

Semester: **summer**	Number of hours (total): **45**
ECTS: **4**	*Lecture: **10** *Laboratory: **10** *Field work: **25**

Substantive content:
The main goal of the course is to introduce students with the primary concepts and methods used in plants biology and ecology. Students will carry out the research from framing the questions, through design and conducting the study in the field, to data visualization and interpretation. Laboratory and field works will be focused on two main subjects: 1) collecting the data about plants size structure and reproduction and spatial patterns of plant populations in context of different environmental conditions and plants communities; 2) the second goal of the course is to present biological and ecological aspects of plant breeding system as an evolutionary adaptation to challenges posed by pollinators limitation. The primary subjects e.g. What is “plant breeding system”? Evolutionary consequences of self- and cross-pollination. Why plants are self-compatible? How floral architecture protects against self-pollination? How plant community shapes breeding system of the particular plant species?
Place: Białowieski National Park, Biebrzański National Park, Turczyński and Zwierzyniecki Forests (Białystok)

Literature:
1.Charlesworth, Deborah. "Evolution of plant breeding systems." *Current Biology* 16.17 (2006): 726-735.
2.Jersáková, Jana, and Pavel Kindlmann. "Reproductive success and sex variation in nectarless and rewarding orchids." *International Journal of Plant Sciences* 165.5 (2004): 779-785.
3.Goodwillie, Carol, Susan Kalisz, and Christopher G. Eckert. "The evolutionary enigma of mixed mating systems in plants: occurrence, theoretical explanations, and empirical evidence." *Annu. Rev. Ecol. Evol. Syst.* 36 (2005): 47-79.
4.Willmer, Pat. *Pollination and floral ecology*. Princeton University Press, 2011.
5. Gibson D.J. 2002. Methods in comparative plant population ecology. Oxford University Press.
6. Falińska K. 1998. Plant Population Biology and Vegetation Processes. W. Szafer Institute of Botany, Polish Academy of Science, p. 368.

Forms and conditions of credit:
- attendance and active participation in the laboratories and field course
- active participation in the course
- preparing a protocol of laboratory and field studies according to scheme prepared by instructor

Course: **Plant Physiology**

Course Coordinator: prof. dr hab. Iwona Ciereszko
Email: icier@uwb.edu.pl

Language: English

Semester: **winter/summer**	Number of hours (total): **45** *Lecture: **10** *Laboratory: **35**
ECTS: **4**	

Substantive content (lecture):

1. Introduction to plant physiology
2. Water transport, transpiration, and water balance of plants
3. Mineral nutrition of plants
4. Photosynthesis: physiological and ecological considerations
5. Assimilate translocation in plants
6. Respiratory metabolism
7. Growth processes and plant development
8. Plant hormones, plant/tissue regeneration processes
10. Stress physiology: plants' response to environmental factors

Substantive content (laboratory):
The exercises are an introduction to the methods and techniques commonly used in plant physiology - measurements of water content and transport, primary and secondary metabolism parameters during plant growth and development as well as during abiotic and biotic stress. Laboratory classes in the field of primary metabolism use standard methods, such as e.g. measurements of pigment content or reducing and non-reducing sugars in plant tissues, as well as modern methods, e.g. with the use of devices for measuring the kinetics of chlorophyll fluorescence. The exercises also use methods related to the measurements of primary and secondary metabolism, including photosynthesis, which are aimed at showing its changes during stress, e.g. nutrient deficiency, drought, or temperature changes. We will use different techniques e.g. measurements of photosynthetic efficiency, phenolic compounds content, and DNA isolation to explore several important processes that help plants to survive in their environment. Students also will be acquainted with the basics of plant cell *in vitro* culture plant regeneration processes and the function of hormones. Upon completing this course, students should be familiar with contemporary methods used in plant physiology, especially in research connected with plant stress physiology.

