<table>
<tr><td colspan="2">Course: Animal Physiology</td></tr>
<tr><td colspan="2">Course Coordinator: Sebastian Maciak, PhD,
Email: maciaks@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): 30
*Lecture: 15
*Laboratory: 15</td></tr>
<tr><td>ECTS: 3</td></tr>
<tr><td colspan="2">Substantive content:
Basal Metabolic Rate as a fundamental trait of all living organisms. Metabolic rate measurements. Closed respirometry;
Experiments with artificial selection as a model systems;
The structure and function of different types of cells. The basis for animal’s histology. Histological slides preparation;
Animal cell growth and cell division rate;
DNA content and cell size variation. The impact of cell size and cell division rate on physiological properties of an organism and variation in the metabolic rates;
The basic microscopy techniques. Cell size measurements;
The main genes involved in regulation of cellular metabolism. Metabolic signaling pathways;
Cellular aerobic pathways and formation of reactive oxygen species (ROS);
Oxidative stress and examples for dietary interventions;
Evolution of the cell size as a key factor to develop nowadays maladies as metabolic syndrome, diabetes, or cancer;
Peto’s paradox and general methods of cancer prevention;
Evolutionary context of carcinogenesis and its possible contribution to 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;</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td colspan="2">Forms and conditions of credit:
- attendance on the lecture
- final report from the laboratory</td></tr>
</table>

<table>
<tr><td colspan="2">Course: Biochemistry</td></tr>
<tr><td colspan="2">Course Coordinator: dr hab. Andrzej Bajguz, prof. UwB
Email: abajguz@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): 30
*Lecture: 15
*Laboratory: 15</td></tr>
<tr><td>ECTS: 3</td></tr>
<tr><td colspan="2">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</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td colspan="2">Forms and conditions of credit:
- final report and pass test from the laboratory
- attendance at the lab and lecture
- written exam (lecture part)</td></tr>
</table>

Course: **Ecology**	
Course Coordinator: Paweł Brzęk, PhD Email: brzek@uwb.edu.pl	
Language: English	
Semester: **winter/summer**	Number of hours (total): **45** *Lecture: **30** *Laboratory/field course: **15**
ECTS: **4**	

Substantive content:

The course presents 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 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, structure, growth, 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. Optimalization 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, optimalization 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).

<table>
<tr><td colspan="2">Course: Genetics (Basic)</td></tr>
<tr><td colspan="2">Course Coordinator: Agata Banaszek, PhD
Email: banaszek@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): 30
*Lecture: 15
*Laboratory: 15</td></tr>
<tr><td>ECTS: 3</td></tr>
<tr><td colspan="2">Substantive content:
Information for students – if you are not familiar with basic laws of inheritance or just have the problem with understanding them, this subject is for you. If you already had basic genetics choose rather the advanced level
1. Basic laws of inheritance (Mendel laws). The structure and behavior of chromosome 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 fenotype. 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 in proteins. Metabolic blocks and diseases.
6. Chromosomal mutations, types and examples. The mutations on chromosome number and structure. Human aneuploidy. Polyploidy in evolution of cultivated plants.</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td colspan="2">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</td></tr>
</table>

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 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 effect of mutations, epigenetic changes and environmental factors 6. Ecogenetics – the interaction between genotype and environmental factors. The explanation why some people have 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 acess 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: **Hydrobiology**	
Course Coordinator: Maciej Karpowicz, PhD Email: m.karpowicz@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 type 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 (pelagial, littoral, bentos) and subhabitats (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: **Microbiology**	
Course Coordinator: Marek Bartoszewicz, PhD Email: mbartosz@uwb.edu.pl	
Language: English	
Semester: **winter**	Number of hours (total): **45** *Laboratory: **45**
ECTS: **4**	
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 (eg. API) Antibiotics and bacterial resistance. Susceptibility testing (disc diffusion tests, gradient strips) Gram-positive aerobic bacteria. Gram-negative bacteria Anaerobes (eg *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).	

