

2014 curriculum provisions for the Master of Science Programme in Medicinal Chemistry (MSc in Medicinal Chemistry) at the Faculty of Health and Medical Sciences, University of Copenhagen

These curriculum provisions come into force on 1 September 2014 and apply to students admitted to the programme since 1 September 2011.

The curriculum provisions were approved by the Dean on the 1st of September 2014 with changes approved in August 2016, March 2018, March 2019, March 2020, March 2022 and March 2023.

This subject-specific curriculum, the course or module descriptions in the overall University of Copenhagen course database and the general curriculum provisions together comprise the curriculum for the degree of Master of Science in Medicinal Chemistry (MSc in Medicinal Chemistry).

Part 1 Objectives and qualification profile

§ 1 Objectives

The objectives of the Master of Science Programme in Medicinal Chemistry are

1. To enhance the student's academic knowledge and ability, and to increase the theoretical and methodological qualifications acquired by the student on the bachelor programme
 2. To provide the student with theoretical and methodological interdisciplinary qualifications enabling him or her upon completion to identify and solve complex problems in organic chemistry and medical chemistry independently and at an academic level
 3. To provide the student with considerable training in scientific work and methods qualifying for a PhD or other postgraduate programme, and developing the student's ability to work in the pharmaceutical or biotechnological industries in particular
 4. To give graduates the competence to take on responsibility for exploiting research into pharmaceuticals.
- 1.2. Successful completion of the programme gives the right to use the title of Master of Science (MSc) in Medicinal Chemistry, the Danish title kandidat i medicinskemi, candidatus / candidata scientiarum in Medicinal Chemistry, and cand.scient. in Medicinal Chemistry.
- 1.3. The programme is worth 120 ECTS credits.
- 1.4. The programme belongs under the Study Board for the Pharmaceutical Sciences.
- 1.5. The programme belongs under the corps of external examiners for pharmaceutical degree programmes in Denmark.

§ 2 Admission requirements and competency profile

Applicants must have completed a bachelor programme in chemistry, medicinal chemistry or pharmacy at a Danish university and

1. Have accumulated at least 80 ECTS credits on chemistry courses in the fields of organic chemistry and physical chemistry with the emphasis on theoretical and experimental chemistry courses.

2. Have accumulated at least 30 ECTS credits from biology courses in the fields of biochemistry, molecular biology, physiology and pharmacology, of which at least 5 ECTS credits must come from within general pharmacology.

3. Submit a document certifying English skills equivalent to Danish secondary school 'English level B' with a weighted average of 3 (Danish grading scale) or 'English level A' with a weighted average of 2 (Danish grading scale) or one of the following language tests: International English Language Testing System (IELTS/Academic) or the Test of English as a Foreign Language (TOEFL).

- IELTS-test (British Council) with a minimum score of 6.5
- Paper-based TOEFL-test with a minimum score of 560 points
- Internet-based TOEFL-test with a min score of 83 points
- Passed Cambridge English Certificate: Advanced (CAE) – level C1

4. Applicants with a degree from an English taught qualifying upper secondary school diploma, bachelor's degree or master's degree from USA, Canada, Australia, New Zealand, UK or Ireland are exempted from the language requirement.

2.2. Applicants with a bachelor's degree in Medicinal Chemistry from the University of Copenhagen is granted legal right of admission to the MSc Programme in Medicinal Chemistry within 3 years of completing your bachelor's degree.

2.3. Applicants with the following degrees are directly academically qualified for admission onto the MSc Programme in Medicinal Chemistry:

- Bachelor's degree in Chemistry with a specialization in Medicinal Chemistry – University of Copenhagen
- Bachelor's degree in Pharmacy – University of Copenhagen, including:
 - The course NKEA05040U Advanced Organic Chemistry
 - A bachelor's project in Pharmaceutical Sciences within the scientific disciplines of medicinal chemistry and/or experimental organic chemistry

2.4. Applicants with Danish bachelor's degrees at variance from those described in 2.1 above may also apply for admission. The admissions panel will decide whether such applications equate to the specific requirements stipulated in 2.1. above.