Literature:
Handbook of Photosynthesis 2005. Second Edition, Pessarakli M (ed.)
https://nishat2013.files.wordpress.com/2013/11/handbook-of-photosynthesis.pdf
Taiz L., Zeiger E. 2006. Plant Physiology. 4th. Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts (or other editions)
The Arabidopsis Book, CR Somerville, EM Meyerowitz (eds.), American Society of Plant Biologists, Rockville, http://www.arabidopsisbook.org/topical/
A. & Vijaya Luxmi Bhattacharya, 2015. Methods and Techniques in Plant Physiology. NIPA
Cornelio Losa, 2016. Methods and Techniques in Plant Physiology. Scitus Academics LLC
B.K. Garg, 2012. Plant Analysis: Comprehensive Methods and Protocols. Scientific Publishers
Modern Methods in Plant Physiology, 2009. red. Sirvastava GC, New India Publishing
papers in scientific journals: Journal of Plant Physiology, Plant Physiology, Physiologia Plantarum, Acta Physiologiae Plantarum etc.

Forms and conditions of credit:
- attendance on the lecture
- attendance on the laboratory
- final report from the laboratory

Course: **Plant In Vitro Culture**	
Course Coordinator: Aleksandra Staszak, PhD Email: a.staszak@uwb.edu.pl	
Language: English	
Semester: **winter/summer**	Number of hours (total): **15** *Laboratory: **15**
ECTS: **1**	
Substantive content: During the course, students prepare experiments based on plant material with *in vitro* culture. Students will be able to characterize the stage of the in vitro culture experiment and the role of plant hormones. Students will understand the influence of different conditions, explant types, and mediums on *in vitro* cultures. Students will be able to plan an experiment, choose the right explant types and medium ingredients, and select proper growth conditions in the phytotron. Students will be able to prepare culture medium, and establish and carry on experiments, and observation. After the course, students will be familiar with the *in vitro* cultures of plants and will know how to choose the right medium, explants, and conditions.	
Literature: Taiz L., Zeiger E. 2006. Plant Physiology. 4th. Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts (or other editions) A. & Vijaya Luxmi Bhattacharya, 2015. Methods and Techniques in Plant Physiology. NIPA Cornelio Losa, 2016. Methods and Techniques in Plant Physiology. Scitus Academics LLC B.K. Garg, 2012. Plant Analysis: Comprehensive Methods and Protocols. Scientific Publishers Modern Methods in Plant Physiology, 2009. red. Sirvastava GC, New India Publishing papers in scientific journals: Journal of Plant Physiology, Plant Physiology, Physiologia Plantarum, Acta Physiologiae Plantarum	
Forms and conditions of credit: - attendance on the laboratory - final report from the laboratory	

Course: **Plant-Pathogen Interactions**	
Course Coordinator: Violetta Macioszek, PhD Email: v.macioszek@uwb.edu.pl	
Language: English	
Semester: **winter/summer**	Number of hours (total): **25** *Lecture: **10** *Laboratory: **15**
ECTS: **2**	
Substantive content: Topics of the lecture focus on mechanisms of plant resistance against pathogens and molecular interactions of plant and pathogens molecules during signal transduction of defense reactions in host cells. Concepts of classical and modern plant pathology will be presented. Also, examples of the most devastating diseases caused by viruses, bacteria, and fungi in crop plants mostly in Europe will be described. 1. Symbiotic and pathogenic interactions of microbes and insects with plants 2. Gene for gene interaction, plant receptors, and pathogen avirulence factors 3. Viral plant diseases 4. Agrobacterium as an example of a plant bacterial pathogen 5. Biotrophic and necrotrophic fungi interacting with crop plants Laboratory classes contain: plant infection methods, investigation of pathogen infection process on a microscopic level, symptoms of plant infection, changes in primary and secondary metabolisms in response to infection	
Literature: Matthew Dickinson, Molecular Plant Pathology, 2003, BIOS Scientific Publication, Taylor and Francis Group Kumar Sanjeev, Plant Pathogens and Principles of Plant Pathology, 2015, New India Publishing Agency-NIPA Jeremy J. Burdon, Anna-Liisa Laine, Evolutionary Dynamics of Plant-Pathogen Interactions, 2019, Cambridge University Press	
Forms and conditions of credit: - attendance	

