*The list of courses presented in this document is indicative and provides an overview of the potential course structure within the selected degree programme. The final study programme, including the list of courses and their content, may be subject to modifications depending on the academic year in which the student commences their studies. The university reserves the right to make adjustments to the study programme while maintaining the overall academic objectives and intended learning outcomes of the degree.*

| No. | Name of the course | Curriculum content |
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| 1. | Chemistry of organic and inorganic compounds | Consolidation and extension of selected topics in general chemistry essential for understanding natural phenomena and processes. Introduction to fundamental concepts and principles used in analytical chemistry. Mastering the knowledge on key topics in organic chemistry, particularly the properties and applications of organic compounds based on their functional groups and the types of isomerism. Preparation for independent laboratory work in accordance with basic safety rules and proper interpretation of experimental results. |
| 2. | Functional anatomy of the plant | Plant architecture: macromorphology, organography. Specific functional features of the primary and secondary plant tissues: protective/epidermal, conductive, mechanical, parenchymatous. Shoot and root apical meristems – general introduction to the topic, functioning and regulation, initial cells (stem cells). Vascular meristems (procambium and cambium) and phelogen (structure and function). Primary and secondary structure of roots and stems. Structure and function of leaves and flowers. |
| 3. | Diversity, biology and systematics of embryophytes | Fundamental knowledge of the diversity of major plant groups. Discussion of their morphological and anatomical characteristics, reproductive strategies, and life cycles, with emphasis on alternation of generations. Ecological roles and evolutionary significance of each group in terrestrial ecosystems. Overview of the plant orders and families, with selected representatives, of high economic, ecological, and cultural importance. Presentation of methods of vegetative and generative propagation, including natural and artificial techniques. Introduction to modern in vitro methods. |
| 4. | Fundamentals of systematic zoology | The phylogeny, diversity, characteristics, and systematics of the main phyla of invertebrates and the principal groups of chordates, as well as the basic methods used in their study. |

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| 5. | Animal histology | Animal tissues: epithelial, connective, muscular, nervous. Histology of the organs of the digestive, respiratory, circulatory, endocrine, urinary, and reproductive systems. |

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| 6. | Microbiology | Overview of the role and diversity of microorganisms in nature. Structure and characteristics of a prokaryotic cell. Major groups of prokaryotic organisms, including species important for human health and industrial applications. Differentiation of microorganisms based on their growth in selected media. Methods for isolation, cultivation, and detection of selected microorganisms from environmental samples. |
| 7. | Basis of entrepreneurship | The concept of entrepreneurship in the academic literature. Characteristics of the entrepreneur. Types of entrepreneurship. Entrepreneurial competencies, motivation, risk, and empathy in business. Developing creativity. How to find a business idea. Sources of inspiration for starting a business. Creating a business plan. |
| 8. | Biochemistry | Molecular foundations of life. The role of water in biological systems. Amino acids and proteins. Protein structure. Biological functions of proteins. Mechanisms of enzyme action and regulation of their activity. Structure and function of lipids. Biological membranes. Structure and function of carbohydrates. The role of nucleotides and the structure of nucleic acids. Vitamins. Basic metabolic pathways of carbohydrates, lipids, and proteins. Fundamental mechanisms of metabolism regulation and integration. |
| 9. | Genetics | Mendelian genetics. Population genetics. Cancer genetics. Fundamentals of genetics of fruit flies, bacteria, viruses, plants, animals, and humans. Concept of the gene. Genetic code. Morgan’s theory. Extranuclear inheritance. Mutagenesis and DNA repair. Genetic interactions. Genomes and their evolution. Basics of genomics. |
| 10. | Plant cell biology | Identity, structure and origin of a plant cell. Methods used in cell biology studies. Composition and function of selected cellular structures and compartments. Cell cycle and its regulation in a plant cell. Intercellular connections. Programmed cell death (in plants). |

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| 11. | Animal cell biology | Structure of the nucleus, cytoplasmic structures (membrane-bounded organelles, cytoskeleton), cell divisions, animal cell cycle, types of animal cell death. Visualisation of selected organelles, subcellular fractionation, extraction and isolation of subcellular organelles from tissue, *in silico* methods in animal cell biology. |
| 12. | Microscopic techniques | Preparation of material for observations in a light microscope. Preparation of material and observations in fluorescence and confocal microscopy, transmission electron microscopy (TEM), scanning electron microscopy (SEM); immunocytochemical techniques. |

