

PROGRAMME DESCRIPTION

Master in Biology

120 credits

Campus Tromsø

The programme description has been approved by the Faculty of Biosciences, Fisheries and Economics. Revised in 2018.

Study program name	Biology – master
Obtained degree	Master of Science in Biology
Target group	The Master`s program in biology is aimed at students holding a Bachelor`s degree in biology or similar who are interested in pursuing a career in a wide range of jobs, both public and private sectors; research, administration, consulting and the teaching profession.
Admission requirements, required prerequisite knowledge, recommended prerequisite knowledge	<p>Admission to the Master`s program in Biology requires a Bachelor`s degree (180 ECTS) or equivalent qualification, with a major in biology of minimum 80 ECTS. An average grade of equivalent to C or better in the Norwegian grading system is required.</p> <p>Admission to a given master`s discipline may require some specified courses at bachelor level. Please contact the student adviser for more information about this.</p>
Academic content and description of the study programme	<p>Several master disciplines are offered which reflect the University of Tromsø`s unique geographic location in the high north. They provide opportunities to explore an array of fascinating questions within modern biology and emphasize some of the society`s challenges, with regard to management of natural resources and biodiversity.</p> <p>Each discipline is connected to ongoing and relevant research in the different fields. They will provide the relevant theoretical background, training in state-of-the-art laboratory and field methods as well as training of presentation and knowledge transfer proficiency.</p> <p>The Master`s program in biology offers the following five disciplines:</p> <ul style="list-style-type: none"> • Arctic animal physiology • Freshwater ecology • Marine ecology and resource biology • Molecular environmental biology • Northern populations and ecosystems

Table: program structure

Overall program structure in table below.

BIO-3012 Study design and data analysis II is a compulsory course for all master`s students in biology. The course BIO-3503/HEL-6320 is compulsory for students who carry out experiments on living animals. Please note that there is an own application deadline for HEL-6320.

Safety training courses (HMS-0501, HMS-0502, HMS-0503 and HMS-0504) are also compulsory for all master`s students in Biology. Three of the courses consist of web-based modules while the first aid course (HMS-0502) is a practical course which requires physical attendance. Students only receive course diploma for the HMS-courses.

Amount of compulsory and elective courses will vary depending on the Master's Discipline. The course portfolio taken by individual students will be decided upon by consultation with project supervisors. You may start on work for a 60 ECTS thesis in the second or third term, depending on your own preferences and the character of the project.

You find information about the different disciplines at the end of the document.

Semester	10 credits	10 credits	10 credits
Semester 1	Compulsory/elective course for disciplines	Compulsory/elective course for disciplines	Compulsory/elective course for disciplines
Semester 2	BIO-3012 Studydesign and dataanalysis in biology II	BIO-3503 Aquatic Animal Welfare HEL-6320 Animal Experimentation for Researchers	Compulsory/elective course for disciplines
Semester 3	BIO-3950 Master`s Thesis in Biology		
Semester 4	BIO-3950 Master`s Thesis in Biology		

<p>The study program's Learning Outcome</p>	<p>A Master's candidate is expected to have advanced and comprehensive knowledge of biological methodology, theories, concepts, and scientific approaches. The candidates who complete the program are expected to have achieved the following learning outcomes, defined by general proficiency, knowledge and skills.</p> <p>Knowledge Students will have advanced knowledge in biology and in one of the following disciplines offered:</p> <ul style="list-style-type: none"> • Arctic animal physiology • Freshwater ecology • Marine ecology and resource biology • Molecular environmental biology • Northern populations and ecosystems <p>Skills Students will have the ability to:</p> <ul style="list-style-type: none"> • Formulate relevant research questions in an independent manner, and apply theories, concepts, and methods pursuant to the scientific and ethical standards in the field. • To search for and evaluate recent biological research in a critical manner, and to make assessments using scientific knowledge in the field. • To present biological knowledge and ideas in an instructive manner to researchers, policy makers and the general public. <p>General proficiency</p> <ul style="list-style-type: none"> • Have acquired specialized expertise in one of the disciplines offered • Have the competence to analyze biological problems that require skills at a high level. • Apply their knowledge and skills in biological theory and methods in new areas relevant to society • Have sufficient competence to participate in and to evaluate research projects or to advance to doctoral studies
<p>The study programs relevance</p>	<p>A Master's of Science degree in Biology will prepare students for a wide range of jobs, in both public and private sectors, including; research, administration, consulting and the teaching profession.</p> <p>Many Master's students in Biology are connected to common projects involving Department of Arctic and Marine Biology (AMB) and other institutes in Tromsø that carry out biological research and consultation work, e.g. Norwegian Polar Institute, Institute of Marine Research, Norwegian Institute for Nature Research (NINA), Bioforsk, Akvaplan-niva and Nofima.</p>
<p>Work scope and learning activities</p>	<p>Several teaching methods are employed, including lectures, seminars, laboratory work, computer lab and field courses. These will vary from course to course. Supervision of the project work that leads to the writing of the Master thesis will be given by faculty staff, sometimes in co-operation with an external supervisor.</p>

