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The uniqueness of our program
– why study Bioinformatics with us?

Our Bioinformatics Master Program has been running for 10 years, with continuous evaluations and improvements along the way. Each lecturer who is associated with our Bioinformatics Master Program is an expert on a sub-field in bioinformatics. These areas include for example nucleic acid sequence analysis, molecular structure prediction, data mining and gene expression analysis.

The lecturers are leading individual research teams of students, postdocs and technical assistants and publish high-level research articles in peer-reviewed international journals such as Science and Nature. Our team of lecturers also write international textbooks about the field in which they are teaching – of which for instance Biological Sequence Analysis is one of the most used and praised textbooks in bioinformatics to date.

This is our way of ensuring that students who enroll with our Bioinformatics Master Program are educated by outstanding lecturers who are leading and performing cutting-edge research within their bioinformatics expertise area. This also allows a close and fruitful interaction between our Master Program students and the research groups, providing a unique opportunity to perform hands-on student projects on genuine research issues.

We take pride in delivering small-scale teaching and offering our students to become a true part of our Bioinformatics community. The bioinformatics program only accepts between 25 to 30 students per year, which means that our students can easily get to know and interact with not only the other students in the program, but also the scientists and personnel in our section. For instance, our students are invited to join both scientific seminars and recreational staff events.

Conversely we invite external partners and collaborators from University and Industry to student project seminars.

Furthermore, the University of Copenhagen is consistently ranked as one of the best universities in Europe.

- Our lecturers are Bioinformatics experts that lead own research groups of high international standard
- Close interaction between our students and the Bioinformatics staff and external scientific community
- Small-scale teaching with close interaction between students and lecturers
- Genuine research issues for hand-on student projects
- Great social and educational environment for students
- Exposure to future employers / employment opportunities
- University of Copenhagen is among the best universities in Europe
2-Year Bioinformatics Master Program
– a brief overview

All courses give 7.5 ECTS points. The academic year is divided into four blocks (7-9 weeks of teaching).

The academic year begins in the first week of September and ends with the last week of June.

Typical structure of the two-year program:

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<th>Block 4</th>
<th>Master Thesis</th>
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<td>Block 3</td>
<td>Supplementary course or Specialised module</td>
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<td>Block 2</td>
<td>Supplementary course or Specialised module</td>
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<td>Block 1</td>
<td>Supplementary course or Specialised module</td>
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**Mandatory Core courses:**

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<th>1. Year (60 ECTS)</th>
<th>Block 4</th>
<th>Bioinformatics of high-throughput analysis</th>
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<td>Block 3</td>
<td>Population Genetics</td>
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<td>Block 1</td>
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| Entry (180 ECTS) | Bachelor Degree from e.g. Computer Science, Biology, Biophysics, Physics, Molecular Biology, Statistics, Mathematics or Engineering fields. |

1 Supplementary courses are elective. Students with a Bachelor’s degree in Biology would typically take a course in computer programming while someone from computer science would take a course in e.g. molecular biology. Supplementary courses are allowed up to a maximum of 37.5 ECTS points.

2 Specialized modules in bioinformatics or projects (7.5 or 15 ECTS) that can be made in groups or individually. Often a project is made as a prelude to the Master’s thesis. A minimum of 22.5 ECTS points is required from specialised modules.
Bioinformatics of high throughput analysis
A wealth of experimental methods can now be applied to study whole genomes including tiling arrays, Chip-Chip and tag-based sequencing. These types of data sets are too large and complex to analyze by hand or by using spreadsheet programs. The primary aim of this course is to introduce the students to bioinformatics methods to handle, visualize, analyze and interpret high-throughput experimental data, such as gene expression data, proteomics data, CAGE, SAGE and sequencing data. A large part of the course consist of hands-on exercises in class, as well as using (and learning) the ‘R environment’ - a very powerful statistics platform which is free to download. This course is taught by Associate Professor Albin Sandelin.

Biological Sequence Analysis
In this course you learn the fundamentals of biological sequence analysis, which forms the basis for a large part of bioinformatics activities. The topics include pair-wise alignment, multiple alignment, substitution matrices, database searching, BLAST, hidden Markov models and sequence profiles. In the lectures, the emphasis is on the theory and during exercises you will learn how to solve practical problems using available programs. The course is taught by Professor Anders Krogh.

Population genetics
The amount of molecular genetic data (especially nucleotide sequences) has increased tremendously in recent years and is expected to explode as the next generation sequencing methods become standard tools. This has implications for a wide spectrum of biological disciplines spanning conservation genetics, molecular ecology, molecular medicine, genome research and evolutionary biology. The purpose of the course is to provide the students with knowledge about the principles of population genetics, phylogenetics and their applications in the diverse areas mentioned before. In addition, the course will train the students to
choose suitable methods to analyze molecular genetic data. The course is taught by Associate Professor Hans Siegismund.