Course: **Population and Conservation Genetics**	
Course Coordinator: Agata Banaszek, PhD Email: banaszek@uwb.edu.pl	
Language: English	
Semester: **winter/summer**	Number of hours (total): **30** *Lecture: **15** *Laboratory: **15**
ECTS: **3**	
Substantive content: The frequencies of genotypes and alleles. The calculation of the allele frequencies in cases of complete dominance. Eugenics in the light of population genetics. The heterozygosity and other indices of genetic variability Hardy – Weinberg genetic equilibrium. The use of HW law for genetic profiling. Forensic genetics for protection of the endangered species. The CITES convention The effects of low numbers in populations. Genetic drift, inbreeding and inbreeding depression, mutational meltdown. The calculation of inbreeding coefficient from pedigrees for individuals and populations F statistics – the differentiation of populations, the gene flow, and inbreeding Protection plans, solving taxonomical problems. The species concept and practical approach to the problem. The barcoding idea. Phylogeography and the units for protection within the species. The idea of ESU evolutionary significant unit and MU management unit The minimum size of the viable population. IUCN categories and criteria for endangered species. The QTLs in the calculation of the viable size	
Literature: Ayala F.J., 1982. Population and evolutionary genetics: a primer. The Benjamin/Cummings Publ. Frankham et al. 2002. Conservation Genetics. Oxford University Press. The articles recommended by the Course Coordinator	
Forms and conditions of credit: - attendance in the lectures and labs - work evaluation at the laboratories – solving genetic problems and tasks - written exam – short questions previously presented to students	

Course: **Social insects**	
Course Coordinator: Tomasz Włodarczyk, PhD Email: t.wlodar@uwb.edu.pl	
Language: English	
Semester: **winter/summer**	Number of hours (total): **15** *Lecture: **5** *Laboratory: **10**
ECTS: **1**	
Substantive content: Social insects are among the most intriguing organisms on our planet. The sacrifice of own reproduction in favor of the fitness of other individuals posed a serious challenge to the Darwinian view of evolution. Moreover, advanced insect societies add a new level to the organization of living things, called superorganisms. During the course, students are introduced to the theoretical background explaining social phenomena in insects and other animals. The emphasis is made on the peculiarities of hymenopteran insects (ants, wasps, bees) in that respect. The general rules are exemplified by the natural history of socially primitive and advanced species. During laboratory courses, students prepare experiments demonstrating the communication systems in ants. They also use experimental setups to study the division of labor and competition between alien ant colonies. Students also practice techniques useful in the field studies of ants and learn how to recognize selected species during the trip to the nearby meadow and pine forest (field trips available only during the summer semester).	
Literature: Hölldobler, B., Wilson, E. O. 2009. The superorganism: The beauty, elegance, and strangeness of insect societies. New York: W.W. Norton. Bourke A. F. G. 1995. Social Evolution in Ants, Franks N. F. Monographs in Behavior and Ecology. Princenton University Press Czechowski W., Radchenko A., Czechowska W. 2002. The ants of Poland. Museum and Institute of Zoology Polish Academy of Sciences.	
Forms and conditions of credit: - attendance at the lecture - tasks completion	