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| 13. | Science behind mindfulness, mindfulness for science | Science of mindfulness including the latest neurobiological discoveries and concepts. The default mode network and its role in maintaining of awareness. Biological and social costs of being unmindful. Mindful approach to study and life. Mindfulness techniques and meditation practice. Mindful critical thinking. Effective decision-making. Foundations of logic and formal reasoning. Cognitive biases. |
| 14. | Calculations in experimental biology | Basic SI units and their scaling. Preparation of solutions: reagents mass calculation, conversion of molar and percentage concentrations, dilution, mixing solutions of different densities and concentrations, calculation of pH and buffer capacity. Fundamentals of spectrophotometric measurements. |
| 15. | Physical education | Students will get acquainted with various sport disciplines, exercises and activities, together with taking care of health and safety. Team activities will help to broaden the social competences. |
| 16. | Foreign language | Linguistic proficiency in the use of a selected modern foreign language, encompassing content and vocabulary consistent with the requirements of the B2 level of the Common European Framework of Reference for Languages (CEFR). |
| 17. | Polish language for foreigners | The module on "Polish language" includes vocabulary and grammar of a foreign language in accordance with the requirements specified for the A1 level of the Common European Framework of Reference for Languages. Students acquire reading, writing, speaking and listening skills in a foreign language at the level |

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| | | specified in the programme. Communication competencies are broadly developed, enabling understanding in various situations. |
| 18. | Experimental approach to plant developmental biology | Specificity of plant development: structure, function and regulation of plant meristems. Mechanisms protecting genetic information of proliferating cells. The role of transcription factors and induction in plant developmental processes determination. Genotype vs phenotype. General information on genetic crosses, chemical and insertion mutations and transgenic Arabidopsis plants creation. Methods used to visualise cellular compartments and molecular components of a plant cell (e.g. reporter genes GUS and GFP, immunolocalisation), fluorescent tracers application to plants and the use of dyes and probes in plant developmental research. Anatomical sections preparation of plant material and guidelines for their proper use. Experimental methods related to the analysis of secondary tissues and their applicability. |

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| 19. | Genetic engineering techniques | Concepts of genetic engineering, cloning, and heterologous expression. Restriction analysis. Ligation. Protein labeling and detection. Gene cloning. Reporter genes. DNA purification. Transformation of bacteria and yeast. |
| 20. | PCR techniques in use | PCR reaction. Reaction optimization. Principles of primer design for PCR. Sitedirected and random mutagenesis. Comparison of PCR and real-time PCR techniques – in theory and practice. Applications of PCR methods. |
| 21. | Basics of evolutionary biology | Evolution of genes and genomes. Evolutionary ecology. Macroevolution. Coevolution. Diversity patterns and extinction. Speciation and species. Origin of life. Human evolution. |

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| 22. | Molecular genetics | Structure and properties of nucleic acids. Organization of prokaryotic and eukaryotic chromosomes. Mechanisms of DNA replication, repair, and recombination. Mobile genetic elements including transposons, retrotransposons, and retroviruses. Oncogenes. Transcription and translation processes. Principles of gene expression regulation. Operon model. Molecular foundations of immune responses. Gene libraries. Extranuclear and viral genomes. |
| 23. | Plant physiology | Plant water management. Plant pigments. Processes involved in photosynthesis. Mineral nutrition of plants. Cellular respiration. Germination of plants. Phytohormones and regulation of plant cell growth and other physiological processes. Plant movements. |
| 24. | Animal physiology | Excitable cell I – Neuron. Synaptic transmission. Excitable cell II – Muscle. Somatosensory receptors. Chemoreception. Vision. Neural regulatory centers – central and peripheral nervous system. Endocrine system. Respiration – $O_2$ and $CO_2$ Transport. Circulation. Energy homeostasis. Biological rhythms. Mechanisms of addiction development. Effects of psychoactive substances on the human brain and behaviour. |
| 25. | Principals of immunology and virology | Immune cells and the anatomy of the immune system. Innate and adaptive immune response. Active and passive immunity. Mechanisms of cell-mediated and humoral immunity. Antibodies. T-cell receptors (TCRs) and antigens. Generation of antibody diversity. Major histocompatibility complex (MHC). Antigen processing and MHC restriction. Immunodiagnostic techniques and their application in microbiology. Structure, classification, origin, and importance of prokaryotic and eukaryotic viruses. Viral replication strategies and pathogenicity mechanisms. Overview of the most important human viruses and viral diseases. Subviral agents including viroids, satellite viruses, and prions. Antiviral therapeutics and vaccines. |

