Master of Science in Biomedicine

Masters' degree in Biomedicine 120 ECTS

Program description - 4th of February 2016
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1. Introduction

1.1 Target audience

This Program is designed for students who wish to acquire advanced knowledge and primary research skills in human biology and biomedical issues, including specialised technical laboratory skills related to modern cell and molecular biology research activities. The Program is a continuation of the education for students with completed bachelor degrees in biomedicine, or who have a comparable educational background from a university or other institution of higher education aiming for careers in research and development, management or teaching.

1.2 Admission requirements

Admittance to the programme requires a 3-year bachelor’s degree with specialization in the master’s programme subject. An additional requirement is specialization in biomedical topics (i.e. biochemistry, bioinformatics, cell- and molecular biology, human physiology, immunology, microbiology and pharmacology) worth a minimum of 80 credits. For admission students will also have to document completed practical laboratory courses in biochemistry, cell and/or molecular biology comprising a minimum of 100 hours. Applicants with a degree in Biomedical laboratory sciences (“Bioingenjør”) must have authorization with the Norwegian authorization board as a qualified Bioingenjør. It is also recommended that students with a degree in Biomedical laboratory sciences have an additional 20 credits with specialization in biomedical topics.

Bachelor of Pharmacy, Medicine or Dentistry does not fulfil the admission requirements.

General admission requirements for Master’s degree programs at UiT are as follows:

- **Norwegian Higher Education Entrance Qualification**
  (proof of schooling equivalent to 3 years of Norwegian upper secondary school)

- **Proof of English Proficiency**

- **Bachelor’s Degree Diploma or equivalent**
  (at least 3 years of higher education with a major within the subject applied for)

The **minimum average grade requirement** is:

- C - for bachelor’s degree or equivalent issued in Europe, Canada, USA, Australia and New Zealand
- B - for bachelor’s degree or equivalent issued in all other countries

- **Proof of funding - Self-financing applicants from NON-EU/EEA countries only**
  - 94 400 NOK per academic year (approx. 7 300 USD / 5 900 EURO)
1.3 Job prospective

After completing the program, the candidate will be prepared for exciting assignments of research and method development in business, management and research-oriented institutions where the demands for qualified professionals are increasing.

Career options may include: molecular diagnostics, medical research, fisheries, food processing, public administration, educational institutions at all levels, the pharmaceutical industry, private research and innovation enterprises, technical positions at universities, hospitals and other laboratories.

1.4 Language of instruction

English

1.5 Exchange possibilities

It will be possible for Norwegian students following the programme to study abroad for one semester. Please see Utvekslingsportalen for more information.

2 Learning outcomes

On completion of the programme of study, the candidates shall have attained the following learning outcomes and shall be able to:

- analyse and assess scientific literature and research
- demonstrate good scientific communication skills, both orally and in writing
- understand, perform and explain basic biomedical laboratory techniques
- understand biological processes at the organ, cellular and molecular level
- demonstrate a thorough understanding in one of the specialisation areas
- formulate plain research questions and suggest approaches how to answer them
- demonstrate the ability to plan, carry out and report on a specific research project
- demonstrate the ability to work independently in the laboratory, and with problem solving on issues related to biomedical sciences
# Programme structure

The program is organized as a full-time study over 2 years (120 credits). Content of education is divided in relation to the 2 years of study (Table 1-4). Each course ends with an exam. In addition the course MBI-3011 can be taken either during the second or third semester, depending on the master degree project.

It will be possible for Norwegian students to take a semester abroad, either on the second or third semester. Contact the student advisers in the Department of Medical Biology for more information.

Table 1. Programme structure (elective courses in the spring semester).

<table>
<thead>
<tr>
<th>Semester</th>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st semester</td>
<td>MBI-3010 Advanced methods in experimental biomedicine 2 (30 ECTS)</td>
</tr>
<tr>
<td>(fall)</td>
<td></td>
</tr>
<tr>
<td>2nd semester</td>
<td>MBI-3xxx Elective (10 ECTS)</td>
</tr>
<tr>
<td>(spring)</td>
<td>MBI-3xxx Elective (10 ECTS)</td>
</tr>
<tr>
<td></td>
<td>MBI-3011 Literature study with thesis and presentation (10 ECTS)</td>
</tr>
<tr>
<td>3rd semester</td>
<td>MBI-3911 Master thesis (30 ECTS)</td>
</tr>
<tr>
<td>(fall)</td>
<td></td>
</tr>
<tr>
<td>4th semester</td>
<td>MBI-3911 Master thesis (30 ECTS)</td>
</tr>
<tr>
<td>(spring)</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Programme structure (elective courses in the fall semester).

<table>
<thead>
<tr>
<th>Semester</th>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st semester</td>
<td>MBI-3010 Advanced methods in experimental biomedicine 2 (30 ECTS)</td>
</tr>
<tr>
<td>(fall)</td>
<td></td>
</tr>
<tr>
<td>2nd semester</td>
<td>MBI-3911 Master thesis (20 ECTS)</td>
</tr>
<tr>
<td>(spring)</td>
<td>MBI-3011 Literature study with thesis and presentation (10 ECTS)</td>
</tr>
<tr>
<td></td>
<td>MBI-3xxx Elective courses (20 ECTS)</td>
</tr>
<tr>
<td>3rd semester</td>
<td>MBI-3911 Master thesis (10 ECTS)</td>
</tr>
<tr>
<td>(fall)</td>
<td></td>
</tr>
<tr>
<td>4th semester</td>
<td>MBI-3911 Master thesis (30 ECTS)</td>
</tr>
<tr>
<td>(spring)</td>
<td></td>
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</tbody>
</table>

Table 3. Programme structure (elective courses in fall and spring semester).

<table>
<thead>
<tr>
<th>Semester</th>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st semester</td>
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</tr>
<tr>
<td>(fall)</td>
<td></td>
</tr>
<tr>
<td>2nd semester</td>
<td>MBI-3xxx Elective (10 ECTS)</td>
</tr>
<tr>
<td>(spring)</td>
<td>MBI-3911 Master thesis (10 ECTS)</td>
</tr>
<tr>
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<td>MBI-3011 Literature study with thesis and presentation (10 ECTS)</td>
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<tr>
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</tr>
<tr>
<td>(fall)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MBI-3xxx Elective courses (20 ECTS)</td>
</tr>
</tbody>
</table>
4 Programme description

4.1 Contents of the programme

The Master’s programme in Biomedicine will shed light on contemporary problems and methods in biomedicine. The students will be trained in experimental work as well as written and oral presentations of independents scientific papers.

