Subject card

Subject name and code	Toxicology, PG_00188310						
Field of study	Forensic Analytics						
Date of commencement of studies	October 2026		Academic year of realisation of subject	2027/2028			
Education level	Bachelor's studies		Subject group	Obligatory subject group in the field of study Subject group related to scientific research in the field of study			
Mode of study	full-time studies		Mode of delivery	at the university			
Year of study	2		Language of instruction	Polish			
Semester of study	4		ECTS credits	3.0			
Learning profile	academic		Assessment form	exam			
Conducting unit	Faculty of Chemistry -> Rector						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. Joanna Makowska				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	0.0	0.0	0.0	30
	E-learning hours included: 0.0						
Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan		Participation in consultation hours		Self-study	SUM
	Number of study hours	30		10.0		35.0	75
Subject objectives	The aim of the lectures is to familiarize students with the basic concepts of toxicology, including: the definitions, history, and epidemiology of poisoning; the mechanisms of toxic effects of substances on the human body (pharmacodynamics) and their absorption, metabolism, and excretion (pharmacokinetics); the characteristics and hazards associated with selected groups of toxic substances (e.g., alcohol, medicines, narcotics, environmental poisons, heavy metals); the impact of pharmacologically active substances on health, public safety (e.g., in road traffic), and the environment (ecotoxicology); and toxicological analysis and interpretation of poisoning results (forensic and clinical toxicology). The lectures are designed to provide knowledge about wise choices in the context of potentially toxic environments and to understand the medico-legal aspects of poisoning and addiction.						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[AKRL3_W03] The graduate knows and understands the structure and chemical properties of compounds relevant in forensic examinations.	Student knows the structure, chemical properties, and mechanisms of action of toxic substances important in forensic and toxicological investigations and understands their significance in the identification and evaluation of evidence material..	[SW4] test/exam - oral or written [SW1] oral statement/ conversation/discussion [SW5] implementation of a problem task
[AKRL3_W12] The graduate knows and understands, at an advanced level, the latest trends and achievements in analytical chemistry, toxicology, molecular biology and instrumental methods used in forensic science.	Student knows modern analytical and instrumental techniques used in the analysis of toxic substances and understands their importance in the identification and analysis of evidence material.	[SW1] oral statement/ conversation/discussion [SW5] implementation of a problem task
[AKRL3_K06] The graduate is ready to follow occupational health and safety regulations in the laboratory and care for the safety of themselves and others.	Student is prepared to follow health and safety regulations while working with toxic substances, properly handle hazardous materials, and ensure their own safety and the safety of others in a toxicology laboratory.	[SK5] implementation of a problem task [SK6] demonstration of practical skills
[AKRL3_U10] The graduate is able to interpret data from different analytical techniques to reconstruct events or identify evidence material.	The student is able to interpret the results of toxicological analyses obtained using various analytical techniques and apply them to the identification of toxic substances and the assessment of their significance in evidence material analysis.	[SU1] oral statement/conversation/ discussion [SU2] presentation/project/paper/ report [SU5] implementation of a problem task

