

16. CLINICAL APPLICATIONS OF MASS SPECTROMETRY	
Level I	
Department of Experimental and Clinical Biomedical Sciences "Mario Serio"	
Course coordinator	Giovanna Danza
Executive Committee	Giovanna Danza Gianluca Bartolucci Giancarlo La Marca Gianluca Giorgi ⁱ Luca Calamai
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Practical-professional profile of the course and industry sector of reference	<p>The Course aims to provide:</p> <ol style="list-style-type: none"> 1. adequate basic technical and scientific knowledge and skills of mass spectrometry (MS) 2. specific knowledge and skills, both theoretical and practical, and qualitative and quantitative applications of MS and analysis of samples with a complex matrix 3. specific knowledge and skills on MS applications in the clinical field <p>In particular, the Course aims to train a professional profile of a laboratory technician skilled in mass spectrometry techniques.</p> <p>The mass spectrometry techniques covered in this Master Course are increasingly being used extensively in analytical laboratories in various fields of application, in clinical, food, environmental, and pharmacological analysis, in zoo prophylactic institutes, in anti-doping, and even in the forensic medical field.</p> <p>The professional profile trained by this Master Course will be able to find a place in analytical laboratories in all the areas listed above and will have special training for the clinical field, which is why the Master is open to the specific profile of Biomedical Laboratory Technician (L/SNT3)</p> <p>To this end, training will be structured as follows:</p> <p>Three integrated subjects and two practical internship activities. The activities are detailed below.</p> <p>First subject: "General principles of mass spectrometry." CREDITS 12</p> <p>This subject is divided into three modules.</p> <p><u>Module 1</u> "General principles of mass spectrometry, instrumentation and coupling with chromatographic systems" 6 CREDITS; Academic discipline: CHIM06</p> <p><u>Module 2</u> "Applications in proteomics, metabolomics, lipidomics, and imaging" 3 CREDITS; academic discipline: CHIM08</p> <p><u>Module 3</u> "Interpretation of mass spectra" 3 CREDITS; academic discipline: AGR13</p> <p>The subject covers content regarding the general principles of mass spectrometry, the function of the various instrumental parts, the main types of experiments that can be performed the different information that the instrumental data provides. It then moves on to techniques for coupling mass spectrometry with chromatography and illustrates the leading applications in the omics field of mass spectrometry with mentions of proteomics, metabolomics, and lipidomics and mass spectrometry imaging techniques. It then addresses the chapter on the interpretation of mass spectra in electron ionization of different classes of organic substances with particular reference to</p>

compounds of biological interest

The subject aims to provide the main knowledge about the basis of mass spectrometry, operation of instrumentation and coupling with chromatographic techniques, knowledge about the information that can be gained from studying a substance with this technique, fragmentation patterns of organic molecules, and the contribution of mass spectrometry to omics studies and MS-imaging.

It also intends to provide skills on the choice of the most suitable experiments to be performed and the instrumental and chromatographic systems to be used depending on the type of substance to be analyzed and the experimental objectives, and the main ways of analyzing the experimental data obtained.

Second subject: "Quantitative mass spectrometry on complex matrices."

12 CREDITS:

This subject is divided into 2 modules.

Module 1 "Principles of chromatography and purification of substances from complex mixtures"

6 CREDITS; Academic discipline: CHIM08

Module 2 "Principles of quantitative analysis in mass spectrometry"

6 CREDITS; Academic discipline: MED46

The content covers the main techniques for extraction and purification of substances from complex matrices, basic principles of chromatography, instrumental techniques in gas chromatography (GC) and liquid chromatography (LC), and theories of chromatography

The basic principles of quantitative analysis, calibration methods, and the development and validation of quantitative methods on complex matrices with special reference to mass spectrometry methods are then addressed.

The module aims to provide essential knowledge on the purification techniques of substances from complex matrices with a special focus on chromatographic techniques, operation of the main instrumentation for GC and LC, quantitative analysis by mass spectrometry on complex matrices, and the development and validation stages of a method. It also intends to provide skills on the choice of purification methods based on the types of substances and matrices and the use of instrumental chromatographic techniques, how to design analytical method development based on the nature of the sample to be analyzed and the analytical question, analysis of results, and method validation.

Third subject: "Clinical applications of mass spectrometry."

18 CREDITS:

This subject is divided into 6 modules.