The laboratory course (MBI-3010) is obligatory for all students the first semester. It offers training in relevant techniques for biomedical research, including cell culturing, detection and expression of DNA, RNA and proteins, imaging, electron microscopy, histological analysis, immunohistochemistry and scientific report writing. Students will also receive safety training for work in laboratories. During the second semester the students specialize in various areas of biomedicine. Alternatively, students get an early start on their thesis, and take the last 10 ECTS of a specialization elective in the third semester.

The obligatory course MBI-3011 provide training in oral and written research presentations, thus students are recommended to attend them during the second or third semester.

The second year focuses mainly on the student’s individual research project and on the writing of his/her Master’s thesis (60 credits). Work on the thesis is regulated by a standard agreement between the student, supervisor and department. Generally the student participates in one of the department’s research projects under supervision by research group members. The Master’s thesis is expected to be an independent body of scientific work performed and presented by each student, after having received introductions to and training in practical and theoretical aspects of medical-biological research. The result of the work must be submitted as a written thesis, and students will go through an oral presentation followed by an oral examination. The thesis, presentation and oral examination together counts as the final exam, and will be graded as a whole.

4.2 Academic specialization

The Master’s degree Program of Biomedicine covers two years and a total of 120 ECTS (see Table 1). About two-thirds, 70 ECTS go to academic specialization. The following courses are considered as academic specialization: MBI-3010 (Thesis; 60 ECTS) and MBI-3011 (Literature study with presentation 10 ECTS). The remaining 50 ECTS are used to specialize in various areas of biomedicine.

4.3 Elective courses
There are 20 ECTS of elective courses in the program, and students choose elective subjects depending on the theme of the master’s thesis. The elective courses are built up around thematic profiles, integrating relevant components from the core subjects: biochemistry, cell biology, pharmacology, physiology, genetics, histology, immunology, microbiology and pathology. The elective courses are:

- MBI-3002 Pharmacology (10 ECTS)
- MBI-3003 Toxicology (10 ECTS)
- MBI-3004 The biology of cancer (10 ECTS)
- MBI-3005 Normal flora/infection/inflammation (10 ECTS)
- MBI-3006 Biotechnology (10 ECTS)
- MBI-3007 Eukaryotic genes and genomics (10 ECTS)
- MBI-3103 Rettsgenetikk og medisinsk genetikk (10 ECTS) – language of instruction is Norwegian only!
- BIO-3008 Animal Physiology (20 ECTS)
- KJE-3603 Protein Production Technology (10 ECTS)
- BIO-3323 Bioinformatics: Genomes and genomics (10 ECTS)

5 Teaching methods

Course activities consist of different teaching methods. Lectures will give the students an overview of the scientific field and deeper knowledge of selected areas of biomedicine. At seminars students will analyse, discuss, and put their knowledge into relevant contexts. The laboratory exercises will train practical skills, understanding and applications of methods and technology for use in experimental design. By group work students are allowed to discuss subjects for deeper understanding. In the individual tasks students will use scientific literature to present scientific work orally and in writing. Students will obtain supervision for individual guidance in laboratory practice, literature studies and scientific writing. Students are expected to perform independent studies, including curriculum not specified in the scheduled teaching.

6 Examination and assessment

6.1 Examination methods

Students will be assessed by course work requirements and examinations. Course work requirements must be approved in order to qualify for examination. Examination methods will vary between courses, and will in general be written exams, home exams (writing tasks), and oral exams. Exams will be evaluated with letter grades (A-F) or pass / fail.

6.2 Requirements for participation

Students can have an authorized absence of up to 20% on mandatory teaching. If a student has authorized absence he/she has the responsibility to acquire knowledge, skills and attitudes, as described in the learning objectives. Students are required to report all absence to the student advisor as soon as possible and a medical certificate must be produced.
6.3 Qualifications for examination

Course work requirements must be approved in order to qualify for examination. 5 out of 7 of the course work requirements (lab reports) in MBI-3010 must be approved in order to start on the Master thesis, and MBI-3011. The Master thesis must be submitted before the assigned deadline but it will not be evaluated until all previous exams in the MSc program have been passed.

6.4 Grading system

The grading system is twofold. One system consists of letter grades from A-F, and the second system consists of the values pass/fail.

The following grading scale is used for letter grades A-F:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>General, qualitative description of valuation criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Excellent</td>
<td>An excellent performance, clearly outstanding. The candidate demonstrates excellent judgement and a very high degree of independent thinking.</td>
</tr>
<tr>
<td>B</td>
<td>Very good</td>
<td>A very good performance. The candidate demonstrates sound judgement and a high degree of independent thinking.</td>
</tr>
<tr>
<td>C</td>
<td>Good</td>
<td>A good performance in most areas. The candidate demonstrates a reasonable degree of judgement and independent thinking in the most important areas.</td>
</tr>
<tr>
<td>D</td>
<td>Satisfactory</td>
<td>A satisfactory performance, but with significant shortcomings. The candidate demonstrates a limited degree of judgement and independent thinking.</td>
</tr>
<tr>
<td>E</td>
<td>Sufficient</td>
<td>A performance that meets the minimum criteria, but no more. The candidate demonstrates a very limited degree of judgement and independent thinking.</td>
</tr>
<tr>
<td>F</td>
<td>Fail</td>
<td>A performance that does not meet the minimum academic criteria. The candidate demonstrates an absence of both judgement and independent thinking.</td>
</tr>
</tbody>
</table>

The grades pass/fail are mainly used in the courses MBI-3010 and MBI-3011. To pass, the candidate must display good skills and apply them properly. The candidate must demonstrate a reasonable degree of judgment and independent thinking in the most important areas. The grade pass corresponds to a grade of C or better.