Subject contents	**1. The Wise Search for Endorphins in a Toxic World as an Introduction to Toxicology** An outline of contemporary toxicology in the context of wise choices. The history of toxicology. The epidemiology of poisoning in Poland and worldwide. Basic toxicological concepts (poison, toxin, xeonobiotic, therapeutic, toxic, and lethal dose). Fields of toxicology (forensic, clinical, environmental, and industrial toxicology). Basic groups of poisons. Mechanisms of toxic action on the human body. Therapeutic, toxic, and lethal concentrations in biological material. Factors influencing the toxicity of xenobiotics. Toximetry. **2. Pharmacodynamics - Mechanisms of Toxic Action** Toxidromes: cholinergic, anticholinergic, opioid, sympathomimetic, sedative-hypnotic, alcohol and sedative-hypnotic withdrawal, opioid withdrawal. Comparison of symptoms characteristic of individual toxidromes. Comparison of symptoms of poisoning and disease states. Tissue hypoxia or abnormal utilization of combustion energy. Inhibitors of enzymatic reactions. Effect of poisons on impulse conduction processes in the nervous system. Active metabolites (covalent bond). Toxic effects of free radicals. Physical and chemical effects (chemical carcinogenesis). Interactions of xenobiotics. Biomarkers. **3. Pharmacokinetics - Kinetics of transformation and excretion of toxic substances** Absorbtion routes. Transport of xenobiotics across biological membranes. Absorption in the respiratory tract, through the skin, and through the digestive tract. Distribution and tissue binding of xenobiotics. Biotransformation of xenobiotics. Excretion of substances from the body. Kinetic models. Exposure rhythms. LADMET: L Liberation, A Absorption, D Distribution, M Metabolism, E Excretion/Elimination, T Toxicity. **4. Medical Basis of Addiction** The phenomenon of drug addiction and drug dependence, epidemiology. Factors influencing addiction. Brain mechanisms of addiction. Pharmacological tolerance, cross-tolerance. Withdrawal syndrome. Factors increasing and decreasing the risk of drug abuse. Poisoning with addictive substances. Classification of pharmacologically active substances. Narcotic drugs and psychotropic substances, precursors, substitutes, classic and new psychoactive substances (legal highs), inhaled narcotics. **5. Ethyl Alcohol and Humans A Toxic Compound** Alcohol and Public Health. Intoxication from a Medical and Legal Perspective. Types of Breath Analyzers. Laboratory Tests Using the ADH Enzymatic Method and Gas Chromatography (GC). Phases of Alcoholemia and Alcohol Metabolism. Interactions of Ethanol with Xenobiotics. Prognostic and Retrospective Calculations. The Effect of Ethanol on Psychomotor Performance. Assessment of Alcohol's Effects on Children. Interpretation of Post-Mortem Examinations, Endogenous Ethanol and Residual Alcohol. Ethyl Alcohol Substitutes (Ethylene Glycol, Methanol, Propan-2-ol). Markers of Alcohol Abuse and Dependence. **6. Pharmacologically Active Substances and the Threat to Life and Health** Substances Facilitating the Commitment of Crimes, Including Substances Facilitating Sexual Abuse. Doping in Sports. Dietary Supplements. Counterfeit Medicines. Poisoning with Carbon Monoxide, Hydrogen Sulphide, and Cyanides (Hydrogen Cyanide). Poisoning with Metals (Arsenic, Chromium, Cadmium, Lead, Mercury) and Their Compounds. Poisoning with Volatile Organic Solvents. Poisoning with Animal (Bites, Stings) and Plant (Mushroom) Poisons. Biocidal Products. Corrosive Substances, Household Chemicals, and Cosmetics. **7. Pharmacologically Active Substances and Road Safety** Road safety issues. Legal Regulations in Forensic Chemistry. The Effect of Drugs on Drivers' Psychophysical Performance. Pharmacodynamics and Impairment of Psychomotor Functions. Symptoms of Impairment. Groups of drugs at particular risk: psychotropic drugs, antidepressants, neuroleptics, opioid analgesics, antihistamines, antihypertensive drugs, antiepileptic drugs, muscle relaxants. Drug and alcohol interactions. Summary of Product Characteristics and patient information leaflet. Patient awareness. Substances with similar effects to alcohol. Psychomotor performance tests: reaction time, coordination, perception assessment. Diseases and their impact on road safety. **8. Pharmacologically active substances and environmental pollution** Main classes of pollutants and their toxicity. Ecotoxicology. Poisoning with pesticides (plant protection

products). Classification of pesticides. Specific toxicity of pesticides. Persistent organic pollutants. Pesticides currently used and their mechanisms of action (e.g., neurotoxicity) and persistence in the environment. Dioxins and polycyclic aromatic hydrocarbons (PAHs). Endocrine active substances (bisphenol A, phthalates, selected pesticides). Fate of pollutants between various environmental compartments (soil, water, air, sediments) and possible xenobiotic transformations (e.g., biodegradation, photolysis, biotransformation). Bioaccumulation and biomagnification. Bioavailability. Microplastics and nanoplastics. Risk assessment and research methods. Biomonitoring. Biomarkers of exposure and effect. Toxicology of air pollution (SMOG). PM2.5 and PM10 particulate matter, PAHs, metals. Mechanism of toxic effects on the respiratory and cardiovascular systems (oxidative stress, inflammation). Toxic gases (carbon oxides, sulfur oxides, nitrogen oxides).

