

BIOTECHNOLOGY

- 1. Fundamentals of Biotechnology (ABtE010)**
 - 1.1 Introduction (ABtE0101)
 - 1.2 Historical Development (ABtE0102)
 - 1.3 Scope of Biotechnology (ABtE0103)
 - 1.4 Industrial Application (ABtE0104)
 - 1.5 Safety Concerns, Public perception and Bioethics (ABtE0105)
 - 1.6 Intellectual Property Rights: International conventions, patents, Methods of application of patents-legal implications (ABtE0106)

- 2. Biotechnology Prerequisites. (ABtE02)**
 - 2.1 Biological Sciences: Botany, Zoology, Microbiology, Cell and Developmental Biology, Physiology. (ABtE0201)
 - 2.2 Biochemistry: Water, Carbohydrates, Aminoacids, Proteins, Lipids, Nucleic acids, Enzymes, Hormones, Vitamins, Minerals (ABtE0202)
 - 2.3 Concepts of molecular biology (Central Dogma, DNA replication, transcription, translation, Post-transcriptional/translational modifications, mutation), Genetics, Metagenomics and Cytogenetics (ABtE0203)
 - 2.4 Metabolic pathways (Catabolism): Breakdown of carbohydrates(glycolysis,TCA cycle,HMP shunt), lipids (β - oxidation), electron transport chain,oxidative phosphorylation. (ABtE0204)
 - 2.5 Metabolic pathways (Anabolism): Bio-synthesis of carbohydrates (gluconeogenesis,ketogenesis), lipids (fattyacid synthesis). (ABtE0205)
 - 2.6 Introduction to Chemical engineering and biochemical engineering, Basics of Thermodynamics. (ABtE0206)

- 3. Plant Biotechnology (ABtE03)**
 - 3.1 Totipotency, Regeneration of plants, Plant growth regulators and elicitors, Tissue culture and cell suspension culture system - methodology, kinetics of growth and nutrient optimization. (ABtE0301)
 - 3.2 Micro-propagation, Embryogenesis, Somaclonal and gametoclonal variations,Hardening of tissue culture plants, Plant product of industrial importance. (ABtE0302)
 - 3.3 Protoplast Culture, Fusion techniques,selection, regeneration of hybrid plants, somatic hybridization, cybridization. (ABtE0303)
 - 3.4 Haploid Culture and Molecular Markers and their Use in Plant Breeding. (ABtE0304)
 - 3.5 Genetic Transformation of Plants, vectors and marker genes, foreign gene transfer techniques, plant disease resistance and stress tolerance. (ABtE0305)
 - 3.6 Production of Secondary Metabolites, Artificial seeds, Selection marker and reporter gene. (ABtE0306)

- 4. Animal Biotechnology. (ABtE04)**
 - 4.1 Culture media composition and growth conditions, Primary and Secondary culture, Cell lines, Animal cell and tissue preservation. (ABtE0401)

- 4.2 Vaccines, Types of Vaccines, Recombinant vaccines for animal health, Therapeutic proteins, Hybridoma Technology and Monoclonal Antibody. (ABtE0402)
- 4.3 Embryo Transfer, *In Vitro* Fertilization, Cryopreservation, Animal cloning, Transgenic Animals. (ABtE0403)
- 4.4 Stem cell technology, Xenotransplantation, Micro & macro-carrier culture. (ABtE0404)
- 4.5 Manipulation of growth of animals, products, different breeds, genetic characterization. (ABtE0405)
- 4.6 Gene Therapy: Types of gene therapy, Gene transfer techniques, Vector system. (ABtE0406)
- 5. Microbial Biotechnology. (ABtE05)**
- 5.1 Isolation, Development and preservation of industrial microorganism. (ABtE0501)
- 5.2 Substrate for industrial microbial process, Regulatory mechanisms of metabolic pathways in industrial strains. (ABtE0502)
- 5.3 Production of biomass and primary/secondary metabolites - biofuels, bioplastics, industrial enzymes, antibiotics. (ABtE0503)
- 5.4 Large scale production and purification of recombinant proteins and metabolites.
- 5.5 Clinical, food and industrial microbiology. (ABtE0505)
- 5.6 Microorganism in degradation of xenobiotics and removal of heavy metals, Screening strategies for new products. (ABtE0506)
- 6. Medical Biotechnology. (ABtE06)**
- 6.1 Immune system, Immunoglobulins, Immune Response, Medical Immunotechniques, Immunotherapy, Immunotechnology. (ABtE0601)
- 6.2 Viral Diseases, Diagnosis and Control. (ABtE0602)
- 6.3 Cancer Biology: Fundamentals of Cancer Biology, Carcinogenesis, Cancer metastasis, Cancer therapy. (ABtE0603)
- 6.4 Biopharmaceuticals, Drug Design, Drug metabolism, Drug toxicity and Discovery. (ABtE0604)
- 6.5 Sterility and *In Vitro* Fertilization. (ABtE0605)
- 6.6 Stem Cell Bioengineering, therapeutic applications of stem cells. (ABtE0606)
- 7. Environmental Biotechnology. (ABtE07)**
- 7.1 Environment and Biodiversity: Ecology, ecosystem, Environmental pollution; sources and effects. (ABtE0701)
- 7.2 Principles and concepts of ecosystem, Energy transfer in an ecosystem, Basics of environmental microbiology. (ABtE0702)
- 7.3 Sewage and Waste Water Management: Industrial and Municipal waste, Biological treatment, Use of genetically engineered organisms. (ABtE0703)
- 7.4 Environmental health: Ecotoxicology - Heavy metals, pesticides and their effects, Indices of toxicity, Microbial biosensors in environmental monitoring. (ABtE0704)
- 7.5 Environmental technologies: Microorganism and renewable sources of energy, Biodegradation and bioremediation. (ABtE0705)
- 7.6 Risk assessment: Life cycle analysis, Role of biotechnology in environmental protection. (ABtE0706)