Examination and assessment	Several assessment methods are employed, including oral or written examinations, assessments of project work/ lab reports/field reports, often in combination.
For master's theses/ independent work in master's degrees	<p>The master thesis is an independent scientific work (60 ECTS), under the guidance by one or several supervisors. The thesis is written within one of the following disciplines:</p> <ul style="list-style-type: none"> • Arctic animal physiology • Freshwater ecology • Marine ecology and resource biology • Molecular environmental biology • Northern populations and ecosystems <p>The number of pages required for a master's thesis, may vary depending on type of project and has to be discussed with your supervisor. The general work effort in a master's project is 1500-1800 hours (including field and lab work).</p> <p>Students who are admitted to the master's degree normally select a project during the first semester, and no later than one month before the end of the second semester. For students associated within a research project, the supervisor and the student must ensure that it is being written a supervisor contract.</p> <p>Deadline for handing in the contract is during the third semester for all students:</p> <ul style="list-style-type: none"> • September for students admitted in autumn. • February for students admitted in spring. <p>Deadline for submission of thesis is May 15th for students admitted in autumn, November 15th for students admitted in spring.</p> <p>After the master's thesis is submitted, there will be an oral master's examination. This examination consists of a public presentation at minimum 30 minutes where the student provides an overview of the project. Then follows an oral examination with the examination commission. The final oral exam is normally within 2-3 weeks after the submission, and not later than within six weeks.</p>
Language of instruction and examination	<p>Language of instruction is English, and all of the syllabus material is in English. Examination questions will be given in English but may be answered either in English or a Scandinavian language.</p> <p><u>The Master's thesis must be written in English.</u></p>
Internationalisation and student exchange	Students can apply for exchange studies or field work abroad according to the available cooperation agreements within scholarship programs such as Erasmus, Nordplus, Barentsplus or North2North. Please consult the program study adviser for more information. Students can also undertake periods of studying at The University Centre at Svalbard, UNIS
Administrative responsibility and academic responsibility	Department of Arctic and Marine Biology, Faculty of Biosciences, Fisheries and Economics. Institute leader, study administration and Master study program leader.
Quality assurance	The study program is normally evaluated every year according to the university's quality assurance system. The courses in the study program are evaluated every third time they are given, as a minimum.

Master's Disciplines

Arctic animal physiology

The master discipline in arctic animal physiology focuses on physiological adaptations to life at high latitudes in fishes, birds and mammals. Particular emphasis is placed on how these animals cope with the climatic variability, extreme light-dark cycles and large seasonal fluctuations in food availability that are all typical of their environment. Physiological adaptations of diving birds and mammals, which are abundant at high latitudes, also represent an important topic.

Students will be introduced to and given the opportunity to specialize within many aspects of animal physiology (e.g., chronobiology, endocrinology, reproductive physiology, thermoregulation, nutrition/digestion, cardiovascular physiology), with approaches spanning from studies of molecular and cellular/subcellular mechanisms, to integrative, whole-animal studies that may be conducted in the field or as experimental studies in the laboratory (or as a combination of these). For this purpose, specialized laboratories and approved research animal facilities, where several relevant species of fishes, birds and mammals are maintained, are available.

