INSTITUTE OF BIOMEDICINE AND BIOTECHNOLOGY OF CANTABRIA
INSTITUTO DE BIOMEDICINA Y BIOTECNOLOGIA DE CANTABRIA

UC Summer Programs 2013

"Research in Biotechnology"

Aims and Scope

Program aimed at teaching undergraduate students the basics of biotechnological research and applications. The students will be introduced to the fundamentals of modern molecular biology and genome structure. This will provide the background for the study of genetic engineering techniques and advanced technology of genomic-level gene analysis in Biomedicine. They will also be introduced into the biotechnological procedures for animal manipulation and for production of biological molecules of industrial interest. Additionally, several leaders of biotechnological research groups will introduce the students to the scientific method and present their research fields and teams.

The course will be taught mainly by researchers belonging to the IBBTEC (Research Institute for Biomedicine and Biotechnology, http://www.unican.es/ibbtec/en), located in a brand-new building endowed with state-of-the art equipment to reach high biotechnological research standard. The IBBTEC ranks among the highest in scientific production in Spain (http://www.unican.es/ibbtec/en/Press/news/20120622.htm). The research fields include varied fields such as genomics and cancer, microbial biotechnology, neuropharmacology, or vertebrate development.

Course structure and content

- During the first four weeks, the students will receive compulsory courses covering basic aspects of biotechnology, from genetic engineering techniques to biotechnology applications in biomedical and industrial fields, plus an introduction to biotechnological research leaded by different IBBTEC staff research leaders. These courses will be held in the morning sessions.
- In addition, the students will take two courses of their choice among "European culture and civilization", "Spanish language", "Gender and Culture in European History", "Modern Cosmology", or "Spanish Arts and Gastronomy". These courses will be taught in the afternoon sessions from Monday to Thursday.

- During weeks 5 to 8, the students will individually enroll in IBBTEC teams and will join ongoing research projects covering diverse aspects of current biotechnology and biomedicine.

Part A) Biotechnology fundamentals – compulsory courses

WEEK 1: FUNDAMENTALS OF MOLECULAR BIOLOGY AND GENETIC ENGINEERING

Monday

Basic tools of genetic engineering.

The first talks will be focused on the fundamental techniques of gene manipulation (gene-cloning strategies, site-directed mutagenesis, sequencing, etc…)

Tuesday

Genome structure in bacteria: Modified microorganisms for protein production.

Synthesis of commercial products by recombinant microorganisms. Bacteria as bioreactors. Metabolic engineering in bacteria for bioremediation and biomass utilization.

Wednesday

Transgenic plants and animals.

Strategies for gene transfer to plants and animals. Advanced technology, which does not require the direct modification of the target gene (Antisense RNA, RNA interference, intracellular antibodies, etc…). Transgenic plants and animals can also be used as bioreactors. Commercial transgenic plants.

Thursday

Organization of the human genome.

General organization (protein-coding genes, RNA genes and highly repetitive DNA). Comparative genomics and genome evolution. Human gene expression.

Friday

Free day

WEEK 2: BIOTECHNOLOGY IN MEDICINE

Monday

Diagnostic molecular methods in infectious diseases

The application of molecular diagnostic techniques has initiated a revolution in the diagnosis of infectious diseases. Sequence analysis of amplified microbial DNA allows for a rapid identification of the pathogen. Subspecies variation, identified by various techniques, has been shown to be important in the prognosis of certain diseases.

Tuesday

Diagnostic molecular methods in oncology.

Cytogenetic and microarray analyses give genomewide views of the changes in cancer cells. Sequencing and association studies to determine susceptibility to different types of cancer. DNA sequencing of tumor cells for personalized cancer treatment. Epigenetic changes in tumors.

Wednesday

Stem cells and regenerative medicine.

Stem cells therapies promise to transform the potential of transplantation. Embrionic and tissue stem cells. Nuclear reprogramming for disease treatment. Induced pluripotency in somatic cells.

Thursday

Gene therapy approaches.

Genes can be transferred to patient´s cells. Review of the different approaches (viral and non-viral vector systems), Gene therapy in practice: struggles and successes.

Friday

The ethics behind: use and abuse of the human genome information.

DNA profiling has revolutionized forensic investigations but raises issues of civil liberties. Ethical and political issues.