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| 26. | Isolation of plant subcellular fractions | Principles of separation of plant subcellular fractions. Differential centrifugation, centrifugation in the PEG-Dextran two-phase system, centrifugation in density gradient. Determination of purity of isolated subcellular fractions. Characterisation and activity assay of enzyme markers specific to subcellular fractions. |
| 27. | Animal developmental biology | Gametogenesis: oogenesis, spermatogenesis. Fertilization. Early stages of embryonic development. Basic information on mechanisms of embryonic induction. |
| 28. | Statistics in biology | Fundamental concepts of mathematical statistics. Statistical software tools for data analysis. Properties of the normal distribution. Statistical hypothesis testing. Analysis of variance (ANOVA). Regression analysis. |
| 29. | Preparation of B.Sc. thesis | The detailed substantive content corresponds to the research topic pursued by individual scientific units within the proposed subjects. |
| 30. | Genetics and molecular biology of plants | Model plants in molecular biology. GMO crop plants. Methods for the isolation of nucleic acids (DNA, RNA) from plant tissues. Reverse transcription and PCR reactions used in plant molecular biology. Reference genes in plant research. Cloning of complete gene sequences into vectors. Vectors used for cloning and expression of plant genes or for analysis of plant gene promoter activity. Methods of plant transformation. Biology and properties of *Agrobacterium tumefaciens* and *A. rhizogenes*. Ti and Ri vectors. Silencing of plant gene expression. Genome modifications involving programmed nucleases: ZFN, TALEN and CRISPR-Cas systems. Examples of heterologous systems used in plant protein production and function studies. |
| 31. | Molecular organization of the cell | Organization of the cell nucleus including chromatin structure, posttranslational histone modifications, histone code, chromatin remodeling, nuclear pores, and nuclear lamina, nucleocytoplasmic transport. Protein sorting via translocators, vesicular transport, endocytosis. Molecular mechanisms of regulated cell death. |

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| 32. | Informatics in experimental biology | Subject and levels of analysis in genomics and bioinformatics. Types of biological databases. Genome analyses and comparative genomics. Pairwise and multiple sequence alignment. Searching for similar sequences in databases. Motifs and patterns in sequences. Computational analysis of protein sequences: examination of basic physicochemical properties of proteins, identification of transmembrane regions, motifs, and domains, determination of protein secondary structure. Databases of spatial structures and methods for predicting tertiary structure. Phylogenetics and molecular evolution: construction and evaluation of phylogenetic trees. |
| 33. | Copyright and labour law | Legal concept of employment relationship. The concept of employer and employee. Employment contract – form, content, types. Termination of the employment relationship. Termination by mutual agreement. Termination with notice. Contract modifying notice and Termination without notice. Intellectual property law – concept, scope of regulation, sources of law. Work under copyright law – definition, types of works: employee works, scientific works, student works, computer works. Personal and economic copyrights – scope and protection. Invention projects and their types. Invention under industrial property law. Types of inventions. Employee inventions. Biotechnological inventions. Remuneration/salary for work + case studies. Employee leaves and leaves from work (e.g. dismissal, resignation, layoff) and Parental rights. Noncompete clause. Discrimination. Mobbing (workplace bullying). Dealing in copyrighted works. Permitted use of copyrighted works – assessment of infringement. Patent rights and other protective rights. Scope and protection. Trademark law. Industrial design law – assessment of infringement. |
| 1. | Histological techniques | Steps in the histological preparation of materials from animals: tissue collection, fixation, staining. Animal cytochemistry. Histochemistry. Interpretation of results. Application of histological techniques in histopathology. Reasons for misinterpretation of results. |

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| 2. | Introduction to cytogenetics | An introduction to the history of cytogenetic research. Genome structure and organization. Chromosome morphology and number. Fundamental methods in cytogenetic studies. Mutational changes in chromosomes and genomes and their effects on the karyotype and the organism as a whole. The cell cycle, mitosis, and meiosis in plant and animal cells, including cell cycle aberrations, polyploidization, types of polyploids, and additional chromosomes such as artificial, sex, and B chromosomes. Methods for artificial chromosome creation. Endomitosis in plants. Karyotype analysis in animal systematics, comparative biology, and phylogenetic studies. Chromosomal rearrangements and their role in speciation. Examples of karyotype/genome evolution. Cytogenetic analysis of ploidy levels as a tool for investigating changes in reproductive strategies in vertebrates. |
| 3. | Evolutionary innovations of land plants | Structural and functional adaptations of plants during land colonisation (e.g. evolution of protective and conducting systems, the role of lignin, cutin and suberin). Evolution of the plant form, emergence and evolution of plant structures (e.g. roots, leaves, ovules, flowers etc.). Evolutionary changes of the land plant life cycles. |
| 4. | Methodology of designing scientific research | Introduction to research methodology. Research problem, question, and hypothesis – definitions, examples, and characteristics of a good hypothesis. Types of studies on microorganisms, research ethics, and scientific responsibility. Research plan – structure, logic, variables, and control. Selection of experimental methods and techniques. Designing replication and research samples. Fundamentals of data interpretation and statistical planning. Analysis of results from sample studies. Critical review of publications – exemplary and flawed designs. Presentation of scientific results – graphs, tables, charts, and diagrams. Construction of a research report and mini-grant. Preparation and presentation of final projects. Consultation and project revisions. |