Master projects will normally form a part of ongoing projects which encompass both curiosity-driven basic research projects and projects important for production and management of natural resources in aquatic and terrestrial environments. Students will be expected to participate actively in seminars that are given within the research group, as well as at the institute.

Study plan/Program structure

Term	10 ects		10 ects		10 ects
First semester (autumn)	BIO-3008 Animal Physiology*			Elective course	
Second semester (spring)	Elective course (10 ECTS) BIO-2310 Arctic biology (Compulsory for students who have not taken this course during bachelor)*	BIO-3503 Aquatic Animal Welfare (Compulsory for students with Master`s topic on fish (5 ECTS)) HEL-6320 Animal experimentation for researchers (FELASA category C) (Compulsory for students with Master`s topic on birds/mammals (6 ECTS))*	Elective course (5 ECTS)	BIO-3012 Study design and data analysis in biology II (Compulsory for all Master`s students in biology)*	
Third semester (autumn)	BIO-3950 Master's Thesis Biology				
Fourth semester (spring)	BIO-3950 Master's Thesis Biology				

Recommended elective courses for the master's discipline:

Autumn:

- BIO-3014 Biological Rhythms - 10 ECTS (Chronobiology and Physiology)*
- BIO-3009 Arctic Marine Pollution - 10 ECTS (Physiology and ecotoxicology)*
- BIO-3020 Fundamentals of Ecotoxicology - 10 ECTS (Physiology and ecotoxicology)*
- BIO-3013 Northern Food Web Ecology - 10 ECTS (Ecophysiology)*
- BIO-3505 Ecological interactions - 10 ECTS (Ecophysiology)*
- BIO-3506 Top predators - 10 ECTS (every second year)
- BIO-3805/3810/3815/3820 Individual Special Curriculum (autumn/spring), 5/10/15/20 ECTS (not scheduled)

Spring:

- BIO-3004 Ecosystem-based management - 10 ECTS (Ecophysiology)
- BIO-3118 Microscopical Imaging Techniques - 10 ECTS
- BIO-3029 Sea ice habitats and biology - 5 ECTS*
- BIO-3805/3810/3815/3820 Individual Special Curriculum (autumn/spring), 5/10/15/20 ECTS (not scheduled)

*Schedule is coordinated (for the compulsory parts). For intensive courses and field courses there might be overlap. Students have to prioritize compulsory parts, e.g. laboratory/field course.

In addition, some courses at bachelor level (e.g., the compulsory course BIO-2310 or other relevant courses) may be included in the master's discipline, if such courses were not taken during the bachelor studies.

The students are encouraged to discuss with supervisors what would be the optimal set of courses.

Freshwater ecology

The master projects are usually related to topical activities within freshwater ecology, which include research in lakes, rivers and coastal areas related to landlocked and anadromous populations of fish (in particular salmonids) as well as invertebrates. Research activities comprise basic aspects of ecology and more applied topics related to nature and resource management. Important keywords are population and community ecology, predation, competition, parasitism, trophic ecology, ecological speciation, invasion biology, anadromy, life history and migration.

The students will acquire broad skills in ecological and evolutionary theory, management-related knowledge and key methodologies for research in freshwater and fish ecology. With a degree within this area the students will be ready to take on jobs within nature management, higher education and consultancy, or continue with research within freshwater ecology and related subjects.

Study plan/Program structure

Term	10 ects		10 ects	10 ects
First semester (autumn)	Elective course (5 ECTS)	BIO-3521 Seminar in Freshwater ecology (5 ECTS)*	BIO-3505 Ecological Interactions*	Elective course
Second semester (spring)	BIO-3518 From catchment to coast: Northern inland waters and global change (10 ECTS)*		BIO-3012 Study design and data analysis in biology II (Compulsory for all Master`s students in biology)*	Elective course
Third semester (autumn)	BIO-3950 Master's Thesis Biology			
Fourth semester (spring)	BIO-3950 Master's Thesis Biology			

BIO-3521 Seminar in Freshwater ecology is a course where students participate at seminars over several terms. Students must remember to sign up for teaching all semesters and only sign up for the exam the last semester.

