

## ***MSc in Bioinformatics (Cycle 2, level 4)***

The objective of the program in Bioinformatics is to prepare students for careers in academia and industry, and in particular to deepen their knowledge in both the biosciences and computational sciences to apply this knowledge to manage and analyze data in the life sciences and to train them in research.

MSc in Bioinformatics is a 2 year full-time graduate study program of 120 ECTS credits (4 semesters, 30 ECTS each semester).

All students are required to complete one, two or three semesters of courses (total of 30 to 90 ECTS) selected to deepen and widen their knowledge in bioscience, algorithms, quantitative reasoning and data analysis. Study program will be constructed on an individual basis and based on the students' knowledge and skills from his study in the first cycle (level 2, BSc). Students can take 90 ECTS in courses and a 30 ECTS MSc thesis, 60 ECTS in courses and a 60 ECTS MSc thesis or 30 ECTS in specialized courses and a 90 ECTS MSc thesis with a stronger research focus.

Admission requirement is a BSc degree in the natural sciences, engineering, mathematics, computer science or related field. The applicant must have demonstrated strong potential for graduate studies.

After successful completion of the programme the student is awarded the degree Master of Science in Bioinformatics..

On the completion of the MSc program in addition to relevant undergraduate studies, the following criteria shall be fulfilled, in addition to the criteria fulfilled at former levels. For further information, i.e. learning outcomes for each course see the Course Catalog [www.ru.is](http://www.ru.is)

### **KNOWLEDGE AND UNDERSTANDING**

The program draws on the computational sciences and their application to the biosciences. The knowledge-base equips students to deal with a range of problems and challenges characterized by the interdisciplinary growth area where the mathematically and computationally based disciplines meet the health and biosciences. Students are expected to have a deep knowledge of methodologies in computer science and in the computational sciences and have a basic knowledge of the biological science in order to competently model into a computational framework problems arising in those fields.

The students will take courses in the computational sciences and in the biological sciences. The relative emphasis of each subject area will be dependent on the student's background. A student with a solid background in the biosciences will typically take a number of courses that have principally a quantitative nature and a student that has background in mathematics, computer science or engineering will take courses that that gives him a solid basis for applying his quantitative or technical skills to problems in the biomedical sciences.

Student with strong background in the biological sciences and little in the physical sciences would typically deepen their knowledge in programming, algorithms, advanced statistics and bioinformatics as well as in a selection of subjects that

directly serve the students research interests.

Student with a strong background in mathematics, computer science and engineering and little background in the life sciences would typically deepen their understanding of molecular and cellular biology, genetics and chemistry, as well as a selection of courses that directly serve the students research interests.

On completion of the MSc program the student shall possess the following systematic generalized understanding and knowledge:

- Knowledge and understanding of the basic principles and the more important theories relevant to the thesis project, drawn from both computational sciences and the biosciences and their application.
- Knowledge and understanding of specific features of the subject of the specialized field taken, as seen in relation to application across the two disciplines of computational and bioscience.
- Advanced knowledge of a broad range of analytical and modelling methodologies and tools commonly used when quantitative methods are applied to the biomedical sciences.
- Understanding and knowledge of basic research and practices relevant to mainstream bioscience.
- Knowledge of the main methods and tools used to gather, analyze, interpret and present data.
- Knowledge of key professional, safety and ethical issues arising in modern research in biology, medical research and in engineering.
- Research methodology, including the fundamentals of scientific writing, literature search, how to give a scientific presentation, how to evaluate a scientific paper, and research ethics.

### **TYPE OF KNOWLEDGE**

The program touches on many diverse disciplines with the aim of teaching the student to assimilate and integrate knowledge from many sources. Students can choose to focus on a variety of subjects, depending on their interests and undergraduate background.

On completion of the MSc program, the student shall possess specific, advanced knowledge and understanding of the following topics and their context within the broad field of Bioinformatics:

- Mathematics: Optimization and statistics.
- Computer Science: Algorithms, Programming
- Biosciences: Molecular and cell biology, genetics.