Module 1 "Applications in endocrinology"

3 CREDITS; academic discipline: MED46

Module 2 "Applications in pharmacology"

3 CREDITS; academic discipline: MED46

Module 3 "Applications in toxicology and forensic medicine"

3 CREDITS; academic discipline: MED46

Module 4 "Applications in newborn screening"

3 CREDITS; academic discipline: BIO12

Module 5 "Applications in microbiology"

3 CREDITS; academic discipline: MED46

Module 6 "Quality Control and accreditation in the clinical laboratory"

3 CREDITS; academic discipline: MED46

The subject covers the main applications of mass spectrometry in various clinical fields by reporting examples and experiences of professionals from different sectors. It also addresses the fundamental topic of Quality Control and of accreditation in clinical laboratories.

The module aims to provide the main knowledge of assays and analyses used in

	<p>various fields and the advantages and limitations of mass spectrometry techniques for clinical diagnostics compared with other techniques in use in the clinical laboratory, the use of these methods in daily clinical routine, and analytical and organizational issues. It also intends to provide <u>expertise</u> on the issues to be addressed in the development of methods suitable for clinical routines and on the management of these techniques from the point of view of analytical, quality control, work organization, and quality assurance management in the clinical laboratory.</p> <p><i>Teaching Methods</i></p> <p>This Course makes use of 3 MOOC distance learning courses, one for each subject, for the acquisition of the main concepts regarding the topics covered, and subsequent face-to-face lectures, held in dual mode, with in-depth topics and interactive activities to consolidate knowledge and acquire skills on the topics covered. Some interactive activities are also offered remotely in the Master's MOODLE platform. Training interventions by experts in the fields covered carried out in-person (dual mode), or online are also planned.</p> <p>Assessment method</p> <p>Learning is verified through a <u>Final examination</u></p> <p>9 CREDITS:</p> <p>The final examination consists of a written paper on the activity carried out in the second internship and its discussion.</p> <p>At the end of the Course, learners will have acquired the following knowledge and skills:</p> <p>Theoretical/practical knowledge of the principles of mass spectrometry, the instrumentation and function of the various instrumental parts, and the main types of experiments that can be conducted with this technique.</p> <ul style="list-style-type: none"> • Basic knowledge and skills in the application of mass spectrometry to omics science and imaging mass spectrometry. • Basic knowledge and skills in the interpretation of mass spectra performed in electron ionization aimed at identifying the molecular structure of the substances analyzed. • In-depth knowledge and skills in quantitative analysis in mass spectrometry on complex matrices and primarily biological matrices. • Specific knowledge and skills in MS applications in different clinical fields. • Ability to use advanced mass spectrometry instrumentation. • Ability to self-study and plan regarding problems involving the development and use of analytical methods in mass spectrometry in various applications. • Autonomy of judgment and problem-solving skills with respect to experimental data obtainable in mass spectrometry. • Ability to assume proper professional behavior in the analytical laboratory environment. • Ability to work as part of a team and ability to communicate with appropriate terminology in analytical chemistry and mass spectrometry topics.
<p>Access prerequisites</p>	<p>Bachelor's degree obtained in accordance with the system under Ministerial Decree No. 270/2004 (or degree under Ministerial Decree No. 509/1999 equated under I.D. July 9, 2009) in one of the following classes:</p> <ul style="list-style-type: none"> • L-2 Biotechnology; • L-13 Biological Sciences; • L-25 Agricultural and Forestry Science and Technology; • L-26 Agri-Food Science and Technology;

