

MSc Molecular Medicine - course descriptions

Detailed descriptions of each course module in the curriculum are given below.

The applicable Dublin descriptors and end goals of the MSc program (*as listed on pages 11 and 9 of the student manual*) are indicated by number.

Code: **MM-LI**

Name: **Laboratory Introduction**

ECTS: 2

Study hours: 56

Period: Year 1, Aug - Sep

Setup: One week in August: morning lectures and daily lab practices.
First weeks of September: introductory talks by faculty members and optional lab visits.

Course directors: Dik van Gent, Tom Cupedo

Teachers: Dik van Gent, Koos Jaspers, Tom Cupedo

Faculty hours: 160

Study materials: Alberts et al., *Molecular Biology of the Cell* (5th edition 2008): chapter 8

Dublin descriptors: 1, 2, 5

End goals: 1, 2, 4, 5

Course aims: Familiarize students with laboratory techniques.

Get acquainted with various MSc faculty members, research groups, and group leaders. Assign tutors. Give students a broader view of possible lines of investigation, to help them make a choice for the six-month research project.

Description: Erasmus MC medical bachelors who participate in the MSc Molecular Medicine program – as premaster students - will be presented with a full week of laboratory practices in August (before the start of the medical bachelor year 3). Sessions will be held in Ee 17-32.

During the week, you will practice general laboratory techniques that are commonly used in Molecular Medicine:

- pipetting techniques
- purification and analysis of DNA
- PCR
- analysis of proteins (SDS-PAGE and Western blotting)
- cell culturing
- tissue staining and microscopy
- immunohistochemistry and/or fluorescence microscopy

Theory of these techniques will be given as lectures by the course supervisors. You will write a short report on the experiments you conduct during the week.

After the lab practices, in the first weeks of September, you will get the opportunity to listen to a number of introductory talks by MSc faculty members and scientific group leaders. This should give you a broader view of possible lines of investigation, and help you make a choice for the research projects ahead.

Evaluation: Short written report, performance assessment by course leader.

Code:	MM-IW
Name:	Introduction Weeks
ECTS:	2
Study hours:	56
Period:	Year 1, Sep
Setup:	Introductory talks, lectures, lab practices, and lab visits.
Course directors:	Dik van Gent, Anton Grootegoed
Teachers:	various
Faculty hours:	56
Study materials:	Alberts et al., <i>Molecular Biology of the Cell</i> (5 th edition 2008): chapter 8, and/or any literature relevant to the topics being presented in the lectures or practiced in the labs
Dublin descriptors:	1, 2, 5
End goals:	1, 2, 4, 5
Course aims:	Get acquainted with various MSc faculty members, research groups and group leaders. Assign tutors. Give students a broader view of possible lines of investigation, to help them make a choice for the six-month research project.
Description:	The <i>Introduction Weeks</i> serve as a general introduction to the whole MSc program. You will get to know a number of MSc faculty members, scientific group leaders, as well as the MSc course directors and coordinator. You will have the opportunity to visit several basic and/or translational research laboratories, to get a broader view of possible lines of investigation, and get (further) acquainted with various research techniques. This will enable you to make an informed choice for the research projects ahead.
Evaluation:	Mandatory attendance, evaluation by lab supervisor.

Code: **MM01-MCB-A**
Name: **Molecular and Cell Biology – A**

ECTS: 2
Study hours: 56

Period: Year 1, Oct – Dec
Setup: 7 lectures of 90 minutes, in a group of 20 to 30 students

Course director: Anton Grootegoed

Teachers: Elaine Dzierzak, Riccardo Fodde, Frank Grosveld, Jan Hoeijmakers, Bert van der Horst, Manfred Kayser, Ab Osterhaus

Faculty hours: 125

Study materials: Alberts et al., *Molecular Biology of the Cell* (5th edition 2008): selected chapters

Brabletz et al. (2005)
Migrating cancer stem cells: an integrated concept of malignant tumor progression
Nature Cancer Reviews 5:744-749

Garrigan and Hammer (2006)
Reconstructing human origins in the genomic era
Nature Reviews Genetics 7:669-680

Reppert and Weaver (2002)
Coordination of circadian timing in mammals
Nature 418:935-941

Dublin descriptors: 1, 5
End goals: 2

Course aims: Laying foundations of basic knowledge in molecular genetics and cell biology, spark interest for life sciences.