During the academic year 2012/2013, new guidelines for grading master’s theses in mathematics, natural sciences and technology came into effect. The new system applies to students who began a
2-year master’s degree during autumn 2012, and students who started the last two years of a 5-year master’s degree in autumn 2012.

<table>
<thead>
<tr>
<th>Grade/Level</th>
<th>Description</th>
</tr>
</thead>
</table>
| A Excellent | - An outstanding thesis which clearly demonstrates a talent for research and/or originality, in a national perspective.  
- The candidate has very good insight into the scientific theory and methods in his/her field and has demonstrated scientific knowledge at a very high level. The objectives of the thesis are well defined and easy to understand.  
- The candidate is able to select and apply relevant scientific methods convincingly, has all the technical skills required for the work, can plan and conduct very advanced experiments or computations without help, and works very independently.  
- The thesis is considered extensive and/or innovative. The analysis and discussion have an extremely good scientific foundation and justification, and are clearly linked to the topic that is addressed. The candidate demonstrates extremely good critical reflection and distinguishes clearly between his/her contributions and the contributions from others.  
- The form, structure and language in the thesis are at an extremely high level. |
| B Very good | - A very good thesis that is clearly and positively distinguishable.  
- The candidate has very good scientific knowledge and insight into the scientific theory and methods in his/her field. The objectives of the thesis are well defined and easy to understand.  
- The candidate is able to select and apply relevant scientific methods soundly, has almost all the technical skills required for the work, can plan and conduct advanced experiments or computations without help, and works very independently.  
- The thesis is considered extensive and/or innovative. The analysis and discussion have a very good scientific foundation and justification, and are clearly linked to the topic that is addressed. The candidate demonstrates very good critical reflection and distinguishes clearly between his/her contributions and the contributions from others.  
- The form, structure and language in the thesis are at a very high level. |
<p>| C           |             |</p>
<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
</table>
| **Good** | A good thesis.  
- The candidate has good scientific knowledge and insight into the scientific theory and methods in his/her field. The objectives of the thesis are generally well defined, but may contain some inexact formulations.  
- The candidate uses the relevant scientific methods satisfactorily, has most of the technical skills required for the work, can plan and conduct quite advanced experiments or computations without help, and works independently. The thesis is considered good with elements that are creative. The analysis and discussion have a good scientific foundation and justification, and are linked to the topic that is addressed. The candidate demonstrates good critical reflection and usually distinguishes clearly between his/her contributions and the contributions from others.  
- The form, structure and language in the thesis are at a good level. |
| **Satisfactory** | A satisfactory thesis.  
- The candidate has quite good scientific knowledge and insight into the scientific theory and methods in his/her field. The objectives of the thesis are defined, but may contain some inexact formulations.  
- The candidate is generally able to apply relevant scientific methods, has the main technical skills required for the work, and can plan and conduct experiments or computations without help. The candidate works independently to some extent, but needs quite close supervision to achieve satisfactory scientific progress. The candidate may have problems utilizing the research group’s expertise in his/her own work.  
- The thesis is considered satisfactory. The analysis and discussion have a satisfactory scientific foundation and justification, and are linked to the topic that is addressed, but there is room for improvement. The candidate demonstrates his/her ability for critical reflection, but has problems distinguishing clearly between his/her contributions and the contributions from others.  
- The form, structure and language in the thesis are at an acceptable level. |
| **Sufficient** | A thesis that is acceptable and satisfies the minimum criteria.  
- The candidate has sufficient scientific knowledge and insight into the scientific theory and methods in his/her field. The objectives of the thesis are described, but are vague and imprecise.  
- The candidate is able to apply some relevant scientific methods, has a minimum of technical skills required for the work, and can plan and conduct |
The candidate achieves limited scientific progress without close supervision, and has problems utilizing the research group’s expertise in his/her own work.

- The thesis is considered limited and somewhat fragmented. The analysis and discussion have an adequate scientific foundation and justification, but ought to have had a better link to the topic that is discussed. The candidate demonstrates sufficient critical reflection, but may have problems distinguishing between his/her contributions and the contributions from others.

- The thesis is mostly acceptable, but has definite shortcomings with respect to form, structure and language.

### F Fail

- A thesis that does not satisfy the minimum requirements.

- The candidate does not have sufficient scientific knowledge and insight into the scientific theory and methods in his/her field. The objectives of the thesis are not clearly defined or are lacking.

- The candidate demonstrates a lack of competence in the use of scientific methods, does not have the required technical skills and independence for the work, and has scarcely utilized the research group’s expertise in his/her own work.

- The thesis is considered very limited and fragmented. The analysis and discussion do not have an adequate scientific foundation and justification, and are loosely linked to the topic that is discussed. The candidate does not demonstrate sufficient critical reflection, and does not clearly distinguish between his/her contributions and the contributions from others.

- The thesis has major shortcomings with respect to form, structure, and language.

### 7 Supplementary regulations

For a more descriptive regulations for the master’s program, we refer to "Supplementary regulations for master’s degrees (120 credits) at the Department of Medical Biology, Faculty of Health Sciences," which was approved by the Teaching Committee of the department 11th of January 2011.

### 8 Course descriptions
8.1 Compulsory courses

MBI-3010 Advanced methods in experimental biomedicine 2 (30 ECTS)

Type of course
The course is mandatory for students accepted at master’s degree programme in biomedicine. This course cannot be taken as a singular course.

Admission requirements
A bachelor degree in biomedicine,

Course contents
The course includes relevant techniques for biomedical research including cell culturing, detection and expression of DNA, RNA and proteins, imaging, EM and other methods used at our core facilities.