<table>
<tr><td colspan="2">Course: Plant Biology and Ecology</td></tr>
<tr><td colspan="2">Course Coordinator: Izabela Tałałaj, PhD
Email: izagry@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): 45
*Lecture: 10
*Laboratory: 10
*Field work: 25</td></tr>
<tr><td>ECTS: 4</td></tr>
<tr><td colspan="2">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 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: Turczyński and Zwierzyniecki Forests (Białystok).</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td colspan="2">Forms and conditions of credit:
- 100% attendance
- active participation in the course
- preparing a protocol of laboratory and field studies according to scheme prepared by instructor</td></tr>
</table>

Course: **Plant Physiology**

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

Language: English

Semester: **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 pigments 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 a 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 which help plants to survive in their environment. Students also will be acquainted with basics of plant cell *in vitro* culture and plant regeneration processes and function of hormones. Upon completing this course, student should be familiar with contemporary methods used in plant physiology, especially used 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

<table>
<tr><td colspan="2">Course: Amphibian Ecology and Conservation</td></tr>
<tr><td colspan="2">Course Coordinator: Adam Hermaniuk, PhD
Email: adamher@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):30
*Seminar: 5
*Field course: 25</td></tr>
<tr><td>ECTS: 3</td></tr>
<tr><td colspan="2">Substantive content:
Traffic is now one of the most important factors impacting upon wildlife. Furthermore, as road infrastructure is developing steadily, its negative effect can only be expected to increase. The aim of the course is to analyse mortality of vertebrates due to traffic on Carska Road in the Biebrza National Park.
Course contents:
- the impacts of roads and traffic on terrestrial animal populations;
- field methods to evaluate the impact of roads on wildlife;
- mortality assessment on the Carska Road;
- identification of the killed vertebrates using identification keys;
- traffic intensity assessment;
- determination of the road sections with the highest mortality on the basis of the collected results;
- road-wildlife mitigation planning, how to reduce the negative effects of traffic road.</td></tr>
<tr><td colspan="2">Literature:
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.</td></tr>
<tr><td colspan="2">Forms and conditions of credit:
- oral presentation</td></tr>
</table>

Course: **Analysis of the 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 the insight into the processes of cell development and differentiation with the resolution which is unattainable using bulk data. In brief, this method consists of disassembling of tissue or organ 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 the new problems we should be addressed to 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 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 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 Bioconductor ecosystem, which is being developed under 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: **Animal Bioacoustics**	
Course Coordinator: Krzysztof Deoniziak, PhD Email: k.deoniziak@uwb.edu.pl	
Language: **English**	
Semester: **winter/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 impacts of anthropogenic sounds by on animals. The course is divided into lectures and practical's 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. Practical's aim at giving the students hands-on experience of 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: **Avian Biology**	
Course Coordinator: Paweł Brzęk, PhD Email: brzek@uwb.edu.pl	
Language: English	
Semester: **winter/summer**	Number of hours (total): **35** *Lecture: **15** *Field course: **20**
ECTS: **3**	

Substantive content:
Lecture presents summary of avian systematics, anatomy, physiology, behaviour 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 studies in different fields of biology, lectures will frequently refer to more general problems of evolutionary, physiological and behavioral ecology. 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 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 summer semester students will visit birding hot spots in 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

<table>
<tr><td colspan="2">Course: Biological invasions</td></tr>
<tr><td colspan="2">Course Coordinator: Edyta Jermakowicz, PhD
Email: edytabot@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): 30
*Lecture: 10
*Laboratory/field course: 20</td></tr>
<tr><td>ECTS: 3</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td colspan="2">Forms and conditions of credit:
- attendance on the lecture
- final report from the laboratory and field course</td></tr>
</table>

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 ecology and conservation of insects. The aim of the lectures is to familiarize students with diversity and ecology of butterflies in Poland with special reference to Large Blue butterflies which larvae are social parasites of red ants. Participation in field courses will give opportunity to visit some selected sites interesting because of the butterfly fauna as well as overall biodiversity and also to know research methodology. Butterflies and moths: classification, systematics and evolution of Lepidoptera; Morphology, anatomy and development; Wing colouration, camouflage, aposematism, mimicry; Behaviour: 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 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	

<table>
<tr><td colspan="2">Course: Data visualization and computer vision</td></tr>
<tr><td colspan="2">Course Coordinator: Tomasz Włodarczyk, PhD
Email: t.wlodar@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:
Researchers have to deal with the increasing load of the data deriving from image recording devices and whole systems like field camera traps or automated systems to behavioral observations. Moreover, data from other high throughput sources have to be handled, structured, and presented in a human-readable form. This course shows how to manipulate large data sets to create an input to the graphics tools. Students also learn how to create data plots using open-source software. Moreover, the course entails an introduction to the techniques used in object detection, tracking, and automated image processing.</td></tr>
<tr><td colspan="2">Literature:
Haddock, S. H. D., Dunn, C. W., & Sinauer Associates. (2018). Practical computing for biologists. Sunderland, MA: Sinauer Associates.
Alon U., An introduction to systems biology. Design principles of biological circuits. Chapman&Hall/CRC, 2007.</td></tr>
<tr><td colspan="2">Forms and conditions of credit:
- attendance on the lecture
- tasks completion</td></tr>
</table>