On completion of the MSc program, the student shall possess the following significant, in-depth knowledge and understanding of the research leading to his or her MSc thesis:

- The theories introduced in the specialized courses and the application of these to analyzing and solving problems in the field of Bioinformatics.
- The background and theoretical base in the chosen research area.

On completion of the MSc program, the student shall have experience in designing, building and operating computer programs that are useful to hthe student's field of research.

The student will have established knowledge and be competent in applications of techniques developed within the chosen area of research.

### **PRACTICAL SKILLS**

On completing the programme students should be able to:

- Make creative and knowledgeable use of a range of existing theories, techniques and tools relevant to their field of research.
- Refine existing techniques or define novel ones, as necessary, in the process of solving research problems.
- Organize and carry out research tasks
- Propose, plan and manage well defined research and design projects involving a team of individuals.
- Interpret and critically assess existing theories and models within his field of specialization.
- Have the ability to assess research and implementation projects that include components from both engineering/computer science and biomedical sciences and identify the key factors in a given situation.
- Work on a project in a team of professionals from different fields, contributing to the analysis of the project; participate in implementing and carrying out the work needed, and in evaluating the results.
- Work with confidence in a typical biological laboratory and be aware of safety and contamination issues.
- Appreciate the meaning and importance of professionalism, including integrity and adherence to independent informed judgement.
- Be able to make an expert use of software tools embodying the most recent theoretical advances in their area of research.
- Be familiar with the publication process of scientific results and be able to select the appropriate publication outlets for articles reporting on their research work.

### **THEORETICAL SKILLS**

On completion of the MSc program, the students shall have sufficient, comprehensive understanding to be able to:

- Assimilate and integrate their knowledge, make assessments and utilize their knowledge and understanding in solving relevant problems in Bioinformatics.
- Identify, adapt and develop models appropriate to the study of a range of different Bioinformatics projects.
- Apply standard scientific principles in carrying out different type of problems.
- Be able to carry out research in their field of expertise.
- Appreciate the characteristics of scientific research, its progress, milestones and ethical values that make it a source of reliable knowledge.
- Abstract the essential core of a research problem.
- Be familiar with research methods, techniques, and problem solving approaches from the field of research in which they are specializing.
- Be able to infer new and complex results from the collected data and body of knowledge.

### **COMMUNICATION SKILLS AND INFORMATION LITERACY**

On completion of the MSc program, the student should be able to:

- Propose, plan and manage well defined research projects involving a team of individuals. Prioritise, organise and schedule work activities effectively. Work effectively in a team of individuals.
- Communicate effectively and professionally and formulate sound arguments both in writing and by means of presentations using appropriate technical language.

- Find information that is relevant to research using search engines, on line libraries and repositories. Effectively utilize modern information resources and technologies.
- Analyze and communicate statistical data.
- Report on their work, and that of others, both to a specialist and a general audience.
- Discuss ethical issues in research work with their peers in an informed and reasoned fashion.
- Be well informed of issues related to ethical conduct in science.
- Be able to organize and write a MS dissertation reporting on a substantial amount of technical work.

### **LEARNING SKILLS**

On completion of the MSc program, the student should be able to:

- Ask new questions based on available information and knowledge and use known facts to create new ones.
- Make creative use of known information, methods, concepts and theories in new situations.
- Generalize from a collection of specific instances. Infer possible causes from the available data, discovering patterns in the available information.
- Interpret facts by comparing them and contrasting them with one another, drawing conclusions and predicting possible outcomes.
- Make choices based on reasoned arguments, and evaluate the outcomes of those choices by comparing them with alternative solutions.
- Appreciate the importance of continuing education and lifelong learning and undertake the study required to maintain and expand professional competence and keep up with evolving technology..
- Continue studies within this field towards an advanced degree i.e. at PhD level, having developed the necessary personal autonomy and knowledge to do so.