Short list of content:
1) Safety course: This part is an intensive course for students and employees at UiT and will provide safety skills relevant to lab work. Obligatory parts: EHS work, biological substances, use of gloves, allergy, liquid nitrogen and gas under pressure.
2) Exercise - Detection of gene mutation using PCR (2 weeks): Detection of gene mutation using PCR. This exercise aims to give students a basic understanding of practical skills necessary for conducting RNA isolation, RT-PCR and PCR, gene cloning and DNA sequencing. This is performed to demonstrate and quantify the BCR-ABL transcripts in connection with chronic myeloid leukemia. A demonstration of cell sorting using flow cytometry is also given.
3) Exercise - Tissue preparation for histological investigations (1 week): Tissue preparation and dissection, staining and microscopy. The students are introduced to various methods for preserving tissue samples for histological investigations.
4) Exercise - Regulation of proopiomelanocortin (POMC) promoter activity by the tumor suppressor protein p53 (2 weeks): Regulation of proopiomelanocortin (POMC) promoter activity by the tumor suppressor protein p53. In this exercise, the students will learn and perform PCR-based site-directed mutagenesis, restriction enzyme digestion, agarose gel electrophoresis, transformation of bacteria, DNA isolation, DNA sequencing, transfection of mammalian cells, reporter gene analysis (luciferase assay), and Western blot.
5) Exercise - Enzyme kinetics and molecular modelling (2 weeks): Enzyme inhibition and molecular modelling. In the first part of this exercise, the student will study enzyme activity measurements and the use of reversible and irreversible inhibition assays. In the other part, the students will study molecular modeling and docking.
6) Exercise - Protein investigations (2 weeks): In this exercise, students will perform purification of recombinant proteins, protein concentration determinations and GST-pulldown assay. Sample preparation for identification of proteins from SDS-PAGE by mass spectroscopy (MS) will be performed.
7) Exercise - Confocal and electron microscopy (2 weeks): This exercise introduces the use of confocal microscopy in biomedical research. Students will explore typical imaging applications using both fixed and live cells. There will also be given an introduction to and a demonstration of immuno electronmicroscopy.
8) Exercise - Whole genom analysis (2 weeks): The overall aim of this exercise intends to illustrate whole genome analysis and detection of specific nucleotide sequences.

Learning outcomes
The overall aim of the course is to make students able to perform modern basic laboratory methods that may be required to accomplish their master degree research projects. After the course, students will be able to
- perform independently the selected methods in the course and discuss the results obtained
- explain the selected methods with emphasis on the usefulness and limitations of the methods in biomedical research
- describe the methods that are demonstrated in the course and underline their applicability in research
- write a report including a proper discussion of results obtained

Teaching and learning methods
The course is divided into a safety course and seven practical laboratory exercises, each limited to a period of one or two weeks. Each exercise will be introduced by lectures followed by individual or group exercises. Report writing and discussions are included into the given timeframes.

Assessment
Written exam (6 hours). Students will be evaluated with pass/fail.

Course work requirements
Participation in the safety course and all sections of the laboratory exercises is mandatory. Students should be prepared for full day activities throughout the semester, including work on the seven compulsory reports. If unavoidable absence is higher than 20% in any of the exercises, the students need to repeat the exercise the next period. Students have to write an individual report after each exercise and are encouraged to obtain feedback on the progress of their reports from teachers throughout the semester. For the last lab exercise feedback/supervision is only given until the last day of the exercise. The students are expected to have the necessary skills to write reports by this last exercise, and the final deadline for handing in the last report will be much shorter than for the previous reports. All lab reports must be approved in order to attend the final exam. The lab exercises will not be approved infinitely. After 5 years the student will have to do the exercises all over again.

Re-sit exam/postponed exam
Re-sit exam/postponed exam A re-sit exam/postponed exam will be arranged early in the following semester, for candidates who failed the exam, or who, for valid reasons, were unable to attend.

Syllabus
A syllabus will be given, partly as hand-outs for the lab exercises.

Language of instruction
English

_MBI-3011 Literature study with thesis and oral presentation (10 ECTS)_

This is a course for students enrolled in the Master of Science program in Biomedicine/Medical laboratory science at the Department of Medical Biology.

On the basis of a given topic the student will undertake a literature search to find out what has been written on a certain matter/topic in international journals. The course includes writing a thesis based on a problem description within a specified topic. The supervisor of the course is the same person who will supervise the student at his/her masters’ degree project. The topic is chosen by the student together with the supervisor, and the supervisor makes the problem statement within this topic. The student is expected to find literature equivalent to approx. 200 pages from advanced text books and original scientific publications. The student is supposed to work out a thesis of 10-15 pages based on this literature. The thesis has to include a clear problem description, presentation of the scientific publications that is used and an independent discussion. A correct reference list is required. The
thesis is not to be a copy of part of the introduction in the master degree thesis, but might give deeper understanding of a chosen topic from this introduction. The subject material should then be presented by the student as a seminar with an examiner present. The presentation should last for 45 minutes (40 minutes with lecture and 5 minutes for questions). The target group for the presentation is other masters' degree students in biomedicine. The presentation is public and will be announced at the Department of medical biology.

**MBI-3911 Master's thesis in Biomedicine (60 ECTS)**

**Type of course**
The course is mandatory for all students enrolled in the master's degree programme in Biomedicine.

**Admission requirements**
Only students enrolled in the master's degree programme in Biomedicine are able to attend the course. The coursework requirements in MBI-3010 must also be approved in order to take the course MBI-3911.

**Course contents**
The course consists of the final research project conducted by a student following the Master's degree program in biomedicine, and will culminate in a master thesis.

**Learning outcomes**
After ending the course the student should be able to define a scientific problem and to point out an approach to a solution. The student should be able to collect knowledge from the literature and explain the background for the problem. The student should work through selected methods and analyse the results. The student should be able to discuss obtained results in relation to other findings and draw conclusions. The student should be able to present his/her scientific work in a thesis and an oral presentation.

**Teaching and learning methods**
Independent research project under supervision.

**Assessment, re-sit and postponed exam**
Thesis, oral presentation and examination. Grade type: alphabetical grades (A-F)

Failing the master's thesis and new master's examination

Only if the master's thesis is assessed as F (fail) can a revised version be submitted. The student will be given 3 months to submit a revised version of the thesis.

If the thesis is assessed as F (fail) twice, the student must apply to the department for a new thesis topic. A new topic will be given only once.

If a thesis is not submitted by the deadline and no application for an extended deadline has been approved, the student is registered as not attended for an examination. The student must then apply to the department for a new thesis topic.

For further information we refer to the supplementary regulations.

**Syllabus**
The literature will be specified individually and include relevant scientific articles and reviews.
8.2 **Elective courses – spring semester**

**MBI-3002 Pharmacology (10 ECTS)**

**Type of course**
Students following the master programme in biomedicine, or other students interested in the topic such as singular course students.