	<ul style="list-style-type: none"> • L-27 Chemical Science and Technology; • L-29 Pharmaceutical Science and Technology; • L-32 Science and Technology for the Environment and Nature; • L-34 Geological Sciences • L-38 Animal Science and Technology in Animal Production • L/SNT3 Class of degrees in technical health professions-Biomedical laboratory technician or Equivalent diplomas in accordance with Art. 1, paragraph 10, Law 8/1/2002, no. 1 or Diplomas awarded by Schools directed for special purposes/ University diplomas equivalent in accordance with Art. 17 paragraph 1 Law 30/12/2010 no. 240. <p>Single-cycle degree obtained in accordance with the system under Ministerial Decree No. 270/2004 (or specialist degree under Ministerial Decree No. 509/1999 equated under I.D. July 9, 2009) in the class</p> <ul style="list-style-type: none"> • LM-13 Pharmacy and Industrial Pharmacy <p>Degree awarded according to a system prior to Ministerial Decree No. 509/1999 in</p> <ul style="list-style-type: none"> • Agribusiness biotechnology • Pharmaceutical biotechnology • Biotechnology - Agricultural plant biotechnology curriculum • Biotechnology - Industrial biotechnology curriculum • Biotechnology - Medical biotechnology curriculum • Biotechnology - Veterinary biotechnology curriculum • Biotechnologies • Pharmaceutical chemistry and technologies • Industrial Chemistry • Chemistry • Pharmacy • Agricultural science • Agricultural, tropical, and subtropical sciences • Environmental sciences • Biology • Agricultural science and technologies • Food science and technology • Animal production science and technology • Geological sciences • Natural sciences <p>degree awarded according to a system prior to Ministerial Decree No. 509/1999 of closely related content, deemed suitable by the Executive Committee or a Commission specifically appointed by it.</p>
How the admission procedure takes place	Selection by academic qualifications
Duration	10 months
Teaching methods	<p>Blended</p> <p><u>In person</u>: DSBSC classrooms</p> <p><u>Asynchronous Distance learning</u>: Federica.eu platform; UNIFI Moodle platform</p> <p><u>Synchronous Distance learning</u>: UNIFI Moodle platform/ Webex</p>
Language of instruction	Italian
Attendance requirements	It is mandatory to attend at least 80% of the activities considering both in-person and distance learning activities
Location of the Course	Offices of the Department

Foreseen lecture schedule	Classes are held on Thursdays and Fridays for 1 to 2 weeks per month
Examinations procedures and schedule	Assessments consist of tests including multiple-choice questions for knowledge testing and open-ended problem-solving questions for skills testing. The grade is given in thirtieths. There may also be a structured collective discussion with the presentation of analytical or data interpretation questions aimed at assessing teamwork and interaction skills and the appropriateness of technical language. Tests can be conducted online or in-person, depending on organizational needs. Assessment schedule Subject I assessment: by January 15, 2023 Subject II assessment: by the end of February 2023 Subject III assessment: by May 15, 2023
Final examination	The final examination consists of presenting a paper related to the internship and its discussion in front of the examination board.

Available places and enrolment fees	
Full-fee students	
Minimum number	5
Maximum Number	14
Enrolment fee	€1,800
Free-of-charge supernumerary places	
UNIFI employees	1
AOU Careggi Employees	1
AOU Meyer Employees	1
SINGLE MODULES	
None planned	

Description of the activities and training objectives of the internship	<p><u>1st practical internship: 3 CREDITS</u> Observational internship <u>Activity</u> This internship takes place at the AOU-Careggi "Piastra dei Servizi" in the laboratory of industrial toxicology and occupational medicine - endocrinology. It consists of the following activities</p> <ul style="list-style-type: none"> • the main mass spectrometry instrumentation in the laboratory (GC-MS, LC-MS, LC-MS/MS, ICP-MS) are explained • the main routine maintenance operations on the different instruments are shown, • various instrument management software are explained, • the main activities carried out in the laboratory are explained. <p><u>Learning Objectives</u> The internship provides general knowledge of the main mass spectrometry instruments that may be present in analytical laboratories, their routine management, the different software for both instrumental operations and data analysis, and the general management of the activities of a mass spectrometry laboratory in a clinical setting.</p> <p><u>2nd practical internship: 6 CREDITS</u> Practical professionalizing internship It takes place at laboratories that use mass spectrometry for clinical or biomedical/pharmacological-related applications It can be carried out at the workplace if it meets the above requirement, with recognition of the working hours as internship hours.</p> <p><u>Activity</u></p>
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	<p>The student is actively involved in tackling a topic that involves putting the topics studied during the Course into practice in a work environment and using mass spectrometry instrumentation. The subject matter is agreed upon, in accordance with the learning objectives, according to the needs of the host laboratory (method development, optimization problem, analysis of clinical case samples, etc.). The student is supervised by a university mentor who is a lecturer in the Master Course and a corporate mentor who is part of the host laboratory. The results of this internship activity constitute the topic of the Master Course's final examination.</p> <p><u>Learning Objectives</u></p> <p>The internship provides the skills to design an experimental activity aimed at solving problems involving the use of advanced qualitative or quantitative mass spectrometry techniques, skills and autonomy in working on the mass spectrometry instrumentation used regarding sample preparation, ability to make critical judgments of the results obtained, and soft skills in teamwork and proper behavior in an analytical laboratory.</p> <p>Practical activity in the laboratory. 225 total hours of internship.</p>
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ⁱ D.R. n. 1615 prot. n. 301501, December 29th, 2022