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, 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 communicable 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 in 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, communicable 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 on the lectures and labs - work evaluation at the laboratories – solving problems and tasks - written exam – short questions previously presented to students	

<table>
<tr><td colspan="2">Course: Experimental Design and Data Analysis for Biologists</td></tr>
<tr><td colspan="2">Course Coordinator: Piotr Jadwiszczak, PhD
Email: piotrj@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): 20
*Seminar: 10
*Laboratory: 10</td></tr>
<tr><td>ECTS: 2</td></tr>
<tr><td colspan="2">The aim of this course is to familiarize students with steps of the Scientific Method and selected techniques of the statistical data analysis.
Students will learn about the role and correct hypothesis formulation in research, experimental design and research planning with particular focus on the ecological/ecophysiological studies (including the definition of a sample, correct sample unit identification and collection methods, types of data, replications and pseudoreplications, techniques of taking notes). Discussed topics also include data processing an ethical issues in science and scientific writing/publications (data manipulation, plagiarism, authorship issues, duplicate or concurrent publications, conflicts of interest, frauds, animal use and local law).
Student will also learn about Fisher’s and Neyman-Pearson’s approaches to verification of statistical hypotheses, selected parametric and randomization tests, Monte Carlo simulations, and elements of Bayesian methodology (Bayes’ rule in practice).</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td colspan="2">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</td></tr>
</table>

Course: **Forensic biology**	
Course Coordinator: Ada Wróblewska, PhD Email: adabot@uwb.edu.pl	
Language: English	
Semester: **winter**	Number of hours (total): **20** *Lecture: **5** *Laboratory: **15**
ECTS: **2**	
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 laboratory student will learn basic description of forensic entomology which defines the interactions between insects as evidence and the legal system. Student will acquire knowledge 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.	
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 - exam	

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): **15** *Lecture: **6** *Laboratory: **3** *Field course: **6**
ECTS: **1**	
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 sources 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	

<table>
<tr><td colspan="2">Course: Introduction to bioinformatics</td></tr>
<tr><td colspan="2">Course Coordinator: Maciej Matosiuk, PhD
Email: m.matosiuk@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:
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. 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: easy way for 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. Futher automatization of scripts using loops (for, while, until). (4 hours)
5. Main molecular biology databases. (2 hours)</td></tr>
<tr><td colspan="2">Literature:
1. Haddock SHD, Dunn 2010. Practical computing for Biologist. Oxford University Press.</td></tr>
<tr><td colspan="2">Forms and conditions of credit:
- attendance
- practical skill test on remote server</td></tr>
</table>

<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, labelling
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: **Mechanisms of evolution**	
Course Coordinator: Agnieszka Bona, PhD	
Language: English	
Semester: **winter/summer**	Number of hours (total): **30** *Lecture: **6** *Laboratory: **24**
ECTS: **3**	
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	

<table>
<tr><td colspan="2">Course: Molecular phylogenetics</td></tr>
<tr><td colspan="2">Course Coordinator: Mirosław Ratkiewicz, PhD
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: 7
*Laboratory: 8</td></tr>
<tr><td>ECTS: 1</td></tr>
<tr><td colspan="2">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 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 tree 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, test for selection and neutral evolution.</td></tr>
<tr><td colspan="2">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</td></tr>
<tr><td colspan="2">Forms and conditions of credit:
- attendance in laboratory and lectures
- simple, practical test for skills gained on using MEGAXI software or higher.</td></tr>
</table>

<table>
<tr><td colspan="2">Course: Molecular techniques in biology</td></tr>
<tr><td colspan="2">Course coordinator: Magdalena Czajkowska, PhD
Email: magdacz@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): 30
*Lecture: 10
*Laboratory: 20</td></tr>
<tr><td>ECTS: 3</td></tr>
<tr><td colspan="2">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 (invasine and noninvasice) (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)</td></tr>
<tr><td colspan="2">Literature:
Carson S., Miller H.B., Witherow D.S. Molecular Biology Techniques: A Classroom Laboratory Manual, 3th 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</td></tr>
<tr><td colspan="2">Forms and conditions of credit:
- attendance on the lecture
- active participation in laboratory work.</td></tr>
</table>

