University of Gdańsk

Subject card

Subject name and code	Graduate study lecture - Simple sugars – structure and stereochemistry, PG_00040376		
Field of study	Chemistry		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2025/2026
Education level	Master's studies	Subject group	Obligatory subject group in the field of study Optional subject group
Mode of study	full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	2	ECTS credits	3.0
Learning profile	academic	Assessment form	
Conducting unit	Laboratory of Carbohydrate Chemistry -> Department of Organic Chemistry -> Faculty of Chemistry -> Rector		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. Barbara Dmochowska	
	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	5.0	40.0	75

Subject objectives

- To introduce students to the basic division of sugars according to the number of carbon atoms;
- to introduce students to the nomenclature of sugars (IUPAC and customary);
- to introduce students to the conformations of the five-membered ring, six-membered ring of sugar and cyclic unsaturated systems;
- to introduce students to steric and electron interactions in pyranoses;
- learning the basics of calculating the composition of the equilibrium mixture, calculating G of conformational and configurational equilibrium;
- learning the basics of physical methods of construction monosaccharides.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[CHEMMU2_U02] Critically assesses the results of conducted, performed observations and theoretical calculations and discusses errors.	• Possesses the ability to critically evaluate the results of experiments, observations, and/or theoretical calculations.	[SU4] test/exam - oral or written
[CHEMMU2_K01] Knows the limitations of her/his own knowledge; understands the need for further education and can inspire other people to do so.	• Appreciates and understands the role of sugars in human life. • Understands the need for further education to gain a deeper understanding of the reactions occurring in living organism cells.	[SK1] oral statement/conversation/ discussion
[CHEMMU2_W05] Has extended knowledge in the field of the specialisation studied.	• Formulates and defines basic laws and concepts used in carbohydrate chemistry. • Knows the IUPAC nomenclature rules for chain and cyclic sugars. • Distinguishes stereochemical relationships between monosaccharides. • Identifies factors affecting the magnitude of the anomeric effect. • Differentiates between the anomeric effect and the reverse anomeric effect. • Presents conformational and configurational equilibrium and identifies factors affecting ΔG of conformational and configurational equilibrium. • Knows the physical methods for studying the structure of sugars in carbohydrate chemistry and the spectral characteristics of sugars and their derivatives.	[SW4] test/exam - oral or written

Subject contents

Topics of the lectures:

1. The occurrence and the role of sugars in nature. Classified sugars according to the number of carbons. Structure and constitution of the parent monosaccharides in the acyclic form (aldose and ketose family tree). The Fischer and Newman projection of the acyclic forms.
2. Nomenclature of D,L-sugars configuration. Enantiomers. Diastereoisomers. Epimers. Classification of sugars by functional groups other than OH. Family tree of diastereoisomers. IUPAC and trivial nomenclature of sugars higher than hexacarbons and modification sugars.
3. The family tree in acyclic forms: hemiacetals. Configuration (and the rules of nomenclature) of the anomeric carbon atom: piranoses, furanoses and sugars having carbon numbers greater than six.
4. Anomeric configuration: mutarotation, optical activity, reduction, oxidation, enediol reactions, properties of the anomeric OH group, and the another OH groups, acetal structure, conversion from aldoses to ketoses. The constitutional isomerism monosaccharides in an aqueous solution.
5. Structure and naming of selected monosaccharides: *O*- and *N*-glycosides, deoxysugar, glycosyl halides, unsaturated monosaccharides, disaccharides, oligosaccharides, uronic acids, aldaric acids. Vitamin C. The Mills depiction.
6. The conformational isomerism (determination of the stability of erythro- and threo-but-2,3-diol). Conformations of acyclic sugar derivatives. The rules transformation Fisher formulas to a perspective formulas. Zig-zag and crescent conformations, destabilizing effects: 1,2-syn and 1,3-syn.
7. The conformations of the pyranose rings (nomenclature). Conformational symbols to distinguish the epimers and diastereoisomeric sugars. Map of conformational transformation of the sugar ring. Energy diagram for sugars and cyclohexane. Steric and electronic effects in a pyranoses. Factors influencing the overall conformational energy value varieties pyranoses. Method of determining the interaction energy values based on the examination of non-binding equilibrium formation of borate complexes cyklitol models and selected pairs of anomers of sugars and their derivatives. The destabilizing effects.
8. The calculation of conformational and configuration G equilibrium. Anomeric effect. Impact on the stability of the conformation of the sugar. The reverse anomeric effect. Solvent effects and the exo-anomeric effect.
9. Physical methods analysis of carbohydrates: Infrared Spectroscopy, NMR spectroscopy (information about: the chemical shifts of the signals; their integration; the coupling constants J deduced from the detected multiplets), determination of the composition of the equilibrium mixture of free sugars in D_2O, determination of pyranose configuration, spin-spin coupling, relations configuration of protons in pyranose and furanose rings, long range coupling, spectra analysis, 13C NMR comparison to the furanose and pyranose.

Prerequisites and co-requisites

Organic chemistry, Spectroscopic techniques.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
The final course grade is determined by the average of the grades of the written three tests of the individual parts of the lecture or one grade of the written overall test.	51.0%	100.0%

Recommended reading	Basic literature	J. F. Stoddart *Stereochemistry of Carbohydrates* A. Wiśniewski, J. Madaj *Podstawy Chemii Cukrów*
	Supplementary literature	T. Sokołowska, A. Wiśniewski *Nomenklatura węglowodanów* odpowiednik *Nomenclature of Carbohydrates* (Recommendations 1996) B. O. Fraser-Reid, K. Tatsuta, J. Thiem *Glycoscience: Chemistry and chemical Biology* G-J Boons, K. J. Hale *Organic Synthesis with Carbohydrates* S. A. Brooks, M. V. Dwek, U. Schumacher *Functional & Molecular Glycobiology* P. Crabbé *Metody chiralooptyczne w chemii* J. Świderski, J. Struciński, A. Temeriusz *Podstawy chemii węglowodanów*
	eResources addresses	
Example issues/ example questions/ tasks being completed	questions from the program content of the lecture	
Work placement	Not applicable	

Document generated electronically. Does not require a seal or signature.