BSc (Hons) Biotechnology – A325

1. Objectives

Biotechnology originates in the 1950's, when the secret of life, DNA was disclosed by two UK researchers, Watson and Crick. The term is now described as a multi-disciplinary science covering a range of disciplines including molecular biology, genetics, biochemistry, analytical chemistry and bioprocess engineering. People's lives have been influenced by biotechnology for centuries as a result of the use of microorganisms to produce food and drinks. The production of antibiotics by the large-scale fermentation of microorganisms in the pharmaceutical industry has revolutionized healthcare. Biotechnological methods are now being applied to provide solutions to various problems such as the use of novel drugs for the cure of cancer, AIDS and other diseases and can also be exploited to provide environment friendly solutions to very difficult problems such as the microbial digestion of wastes for the production of biogas. Biotechnology has also a crucial role to play with respect to food security issues through the use of cell and tissue culture technology for rapid propagation of plants and techniques of molecular diagnosis.

This programme is designed to provide students with grounding in the various disciplines mentioned highlighting the recent possibilities for medical, pharmaceutical and agricultural applications while considering the ethical issues.

Upon successful completion of this programme, learners will be able to:

- Demonstrate a broad understanding of the concepts and applications of biotechnology;
- Apply their knowledge of biotechnology to solve various problematic issues;
- Communicate effectively the information and arguments while showing critical analytical skills;
- Use a range of techniques to initiate and undertake the analysis of data and information;
- Show practical competencies and techniques in molecular biology and biotechnology;
- Depict the uncertainty, ambiguity and limitations of knowledge in biotechnology;
- Describe and comment on particular aspects of recent trends in biotechnology;
- Apply their knowledge and understanding in order to initiate and carry out an extended piece of work or project.

2. General Entry Requirements

In accordance with General Entry Requirements for Admission to the University for Undergraduate Degrees.

3. Programme Requirements

SC : Credit in Mathematics, Biology and Chemistry
2 GCE 'A' Levels passes in Food Science, Biology, Chemistry, Mathematics or Physics.

4. Programme Duration

	Normal (Years)	Maximum (Years)
Degree	3	5

5. Credits per Year: Minimum 18 credits, Maximum 48 credits subject to Regulation 4.

6. Minimum Credits Required for Award of Undergraduate Degree: 103
Breakdown as follows:

	Credits from	
	Core Taught Modules	**Project**
Degree	94	9

The module Practical Training – AGRI 2000 and the module Scientific Communication – AGRI 2100 must be completed satisfactorily for the award of the degree.

Students may exit with a:

- Certificate after having earned 30 credits in core modules.
- Diploma after having earned 60 credits in core modules.

7. Assessment

Each module will be assessed over 100 marks (i.e. expressed as %) with details as follows (unless otherwise specified).

Assessment will be based on a Written Examination of 2-3 hour duration, carrying a weighting of 70%, and Continuous Assessment carrying 30% of total marks for AGRI modules. Modules from other Faculties/Departments/Centres will carry weighting in the Written Examination and the Continuous Assessment as specified by the Faculties/Departments/Centres concerned. Continuous Assessment will be based on laboratory/field works, and/or assignments, and should include at least 1 class test.

An overall total of 40% for combined continuous assessment and written examination components would be required to pass the module, without minimum thresholds within the individual continuous assessment and written examination.

Modules will carry the weightings of 1, 3 or 5 depending on their status (Introductory, Intermediate or Advanced). Weighting for a particular module is indicated within parentheses in the module code.

Each module will carry credits in the range of 3 to 6. Project – AGRI 3000Y(5) will carry 9 credits.

Assessment of the module AGRI 2100 - Scientific Communication will be based on continuous assessment of students throughout the module and/or submission of a portfolio. The module carries no credits. For satisfactory completion of the module, a minimum of 40% should be attained.

Assessment of practical training will be based on the on-site supervisor's evaluation and the student's portfolio. For satisfactory completion of the practical training, a minimum of 40% should be attained.

Written examinations for all AGRI modules will be carried out at the end of the academic year.

Submission Deadlines for Dissertation:

- First Draft: by last week day of February of the Academic Year.
- Final Copy: three copies of the dissertation (2 spiral-bound copies and 1 copy on electronic storage media) by last week day of March of the Academic Year by 4.00 p.m at latest.

8. Academic Teaching in Case of an Emergency

To ensure minimal disruption of normal academic teaching in case of an emergency (eg. closure of the University for more than 2 weeks), the Moodle e-Learning Platform of VCILT will be used to deliver Teaching and Learning content. Relevant learning resources will be posted on the Platform. Assignments (if any) will be submitted using the online submission box. Arrangements will be made to register students on the Moodle platform at the beginning of the academic year.