9. Diagnosis of the most common poisonings

Diagnosis of in vivo and fatal poisonings. Multi-directional and targeted toxicological analysis. Colors and odors of poisons. Screening, confirmatory, and evidentiary tests. Diagnostic algorithm. Time ranges for xenobiotic detection, result interpretation, laboratory methods and instrumental techniques (including thin-layer chromatography, liquid chromatography, gas chromatography, mass spectrometry), properties and applications of classic biological materials (blood and urine) and alternative materials (saliva, hair, nails, meconium). Interpretation of laboratory test results. Analysis of the composition of physical evidence. Proficiency testing and accreditation of diagnostic laboratories.

10. Forensic Medical Case Studies

Pharmacological substances used for criminal, suicidal, and accidental purposes, based on examples from our own consulting practice and the literature.

Prerequisites and co-requisites

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Written examination (open-ended and multiple-choice questions) covering the topics discussed during the lectures.	51.0%	100.0%

Recommended reading

Basic literature	1. Piotrowski J.K. (red.), Podstawy toksykologii, Kompendium dla studentów szkół wyższych, WNT, Warszawa 2017. https://libra.ibuk.pl/book/195421 2. Seńczuk W. (red.), Toksykologia współczesna, PZWL, Warszawa 2005. https://libra.ibuk.pl/book/41533 3. Łukasik Głębocka M. (red.), Ostre zatrucia w praktyce ratownika medycznego, PZWL, Warszawa 2018. https://libra.ibuk.pl/book/199591 4. Teresiński G. (red.), Medycyna sądowa, Tom 1 Tanatologia, PZWL Wydawnictwo Lekarskie, Warszawa, 2019, https://libra.ibuk.pl/book/212402 5. Teresiński G. (red.), Medycyna sądowa, Tom 2 Diagnostyka sądowa, PZWL Wydawnictwo Lekarskie, Warszawa 2020, https://libra.ibuk.pl/book/230805 6. Teresiński G. (red.), Medycyna sądowa, Tom 3 Opiniowanie i kliniczna medycyna sądowa, PZWL Wydawnictwo Lekarskie, Warszawa 2021, https://libra.ibuk.pl/reader/256989 7. Król M., Kościelniak P., Wietecha-Posłuszny R., Woźniakiewicz M. (red.), Analityka sądowa, Wydawnictwo Naukowe PWN, Warszawa 2022. 8. Wiergowski M., Sein Anand J., Alkohol i człowiek - toksyczny związek. Problemy wywołane spożywaniem alkoholu etylowego, PZWL, Warszawa, 2023. 9. Nutt D.J., Narkotyki bez paniki. Co trzeba wiedzieć o legalnych i nielegalnych środkach psychoaktywnych, Wydawnictwo Krytyki Politycznej, 2021. 10. Flanagan R.J., Cuypers E., Maurer H.H., Whelpton R., Fundamentals of Analytical Toxicology: Clinical and Forensic, Wiley 2020. 11. Rębała K. (red.), Contemporary aspects of laboratory diagnostics in forensic medicine , GUMed , Gdańsk 2015 ((skrypt w języku angielskim z dziedziny toksykologii i genetyki sądowej)
Supplementary literature	n/a
eResources addresses	

Example issues/ example questions/ tasks being completed

1. Analysis of poisoning cases and interpretation of toxicological test results.
2. Selection of appropriate analytical techniques for the identification of toxic substances in biological and evidence materials.
3. Development of a diagnostic procedure algorithm for selected poisoning cases.
4. Interpretation of toxidromes and assessment of the effects of psychoactive substances on the human body.
5. Analysis of the impact of toxic substances on road safety based on case studies.
6. Assessment of toxicological risk and interpretation of data related to exposure to xenobiotics.

Work placement	Not applicable

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