Recommended elective courses for the master's discipline:

Autumn:

- BIO-3519 Parasittologi og epidemiologi - 10 ECTS (given in Norwegian)*
- BIO-3111 Geographical Information Systems (GIS) and Earth Observation - 10 ECTS*
- BIO-3013 Northern food web ecology - 10 ECTS*
- BIO-3805/3810/3815/3820 Individual Special Curriculum (autumn/spring), 5/10/15/20 ECTS (not scheduled)

Spring:

- BIO-3028 Evolutionary and ecological interactions - 10 ECTS (every second year)*
- BIO-3003 Fish migration: Theory and technology - 10 ECTS*
- BIO-3805/3810/3815/3820 Individual Special Curriculum (autumn/spring), 5/10/15/20 ECTS (not scheduled)

*Schedule is coordinated (for the compulsory parts). For intensive courses and field courses there might be overlap. Students have to prioritize compulsory parts, e.g. laboratory/field course.

The students are encouraged to discuss with supervisors what would be the optimal set of courses.

Please be aware that not all elective courses are timetable coordinated.

Marine ecology and resource biology

Marine ecology and resource biology is a diverse field covering marine ecology, biodiversity, fisheries ecology, fish biology and aquaculture. Master projects may be chosen within the following main areas of research:

- **Marine Ecology and Biodiversity**
- **Fisheries Ecology**
- **Fish Biology and Aquaculture**

Study plan/Program structure

Term	10 ects	10 ects	10 ects
First semester (autumn)	Elective course	Elective course	Elective course
Second semester (spring)	BIO-3012 Study design and data analysis in biology II (Compulsory for all Master`s students in biology)**	BIO-3503 Aquatic Animal Welfare	Elective course
Third semester (autumn)	BIO-3950 Master's Thesis Biology		
Fourth semester (spring)	BIO-3950 Master's Thesis Biology		
	<p>The course BIO-3503 is compulsory for students who carry out experiments on living animals.</p> <p>Amount of compulsory and elective courses will vary depending on the master topic, and the students are encouraged to discuss with supervisors what would be the optimal set of courses. You may start on work for a 60 ECTS thesis in the second or third term, depending on your own preferences and the character of the project.</p>		

Recommended elective courses for the Master's discipline, within the main topics include:

Marine ecology and biodiversity:

Autumn:

- BIO-3015 Arctic Marine System Ecology, Productivity and Climate Change - 10 ECTS*
- Bio-3009 Arctic Marine Pollution - 10 ECTS*
- BIO-3020 Fundamentals of Ecotoxicology - 10 ECTS
- Bio-3524 Applied ecological statistics (autumn/spring) - 10 ECTS
- BIO-3516 Food-webs and fisheries - 10 ECTS*
- BIO-3805/3810/3815/3820 Individual Special Curriculum (autumn/spring), 5/10/15/20 ECTS (not scheduled)

Spring:

- BIO-3003 Fish migration: Theory and technology - 10 ECTS
- BIO-3512 Early life of marine fish – 10 ECTS
- Bio-3524 Applied ecological statistics (autumn/spring) - 10 ECTS
- BIO-3805/3810/3815/3820 Individual Special Curriculum (autumn/spring), 5/10/15/20 ECTS (not scheduled)

*schedule is coordinated (for the compulsory parts). For intensive courses and field courses there might be overlap. Students have to prioritize compulsory parts, e.g. laboratory/field course.

Fisheries ecology:

Autumn:

- BIO-3015 Arctic Marine System Ecology, Productivity and Climate Change - 10 ECTS*
- Bio-3009 Arctic Marine Pollution - 10 ECTS*
- Bio-3506 Top predators (every second year) - 10 ECTS
- Bio-3516 Food-webs and fisheries - 10 ECTS*
- BIO-3805/3810/3815/3820 Individual Special Curriculum (autumn/spring), 5/10/15/20 ECTS (not scheduled)

Spring:

- Bio-3512 Early life history of marine fishes - 10 ECTS*
- BIO-3003 Fish migration: Theory and technology - 10 ECTS*
- Bio-3524 Applied ecological statistics (autumn/spring) - 10 ECTS
- BIO-3805/3810/3815/3820 Individual Special Curriculum (autumn/spring), 5/10/15/20 ECTS (not scheduled)

*schedule is coordinated (for the compulsory parts). For intensive courses and field courses there might be overlap. Students have to prioritize compulsory parts, e.g. laboratory/field course.