9. List of Modules

CORE MODULES

Code	Module Name	Hr / Yr L+P	Credits
AGRI 1046Y(1)	Chemistry Fundamentals and Biochemistry	60+60	6
AGRI 1047Y(1)	Microbiology and Genetics	60+60	6
AGRI 1048Y(1)	Cell Biology and Biotechnology	60+60	6
AGRI 1049Y(1)	Plant and Animal Science	60+60	6
AGRI 1077Y(1)	Biotechniques	30+30	3
AGRI 1056Y(1)	Introductory Statistics	30+30	3
AGRI 2081Y(3)	Statistical Methods and Computational Biology	60+60	6
AGRI 2064Y(3)	Biochemistry II and Human Physiology	60+60	6
AGRI 2085Y(3)	Molecular Biology and Biotechniques	60+60	6
AGRI 2009Y(3)	Cell and Tissue Culture	60+60	6
AGRI 2066Y(3)	Immunology and Molecular Pathology	60+60	6
AGRI 2067Y(3)	Industrial and Environmental Biotechnology	60+45	5
AGRI 2000	Practical Training	-	-
AGRI 2100	Scientific Communication	20+0	-
AGRI 3000Y(5)	Project	-	9
AGRI 3005Y(5)	GMOs, Biosafety and Bioethics	60+60	6
AGRI 3065Y(5)	Genomics and Proteomics	60+60	6
AGRI 3066Y(5)	Plant Biotechnology	60+60	6
AGRI 3067Y(5)	Biotechnology for Medical and Veterinary Applications	60+60	6
AGRI 3068Y(5)	Bioinformatics	45+60	5
Total Number of Credits = 103			

AGRI 2000 - Practical Training can be done in either Year 1 or Year 2.
AGRI 2100 - Scientific Communication will be done in Semester 2 in Year 2.

10. Programme Plan - BSc (Hons) Biotechnology

YEAR 1

CORE MODULES

Code	Module Name	Hr / Yr L+P	Credits
AGRI 1046Y(1)	Chemistry Fundamentals and Biochemistry	60+60	6
AGRI 1047Y(1)	Microbiology and Genetics	60+60	6
AGRI 1048Y(1)	Cell Biology and Biotechnology	60+60	6
AGRI 1049Y(1)	Plant and Animal Science	60+60	6
AGRI 1077Y(1)	Biotechniques	30+30	3
AGRI 1056Y(1)	Introductory Statistics	30+30	3

YEAR 2

CORE MODULES

Code	Module Name	Hr / Yr L+P	Credits
AGRI 2081Y(3)	Statistical Methods and Computational Biology	60+60	6
AGRI 2064Y(3)	Biochemistry II and Human Physiology	60+60	6
AGRI 2085Y(3)	Molecular Biology and Biotechniques	60+60	6
AGRI 2009Y(3)	Cell and Tissue Culture	60+60	6
AGRI 2066Y(3)	Immunology and Molecular Pathology	60+60	6
AGRI 2067Y(3)	Industrial and Environmental Biotechnology	60+45	5
AGRI 2000	Practical Training	-	-
AGRI 2100	Scientific Communication	20+0	-

AGRI 2000 - Practical Training can be done in either Year 1 or Year 2.
AGRI 2100 - Scientific Communication will be done in Semester 2 in Year 2.

YEAR 3

CORE MODULES

Code	Module Name	Hr / Yr L+P	Credits
AGRI 3000Y(5)	Project	-	9
AGRI 3005Y(5)	GMOs, Biosafety and Bioethics	60+60	6
AGRI 3065Y(5)	Genomics and Proteomics	60+60	6
AGRI 3066Y(5)	Plant Biotechnology	60+60	6
AGRI 3067Y(5)	Biotechnology for Medical and Veterinary Applications	60+60	6
AGRI 3068Y(5)	Bioinformatics	45+60	5

Total Number of Credits = 103

11. Outline Syllabus

AGRI 1046Y(1) - CHEMISTRY FUNDAMENTALS AND BIOCHEMISTRY

Basics of organic, inorganic and physical chemistry. Structures of atoms, molecules, bonding, orbitals. Reactions and stoichiometry. Reaction rates and equilibrium. Acid/base redox reactions. Isomerism. Stereochemistry. Free radicals. Electrophilic, nucleophilic reactions. Spectroscopic techniques. Structures of biomolecules. Lipids, carbohydrates, proteins and nucleic acids. Biochemical calculations.