2.5. Applicants holding bachelor's degrees from universities abroad may also apply. The admissions panel will decide whether such degree programmes equate in content and scope to the specific requirements stipulated in 2.1. above.

2.6. The bachelor's degree in question must have been gained no more than five years before commencement of the first semester of the programme.

2.7. In special circumstances the admissions panel may waive the requirements stipulated in 2.1.

2.8. 50 students may be admitted per annum.

§ 3 Competence profile

Graduates with an MSc in Medicinal Chemistry have completed a research-based degree programme underpinned by the subject areas of medicinal chemistry, structural chemistry, advanced organic chemistry, and peptide and protein chemistry, thereby achieving chemical competency in the core subjects relevant in drug discovery. These qualifications are applicable in other contexts in the pharmaceutical, biopharmaceutical and biotechnical industries, for example, in connection with the design, production and development of potential new drugs.

Knowledge:

The holder of an MSc in Medicinal Chemistry has acquired knowledge about:

- The rational basis for design, syntheses and development of drugs.
- New and effective methods of synthesis for incorporation or transformation of the most important functional groups.
- The relationship between molecular structure and biological activity at the molecular level, including comprehensive knowledge of the importance of steric, stereochemical, conformational and electrostatic factors.
- Structural chemical methods that can be used in the rational design of drugs
- Solid-phase methods of synthesis used to make peptides and peptide derivatives, including peptidomimetics.
- The significance of conformational, steric and electronic factors with regard to regio- and stereoselective syntheses of drug candidates.
- Physical-chemical parameters important for the development of potential drug substances.

The holder of an MSc in Medicinal Chemistry is able to:

- Explain and reflect upon the key principles used for the rational basis of design, syntheses and development of new drugs
- Explain the most important chemical, physical-chemical and pharmacokinetic properties of important groups of drugs
- Explain the properties and reactivity of heteroaromatic compounds
- Identify scientific problems in relation to the design, syntheses and development of drugs.

Skills:

The holder of an MSc in Medicinal Chemistry is able to:

- Analyze and evaluate methods of syntheses in order to choose an optimal strategy for the synthesis of a target molecule
- Design, plan and conduct advanced syntheses on the basis of a critical review of articles in international journals and patent literature

- Use and critically evaluate results achieved by modern computer-based methods for structural-activity analyses of biologically active compounds (potential drugs)
- Plan chemical modifications of proteins and estimate the effects.
- Convey research-based knowledge and communicate at a high academic level with peers and non-specialists in the field of organic synthesis for drug research, computational and structural drug design, and biopharmaceuticals.

Competences

The holder of an MSc in Medicinal Chemistry is able to:

- Plan, carry out and report on research and development projects, for example, related to the design and production of new small molecule and macromolecular drugs in cooperation with scientists from other disciplines.
- Plan and conduct advanced organic chemical syntheses as well as syntheses and modifications of peptides, proteins etc. relevant to the pharmaceutical and biotechnological industries.
- Control complex work and development situations that are not known in advance and therefore require new solutions.
- Retrieve, evaluate and summarize new knowledge in one or more of the following fields: medicinal, computational, structural chemistry and biopharmaceuticals.
- Use analytical skills, critical thinking and the ability to collect/find, compound and present information.
- Take responsibility for continued professional self-development and specialization.