Fish biology and aquaculture:

Autumn:

- Bio-2506 Introduction to Fish biology - 10 ECTS*
- Bio-2508 Aquaculture - 10 ECTS*
- Bio-3516 Food-webs and fisheries - 10 ECTS*
- BIO-3805/3810/3815/3820 Individual Special Curriculum (autumn/spring), 5/10/15/20 ECTS (not scheduled)

Spring:

- BIO-3011 Advances in Aquaculture - 10 ECTS*
- Bio-3512 Early life history of marine fish - 10 ECTS*

- BIO-3805/3810/3815/3820 Individual Special Curriculum (autumn/spring), 5/10/15/20 ECTS (not scheduled)

*schedule is coordinated (for the compulsory parts). For intensive courses and field courses there might be overlap. Students have to prioritize compulsory parts, e.g. laboratory/field course.

Compulsory courses are dependent on the Master`s topic, and students are encouraged to discuss with supervisors what would be their optimal set of courses.

Molecular Environmental Biology

The Master candidate will focus on molecular analysis of plants and microorganisms. Research areas cover a broad range of modern research topics ranging from molecular communication within plant cells to functional microbiology and plant/microbe interactions. Students may choose from a variety of different courses applying modern methods of experimental molecular biology and bioinformatics for the study of plant and microbe systems. All courses are designed specifically to prepare the candidates for their Master thesis. Also, the active participation in common seminars and courses are expected as an important part of scientific training.

The Master thesis offers an opportunity for a thorough study within one selected field of research and the participation in an ongoing research project among the following:

- Analysis of molecular signaling and transport processes within and between individual plant and bacterial cells
- Biochemistry and cell biology of parasitic plants and the interaction with their hosts
- Communication and interaction of plants and microorganisms with each other and with the environment.
- Biodiversity, function and activity of microbial communities in environments such as Arctic soil and the rumen of Arctic animals.

Study plan/Program structure

Term	10 ects		10 ects	10 ects
First semester (autumn)	Elective course (5 ECTS)	BIO-3005 Seminar: Molecular Environmental Biology in Microbes and Plants (5 ECTS)*	Elective course	Elective course
Second semester (spring)	BIO-3012 Study design and data analysis in biology II (Compulsory for all Master`s students in biology)		Elective course	Elective course
Third semester (autumn)	BIO-3950 Master's Thesis Biology			
Fourth semester (spring)	BIO-3950 Master's Thesis Biology			
	BIO-3005 Seminar: 30 hours; 1 hour weekly spread over 3 semesters			

BIO-3005 Seminar: Molecular Environmental Biology in Microbes and Plants is a course where students participate at seminars over several terms. Students must remember to sign up for teaching all semesters and only sign up for the exam the last semester.

Recommended elective courses for the master's discipline:

Autumn:

- BIO-3018 Environmental Molecular Genetics, 20 ECTS*
- KJE-3402 Protein Structure, 10 ECTS
- BIO-3805/3810/3815/3820 Individual Special Curriculum (autumn/spring), 5/10/15/20 ECTS (not scheduled)

Spring:

- BIO-3022 Biological membranes and their proteins - 5 ECTS (every second year)
- BIO-3118 Microscopical imaging Techniques - 10 ECTS
- BIO-3027 Scientific Programming with Python in the life sciences - 10 ECTS
- BIO-3805/3810/3815/3820 Individual Special Curriculum (autumn/spring), 5/10/15/20 ECTS (not scheduled)

Courses at The University Centre at Svalbard (UNIS):

- AB-327 Arctic Microbiology (summer), 10 ECTS

Own application deadline at UNIS, <https://www.unis.no/studies/>

The students are encouraged to discuss with supervisors what would be the optimal set of courses.