AGRI 1047Y(1) - MICROBIOLOGY AND GENETICS

Microbial diversity, structures and functions. Microbial physiology. Growth and survival of microorganisms. Control of microorganisms. Importance of microorganisms. Disease-causing microorganisms. Prevention of microbial contamination. Factors affecting microbial growth. Laboratory techniques in culturing, staining and quantification of microorganisms. New technologies in the detection of micro-organisms. Mendelian inheritance. Linkage & chromosome mapping. Sex linked and extranuclear inheritance. Quantitative and population genetics.

AGRI 1048Y(1) - CELL BIOLOGY AND BIOTECHNOLOGY

Introduction to cell structure, Diversity of the genome, Cellular organizations, Cell membrane structure and membrane transport, Intracellular compartments and transport, Cell division and the cell cycle, Cell cycle control, Cell death, Cells in their social context. Introduction to biotechnology. Traditional and modern biotechnology. Basic concepts in Biotechnology. Scope and applications of biotechnology in health care, agriculture, environment. Biodiversity and its conservation.

AGRI 1049Y(1) – PLANT AND ANIMAL SCIENCE

Plant anatomy and structure. Basics of taxonomy. Plant diversity. Economically important plant species.Plant growth and development. Plant physiology and reproductive biology. Environmental influences on growth and development. Plant nutrition. Growth analysis and yield determinants. Introductory plant breeding. Plant diseases and control. Structure and Anatomy (digestive, reproductive and mammary gland) of non ruminant and ruminant animals. Reproductive physiology of animals. Principles of nutritional physiology and biochemistry of animals. Animal diseases and control.

AGRI 1077Y(1) – BIOTECHNIQUES

Laboratory Safety; Record Keeping; Basic laboratory instruments and glassware, Solution preparation and dilution, preparation, and use of buffers; Use of balances, pipettes, pH meters, and spectrophotometers; Mathematical calculations. Use of aseptic technique and some basic procedures for isolation and characterization of bacteria; data collection, analysis, and presentation; Centrifugation types, uses, applications; Chromatographic Techniques, principles and methods, column chromatography, GLC, TLC, HPLC; Spectroscopic Techniques and principles, UV, IR, NMR; Mass spectrometry and detectors; Biosensors.

AGRI 1056Y(1) – INTRODUCTORY STATISTICS

Introducing statistics in microbiology. Descriptive statistics – displaying and summarising data. Probability distributions. Point and interval estimation. Hypothesis testing. Analysis of categorical data. Correlation and regression analysis. Data entry and analysis using EXCEL and MINITAB.

AGRI 2081Y(3) – STATISTICAL METHODS AND COMPUTATIONAL BIOLOGY

Design and analysis of experiments. Non-parametric methods. Sampling methods. Questionnaire development, design and administration. Data processing using EXCEL, MINITAB and SPSS. Elements of research methodology.

Programming in Python: Basic Commands, Flow Control, Input/Output, Files, Modules, Regular Expressions Lists. Storing Amino Acids, Genes and Protein Information. Pattern Matching.

AGRI 2064Y(3) - BIOCHEMISTRY II AND HUMAN PHYSIOLOGY

Protein biochemistry; structures and conformation of proteins. Peptide bonds. Ramachandran plot. Protein synthesis and purification methods. Analytical methods. Enzymes: mechanisms of reaction. Regulatory mechanisms. Protein databases. Metabolic pathways: carbohydrate, lipids and amino acids metabolism. Signal transduction. Cell cycle regulation. Programmed cell death and caspases. Plant biochemistry. Clinical biochemistry. An understanding of how the systems function: Circulatory system, Respiratory System, Nervous and Endocrine Systems, Sensory Structures, Excretory and Reproductive system.

AGRI 2085Y(3) - MOLECULAR BIOLOGY AND BIOTECHNIQUES

Prokaryotic and Eukaryotic genome, Mechanism of genetic exchange, Structure and properties of DNA. Recombination. DNA repair. Mutation and mutagenesis, Gene regulation and gene expression. Protein synthesis. Techniques of DNA analysis. Recombinant DNA technology.

AGRI 2009Y(3) - CELL AND TISSUE CULTURE

Principles of plant micropropagation. The totipotency concept. Role and composition of plant tissue culture media. Micropropagation pathways. Callus induction and culture. Meristem culture. Haploid production. Cryopreservation and germplasm storage. Artificial seed technology. Embryo rescue. Protoplast culture and somatic hybridisation. Variation in plant tissue cultures. Animal cell culture techniques and applications.

AGRI 2066Y(3) - IMMUNOLOGY AND MOLECULAR PATHOLOGY

Components of immune system; cells, organs, soluble mediators; humoral and cell-mediated immunity, Immunoglobulins; cell differentiation; complement system; inflammation. Immunity to bacterial, viral and fungal pathogens. Escape mechanisms. Immunological tolerance. Autoimmunity. Genomics of bacterial, viral pathogens in humans, animals and plants. Molecular basis of virulence; Virology: classes; genome

organisation of viruses; Bacterial genomics. Pathogen genetic diversity; strain differentiation; receptors for pathogen invasion. Drug resistance.