**Admission requirements**
A bachelor degree in biomedicine or equivalent.


**Course contents**
The course provides a quantitative description of drug absorption, distribution and elimination. The pharmacodynamic and pharmacokinetic aspects of the main drug categories will be described and therapeutic medication principles, mechanisms and side-effects will be outlined.

The following topics are included:

- Pharmacodynamics and pharmacokinetics, 4 hours of lectures, repetition from MBI-2005
- Chemical mediators and their receptors, 2 hours of lectures
- Pharmacokinetics, Lectures 4 hours, exercises 12 hours
- Anti inflammatory and immunosuppressive drugs, week analgesic drugs, 2 hours of lectures
- Drugs affecting major organ systems
  - Heart and vascular system (3 hours)
  - Kidney (1 hour)
  - The respiratory system (1 hour)
  - The endocrine system (2 hours)
  - The gastrointestinal tract (1 hours)
  - The haemopoietic system (1 hour)
- Chemotherapy
  - Antibacterial drugs (2 hours)
  - Drugs used in cancer treatment (2 hours)
  - Antiviral drugs (1 hour)
  - Antifungal drugs (1 hour)
- The nervous system
  - Strong analgesic and anaesthetic drugs ( 2 hours)
  - Antiepileptic and antimigrane drugs (1 hour)
  - Drugs used in neurodegenerative disease (1 hour)
  - Anxiolytic and hypnotic drugs (1 hour)
  - Antipsychotic drugs (1 hour)
  - Antidepressant drugs (1 hour)
Learning outcomes
The students shall be able to describe the general principles for drug absorption, distribution, elimination and concentration-effect relationships, and the indications and main pharmacokinetic and pharmacodynamic properties of the drug classes mentioned in the course contents.

Teaching and learning methods
Lectures 34 hours.
Pharmacokinetic calculation (exercises) (20 hours).
Laboratorial work and journal writing (3 days).
Group work (6 hours).

Assessment
Written exam (4 hours). Alphabetical grades (A-F).

Course work requirements
The laboratory journal and pharmacokinetic exercises are mandatory and must be approved before the student can attend the final exam. The laboratory course includes training in laboratory safety specified for lab work in this course.

Re-sit/postponed exam
A re-sit exam/postponed exam will be arranged early in the following semester, for candidates who failed the exam, or who, for valid reasons, were unable to attend.

Syllabus

Language of instruction
English.

MBI-3003 Toxicology (10 ECTS)
Type of course
Students following the master programme in biomedicine, or other students interested in the topic such as singular course students/freemovers.

Admission requirements
A bachelor degree in biomedicine or equivalent.


Course contents
The following topics are included:

- exposure to potentially toxic substances, adverse effects, chemical interactions, epidemiology and human toxicology, toxicodynamics and toxicokinetics, data interpretation, risk assessment and risk management, exposure and monitoring, genetic toxicology, reproductive toxicology, immunotoxicology, skin toxicology, respiratory toxicology, hepato-, nephro- and neuro-toxicity, occupational toxicology, biocides and pesticides, transport, exposure and health effects of arctic pollution, arctic pollution and human health.
**Learning outcomes**
Students should be able to

- explain how toxic substances are handled by an organism (toxicokinetics) and how they affect the organism (toxicodynamics).
- describe the nature of various toxic compounds as well as toxic effects, including their biochemical and molecular mechanisms of action
- explain the dose-response relationships and time-response relationships
- describe transport, exposures and toxic effects of pollution in the arctic area

**Teaching and learning methods**
The course includes lectures (32 hours) and a compulsory semester project. The students must give a mandatory presentation of the semester project to his/her fellow students. The semester project must be approved before the student may attend the exam.

**Assessment**
Written exam (4 hours) and alphabetical grades (A-F). The semester project is not a part of the assessment for the alphabetical grade.

**Course work requirements**
A semester project with an oral presentation of the project must be approved in order to attend the final exam.

**Re-sit /postponed exam**
A re-sit exam/postponed exam will be arranged early in the following semester, for candidates who failed the exam, or who, for valid reasons, were unable to attend.

**Syllabus**
Fundamental toxicology: John, H. Duffus, and Howard, G. J. Worth.

**Language of instruction**
English

**MBI-3004 The Biology of Cancer (10 ECTS)**

**Type of course**
The subject is optional for students accepted to the Master in biomedicine and Master in laboratory science study programs. It is also electable for other students with relevant background knowledge.

**Admission requirements**
The course is offered to students that are accepted to the Master in biomedicine and Master in laboratory science study programs. Students with relevant bachelor degrees may able to take the course as single course students.

**Course contents**
The following topics will be lectured:

The nature of cancer including an introduction to cancer pathology and clinical aspects of cancer. Tumor viruses, cellular oncogenes, growth factors and their receptors, signaling pathways relevant to cancer development, tumor suppressor genes, the control of the cell cycle and apoptosis.
Immortalization, multistep tumorigenesis, genome integrity and cancer development, angiogenesis, invasion and metastasis, tumor immunology and rational treatment of cancer will also be addressed in this course.

**Learning outcomes**
After following the course the students should be able to describe/discuss:

- what types of cellular processes go awry in the transformation of normal cells to cancerous cells.
- what evidence indicate that tumours arise from normal tissues in a multistep process.
- in what ways mutations arise and what evidence indicate that cancer is caused by mutations and how viruses contribute to the cause of cancer.
- what is an oncogene, and in what different ways a proto-oncogene can be activated
- the typical histological features and nomenclature of benign and malignant tumours.
- the mechanisms of a growth factor receptor activation and in what ways growth factor receptors may contribute to cancer
- in what ways oncogenic RAS contribute to the development of cancer.
- what is a tumour suppressor gene, and how one may become inactivated.
- why tumour suppressors typically function as recessive alleles, while oncogenes usually are dominant.
- what is the role of pRB in the cell cycle, and how does disruption of the cell cycle contribute to cancer
- what is the role of p53 in the regulation of DNA repair and apoptosis.
- how loss of p53 may contribute to the development of cancer.
- what is cellular senescence and what triggers this cellular response.
- what role telomers and telomerase play in normal cells and how these roles are altered in tumour cells.
- how multi-step tumourigenesis relates to cancer development over time.
- how tumour promoting agents and mutagens differ in their contribution to cancer development.
- the various methods of DNA repair and how defects in DNA repair are related to cancer.
- principles of angiogenesis, stroma formation and and why its critical to cancer survival.
- different therapeutic approaches targeting angiogenesis and metastatic processes.
- the role of tumour microenvironment, inflammatory cells and substances in tumor promotion
- what evidences suggests that the immune system may play a role in immune suppression and how the immune system may be exploited to make tumour cells more susceptible to immunologic attack.
- the pros and conc of conventional chemotherapy and what classes of molecules might be a valuable targets for the development of new anti-cancer therapies.