**Structural Bioinformatics**
All biological molecules are three-dimensional structures, and information on this structure is of high importance for applications such as drug design and biotechnology. In this course, you will get a thorough introduction to structural bioinformatics, that is, the science of understanding the link between molecular structure and function through computational procedures. Topics discussed in the course include protein structure analysis (including experimental methods), protein and RNA structure prediction and prediction of protein function from structure. Invited speakers from industry and academia discuss topics such as structure based drug design and protein engineering. You will learn how to develop your own custom-made algorithms and applications using Python and Biopython. Many of the algorithms that will be discussed are also used in artificial intelligence, gaming and robotics. The course is taught by Associate Professor Thomas Hamelryck.

**Master thesis (30 ECTS)**
During Blok 3+4 of the second year of the Bioinformatics Master Program, all students are required to do a Master thesis. We encourage the thesis project to be run in collaboration with e.g. a biotech or pharmaceutical partner, a Hospital unit, or with partners at other Universities in Denmark or abroad and we provide ample opportunity to our students, for such collaborative master projects.

**Information on all other relevant courses:**
This link provides a updated information about Mandatory and Supplementary courses as well as Specialised modules for Bioinformatics Master Program [http://www.binf.ku.dk/programmes/](http://www.binf.ku.dk/programmes/)
Career prospects for Bioinformatics Masters Program

Bioinformatics is a very active interdisciplinary field of research that is of increasing importance in science today. Within the past 50 years, advances in biological research have revolutionised our understanding of the molecular basis of life: From the 1940s, when it was first realised that genetic information is encoded in the DNA, to today when we know the complete DNA sequence for a number of species - including Homo Sapiens. This and other major breakthroughs have changed the science of biology for good. Just a few years ago, genes were studied one by one, whereas today, new experimental technologies allow us to survey all the genes in an organism, as well as their activity levels and complex interactions.

Computers are necessary to process and analyse the enormous amounts of data from such experiments and this is where bioinformatics is essential. Bioinformatics (or computational biology as it is sometimes called) aims at solving biological problems using mathematical, statistical and computational techniques. Modern biological and medical research cannot be done without bioinformatics contributions.

As a student, you will learn the fundamentals of bioinformatics, which include sequence analysis, protein and RNA structural analysis, genomics, phylogenetics, analysis of high-throughput sequencing data, machine learning methods and more. As only one third of the Bioinformatics Master Program courses are mandatory, you will have plenty of opportunity to specialise in your favourite topic through elective courses, small research projects and, of course, your Master thesis project. Master Program Graduates with advanced bioinformatics skills are in high demand in both academia and industry because state-of-the art experimental methods today produce very large amounts of data, which require computational analysis to properly processed and analysed. For this reason, our former Bioinformatics Master
Program students are now typically working in leading biotech industry positions or in research positions at different universities around the world.

However, many of our Master Program students choose to do a PhD as their immediate next step, often as a continuation of the Master thesis project collaboration.
Former students – impressions

Maria Garcia, Spain: “The decision to come to Copenhagen and study was based on personal reasons, I think. After having a great experience abroad for my Bachelor degree, I liked the idea of pursuing a Master Degree abroad. Considering different possibilities around Europe, I came across the Bioinformatics Master program, which had been running for some years, with experienced faculty members, and therefore the first years of trial and error should be a thing of the past (I come from the first batch of graduates on my own bachelor, so I know that the first years of the implementation of a program can be tricky). Also, the University of Copenhagen ranked quite high in Europe and the city itself is well-known as one of the cities around the world with better quality of life. Of course, the fact that being an EU citizen allowed me not to pay tuition fees was an incentive. It all seemed worth a try. To summarize, it was basically because it is a program experienced enough, from one good university within Europe, which would allow me to study and work in an international environment and have the opportunity to live in a good city.”

Troels Marstrand, Denmark: “I started the Bioinformatics Masters Program with a Bachelor degree in biology. During my Masters Degree I took several courses in computer science and statistics. This has proven very helpful in understanding current bioinformatics approaches as well as developing new ones. I graduated in 2005 with a thesis on “Prediction of Transcription Start Sites in the Human Genome”, and finished my PhD in 2009. I was then practically head-hunted to a postdoc position at Princeton University.”
Pedro Manuel Garcia, Spain: “For me, bioinformatics is the perfect combination of biology and computer skills. I already have a five-year education as a computer engineer, but I wanted to try a bit more than that. I have had my wishes completely fulfilled by moving to Copenhagen to join the Bioinformatics Master Program. All the classes are taught in English and the teaching is first class.”