Part 2 Modular structure, instruction, maximum duration of study

§ 4 Modular structure and instruction

The programme consists of a number of compulsory course modules (totaling 45 ECTS credits), a number of elective course modules (15-30 ECTS credits) and a master's thesis (45-60 ECTS credits)

4.2. The programme covers:

1. Reactions and Synthesis in Medicinal Chemistry (15 ECTS credits)
2. Medicinal and Biostructural Chemistry (7.5 ECTS credits)
3. Structure-based Drug Research (7.5 ECTS credits)
4. Heterocyclic Chemistry (7.5 ECTS credits)
5. Biopharmaceuticals: Design and Modification of Biomacromolecules (7.5 ECTS credits)
6. Master's thesis of 45, 52.5 or 60 ECTS credits in the field of medicinal chemistry
7. Elective course modules comprising at least 15 ECTS credits and at most 30 ECTS credits,

- 4.3. The constituent subject elements in the programme is constituted by the compulsory study and exam activities, and the Master's thesis. These elements consist of part 4.2.1-6 and must amount to at least 90 ECTS credits.
- 4.4. Each student's syllabus must be drawn up in cooperation with the thesis supervisor to ensure that:
1. There is a reasonable connection and progression between the completed bachelor programme and the master's programme to be undertaken.
 2. The student has acquired the academic foundation necessary to complete the chosen master's thesis.
 3. The master's programme to be followed incorporates optimal academic progression.
- 4.5. If the student completes the first year of the programme at the University of Copenhagen and the second year at Vrije Universiteit, The Netherlands, enrolled on the Master of Science in Drug Discovery and Safety in accordance with the pertaining set of regulations, the student will gain a "double degree" with the title of *kandidat i medicinal kemi* (*cand.scient. i medicinal kemi*) from the University of Copenhagen and the title of *MSc in Drug Discovery and Safety* from Vrije Universiteit.
- 4.6. Instruction is primarily in the form of lectures, dialog-based class teaching, project work (individually and in small groups) and experimental exercises.

§ 5 Maximum duration of study

Students admitted to the programme 1. September 2016 or later must complete the programme within three years of commencement. Students admitted to the programme before the date must complete the programme within four years of commencement.

5.2. The Study Board may extend this deadline in special circumstances.

Part 3 Course modules and exams

§ 6

The master's programme in medicinal chemistry contains the following course modules and exams:

Block 1+2 (1st year): Compulsory course modules and exams, including ECTS

Course title and code	Course certificate and code	ECTS	Exam and code	ECTS
Reactions and Synthesis in Medicinal Chemistry NKEK13007U			Exam in: Reactions and Synthesis in Medicinal Chemistry NKEK13007U	15
Biopharmaceuticals: Design and Modification of Biomacromolecules SMPS20001U	Course in: Biopharmaceuticals: Design and Modification of Biomacromolecules SMPS20001U	2,5	Exam in: Biopharmaceuticals: Design and Modification of Biomacromolecules SMPS20001E	5
Reactions and Synthesis in Medicinal Chemistry NKEK13007U			Exam in: Reactions and Synthesis in Medicinal Chemistry NKEK13007U	15
Medicinal and Biostructural Chemistry SFAK20010U	Course in: Medicinal and Biostructural Chemistry SFAK20010U	2,5	Exam in: Medicinal and Biostructural Chemistry SFAK20010U	5

Block 3+4 (1st year): Compulsory course modules and exams, including ECTS

Course title and code	Course certificate and code	ECTS	Exam and code	ECTS
Heterocyclic Chemistry NKEK22005U			Exam in: Heterocyclic Chemistry NKEK22005U	7,5
Elective module				7,5
Structure-based Drug Research SLKKIL112U			Exam in: Structure-based Drug Research SLKKIL112U	7,5
Elective module				7,5

Block 1+2+3+4 (2nd year): Compulsory course modules and exams, including ECTS

Course title and code	Course certificate and code	ECTS	Exam and code	ECTS
Elective modules And/or master's thesis SSPECIALEU				45, 52.5 or 60

§ 7

The programme includes 45 ECTS credits in compulsory course and exam activities.

7.2. The programme includes 15 – 30 ECTS credits in elective modules or master's thesis.

7.3. The programme includes 45 – 60 ECTS credits for the master's thesis.

§ 8 Group exams

Where the course description permits students to complete an assignment together, the submitted assignment must clearly identify the contribution made by each student in order to enable individual assessment.