**Teaching and learning methods**
The course will be an intensive course taught over a three-week in the beginning of the spring semester. There will be 36-40 lectures of 45 minutes each and at least 10 hours of group work to discuss and present specific topics.

**Assessment**
The final evaluation is based on a 15 page essay on a given topic which should be submitted within three weeks of the end of the lecture series. Grade type A-F.
**Course work requirements**  
Participation in the group work and the oral presentation is compulsory. The oral presentation must be approved before the final evaluation.

If a student is unable to participate in the group work he/she will have to participate in the course next time the course is held.

**Re-sit/postponed exam**  
A re-sit exam/postponed exam will be arranged early in the following semester, for candidates who failed the essay or who, for valid reasons, were unable to attend.

**Syllabus**  
The course will use the 796 pp. book by Robert A. Weinberg “The Biology of Cancer” (Garland Science 2007) as text book.

**Language of instruction**  
English.

**MBI-3007 Eukaryotic genes and genomics (10 ECTS)**  
**Type of course**  
Students following the master programme in biomedicine, or other students interested in the topic such as singular course students who meet the course pre-requisites.

**Admission requirements**  
Pre-requisites: a complete bachelor in biomedicine, or an equivalent.

**Course contents**  
The main focus in this course will be on structure, maintenance, function and regulation of the eukaryotic genome. Lectures will be given on analysis of the genome, evolution of the genome, chromosome structure and chromosome packing and the role of this in metabolic processes that involve DNA, regulation of genome activity by post-translational modifications and epigenetics, chromosomal abnormalities in relation to disease, transcriptomics and RNomics. In addition, the course will give an introduction to state of the art methods for genome analysis and genome activities.

**Learning outcomes**  
The student should be able to;

- Describe the content, structure, organization, regulation and evolution of eukaryotic genes and genomes on the DNA and RNA levels.
- Describe the dynamic genome involving transposable elements, retrovirus and recombination and hypermutation in the immune system.
- Describe epigenetic mechanisms and modification of DNA and RNA.
- Describe the transcriptome, RNA function, structure, organization, evolution and regulation.
- Explain genomic abnormalities in relation to disease.
- Give an oral presentation of a topic based on analyses of scientific articles

**Teaching and learning methods**  
The course will consist of lectures and student seminars.

**Assessment**
4 hours written exam, graded alphabetically A-F.

**Course work requirements**
Students must pass the coursework requirements in the form of a student presentation of a topic based on analyses of scientific articles in order to be able to attend the final examination.

**Re-sit /postponed exam**
A re-sit exam/postponed exam will be arranged early in the following semester, for candidates who failed the exam, or who, for valid reasons, were unable to attend.

**Syllabus**
Course literature will be announced at the start of the semester.

**Language of instruction**
English.

**MBI-3103 Rettsgenetikk og medisinsk genetikk (10 ECTS)**

**Type of course**
Emnet er et valgemne for studenter på programmene master i medisinske laboratoriefag, master i biomedisin og master i molekylær bioteknologi. Emnet kan også tas som enkeltemne. Emnet arrangeres dersom minimum 3 studenter tar emnet. Totalt kan 20 studenter ta emnet.

**Admission requirements**
Opptakskrav til emnet er en bachelorgrad i bioingeniørfag eller biomedisin, eller tilsvarende utdanning med mye erfaring fra laboratoriefag.

Emnet kan maksimalt ta 20 studenter og hvis det er flere interesserte studenter vil de rangeres på følgende måte:

1) studenter som er tatt opp på master i medisinske laboratoriefag

2) Studenter som er tatt opp på mastergradsprogrammer ved IMB; master i biomedisin og master i molekylær bioteknologi

3) enkeltemnestudenter - vil rangeres etter §15 i Forskrift om opptak til studier ved Universitetet i Tromsø.

**Course contents**
Emnet går først gjennom basale tema innen human genetikk som kromosomstruktur og funksjon, oppbygning og organisering av det humane genom.

Undervisningen i medisinsk genetikk tar for seg genom-evolusjon, DNA sekvens-variasjon, Mendelsk nedarving, populasjonsgenetikk, mutasjoner og sykdom og epigenetikk. Undervisningen omfatter teori og metoder innen molekylær genetisk diagnostikk, samt klassisk og molekylær cytogenetikk.

Emnet gir videre en innføring i rettsmedisinsk virksomhet med spesiell vekt på rettsgenetikken. Tema som gjennomgås er rettsgenetisk arbeid i forbindelse med analyse av biologiske spor, identifisering av ukjente lik, farskapssaker/slektskapanalyser og prøver til DNA registeret. Prinsipper for rettsgenetisk analyse, bruk av genetiske markører og tolking av resultat. Spesielle metoder innen rettsgenetisk analyse, laboratorieteknikker og statistiske analyser. Det gis en oversikt over
rettsgenetikkens rolle i strafferettspleien, og de lover og forskrifter som har betydning for rettsgenetisk virksomhet. Bakgrunn for DNA-reformen og betydningen av denne vil bli omtalt.

I løpet av emnet gjennomføres et laboratoriekurs hvor studentene skal analysere en sporprøve og sammenligne DNA-profilen fra sporprøven med DNA-profilen de har fått fra referanseprøver fra mistenkte personer.