Sanne Nygaard, Denmark: “After getting my Bachelor’s Degree in biology, I decided to move to the field of bioinformatics. On the computer, you can address a number of biological questions, that cannot be answered in the lab. Bioinformaticians often work on large-scale problems, looking at general, overall processes and pathways in the cell. This ‘birds-eye’ perspective on biology suits me better than working on one specific gene or pathway for years. Bioinformatics is a very cross-disciplinary field, and collaborations with people from other backgrounds have given me a much greater appreciation of the many different aspects of science. My Master thesis dealt with host-pathogen interactions in malaria parasites. I have just finished my PhD: I now work with assembling of ant genomes!”
Enrollment and tuition for the Bioinformatics Master Program at University of Copenhagen

The application deadline for international students is April 1st. Detailed information on how to apply for the Bioinformatics Master Program can be found on this link http://www.science.ku.dk/english/education/master/admission/. All applicants are expected to fulfill both the General requirements (Proof of English Language proficiency) and Academic requirements (Proof of Bachelor Degree education and course details) to be admitted to the Bioinformatics Master Program at the Faculty of Science, University of Copenhagen.

- The Bioinformatics Master Program is not offered on a part-time basis or via distance education.
- Applicants from EU/EEA countries qualify for a tuition fee waiver and should therefore not pay tuition.
- Applicants from non-EU/EAA countries must pay a tuition fee of 15,300 € per year.
- Cambridge English Exams, TOEFL or IELTS test are accepted proof of English Language proficiency.
- You can apply for a transfer on one year of MSc studies from your home University to Copenhagen University. Please contact international@science.ku.dk for more information.
- Once you have been offered admission, the Office of International Affairs will initiate your visa process. You are not required to do anything prior to your application.
Enrollment and tuition for the Bioinformatics Master Program at University of Copenhagen
Living in Copenhagen, Denmark

Copenhagen is the capital of Denmark and is the largest metropolis in Scandinavia. The city is considered as a centre of culture and arts with plenty of entertainment activities to offer its inhabitants and visitors – together with a multitude of shopping facilities and the longest pedestrian street system in the world.

The city was founded in the years 1160-67 by Bishop Absalon (1128-1201) – who was at that time the counselor for King Valdemar I (1131-1182 - Ruled Denmark 1154–57 as Valdemar the Great). Bishop Absalon completed the task to build a city on the east coast of Zealand to protect trade on the Sound (Øresund).

Today a bridge and tunnel called “Øresundsbroen” – connects Copenhagen with Sweden – and its metropolitan area is named the Oresund Region.

Copenhagen is ripe with ambiance, history and activity that are not least primed by the many students who live here.

The University of Copenhagen is the largest university in Denmark with over 37,000 students and more than 7,000 employees. Inaugurated in 1479, it is also one of the oldest universities in Northern Europe. It has more than 200 study programs and is located at four campus areas in central Copenhagen. The University of Copenhagen is consistently ranked as one of the best universities in Europe.

Moving away from home can at times be challenging and doing so in Copenhagen at the start of the academic year can be even more so. From the experience of our former international students, we recommend that you
send applications for housing to the ‘Centralindstilling-sudvalget’ (CIU) and ‘Kollegiernes Kontor I København’ (KKIK). You can find the addresses and more information on this link http://studies.ku.dk/housing/finding_housing_on_your_own/.

The Copenhagen International Office (http://studies.ku.dk/) also manages a Student Mentor program, in which new students are connected with a mentor student, before arriving at Copenhagen. Here at Science we also have an “International Student Mentor Program”, where all the international students can be connected to a mentor, you can read more about this on the “New at Science” website (http://www.science.ku.dk/english/newatscience). The main objective of this initiative is to help make your landing and first steps in Copenhagen smoother, and also to help you to start a social life outside the Bioinformatics Master Program.

Related, you should also look out for the many associations and social networks for students in Copenhagen. As one example, you can find a relatively new initiative undertaken by students at the SCIENCE faculty: the International Student Society of Copenhagen (http://liisscopenhagen.wordpress.com/).

Native name: København (Copenhagen)
Founded: 1167
Population: 1.8 million (Greater Copenhagen)
Currency: Danish Kroner
Airport: Kastrup
Driving: Right side
Time Zone: UCT+1
Covers from first class scientific papers, and state-of-the-art textbooks in bioinformatics, written by the teachers responsible for the masters program.

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Department of Biology, Faculty of Science
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