- 8. Bioprocess Engineering and Process Biotechnology. (ABtE08)**
- 8.1 Bioreaction Engineering: Rate law, Zero & first order kinetics, Ideal reactors - batch, mixed flow and plug flow, Enzyme immobilization. (ABtE0801)
- 8.2 Kinetics of cell growth, Substrate utilization and product formation, Batch, fed batch and continuous processes, Optimization and scale up. (ABtE0802)
- 8.3 Upstream processing: Media formulation and optimization, Sterilization of air and media. (ABtE0803)
- 8.4 Downstream Processing: Filtration - membrane filtration, ultrafiltration; Centrifugation - high speed and ultra; Cell disruption; Principles of chromatography - ion exchange, gel filtration, hydrophobic interaction, affinity based separation, GC and HPLC ; Extraction, adsorption and drying. (ABtE0804)
- 8.5 Instrumentation: Pressure, temperature and flow measurement devices; Valves. (ABtE0805)
- 8.6 Process Control: First and second order system, Feedback and feed forward control, Types of controllers - proportional, derivative and integral control, tuning of controllers. (ABtE0806)
- 9. Recombinant DNA technology and Other tools in biotechnology. (ABtE09)**
- 9.1 Recombinant DNA Technology: Restriction and modification enzymes; Vectors - plasmids, bacteriophage and other viral vectors, bacterial and yeast artificial chromosomes; Expression vectors. (ABtE0901)
- 9.2 Gene isolation and cloning, strategies for production of recombinant proteins; Transposons and gene targeting; cDNA and genomic DNA library. (ABtE0902)
- 9.3 Gene Integration and Expression Vectors: Analytical techniques, colony and plaque hybridization, factors affecting expression, reporter genes, Fusion proteins, Gene libraries. (ABtE0903)
- 9.4 Molecular Tools: Polymerase chain reaction; DNA/RNA labelling and sequencing; In-situ hybridization; DNA fingerprinting, RAPD, RFLP; Site-directed mutagenesis; Gene transfer technologies; Biosensing and biosensors. (ABtE0904)
- 9.5 Analytical Tool: Principles of microscopy - light, electron, fluorescent and confocal; Principles of spectroscopy - UV, visible, CD, IR, fluorescence; Electrophoresis, blotting technique; Flow cytometry; Whole genome and ChIPsequencing. (ABtE0905)
- 9.6 Computational Tools: Bioinformatics resources and search tools; Sequence and structure databases; Sequence analysis - sequence file formats, scoring matrices, alignment, phylogeny; Genomics, proteomics, metabolomics; Gene prediction; Secondary structure and 3D structure prediction; Knowledge discovery in biochemical databases. (ABtE0906)
- 10. Project Planning, Design and Implementation (AALL10)**
- 10.1 Engineering drawings and its concepts: Fundamentals of standard drawing sheets, dimensions, scale, line diagram, orthographic projection, isometric projection/view, pictorial views, and sectional drawing. (AALL1001)
- 10.2 Engineering Economics: understanding of project cash flow; discount rate, interest and time value of money; basic methodologies for engineering economics analysis

- (Discounted Payback Period, NPV, IRR & MARR); comparison of alternatives, depreciation system and taxation system in Nepal. (AALL1002)
- 10.3 Project planning and scheduling: project classifications; project life cycle phases; project planning process; project scheduling (bar chart, CPM, PERT); resources levelling and smoothing; monitoring/evaluation/controlling. (AALL1003)
- 10.4 Project management: Information system; project risk analysis and management; project financing, tender and its process, and contract management. (AALL1004)
- 10.5 Engineering professional practice: Environment and society; professional ethics; regulatory environment; contemporary issues/problems in engineering; occupational health and safety; roles/responsibilities of Nepal Engineers Association (NEA). (AALL1005)
- 10.6 Engineering Regulatory Body: Nepal Engineering Council (Acts & Regulations). (AALL1006)