**Learning outcomes**

Ved fullført emne skal studentene kunne:

- forklare hvordan arvelige faktorer påvirker fenotypiske trekk hos mennesket.
- forklare genetiske forandringer som årsak til sykdom, hvordan sykdomsassosierede gener nedarves i familier og om slike generers utbredelse i befolkninger.
- forklare hva rettsgenetisk analyse brukes til, hvilke laboratorieteknikker som benyttes, bruk av genomisk og mitokondrielt DNA, samt metodologiske problemer knyttet til rettsgenetiske analyser.
- forklare om bruk av statistikk i sammenligning av DNA-profiler og hvordan kvalitetssikring av analysene foregår, inkludert rollen til Den rettsmedisinske kommisjon.
- greie ut om oppbygning av rettsvesenet og til de lover, regler og forskrifter som regulerer den rettsgenetiske virksomhet.
- greie ut om DNA-registeret, etterforskingsregisteret og sporregisteret.

**Teaching and learning methods**

Forelesninger og laboratorieøvelser. Etter laboratoriekurset skal studentene levere en skriftlig rapport.

**Assessment**

Skriftlig skoleeksamen på 6 timer som vurderes med bokstavkarakterer A-F.

**Course work requirements**

Obligatorisk deltakelse på laboratorieøvelser og innlevering av skriftlig rapport. Rapporten må være godkjent før kandidaten får gå opp til eksamen. Laboratoriekurset inkluderer sikkerhetsopplæring for arbeid på lab i forbindelse med dette emnet.

**Re-sit /postponed exam**

Kontinuasjonseksamen avholdes i starten av påfølgende semester for dem som ikke besto eksamen.

**Syllabus**

Rettsgentikk:


Medisinsk genetikk:

For denne delen av pensum vil det bli laget et kompendium.

**Language of instruction**

Norsk.
BIO-3323 Bioinformatics: Genomes and genomics (10 ECTS)

The course is administrated by
Faculty of Science and Technology

Campus
Tromsø

Application deadline
Applicants from Nordic countries: 1 June for the autumn semester and 1 December for the spring semester.
Exchange students and Fulbright students: 1 October for the spring semester and 15 April for the autumn semester.

Type of course
The course is available as a singular or elective course independent of study program, to exchange students. The course is offered on condition that a minimum number of students register for the course.

Admission requirements
Bachelor’s degree (180 ECTS) in Biology or equivalent qualification in biology. An average grade of equivalent to C or better in the Norwegian grading system is required.

Course contents
Bioinformatics is a combination of biological science and information technology used in analyzing and deriving conclusions from large data sets. This course introduces the students to bacterial genomes and genome analysis. Genome-scale sequencing projects have led to an explosion of genetic information (gene sequences) available for analysis. The student will be shown how these sequences can lead to a much fuller understanding of many biological processes. The aim is to provide a practical description of the topics, tools and current trends in bacterial genomics including their impact on biology, human and veterinary medicine. Major topics will include:

- genome sequencing and assembly
- genome annotation (gene prediction and functional assignment)
- prediction of binding sites
- comparative genomics
- Transcriptomics (RNA-seq)
- systems biology
- phylogenetic analysis

Recommended prerequisites
BIO-2304 Introduction to Bioinformatics

Objective of the course

Knowledge:
The candidate:
- has broad knowledge in genomics and genome analysis including
- is familiar with methods and techniques applied in bioinformatics on prokaryote organisms
- can apply bioinformatics to important areas of this field
- can update his/her knowledge related to comparative genomics
Skills:

The candidate:
- can evaluate information in bioinformatics and use it to work with practical and theoretical problems
- can analyse methods, techniques and interpretations in bioinformatics and work independently on practical problems
- can use relevant methods and techniques in bioinformatics based on well-founded choices
- can carry out a limited research project under supervision.

General competence:

The candidate:
- can apply her/his knowledge and skills in bioinformatics in order to carry out assignments and projects
- can communicate terminology in the field of bioinformatics
- can communicate about academic issues, analyses and conclusions in the field of bioinformatics

Language of instruction

The language of instruction is English and all syllabus material is in English

Teaching methods

The course will be taught as a combination of lectures, demonstrations and practical lab work. Lectures and hands-on laboratory exercises: 80 h.

Assessment

Evaluation of orally presented report.
Pass/not pass.
Candidates who fail the exam can register for re-sit the following semester.

8.3 Elective courses – fall semester

BIO-3008 Animal Physiology (10 ECTS)

Type of course

May be taken as a singular course, but the course is oriented towards MSc-students in Arctic Animal Physiology.

Admission requirements

Previous knowledge: knowledge in animal physiology equivalent to Bio-2002.

Course contents

The course reviews the physiology of animals with emphasis on the basic mechanisms behind specialized functions in different tissue types/organs, and the mechanisms that regulate and maintain homeostasis in an integrated organism. The course reviews physiological adaptations in animals with different modes of living in different environments, with respect to nutrition and energetics, metabolism and temperature regulation, neuronal, sensory and endocrine mechanisms,
reproduction and biological clocks, muscles and movement, respiration and circulation and balance of water and salt.

**Learning outcomes**

**Knowledge:**
- Explain the general principles of function in individual tissues/organs and how they are integrated in the organism •
- Explain how the functions of organs are modified and adapted in organisms living in different environments •
- Demonstrate and explain how physiological mechanisms may limit or potentiate the process of adaptation •
- Present and explain typical examples of physiological adaptations to special environments with respect to nutrition, energetics, locomotion, circulation, respiration, water- and salt balances and neuronal and sensory orientation

**Skills:** •
- Review and communicate, both orally and in writing, current knowledge from the recommended reading/syllabus •
- Teach Animal Physiology at Bachelor- and MSc levels and communicate own research at MSc level

**General skills:** •
- Apply the knowledge and information which is required to plan own research in Animal Physiology at the PhD level •
- Review and extract relevant scientific literature in the process of presenting and discussing own research (MSc) findings •
- Analyze and criticize scientific research within own (MSc) discipline

**Teaching and learning methods**

Seminars/colloquia

**Assessment**

Written exam, 6 hours. Grade: A-F, F is failed.

**Course work requirements**

Course work requirements: one oral 30 min presentation of a given topic from the recommended reading/syllabus (Hill et al., Animal Physiology)

**Syllabus**


**Language of instruction**

English.