Course: **Soils and Landscape**	
Course Coordinator: prof. Andrzej Górniak Email: hydra@uwb.edu.pl	
Language: English	
Semester: **winter/summer**	Number of hours (total): **10** *Lecture: **5** *Field course: **5**
ECTS: **1**	
Substantive content: Soil pedon development. Natural factors of soil genesis. FAO classification of soils; diagnostic horizons, horizons features and relations in the main soil profiles in Europe. Differentiation of soil landscapes on the Earth, with special attention to Polish soil catena in the physiographic regions. Relationships between plant communities, water, climatic conditions, and type of soils. Agricultural and forest soils values, specific plantation and forest types. Field study of soil pedons in the lowland valley, mineral soil catena in the old glaciation highland, soils of moraines and kems. Methods of descriptions of the soil profile in the field filed measurement of pH and $CaCO_3$ content, sampling, texture, and soil aggregation.	
Literature: Album of Polish Soils. PTGleb. Warszawa Polish classification of Soils (English resume). Rocz. Glebozn. 2011, 62,3.	
Forms and conditions of credit: - active participation in the course - preparing a protocol of field study of 5 soil profiles according to scheme prepared by instructor	

Course: **Toxicology**	
Course Coordinator: dr hab. Andrzej Bajguz, prof. UwB Email: abajguz@uwb.edu.pl, alicjap@uwb.edu.pl	
Language: English	
Semester: **winter/summer**	Number of hours (total): **30** *Lecture: **15** *Laboratory: **15**
ECTS: **3**	
Substantive content: General principles of toxicology (history and scope, classification of poisons). Route of toxicant uptake – doses and concentrations. Factors affecting toxic responses: absorption, distribution, and excretion of toxicants. Mechanisms of toxicity. Biotransformation and toxicity of selected inorganic and organic compounds. Plant and animal toxic compounds, and their effect on human health. Toxicology of narcotics.	
Literature: Curtis Klaassen & John B. Watkins III, Casarett & Doull's Essentials of Toxicology. Second Edition. The McGraw-Hill Companies, Inc, 2010. Byung-Mu Lee & Sam Kacew & Hyung Sik Kim, Lu's Basic Toxicology Fundamentals, Target Organs, and Risk Assessment. Seventh Edition. CRC Press, Taylor & Francis Group, 2018.	
Forms and conditions of credit: - final report and pass test from the laboratory - attendance at the lab and lecture - written exam (lecture part)	

Course: **Trends and Methods in Immunobiology**

Course Coordinator: Aneta Książek, PhD
Email: anetak@uwb.edu.pl

Language: **English**

Semester: **summer**	Number of hours (total): **30** *Lecture: **10** *Laboratory: **20**
ECTS: **3**	

Substantive content:

- General definitions: immunobiology, comparative immunology, immunocompetence, evolutionary trade-offs in immunobiology.
- Scientific problems studied by comparative immunology.
- Laboratory techniques applied in comparative immunology.
- General rules of collection of biological samples for immunological analyses.
- Methodology of the extraction of biological fluids from biological samples.
- Immunoenzymatic ELISA technique: general principles, types of ELISA tests, analysis of the results.
- Flow cytometry: definitions and general operation rules of a flow cytometer.
- Practical operation of a flow cytometer to assess blood parameters, and analysis of the results.

Semi-quantitative methods in immunobiology.

Literature:

1. Sompayrac L.M. 2016. How the immune system works? Wiley-Blackwell, 6th edition, 168 pp.Klenerman P. 2018. The immune system: A very short introduction. Oxford University Press, 144 pp.
2. Punt J., Stanford S. Jones P. and Owen J.A. 2018. Kuby Immunology. W.H.Freeman & Co Ltd., 8th edition, 944 pp.
3. Hadi M.S. 2019. Practical Immunology. LAP Lambert Academic Publishing, 172 pp.
4. Cochet O. Teillaud J.L. and Sautès C. 1998. Immunological Techniques Made Easy. John Willey & Sons, 356 pp.

Forms and conditions of credit:

- attendance on the lecture and labs
- active participation in laboratory work

Course: **Water Protection and Restoration**

Course Coordinator: Magdalena Grabowska, PhD
Email: magra@uwb.edu.pl

Language: English

Semester: **winter**	Number of hours (total): **40** *Lecture: **6** *Seminar: **14** *Field courses: **20**
ECTS: **4**	

Substantive content:
Sources of water pollution.
Drinking water treatment.
Wastewater treatment.
Role of organisms in the biological processes of drinking water treatment and wastewater treatment.
Domestic and UE water and wastewater legal regulations
Visits to the water and wastewater treatment plants.
Standards for ecologically successful aquatic restoration and an assessment of potential risks and indicators of water pollution.
Differences in functioning natural and transformed freshwater ecosystems.
The best practices for freshwater restoration on the example of projects implemented in Europe.
The short-term and long-term effects of aquatic restorations.