<table>
<tr><td colspan="2">Course: Natura 2000 network</td></tr>
<tr><td colspan="2">Course Coordinator: prof. dr hab. Andrzej Górniak
Email: hydra@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):10
*Field course: 10</td></tr>
<tr><td>ECTS: 1</td></tr>
<tr><td colspan="2">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 Podlasie region, students on the base of their own observations will identify species and habitats important for the EU, 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 own proposal management of the area of Natura 2000.</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td colspan="2">Forms and conditions of credit:
- participation in fieldwork and
- report from field course</td></tr>
</table>

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 pleistocen glaciation on relief, sediments and water net. Relict permafrost in NE Poland. Neotectonic activity and lakes location and kraton hydrogeology. Pleistocen, artesian groundwaters basin. Features of climate of NE Poland, climatic types in the Koeppen climate classification, continentalism advancement, 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	

<table>
<tr><td colspan="2">Course: Novel technologies in wildlife studies</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: summer</td><td rowspan="2">Number of hours (total): 30
*Field course: 30</td></tr>
<tr><td>ECTS: 3</td></tr>
<tr><td colspan="2">Substantive content:
Novel technologies in wildlife studies will be presented during field-working course
Field classes will contain short theoretic introduction 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</td></tr>
<tr><td colspan="2">Literature:
Silvy NJ. 2020. The Wildlife Techniques Manual: Volume 1: Research. Johns Hopkins University Press
Optional articles provided by the Course Coordinator</td></tr>
<tr><td colspan="2">Forms and conditions of credit:
- attendance
- active participation</td></tr>
</table>

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 are devoted to discussing the method of pollen analysis - a universal research tool used, among others, in palaeobotanical and paleoclimatic research, but also in 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 honeys 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 be 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 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 its 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 digestive system.
10. Gas exchange in animals. Adaptation to life at high altitude 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 environment.
12. Physiology of ageing 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

<table>
<tr><td colspan="2">Course: Plant ageing</td></tr>
<tr><td colspan="2">Course Coordinator: Violetta Macioszek, PhD
Email: v.macioszek@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): 10
*Laboratory: 10</td></tr>
<tr><td>ECTS: 2</td></tr>
<tr><td colspan="2">Substantive content:
Plant ageing processes substantially differ from animal senescence due to the plant cell specific features. However, plant biogerontology is a new is a modern area of plant biology that recently is highly investigated. Lecture will focus on mechanisms of plant ageing process on molecular physiological levels with special attention on ageing 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 ageing
2. Initiation of plant ageing
3. Plant cell ageing and programmed cell death
4. Arabidopsis and crop models of leaf ageing
5. Age-dependent plant resilience against stresses</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td colspan="2">Forms and conditions of credit:
- attendance</td></tr>
</table>

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 experiment base on plant material with *in vitro* culture. Student will be able to characterized stage of in vitro culture experiment and role of plant hormones. Student will understand the influence of different conditions, explant type, medium on *in vitro* cultures. Student will be able to plan experiment, chose right explant types and medium ingredients, select proper growth condition in phytotron. Student will be able to prepare culture medium, establish and carry on experiments, observation. After the course students will be familiar with *in vitro* cultures of plant, will know how to choose right medium, explants and condition.	
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 lecture focus on mechanisms on plant resistance against pathogens and molecular interactions of plant and pathogens molecules during signal transduction of defence 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 the crop plants mostly in Europe will be described. 1. Symbiotic and pathogenic interactions of microbe and insect with plants 2. Gene for gene interaction, plant receptors and pathogen avirulence factors 3. Viral plant diseases 4. Agrobacerium 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 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: **summer/winter**	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 heterozygosities 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 for 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 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 on 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 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 into 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 with 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 (filed trip 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 on 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 of 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 morains and kems. Methods of descriptions of 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	

<table>
<tr><td colspan="2">Course: Toxicology</td></tr>
<tr><td colspan="2">Course Coordinator: dr hab. Andrzej Bajguz, prof. UwB
Email: abajguz@uwb.edu.pl, alicjap@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): 30
*Lecture: 15
*Laboratory: 15</td></tr>
<tr><td>ECTS: 3</td></tr>
<tr><td colspan="2">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, their effect on human health.
Toxicology of narcotics.</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td colspan="2">Forms and conditions of credit:
- final report and pass test from the laboratory
- attendance at the lab and lecture
- written exam (lecture part)</td></tr>
</table>

Course: **Trends and methods in immunobiology**	
Course Coordinator: Aneta Książek, PhD Email: anetak@uwb.edu.pl	
Language: **English**	
Semester: **winter/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 assessment of blood parameters, 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 effect 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