Nepal Engineering Council Registration Examination
GENETIC ENGINEERING (AGtE)

1. Fundamentals of Genetic Engineering & Biotechnology (AGtE01)

1.1 Introduction to Genetics and Biotechnology (AGtE0101)

1.2 Historical Background, Modern and multidisciplinary aspects of Genetic Engineering & Biotechnology (AGtE0102)

1.3 Basics concepts and Scope of Genetic Engineering & Biotechnology (AGtE0103)

1.4 Applications of Genetic Engineering and Biotechnology in pharmaceuticals, food, beverage industries and environmental sectors. (AGtE0104)

1.5 Safety Concerns, Public perception and Bioethics (AGtE0105)

1.6 **Intellectual Property Rights:** International conventions, patents, Methods of application of patents-legal implications (AGtE0106)

2. Genetic Engineering & Biotechnology Prerequisites (AGtE02)

2.1 **Biological Sciences:** Botany, Zoology, Microbiology, Cell and Developmental Biology, Physiology. (AGtE0201)

2.2 **Biochemistry:** Water, Carbohydrates, Amino acids, Proteins, Lipids, Nucleic acids, Enzymes, Hormones, Vitamins, Minerals. (AGtE0202

2.3 **Concepts of Genetics:** Mendelian Genetics, Hereditary, Genes, Oncogenes, Tumor suppressor genes, Genome, Nucleus, chromosome, Cell division (mitosis, meiosis), Cell cycle, apoptosis. (AGtE0203)

2.4 **Concepts of Molecular biology:** (Central Dogma, DNA replication, transcription, translation, Post-transcriptional/translational, mutation), Metagenomics and Ctyogenetics. (AGtE0204)

2.5 **Metabolic pathways (Catabolism):** Breakdown of carbohydrates (glycolysis, TCA cycle, HMP shunt), lipids (β-oxidation), electron transport chain, oxidative phosphorylation, bioenergetics, ATP synthesis. (AGtE0205)

2.6 **Metabolic pathways (Anabolism):** Biosynthesis of carbohydrates (gluconeogenesis, ketogenesis), lipids (fatty acid synthesis). (AGtE0206)

3. Plant Biotechnology (AGtE03)

3.1 Plant cell, tissue and root systems, Plant physiology, Plant Breeding, Haploid Culture and Molecular Markers and their applications. (AGtE0301)

3.2 Totipotency, Regeneration of plants, plants growth regulators and elicitors, Tissue culture and cell suspension culture system – methodology, kinetics of growth and nutrients optimization. (AGtE0302)

3.3 Micro-propagation, Embryogenesis, Somaclonal and gametoclonal variations, hardening of tissue culture plants, Plant product of industrial importance. Plant genomes, Plant Cell and Tissue Culture, Types of plant tissue culture. (AGtE0303)

3.4 Protoplast Culture, Fusion techniques, selection, regeneration of hybrid plants, somatic hybridization, cybridization. (AGtE0304)

3.5 Genetic Transformation of Plants, vectors and marker genes, foreign gene transfer techniques, plant disease resistance and stress tolerance. (AGtE0305)

3.6 Production of secondary metabolites, Artificial seeds, Selection marker and reporter gene. (AGtE0306)

4. Animal Biotechnology (AGtE04)

4.1 Animal cell, tissue, systems, anatomy and physiology, Culture media composition and growth conditions, Primary and secondary culture, Cell lines, Animal cell and tissue preservation. (AGtE0401)

4.2 Vaccines, Types of Vaccines, Recombinant vaccines for animal health, Therapeutic proteins, Hybridoma Technology and Monoclonal Antibody(AGtE0402)

4.3 Embryo Transfer, *In Vitro* Fertilization, Cryopreservation, Animal cloning, Transgenic Animals(AGtE0403)

4.4 Stem cells, Xenotransplantation, Micro & macro – carrier culture. (AGtE0404)

4.5 Animal breeding and manipulation of growth of animals, products, different breeds, , genetic characterization(AGtE0405)

