Applied Bioinformatics MSc

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Industrial-scale bioscience laboratories
Bioinformatics: What’s the Course About?

Computer Science for molecular biology and life sciences
A Masters Level Course

- Longest running course of its kind in the UK

- Winner of the BBSRC-MTG award for best course in life science

- World-class Laboratory and HPC facilities

- Strong industrial links with GSK, AstraZeneca, Unilever, Sanger and more!
Taught Modules

Module 1
Introduction to Bioinformatics using Perl

• Module 2
  Exploratory Data Analysis and Essential Statistic using R

• Module 3
  • Next Generation Sequencing Informatics

• Module 4
  • Informatics for Metabolomics

• Module 6
  • Proteome Informatics

• Module 6
  Programming using Java

• Module 7
  Data Integration and Interaction Networks

• Module 8
  • Simulating Biological Systems
Module 1: Introduction to Bioinformatics using Perl

Aim: To provide an overview of bioinformatics, and to introduce the most relevant concepts in IT, as well as providing students with the ability to program in PERL; the most popular programming language in the bioinformatics community.

Content: Introduction to bioinformatics, IT and bioinformatics; hardware networks & internet, OS & software, algorithms & programming, Introduction to PERL programming for: data manipulation, file maintenance, pipelining, packaging and interfacing system facilities.
Module 3: Next Generation Sequencing Informatics

Aim: To introduce many core types of NGS projects, including \textit{ab-initio} and \textit{de-novo} sequence assembly, RNA-Seq analysis, as well as detailed hands-on practical sessions of our best practice data-analysis workflows.

Content: Gene expression analysis using microarray, Introduction to Next Generation Sequencing (NGS) platforms, genome assembly and quality control, transcriptome informatics (i.e. RNA-Seq), Sequence data analysis platforms (e.g. Galaxy), genotyping and variant calling
Module 5: Informatics for Metabolomics

Aim: To explore the analytical and statistical techniques that are central to the field of metabolomics, and to introduce the emerging technologies that will generate yet more data in the future.

Content: Introduction to metabolomics, NMR, LC-MS and GC-MS, advanced topics in R, multivariate classification (PLS-DA, SVMs, ANNs), Multiway analysis (PARAFAC), compound identification (e.g. spectral library searching), phenomics and biomarker discovery.
Module 6: Programming using Java

Aim: To introduce the concepts of object-oriented programming using Java, the preeminent programming language for serious application development on the Internet. The module covers the basic fundamentals of programming in Java, with hands-on practical sessions on implementing programs using calculations, variables, control statements and loops.

Content: Fundamental principles of programming, object-oriented programming using Java, variables and calculations, strings, arrays, GUI programming
Module 8: Simulating Biological Systems

Aim: To develop the concepts of integrated data towards simulation of systems and to introduce the potential applications of robust simulation.

Content: Networks dynamics (e.g. ODE and stochastic algorithms to rule based systems), SBML, modelling systems, i.e. eCell, concept of 3Rs and systems modelling, in silico approaches to toxicity and efficacy testing, GUI programming.
Group Project (20%)
Example 1: A bioinformatics platform for functional annotation

- The aim of this tool is to provide an integrated platform for functional annotation.

- The platform should integrate established annotation tools into a single user-friendly platform. This should typically include:
  - BLAST
  - Interproscan
  - GO
  - Enzymes
  - Pathways
Example 2: A bioinformatics pipeline for transcriptome assembly and downstream analysis

• The platform should come as a Virtual Machine, bundled with all required tools and libraries to perform the analysis, preconfigured and ready to run

• The VM should also include a user-friendly interface, that allow the user to specify the analysis parameters, allocate memory and threads, and monitor the progress
MSc Thesis Project (40%)

Example 1: Phylotrack

Visit Phylotrack: http://pathogenseq.lshtm.ac.uk/phytoblive/index.php
Next generation genome browser based on HTML5 and related technologies

Visit GenoVerse:
http://elvis.misc.cranfield.ac.uk/genoverseSol/examples/tomato/chromosome08.html?r=8:48682821-48752873
Cranfield AgriFood MSc Programme
Studying Agrifood at Cranfield

Our internationally recognised expertise spans the entire agrifood supply chain; delivering world-leading research and education for over 40 years; ensuring a sustainable, safe, secure and nutritious food supply for a growing global population.

Our impact can be seen in both industry and government worldwide; we are influencing public policy, leading agricultural strategy, and guiding technical policy development and corporate business strategies.
Population growth

Currently about 7.1 billion
9.6 billion (mid-estimate 2050)
Increase equal to population of China and India
Assumes decrease in fertility; 10.5 billion by 2050 if constant

Source: UN World Population Prospects; the 2015 Revision
The challenge

We need a **multidisciplinary** approach to ensure food security and quality.

The challenge is to provide the world’s growing population with a sustainable, secure supply of **safe**, **nutritious**, and **affordable** high-quality food using less land, with lower inputs, and in the context of global climate change, other environmental changes and declining resources.
Cranfield AgriFood programme

- Bacteriology
- Data integration and modelling
- Transport and logistics
- HACCP
- Diagnostics
- Plant genetics
- Food Mycology
- Mathematics
- Soils
- Post-harvest
- Food Chain Systems
- Future Food Sustainability
- Applied Bioinformatics
MSc Food Chain Systems

- Consumer demands regarding food quality and safety has created a need for individuals who are able to drive success in the management of key food chains.

- This MSc, developed as a result of extensive industry-led research, is unique within the UK and Europe in that it examines the whole of the food chain from pre-harvest to market through the integration of science, technology and management.

- The holistic approach responds to the increasingly integrated food supply chain (‘farm to fork’)

- The students will get the relevant knowledge, skills and practical experience needed to pursue a wide variety of career opportunities in today’s food industry.
This course is concerned fundamental challenges we all face today:

- feeding a rapidly growing global population with the given finite resources,
- added uncertainties such as the effects of climate change, and
- a general acknowledgement that our current methods for producing food are not fit for purpose, going forward.

The course sets about bringing together the diverse threads that could present pragmatic and practical answers. As such, it is designed to respond to urgent industry, institutional and government.
Food Chain Systems
Future Food Sustainability

• **Projects with industry**
  – including Unilever, PepsiCo and Waitrose.

• **Learning from the best academics**
  – taught by industry practitioners alongside Cranfield academics, ensuring that you have access to the most up-to-date techniques and innovations.
Agrifood Theses Titles

What would I do? Laboratory or company based project?

- Evaluation of packaging materials for a novel tortilla product
- Evaluating the effect of different fungicides on the growth of Monilinia laxa and M.fructigena on soft fruits based media under different environmental condition
- Sustainable energy and water consumption – a case study in the beverage industry
- Assessing the efficacy of antifungal compounds to control growth and toxin production by Aspergillus flavus under climate change conditions
- Postharvest preservation of bioactive life in gooseberries
- UV inactivation of E.coli on carrots
Previous destinations of students

[Logos of various institutions]
Further Information

Applied Bioinformatics
https://www.cranfield.ac.uk/Courses/Masters/Applied-Bioinformatics

Food Chain Systems
https://www.cranfield.ac.uk/Courses/Masters/Food-Chain-Systems

Future Food Sustainability
https://www.cranfield.ac.uk/Courses/Masters/Future-Food-Sustainability