Description: In this first part of the *Molecular and Cell Biology* course, the Alberts 5th edition 'Molecular Biology of the Cell' textbook is introduced with a series of interactive lectures, in which students are given a high-level overview of some of today's hot topics in biomedical research: stem cells and cancer stem cells, epigenetics, viral pathogens, dynamic behavior of proteins as viewed with cellular imaging, development of new medical therapies, and human evolutionary genetics. In preparation for each lecture, students should read relevant pages/chapters from Alberts' 5th.

Evaluation: Written open-book exam with essay questions. The exam will test insight and scientific inventiveness.

Code:	MM-MCB-B
Name:	Molecular and Cell Biology – B
ECTS:	8
Study hours:	224
Period:	Year 1, Feb – Jun
Setup:	18 lectures of 90 minutes, in a group of 20 to 25 students
Course directors:	Anton Grootegoed, Frank Sleutels
Teachers:	Roland Kanaar, Peter Verrijzer, Frank Sleutels, Dies Meijer, Sjaak Philipsen, Willy Baarends, Titia Sixma, Thamar van Dijk, Ivo Touw, Hans van Leeuwen, Joost Gribnau, Anton Grootegoed
Faculty hours:	230
Study materials:	Alberts et al., <i>Molecular Biology of the Cell</i> (5 th edition 2008): selected chapters and pages
Dublin descriptors:	1, 2, 5
End goals:	2
Course aims:	Deepening knowledge in molecular genetics and cell biology.
Description:	The continued <i>Molecular and Cell Biology</i> course delves deeper into the basic aspects of biology. With lectures by various faculty members, based on Alberts' leading textbook, it aims to bring the students knowledge, insight, and scientific ability. The students are expected to thoroughly study the textbook, and to actively take part in discussions. In broad outlines, the course moves from DNA and proteins to regulation of gene expression and control of cellular functions, finally leading to consideration of more complex systems and problems.
Evaluation:	Written examination with essay questions. The exam will test insight and scientific inventiveness.

Code:	MM-ED
Name:	Evolution and Development
ECTS:	4
Study hours:	112
Period:	Year 1, Jan
Setup:	3-week course with lectures, discussion sessions, workshops, and an excursion, in a group of 25 to 30 students
Course directors:	Anton Grootegoed, Joost Gribnau, Robbert Rottier
Teachers:	Willy Baarends, Riccardo Fodde, Joost Gribnau, Anton Grootegoed, Gert Jansen, Erwin Kompanje, Dies Meijer, Sjaak Philipsen, Raymond Poot, Robbert Rottier, Frank Sleutels, Peter Verrijzer, Rob Willemsen, and others
Faculty hours:	415
Study materials:	Wolpert, <i>Principles of Development</i> (4 th edition 2010)
Dublin descriptors:	1, 4, 5
End goals:	1, 2, 7, 8
Course aims:	The basic aim is for the students to learn about the molecular and cellular mechanisms of embryonic and postnatal development, and the experimental methods that can be used to obtain more information about (dys)regulation of (human) development.
Description:	The evolutionary biologist Theodosius Dobzhansky indicated that “nothing in biology makes sense except in the light of evolution”. This is particularly true for embryonic development. Therefore, the course will address development of different organisms, such as <i>C. elegans</i> , <i>Drosophila</i> , <i>Xenopus</i> , zebra fish, chicken and mouse.

In this perspective, the students will learn how different species provide complementary 'model systems' with specific advantages and disadvantages for experimental analysis of developmental pathways and mechanisms. The students will also gain an understanding of developmental aspects of cellular pluripotency and differentiation, in the context of stem cell research.

Evaluation: Writing assignment in the form of a mini-review. This should be an insightful essay, to be presented and discussed during a series of meetings, in front of all participating students. The review and the presentation will be graded by three faculty members.