Northern populations and ecosystems

We offer master projects integrating field work, theory and statistics for students to achieve research training as well as skills transferable to other disciplines such as nature management and education. We offer projects that reflect current challenges and enhance our knowledge basis in basic ecology and evolution, applied ecology and cross-disciplinary studies between ecology and social sciences. You can choose a project involving topics such as ecological effects of climate change, ecological interactions, ecological modelling, ecosystem monitoring, ecosystem-based management, socio-ecological systems, behavioural ecology and biology didactics, primarily in terrestrial, northern ecosystems. Projects are often conducted as part of larger research projects and in teamwork. We collaborate extensively with partners within the Fram Centre (<http://www.framsenteret.no>) such as the Norwegian Institute for Nature Research (NINA) and the Norwegian Polar Institute.

Students enrolled in the Master`s discipline Northern populations and ecosystems will acquire initial training in basic and/or applied research that could be continued in PhD projects. Basic scholarly competence in the MS project topic chosen will be acquired primarily through the courses provided by the group. However, candidates are advised to take contact with the group in order to decide on their MS project topic on the start of the Master programme as deviations from the recommended courses may be relevant for some of

the topics. More specialized scholarly competence relevant to the specific Master project will be acquired through the reading of scientific literature as advised by the supervisor(s).

Students in the Master's discipline Northern populations and ecosystems will be trained in

- Theoretical and conceptual frameworks relevant to their topic
- Making study designs reflecting the hypotheses or questions of their research project
- Up-to-date methods for acquiring and analyzing data
- Writing a research paper
- Holding a research project presentation

The first-year students take courses relevant for their MSc projects, which are decided upon together with their main supervisor and, if not part of the course portfolio offered by our group, accepted by the study program board. Students could choose to take the more general courses as suggested in the study plan (below) or replace courses to acquire more in-depth knowledge in a specific subject area. The specialization also encourages international exchange with our partner universities. The Master's Thesis is conducted the second year.

Study plan/Program structure

Term	10 ects	10 ects	10 ects
First semester (autumn)	*BIO-3013 Northern food web ecology	Elective course	*BIO-3111 GIS and remote sensing
Second semester (spring)	BIO-3012 Study design and data analysis in biology II (Compulsory for all Master's students in biology)*	Elective course	*BIO-3004 Ecosystem management*
Third semester (autumn)	BIO-3950 Master's Thesis Biology		
Fourth semester (spring)	BIO-3950 Master's Thesis Biology		

*minimum 20 ECTS of the following courses are compulsory

Compulsory courses are depended on the Master's topic, and the students are encouraged to discuss with supervisors what would be the optimal set of courses (list below). Minimum 20 ECTS of the following courses are compulsory:

- BIO-3013 Northern food web ecology (autumn) - 10 ECTS*
- BIO-3111 GIS (autumn) - 10 ECTS
- BIO-2103 "Evolusjon og adferd" is a potential elective course for students reading Norwegian (autumn) – 10 ECTS
- BIO-3004 Ecosystem-based management (spring) - 10 ECTS

Other elective courses for the master's discipline:

- BIO-3505 Ecological interaction (autumn), 10 ECTS*
- BIO-3015 Arctic Marine System Ecology, Productivity and Climate Change (autumn),10 ECTS*
- Bio-3009 Arctic Marine Pollution (autumn), 10 ECTS*
- BIO-3519 Parasittologi (autumn) Norwegian course, 10 ECTS

- BIO-3028 Evolutionary and ecological interactions - 10 ECTS (spring every second year)
- BIO-3118 Microscopical imaging Techniques (spring) – 10 ECTS
- BIO-3518 From catchment to coast: Northern inland waters and global change (spring) – 10 ECTS
- BIO-3805/3810/3815/3820 Individual Special Curriculum - 5/10/15/20 ECTS

*schedule is coordinated (for the compulsory parts). For intensive courses and field courses there might be overlap. Students have to prioritize compulsory parts, e.g. laboratory/field course.

Courses at The University Centre at Svalbard (UNIS):

- AB-326 Arctic Plant Ecology (summer/autumn) - 10 ECTS
- AB-327 Arctic Microbiology (summer) - 10 ECTS
- AB-329 Arctic Winter Ecology (spring) - 10 ECTS

Own application deadline at UNIS, <https://www.unis.no/studies/>