**MBI-3005 Norma flora/Infection/Inflammation (10 ECTS)**

**Type of course**

This course can be taken as part of Master of Science in Biomedicine or Master’s Degree program in Biomedical Laboratory Science. The course may also be taken as a singular course.
Admission requirements
Prerequisites: bachelor degree in biomedicine or in medical laboratory sciences (BLS), or other bachelor degree that covers biochemistry, cell biology, immunology and general microbiology.

Course contents
The course will describe examples of microorganism that infect human and cause acute or persistent infection, or colonization. The human body will be divided into different niches, and examples of microorganisms which colonize/cause infection and/or inflammation in the particular niche will be given.

More specifically, the course will include:

1) an introduction to pathogenic bacteria and viruses
2) definitions of various concepts (normal flora, infection, inflammation, colonization, mutualism, commensalism, parasitism etc).
3) description of how microorganisms may live in peaceful coexistence or infect skin, gastrointestinal tract, upper and lower respiratory tract, blood stream and various organs.
4) examples of how microorganisms can evade the host immune system
5) descriptions of the principles of antimicrobial and antiviral therapy

Learning outcomes
The student should be able to describe how some microorganisms (bacteria or virus) can live in peaceful coexistence with the host, while other cause infections and/or inflammation. The student should be able to give examples of microorganisms of each type for a given tissue. The student should be able to describe human inflammatory responses, and to explain different means of bacterial and viral immune evasion.

Teaching and learning methods
Teaching methods: 10 hours lectures, 20 hours student colloquia and 6-8 hours student seminars.

Assessment
Written exam (6 hours) graded alphabetically A-F

Course work requirements
Each student will prepare and perform an oral presentation of a selected subject for the rest of the group during the student seminars.

Re-sit /postponed exam
A re-sit exam/postponed exam will be arranged early in the following semester, for candidates who failed the exam, or who, for valid reasons, were unable to attend.

Syllabus
The syllabus consists of a combination of articles, text books and internet links. A detailed list will be given at semester start.

Language of instruction
English.
**MBI-3006 Biotechnology (10 ECTS)**

**Type of course**
The course can be taken as an elective course by students following the master programme in biomedicine. The course may also be taken by single course students/freemovers, who meet the pre-requisites.

**Admission requirements**
Pre-requisites: bachelor in biomedicine, or equivalent.

**Course contents**
A definition of Biotechnology is: The application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services.

The course will cover biotechnological production of knowledge, goods and service in medicine, nutrition, agriculture, industry and environment. Topics will include: recombinant DNA technology and gene expression, genetically engineering, genomics, RNAomics, proteomics, metabolic engineering, peptide and protein design, genetic modified organisms, transgenic animals as disease models, development of pharmaceuticals and biopharmaceuticals, high throughput screening, molecular modelling, pharmacogenetics and ?genomics , personalized diagnostics and therapy, nanotechnology, biofuels and biomass, bioremidation, issues concerning regulation, patenting, ethics and safety.

**Learning outcomes**
The student should be able to;

- Describe relevant, basic scientific disciplines and how they may be integrated into biotechnology.

- Describe in some details specific methods and techniques and explain their practical applications in biotechnology.

- Give an oral presentation of recent advances in biotechnology based on scientific articles.

**Teaching and learning methods**
The course will consist of lectures and student seminars.

**Assessment**
4 hour written exam, graded alphabetically A-F

**Course work requirements**
Students must pass the coursework requirements in the form of a student presentation in order to be able to attend the final examination.

**Re-sit/postponed exam**
A re-sit exam/postponed exam will be arranged early in the following semester, for candidates who failed the exam, or who, for valid reasons, were unable to attend.

**Language of instruction**
English

*KJE-3603 Protein production technology (10 ECTS)*
The course is administrated by
Faculty of Science and Technology

Campus
Tromsø

Type of course
Theoretical and practical subject. The course is available as a singular or elective course independent of study program, also to exchange students and free-movers. The course is offered on condition that a minimum number of students register for the course.

Admission requirements
Students should have basic knowledge in biochemistry and molecular biology.

Course contents
Protein expression and protein purification is an art of science and technology. Each protein is unique and needs special treatment. This intensive practical course is dedicated to the current technology and processes available to obtain a pure sample of protein using recombinant DNA techniques, combined with biotechnology of protein production and purification. The course covers cloning and overexpression in bacterial and eukaryotic systems, introduction to fermentation, protein purification and biophysical characterization.

Protein production technology:
i) Recombinant protein technology and fermentation
   • Recombinant protein technology
   • Expression systems i (prokaryote systems)
   • Expression systems ii (eukaryote systems)
   • Introduction to fermentation
ii) Protein purification
   • Initial planning and strategy
   • Biological activity and quantification of proteins
   • General methods for handling enzymes and proteins
   • The protein extract
   • Purification of engineered proteins
   • Fractionation techniques
   • Optimization
   • Scaling up
   • Analysis of purified product

Objective of the course
The objective of the course is to give the students theoretical and practical insight into protein production technologies.

Knowledge:
The candidate:
• has advanced knowledge in protein production technology including recombinant protein technology, fermentation and protein purification.
• has thorough knowledge of methods and techniques applied in protein production
• can apply knowledge to new areas in protein production technology
• can analyse academic problems related to recombinant protein production technology
Skills:
The candidate:
- can analyze and deal critically with various sources of information and use them to structure and formulate scholarly arguments.
- can analyze methods, techniques and interpretations in protein production and work independently on practical problems.
- can use relevant methods and techniques in protein production for research in an independent manner.
- can carry out an independent, limited research or developmental project under supervision.

General competence:
The candidate:
- can apply her/his knowledge and skills in protein production technology in order to carry out assignments and projects
- can communicate terminology in the field of protein production including recombinant protein expression and protein purification.
- can communicate about academic issues, analyses and conclusions in the field of protein production technology.
- Can write an scientific report

Language of instruction
The language of instruction is English and all of the syllabus material is in English.

Teaching methods
The course will be taught as a combination of lectures, demonstrations and practical lab work. Lectures and demonstrations: 20 h, Hands-on laboratory exercises: 40 h. Compulsory attendance.

Assessment
Evaluation of submitted lab report. Pass/not pass. Candidates who fail the exam can register for re-sit the following semester. Compulsory attendance.