Code:	MM-CRT
Name:	Contemporary Research Topics
ECTS:	2 (presentation) + 6 (written exam)
Study hours:	224
Period:	Year 1, Nov - Jun
Setup:	16 weekly lectures, additional excursions, and student presentations, in groups of 5 to 25 students
Course directors:	Ruud Delwel, Raymond Poot
Teachers:	Ruud Delwel, Dik van Gent, Guido Jenster, Niels Galjart, Willy Baarends, Dies Meijer, Catherine Robin, Riccardo Fodde, Gert van Cappellen, Anton Grootegoed, Gert Jansen, Raymond Poot, and others
Faculty hours:	395
Study materials:	Alberts et al., <i>Molecular Biology of the Cell</i> (5 th edition 2008): selected chapters selection of 12 relevant research articles
Dublin descriptors:	1, 3, 4, 5
End goals:	1, 2, 7, 8, 9
Course aims:	The students should gain insight into strategies, complications, and new developments in life sciences research, and the connection of the research to molecular medicine. Students learn to critically read within a restricted time frame, and to identify strengths and weaknesses of the research presented in the article.
Description:	In the course, a number of research papers will be discussed. For each article, one of the faculty members will lead the discussion. Toward the end of the course, the students choose and present an article themselves. Besides the research articles, some pages of the <i>Molecular Biology of the Cell</i> textbook should be studied, highlighting a technique or approach that is of importance to the

paper. For some techniques, an excursion to the technical equipment is included. In small groups, students prepare short technique presentations. Writing an article abstract is practiced during class.

Evaluation:

Presentation by each of the students, and a written examination with open questions on a research article. In the written exam, the students need to answer specific questions on the design of the study and the interpretation of the results, described in an article that was not discussed in the course. They are asked to propose a title and write an abstract for the paper (the original title and abstract are not given).

Code:	MM-BoD
Name:	Biology of Disease
ECTS:	4
Study hours:	112
Period:	Year 1, Mar – May
Setup:	6 to 8 sessions with lectures, patient demonstrations, visit to the outpatient clinic, in a group of 8 to 12 students
Course directors:	Max van Noesel, Marry van den Heuvel-Eibrink, Monique den Boer
Teachers:	Michel Zwaan, Berna Beverloo, Vincent van der Velden
Faculty hours:	80
Study materials:	Phillips, Murray and Kirk, <i>The Biology of Disease</i> (2 nd edition 2001): selected chapters
Dublin descriptors:	1, 2, 3, 4, 5
End goals:	1, 2, 7, 8, 9
Course aims:	Present an overview of mechanisms of disease and clinical cases to students with a non-medical background
Description:	The course focuses on the mechanisms of disease. After a discussion on what is considered 'disease' and several underlying medical ethical issues, a recapitulation of basic anatomy and (patho)physiology is given. This will be followed by a workgroup session with patient simulations. The final session on phase I/II drug development offers a historical perspective. Patient demonstrations and a visit to the outpatient clinic are included.
Evaluation:	Performance assessment by course leader, written examination

Code: **MM-WOPR**

Name: **Written and Oral Presentation of Research**

ECTS: 2 (assessment) +2 (presentation) + 4 (research proposal)

Study hours: 224

Period: Year 1, Sep – May

Setup: 14 sessions with lectures, presentations and writing assignments, in groups of 6 to 20 students

Course director: Claire Wyman

Teachers: Claire Wyman, Willy Baarends, Rudi Hendriks, Dies Meijer, Gerjo van Osch

Faculty hours: 405

Study materials: Strunk and White: *The Elements of Style* (4th edition 2000)
Course manual with related articles and texts

Dublin descriptors: 1, 2, 4, 5

End goals: 1, 2, 3, 4, 5, 6

Course aims: To practice organizing information for a concise and informative presentation. To practice oral presentation skills. To develop skills in scientific writing in English. To understand the content and purpose of different parts of a research proposal such as those prepared in order to obtain funds from granting agencies. To obtain the necessary background information on the topic to be studied as a research project, and demonstrate this knowledge in written form. To clearly state scientific questions and present a realistic experimental plan to answer them in written form. To develop skills in evaluating scientific texts.

Description: In regular course meetings between September and February, the students are educated on how to write a scientific proposal, report, and essay, using scientific texts as examples. The students develop a first draft of their own research proposal based on their interests, classroom experiences, and interactions with their supervisor. The draft proposals are discussed with fellow students and faculty. This will lead to a final research proposal, which will be evaluated for specific elements of scientific writing, as well as content. A research proposal that describes the plan of work for a six-month period of research will be written. This will include: Title, Summary, Specific Aims, Introduction, Experimental Plan, and References (including figures as appropriate). The final proposal will probably be in the range of 6-10 pages long.