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| 5. | Experimental ecology and ecotoxicology | Formulating problems, questions, and research hypotheses in experimental ecology. Planning ecological experiments (Design of Experiments, DOE). Methods for observational and experimental research in the field and laboratory. Theoretical basis of ecotoxicology. Potential sources of environmental contamination, effects of environmental toxins on living organisms. Techniques and standard toxicological tests using model organisms. Ecological parameters and methods used in assessing the impact of toxic substances. Statistical analysis and graphical presentation of research results. |
| 6. | Dynamics and regulation of microbial growth | Bacterial cell division. Determinants of cell morphology. Growth of bacterial populations and the physical and chemical factors affecting microbial growth. Methods for measuring cell number and biomass, including microscopic counts, viable cell counts, spectrophotometric (turbidity) measurements, and advanced techniques such as flow cytometry, qPCR, and fluorescence-based assays. |
| 7. | Genomic engineering | Theoretical basis of CRISPR/Cas9 system: origin, terminology, concept of genome editing. Delivery of CRISPR/Cas components. Identification of induced mutations. Advantages and disadvantages of the CRISPR/Cas9 |

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| | | technology. Applications and rational benefits. Implementation of CRISPR/Cas9 system in practice. |
| 8. | Plants secondary metabolites and their practical application | Characterisation of main groups of plant secondary metabolites. Issues related to the allelopathy, functions of metabolites in plants, and their importance in human life (medicine, food industry, cosmetics, and others). Methods for the separation and identification of selected secondary metabolites. |
| 9. | Population genetics | Overview of population genetics: genetic material and inheritance. Geneenvironment interactions and epigenetics. Allele and genotype frequencies. Qualitative and quantitative traits. Hardy-Weinberg equilibrium and its deviations. Adaptation and selection models. Sources of genetic variation including mutations and mobile elements. Genetic markers and population parameters. Genetic drift, inbreeding, and population bottlenecks. Population structure. Gene flow and molecular tools in population biodiversity analysis. |

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| 10. | Infectious parasitic diseases | Introduction to the most important human parasitic pathogens and diagnostic methods as well as prevention and control of parasitic diseases. General and medical parasitology, opportunistic parasites. Vectorborne, foodborne and waterborne parasitic diseases. Selected diagnostic methods used in parasitology. |
| 11. | Bioinformatic analysis of genes and proteins | Construction and exploration of genes, proteins, and genome databases based on plants. Identification of genes encoding selected proteins in genomes of model plants. Selection and application of bioinformatics tools for the analysis of genes and proteins. Visualisation of protein structures and classification of proteins into specific families and functional groups based on phylogenetic analyses. Functional prediction of novel or uncharacterised proteins. |
| 12. | Journal club | Presentation and discussion of experimental design. Methodology and data analysis based on selected articles from experimental biology field. |
| 13. | Developmental biology of model and non-model invertebrates | Strategies of oocyte growth and maturation, organization of the ooplasm, relationship between somatic and germ cells, ovary structure in phylogenetic studies. Lecithotrophy and matrotrophy. |
| 14. | Applied data analysis in biology | Key aspects of data preparation and quality management in biological research. Applied statistical techniques for analysing biological data (clustering, classification, dimensionality reduction, and multivariate analysis). Statistical modelling, data visualisation, as well as other topics relevant to contemporary biological data analysis. |
| 15. | Molecular and biochemical principles of plant nutrition | Mineral components that function as macro and microelements in plants. Molecular basis of their uptake, transport and assimilation. Functions of mineral components in plants and symptoms of their excess and deficiency. |
| 16. | Human genetics | Structure of the human genome. Inheritance patterns, including autosomal, sex-linked, mitochondrial, and multifactorial. Examples of genetic disorders in humans. Cancer genetics. Genetic diagnostics. Genetic counseling. |

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| 17. | High-throughput data analysis | Introduction to next-generation sequencing. DNA and RNA sequencing methods. Reference genomes. Assembly and de novo assembly. Mapping to reference genomes. Selected bioinformatics tools for analysing next-generation sequencing data. Sequencing data formats. Sequencing data processing. |
| 18. | Research project | The detailed content depends on the topic of a given research project. |