§ 9 Instruction and exam language

Instructions and exams are in English.

§ 10 Elective element

To complete the programme students must take an elective course element worth between 15 and 30 ECTS credits. This element may be taken as a module prior to or in parallel with the master's thesis.

10.2. The Study Board must ensure that the student has access to at least 18 elective courses each worth 7.5 or 15 ECTS credits. The elective courses are described in the course database, where they will be announced no later than 1 May for the following study year.

10.3. The elective course descriptions must be approved by the Study Board no later than a year before the course is held.

10.4. The Study Board offers the elective courses in accord with the objectives of the programme, see 1.1 above.

10.5. An independent research paper or report or similar worth 7.5, 15, 22.5 or 30 ECTS credits may be completed in accordance with the course description for *Individualised Study Units* STADS code: ITSKABA11

10.6. If fewer than 15 students sign up for a module it may be cancelled.

10.7. Students who are refused enrolment on an oversubscribed or cancelled module will be given a new deadline to sign up for modules with vacant places.

§ 11 Master's thesis

During the third and fourth semesters (and possibly the second semester) the student prepares a master's thesis. The thesis demonstrates the student's ability to formulate, analyse and process problems within a relevant, limited scientific subject in a qualified fashion.

11.2. The Master project may be prepared alone or by groups of two students.

11.3. The thesis must be written in English and in accordance with the approved contract. The thesis must be accompanied by an abstract in English of no more than one A4 page. The abstract must summarize problem formulation, methods used, significant results/findings, a discussion when relevant and a conclusion. The abstract will be included in the overall assessment of the Master's thesis. The rules are covered in detail in the course module description.

11.4. Assessment will be based on the student's spelling and writing skills as well as the scientific content of the thesis. The scientific content will carry most weight

11.5. The Master project is worth 45, 52.5 or 60 ECTS credits.

Part 4 Specific provisions

§ 12 Transitional arrangements

These are determined by the Study Board.

12.2. General changes for students admitted in the academic year 2019/20:

Students admitted to the MSc Programme in the academic year 2019/20 must finish the programme as listed in the curriculum above with the following exceptions:

- Medicinal and Biostructural Chemistry (compulsory): Passed SFAK18004U course certificate, 0 ECTS and SFAK18004E written exam, 7,5 ECTS is equivalent to passed SFAK18004U course certificate, 2,5 ECTS and SFAK18004E written exam, 5 ECTS.

- Pharmaceutical Analytical Chemistry (elective): Passed SLVKA0361E written exam, 7,5 ECTS is equivalent to passed SLVKA0361U course certificate 2,5 ECTS and SLVKA0361E written exam, 5.
- Biopharmaceuticals: Protein Production and Analysis (elective): Passed SFKK18007E written exam, 7,5 ECTS is equivalent to passed SFKK18007U course certificate, 2,5 ECTS and SFKK18007E written exam, 5 ECTS.
- Principles and Practice of Bioanalysis (elective): Passed SFKK18003E written exam, 7,5 ECTS is equivalent to passed SFKK18003U course certificate, 2,5 ECTS and SFKK18003E written exam, 5 ECTS.

Stk. 3. General changes for students admitted before the academic year 2022/23.

Students admitted to the MSc Programme before the academic year 2022/23 must finish the programme as listed in the curriculum above with the following exceptions:

- SMPS20038U Contemporary Social Pharmacy (compulsory): Passed SMPS20038U course certificate, 7,5 ECTS is equivalent to passed SMPS20038E oral exam, 7,5 ECTS.

Part 5 Concluding remarks

§ 13 Exemptions from these provisions

In exceptional circumstances, the Study Board may grant exemptions from any curriculum provisions within the sole remit of the Study Board.

§ 14 Date of commencement

These curriculum provisions come into force on 1 September 2014 and apply to students admitted to the programme since 1 September 2011.