Special attention is given to the use of spoken and written English. Once started on their research project, the students should prepare an oral presentation in a work discussion style, sharing in some detail the methods used, the controls applied, and actual data obtained so far.

Evaluation: The evaluation of the written research proposal assignment will be based on organization, clarity and grammar of the writing, and significance, methodology and feasibility of content and logic. The oral presentation will be evaluated on the basis of clarity, organization, content, presentation, the use of visual aids, preparation, and the use of English.

Overall performance and course participation is assessed separately by faculty.

Code: **MM08-LRS-1A, MM8-LRS-1B**

Name: **Laboratory Research 1**

ECTS: 24

Study hours: 672

Period: Year 1, Feb - Aug

Setup: six-month research project in lab of choice

Course director: Claire Wyman

Teachers: Claire Wyman, Anton Grootegoed,
laboratory supervisors

Faculty hours: 3000

Study materials: relevant literature as necessary

Dublin descriptors: 1, 2, 3, 4, 5

End goals: 1, 2, 3, 4, 5, 6, 7, 8, 9

Course aims: To obtain practical experience in laboratory research, to collect scientific data, to practice communication skills, master research techniques, and further develop scientific thinking and reasoning.

Description: Based on the research proposal that was drafted within the context of the WOPR course (MM-WOPR), the student performs a six-month research project, in the host research laboratory. The laboratory scientific group leader functions as the student's direct supervisor. Students will have regular meetings in the presence of faculty members, to discuss progress and problems.

Evaluation: written performance assessment by supervisor

Code:	MM-REP
Name:	Research Report
ECTS:	4
Study hours:	112
Period:	Year 1, Jun-Aug
Setup:	written report assignment
Course director:	Claire Wyman
Teachers:	Claire Wyman, Willy Baarends, Rudi Hendriks, Dies Meijer, Gerjo van Osch, lab supervisors
Faculty hours:	260
Study materials:	Course manual with related articles and texts, detailed assignment descriptions, sample reports from previous students
Dublin descriptors:	1, 2, 3, 4, 5
End goals:	1, 2, 5, 6
Course aims:	To organize the work as one would for publication. To understand the parts of a written research article and present the work in this way. To develop skills in scientific writing; including technical aspects of preparing figures and referencing and dividing the relevant information into Abstract, Introduction, Results and Discussion sections. To produce a final written summary of the research work done.
Description:	Based on the experiments conducted and results obtained during the six-month research project, the students write a scientific report. They will write up the results of their work in the form of a research article (manuscript) with the style used in <i>Current Biology</i> . This will include: Title, Summary, Introduction, Methods (for this purpose in

more detail than is currently standard in publications), Results, Discussion and References, accompanied by figures. The completed report will be about 20-40 pages long.

Evaluation:

Final reports are to be approved by the research supervisor before submission for faculty evaluation. Faculty will provide comments and remarks to be incorporated in a revised version. The student is given one week to incorporate faculty comments and revise the report. This final version is graded by one of the faculty based on the same set of criteria as the written research proposal (with the obvious exception of “feasibility”). Numerical grades are finalized after discussion of the reports among all faculty.

Code:	MM10-CS
Name:	Courses and Seminars
ECTS:	6
Study hours:	168
Period:	Year 2
Setup:	free choice of courses, seminars, lectures, and symposiums available within and outside Erasmus MC
Course director:	n/a
Teachers:	various
Faculty hours:	5
Study materials:	various
Dublin descriptors:	1, 2, 4, 5
End goals:	1, 2, 7, 8
Course aims:	various

Description: Students are encouraged to participate in several courses, seminars, lectures, and symposiums available at Erasmus MC, at Radboud University Nijmegen, or elsewhere, and **at least three** of the specific courses organized by the postgraduate schools MGC and MolMed. In consultation with their research supervisors, the students will compose a program according to their individual needs and interests. Participation in an international meeting is to be considered.

Courses at Erasmus MC

General PhD courses offered by Erasmus MC include:

- Biomedical English Writing and Communication
- Biostatistics
- Philosophy, Ethics and Scientific Integrity
- Safe Laboratory Techniques

- Working with Test Animals

See www.erasmusmc.nl/phd for more information.