AGRI 2067Y(3) - INDUSTRIAL AND ENVIRONMENTAL BIOTECHNOLOGY

Fermentation Technology, Bioreactor design and operation, media composition, gas exchange and mass transfer, sterilisation, bioreactor scale-up. Process engineering and instrumentation. Production and commercial applications of industrial products including amino and organic acids, biodegradable polymers and antibiotics. Biofuels, biotransformation and biosensors. Downstream processing and product purification. Bioremediation; hydrocarbon-oxidising microorganisms, biosurfactants, removal of organic and metallic pollutants from soil. Biodesulphurisation, Biosensors in environmental applications. The emerging roles of GMOs; The plastics dilemma and biodegradable plastics; Microbes in clean production technology.

AGRI 2000 - PRACTICAL TRAINING

Students are required to undergo a full-time practical training of 6-8 week duration during the winter vacation, either in year 1 or in year 2. The practical training placement may take place in the various agricultural institutions and industries in the private or public sector. The aim is to contextualise learning within real-life work environments related to your course. Students are required to submit a training placement portfolio. This module does not carry any credit, but training must be completed satisfactorily for the award of the degree.

AGRI 2100 - SCIENTIFIC COMMUNICATION

Avenues of communication in science. Scientific and technical writing. Oral and poster presentations. Ethics of scientific publishing. The dissertation guidelines. Planning and managing the dissertation writing up process – effective literature search and review, introduction, methodology, results, discussion, conclusions, referencing rules and plagiarism.

AGRI 3000Y(5) - PROJECT

Every student will be allocated a research topic related to biotechnology. The research work will be carried out under academic supervision. Students should demonstrate good practice in using skills and knowledge acquired during the programme and follow dissertation guidelines as laid down by the Faculty of Agriculture.

AGRI 3005Y(5) - GMOs, BIOSAFETY AND BIOETHICS

Ethical issues in biotechnology. Biosafety & risk assessment of GMOs. Public perception. IPR and Trade related aspects. Methods for producing transgenic plants and animals. Important genes of agronomic interest. Current trends in finding useful genes. GMO Act 2004. Traceability. Legislative aspects.

AGRI 3065Y(5) - GENOMICS AND PROTEOMICS

Introduction to Genomics - information flow in biology, DNA sequence data, Experimental approach to genome sequence data, genome information resources. Comparative genomics. Functional Proteomics - protein sequence and structural data, protein information resources and secondary data bases. Analysis of the transcriptome, Proteomics-Expression analysis. Characterisation of proteins. High-throughput analysis of gene function - DNA microarrays, Protein arrays. Molecular markers. Small RNA's.

AGRI 3066Y(5) - PLANT BIOTECHNOLOGY

Applications of plant biotechnology to crop improvement. Development and use of cell lines for specific disease, pest and stress resistance. Phytochemistry and secondary metabolites. Secondary product synthesis by plant tissue cultures. Elicitation and immobilisation. Hairy root cultures. Medicinal and aromatic plant biotechnology. Metabolomics and Systems biology. Commercial perspectives and future prospects.

AGRI 3067Y(5) - BIOTECHNOLOGY FOR MEDICAL AND VETERINARY APPLICATIONS

Nutrition; dietetics; food composition; clinical dietary requirements; diabetes, obesity, diseases and nutritional deficiencies.

Pathologic processes that underlie diseases; molecular basis of carcinogenesis; oncogenes. Gene therapy. Stem cell culture. Toxicology; animal health and disease. Vaccines. Molecular epidemiology. Molecular markers and diseases. Genetics of leukaemia. Gene expression studies: microarrays; Pharmacogenomics.

Cryopreservation techniques, *in vitro* fertilisation and embryo transfer, embryo split and nuclear transplantation. Identification and manipulation of genes. Marker assisted selection in animal breeding programmes (e.g selection against stress sensitive pigs). Transgenic animals with new traits- less fat, high growth rate, high ovulation rate (e.g Fecundin gene) - transgenic animals as bioreactors for producing pharmaceutically important compounds and therapeutics. Disease diagnosis using DNA tools. Immunmodulation of animal castration and growth.

AGRI 3068Y(5) - BIOINFORMATICS

Internet basics, biological data analysis and application, sequence data bases. Sequence alignment and data base search. Protein primary sequence analysis, DNA sequence analysis, pair wise sequence alignment. FASTA and BLAST algorithm. Multiple sequence alignment. Database searching using BLAST and FASTA. Structural data bases. Algorithms used in bioinformatics (to be serviced by computer science department). Genome browsers.