Literature:

- England, J., Angelopoulos, N., Cooksley, S., Dodd, J., Gill, A., Gilvear, D., ... & Tree, A. (2021). Best Practices for Monitoring and Assessing the Ecological Response to River Restoration. Water 2021, 13, 3352.
- Legal regulations and statistics on water protection.
- Palmer, M., & Ruhi, A. (2019). Linkages between flow regime, biota, and ecosystem processes: Implications for river restoration. Science, 365(6459), eaaw2087.
- Szałkiewicz, E., Jusik, S., & Grygoruk, M. (2018). Status of and perspectives on river restoration in Europe: 310,000 Euros per hectare of restored river. Sustainability, 10(1), 129.
- Shackira, A. M., Sarath, N. G., & Puthur, J. T. (2022). Phycoremediation: a means for restoration of water contamination. Environmental Sustainability, 1-14.
- Wang J. 2012. Fundamentals of biological processes for wastewater treatment. In: Biological Sludge Minimization and Biomaterials/Bioenergy Recovery Technologies. Wiley Online Library
- Weber, C., Åberg, U., Buijse, A. D., Hughes, F. M., McKie, B. G., Piégay, H., ... & Haertel-Borer, S. (2018). Goals and principles for programmatic river restoration monitoring and evaluation: collaborative learning across multiple projects. Wiley Interdisciplinary Reviews: Water, 5(1), e1257.

Forms and conditions of credit:
- attendance and participation in discussion during lectures and laboratory and field courses
- final report from the seminar and field courses

Course: **Research Project**

Course Coordinator: If you are interested in a research project, you should find a supervisor first https://biologia.uwb.edu.pl/en/faculty/departments

Language: English

Semester: **winter/summer**	Number of hours (total): **60**
ECTS: **10**	*Laboratory: **60**

Substantive content:

The aim of the "Research Project" is a comprehensive academic endeavor designed to empower students to autonomously plan and execute a scientific experiment or devise an innovative solution to a research challenge within the realm of Biology. This course is meticulously crafted to foster independent thinking, research acumen, and the practical application of scientific principles.

Participants in this course will embark on a journey of exploration and discovery as they select a research problem of interest, formulate clear objectives, and develop a research proposal that outlines the methodology, expected outcomes, and potential contributions to the field of Biology. Armed with the guidance of experienced mentors, students will navigate the complexities of experimental design, data collection, and analysis, honing their critical thinking and problem-solving skills along the way.

Throughout the course, students will have the opportunity to engage in hands-on laboratory work, field research, or computational analysis, depending on the nature of their chosen project. The course promotes interdisciplinary collaboration and encourages students to integrate knowledge from various branches of Biology, fostering a holistic understanding of the subject matter.
In addition to conducting their research, students will be encouraged to communicate their findings effectively through presentations and written reports, preparing them for the rigors of disseminating scientific knowledge. This course not only equips students with the technical skills necessary for research but also cultivates a deep appreciation for the scientific process, ethics, and the broader implications of their work.

By the culmination of the "Research Project" Erasmus course, participants will have not only enriched their academic and practical proficiency in Biology but will also have contributed meaningfully to the ever-evolving landscape of scientific knowledge. This course serves as a beacon of intellectual growth, fostering future scientists who are adept at exploring, questioning, and advancing the boundaries of biological research. Additional benefits of the course include the opportunity to create a scientific publication.

Literature:

- JCR publications related to the field of the project

Forms and conditions of credit:

- implementation of a scientific project
- final report or preparing scientific publications