Courses at Radboud University Nijmegen

The students may take part in selected classes and courses from the MSc program in Molecular Mechanisms of Disease, at the Radboud University Nijmegen:

- Master Classes
- Translational Research Courses
- Course on Science and Society

More information on these courses can be found at the website <http://www.ru.nl/master/ncmls-mmd/>. Interested students can send their application to prof.dr Roland Brock, program director of the MSc Molecular Mechanisms of Disease, via email:

r.brock@ncmls.ru.nl, with cc to [mscmolmed@erasmusmc.nl](mailto:mسلمolmed@erasmusmc.nl)

Postgraduate Courses

The MSc students must participate in **at least three** of the specialized courses organized by the postgraduate schools *Medical Genetics South-West Netherlands (MGC)* and *Molecular Medicine (MolMed)*. A few examples:

- Signal Transduction Spring; 4 days
- Applied Bio-informatics Spring; 2 days
- From Development to Disease Spring; 3 days
- Basic and Translational Oncology Autumn; 4-5 days
- Clinical Genetics, Experimental Endocrinology, and Immuno-endocrinology Autumn; 5 days
- Analysis of Micro-Array Gene Expression Data Spring; 2 days
- In Vivo Imaging: from Molecule to Organism Autumn; 4 days
- SNPs and Human Diseases Autumn; 4-5 days
- Browsing Genes and Genomes with Ensembl Autumn; 2 days

Further information on the courses and online registration is available at:

<http://www.erasmusmc.nl/mgc/>

<http://www.medgencentre.nl/>

<http://www.molmed.nl/>

Registration for these courses is mostly free of charge.

>> **When registering, indicate that you are a member of MGC.**

Seminars

Throughout the year, various departments arrange regular seminars with well-known scientists speaking on topics concerning biomedical research and advances. This includes different lecture series within the Biomedical Science Theme (Frontiers in Science, Lectures on Genetics), as well as the Hematology and JINI Oncology Lectures. You will be invited to attend a small number of these lectures collectively, as MSc students: *see next page*.

For updates and announcements on these lectures and related activities, see the poster boards and websites of the respective departments:

<http://www.erasmusmc.nl/mgc/>

<http://www.erasmusmc.nl/hematologie/>

<http://www.erasmusmc.nl/pathologie/>

Evaluation: Toward the end of year 2, students compile a list of all followed courses, seminars, and lectures. The list is examined and approved by faculty.

Code: **MM11-RD**

Name: **Research Discussions**

ECTS: 2 (assessment) + 2 (presentation)

Study hours:	112
Period:	Year 2
Setup:	participation in weekly lab meetings, individual presentations on research progress, preparatory talks and evaluative discussions around seminars
Course director:	Anton Grootegoed
Teachers:	lab research supervisor, Derk ten Berge, Elaine Dzierzak, Wim Vermeulen, Peter Verrijzer
Faculty hours:	75
Study materials:	assignment description
Dublin descriptors:	1, 2, 4, 5
End goals:	1, 2, 5
Course aims:	<p>To develop skills in gathering information and knowledge from the attendance of scientific seminars.</p> <p>To practice organizing information for a concise and informative presentation. To practice oral presentation skills. To develop skills in scientific writing in English.</p>
Description:	<p>You will attend a small number of preselected seminars from the various departmental lecture series at Erasmus MC (Frontiers in Science, Lectures on Genetics, Hematology Lectures, JNI Oncology Lectures). Prior to these lectures, you are given an introduction on the work of the visiting speaker by one of the faculty members.</p> <p>The students attend weekly department lab meetings and actively contribute to these meetings.</p>

At the halfway point of the full-year research project, each student presents a 15-20 minute talk on her or his research progress, accompanied by a slideshow. The students from the first MSc year are invited to these presentations. This is a chance for the students to work on giving a presentation aimed at scientists outside of their research group, and to get some constructive feedback.

The presentation should include a brief introduction to the project (one or two slides with a title, the main topic, goals and approach), some information on specific experiments, details on methods, controls, and actual data, and a conclusion with a brief statement on the results obtained.

Evaluation: Faculty evaluates the presentation based on clarity, organization and presentation aspects, NOT on the degree to which the student has achieved experimental goals set out in the proposal. Active participation in weekly lab meetings is assessed by the research supervisor.