WEEK 3: INDUSTRIAL BIOTECHNOLOGY

Monday

Synthetic biology.

Microfabrication. Computational and Systems biology. Minimal genomes.

Tuesday

Metabolic engineering of bacteria and fungi in industrial applications.

Protein engineering. Mutagenesis. Directed evolution.

Wednesday

Microbial production of biomolecules.

Fermentation. Bioreactors.

Thursday

Plant biotechnology.

Biofuels. Genetically modified foods and GMOs. Social / Legal Issues

Friday

Creating a biotechnological company and protecting IP.

Spin-offs. Patents and regulation.

WEEK 4: RESEARCH IN BIOTECHNOLOGY: A CASE-BASED APPROACH

Staff scientists will discuss with the students their research projects, and will pose scientific questions to be solved by the students applying the scientific method and proposing an experimental plan.

Monday: Research projects on molecular diagnosis

Tuesday: Research projects on transgenic mice and disease models

Wednesday: Research projects on the bioinformatic analysis of genes and proteins

Thursday: Research projects on biotechnology and nanobiotechnology

Part B) Research practices

Four weeks of laboratory work embedded in research groups of the IBBTEC. Each student will have an assigned lab space, project, and research supervisor. Students will be allocated in the research groups based on their preferences among the offered places and, should there be several applicants for the same place, the research team leader will select the students on the basis of their CVs and/or a personal interview.

Main research lines:

- Horizontal genetic transfer in bacteria
- Genomic basis of disease
- Use of transgenic mice as disease models
- Molecular diagnosis in microbiology
- Molecular diagnosis in cancer
- Discovery and assay of anti-tumor drugs
- Bioinformatic analysis of genes and proteins
- Protein purification and modelling

THE INSTRUCTORS

Most Instructors will be IBBTEC staff members. These will also lead the research practicum period. Their teams and main research goals can be viewed at the IBBTEC web page (http://www.unican.es/ibbtec/en/Research/Research-Teams.htm). A sample of the scientific and teaching trajectory of some of them follows.

Faculty of the Summer Program in Biotechnology

Dr. **Piero Crespo** is a top staff researcher ("Research Professor") of the Spanish High Council for Scientific Research (CSIC) at the IBBTEC. He worked for four years in the National Institutes of Health at Bethesda, MD. Since 1995 he leads a research team working on the Ras-

ERK signal transduction pathways in normal and cancer cells, publishing research papers in prestigious journals of biomedical sciences such as Nature Cell Biol, Molecular Cell, J Cell Biol, etc. He teaches in courses of the Master in Molecular Biology and Medicine of the Universities of Cantabria and Basque Country.

Dr. **Marian Ros**, M.D. and PhD, is currently Research Professor of the Spanish High Council for Scientific Research (CSIC) at the IBBTEC. Her education included several stays at the University of Wisconsin-Madison. Her research group tries to understand the molecular basis of morphogenesis: how the formation of a particular form or structure is genetically and molecularly controlled during vertebrate development. This goal also pursues to uncover the origins of developmental defects that lead to human malformations and other diseases. She has contributed more than 60 original papers in international prestigious journals including Cell, Nature, and Science. She teaches developmental biology in the courses of the Master and PhD program of the University of Cantabria.

Dr. **Javier León** is a Full Professor of Molecular Biology of the University of Cantabria and IBBTEC. He has worked for five years in New York University, Harvard University and Fred Hutchinson Cancer Research Center at Seattle. His research projects deal with molecular biology of cancer, working on topics as cell cycle control and transcriptional control of cell differentiation. He is also engaged in research in the molecular basis of human leukemia. He has extensive experience in teaching in Medical School, Master and PhD programs of the University of Cantabria.

Dr. **Fernando de la Cruz** is a Full Professor of Genetics of the University of Cantabria and IBBTEC. He has worked in the Universities of Bristol (UK), Wurzburg (Germany), University of California at San Diego (USA), British Columbia (Vancouver, Canada), and Institute Pasteur of Paris. He has published 150 papers in peer-review journals, many of them in the top-ranked journals of microbiology and biotechnology. His present research interests are the mechanisms of bacterial conjugation and its impact in resistance to antibiotics, and genetic engineering in bacteria aimed to fuel production. He teaches Genetics to MD students and courses of the Master and PhD program of the University of Cantabria