Code:	MM12-LRS-2A, MM12-LRS-2B
Name:	Laboratory Research 2
ECTS:	40
Study hours:	1120
Period:	Year 2
Setup:	(updated) research proposal assignment, full-year research project in lab of choice
Course director:	Anton Grootegoed
Teachers:	Anton Grootegoed, individual scientific group leaders
Faculty hours:	4500
Study materials:	relevant literature as necessary
Dublin descriptors:	1, 2, 3, 4, 5
End goals:	1, 2, 3, 4, 5, 6, 7, 8, 9
Course aims:	To create a formal plan for the yearlong research project. To obtain practical experience in laboratory research, to collect scientific data, to practice communication skills, master research techniques, and further develop scientific thinking and reasoning
Description:	The students write a brief and clear research proposal describing the plan of work for the one-year period leading to the MSc thesis. This will include a title, a concise introduction to the topic (1 page), the research questions and specific aims (1 page), and a research plan including the experimental approach (2-4 pages expected). Based on this research proposal, the student performs a full-year, in-depth biomedical research project, in the host research laboratory. The laboratory scientific group leader functions as the student's direct supervisor. The written research proposal will be prepared together with, and approved by, the research supervisor.

Students have regular meetings in the presence of faculty members, to discuss progress and problems.

Evaluation:

The research proposal will of course be drafted in consultation with the direct supervisor, but will not be discussed with other faculty as much as the proposal that was written in the context of the WOPR course, and it will not be graded. It will be reviewed by at least one independent MSc faculty member. There will be a meeting between the student and the MSc faculty (and where desired the research supervisor) at which the research proposal will be discussed, and if necessary modified. Attention will be paid to research questions posed, the appropriateness of the experimental approach, feasibility of the work for a one-year project, and suitability of the work for completion of the MSc thesis. A final plan agreed on by student and faculty will be the basis for research work leading to the MSc Molecular Medicine degree.

Performance of the student during the full-year research project will be assessed in written form by the research supervisor. An extra mid-term moment of evaluation for both the supervisor and the student is recommended. This mid-term evaluation is not graded.

Every student will have an individual mid-term meeting with the course director (program director).

Code:	MM13-MSTH
Name:	Master of Science thesis and thesis defense
ECTS:	8 (MSc thesis) + 2 (thesis defense)
Study hours:	280
Period:	Year 2
Setup:	written report and presentation
Course directors:	Anton Grootegoed, Dik van Gent, Elaine Dzierzak
Teachers:	Anton Grootegoed, Dik van Gent, Elaine Dzierzak, individual scientific group leaders
Faculty hours:	385
Study materials:	assignment description, MSc theses of previous students
Dublin descriptors:	1, 2, 3, 4, 5
End goals:	1, 2, 3, 4, 5, 6, 7, 8
Course aims:	<p>The MSc thesis should demonstrate the ability of the student to organize and present results and knowledge in a form required for publication of a scientific article. Submission of the manuscript for publication is not a prerequisite, but is aimed at.</p> <p>The MSc thesis should provide a record of the research work the student has done, a written presentation of knowledge and results, and a useful resource of information for others.</p>
Description:	<p>The second, full-year, research project is concluded by submission and defense of the MSc thesis. The thesis will take the form of a full-length research article, suitable for publication in an international journal. In contrast to a regular article manuscript, the MSc thesis will include a more elaborate introduction, describing the scientific background of the study. The Materials and Methods section will be expanded to include a complete and detailed description of all methods that have been applied.</p>

The thesis is typically 40-70 pages long, including figures, references, et cetera, and will contain separate 'chapters': List of Abbreviations, Summary, Introduction, Materials and Methods, Results, Discussion / Conclusions, and in some cases appendices or supplemental material. The final version of the thesis will have to be accompanied by a 1-2 page summary of the specific improvements that were implemented in the final version, based on the comments the student has received by faculty on the draft version. This should be in the form of a rebuttal letter, as would accompany a manuscript resubmitted after review.

The defense of the thesis will take about 20 minutes, and will be preceded by an oral half hour presentation of aim, results and conclusions of the thesis work.

Evaluation:

The MSc thesis manuscript will be evaluated by the research supervisor and an independent faculty member.

The student's research supervisor and at least two independent MSc faculty members will assess the MSc thesis presentation and defense. Together, they will come up with a final grade both the MSc thesis and the thesis presentation.