4.6 **Gene Therapy:** Types of gene therapy, Gene transfer techniques, Vector system(AGtE0406)

5. Microbial Biotechnology (AGtE05)

5.1 Isolation, Development and preservation of industrial microorganism. (AGtE0501)

5.2 Substrate for industrial microbial process, Regulatory mechanisms of metabolicpathways in industrial strains. (AGtE0502)

5.3 Production of biomass and primary/secondary metabolites – biofuels, bioplastics. Industrial enzymes, antibiotics. (AGtE0503)

5.4 Large scale production and purification of recombinant proteins and metabolites. (AGtE0504)

5.5 Bio-recombination and biomass utilization, Clinical, food and industrial microbiology. (AGtE0505)

5.6 Microorganism in degradation of xenobiotics and removal of heavy metals, screening strategies for new products. (AGtE0506)

6. Medical Biotechnology & Oncology (AGtE06)

6.1 **Biotechnology in medicine:** production of human peptide hormones, insulins, different types of vaccines, blood products & antibiotics. (AGtE0601)

6.2 Production of Biopharmaceuticals, antibodies (monoclonal & polyclonal) (AGtE0602)

6.3 Sterility testing, potency of antibiotics and vaccine, rabbit test. (AGtE0603)

6.4 **Pathogen causing viral diseases:** Influenza, EBV, HIV, Dengue. Plant and animal virus replication, Bacteriophages. (AGtE0604)

6.5 Relation of oncogenes and oncogenic viruses for the development of viruses, use of retroviruses as a vector for gene therapy, prevention and treatment of viral diseases. (AGtE0605)

6.6 **Molecular diagnostics:** DNA isolation, DNA fingerprinting and its application, PCR and itsapplication(AGtE0606)

7. Environmental and Agricultural Biotechnology (AGtE07)

7.1 **Environment and Biodiversity:** Ecology, ecosystem, Metagenomics, Environmental pollution, sources and effects, bioremediation. (AGtE0701)

7.2 Bio-deterioration of leather, wool, feather, plastics, rubber etc., Control of bio-deterioration – physical, chemical & biological method, factors affecting microorganisms to degrade xenobiotics. (AGtE0702)

7.3 **Metal pollution and microorganisms:** Sources of metal, metal bioavailability in the environment, mechanisms of microbial metal resistance and detoxifying, application of biosensors for the detection of environmental pollutants. (AGtE0703)

7.4 **Transgenic agricultural crops:** Importance of transgenic crops, Transformation procedure, Vector construction, transgenic crops for improved crop productivity and nutritional quality. (AGtE0704)

7.5 Molecular marker system and its application, Limitation of mutation breeding, biosafety during industrial production. (AGtE0705)

7.6 **Breeding for diseases & insect resistance:** Mechanism and genetics of disease and insect resistance, source of disease and insect resistance, breeding methods for disease and insect resistance. (AGtE0706)

8. Fermentation and Enzyme Technology (AGtE08)

8.1 **Media formulation and sterilization process:** Media compositions and its types, Factors influencing media formulation, mechanism of sterilization of media, killing kinetics. (AGtE0801)

8.2 **Inoculum preparation and development:** Criteria used for inoculum preparation, different process of preparation, bacterial & fungal inoculum preparation and development. (AGtE0802)

8.3 **Fermentation kinetics:** Rate equation for cell growth, substrate utilization, product formulation, batch, fed-batch and continuous fermentation process and its advantages and disadvantages. (AGtE0803)

8.4 **Enzyme technology:** Industrial approach to enzyme production, Uses of enzyme in biochemical, medical and as a biocatalyst in organic chemistry, industrial and technical uses of enzyme. (AGtE0804)

8.5 **Downstream Processing:** Techniques, instrumentation, Unit operations, Cell disruption, Bio-separation, Filtration, Precipitation, Drying, Commercially important biomolecules(AGtE0805)

8.6 **Protein technology:** Protein employed in health care industry, Protein source (microorganism, plant and animal tissue), Conformational stability of protein, recombinant protein technology. (AGtE0806)

9. Recombinant DNA technology and other tools in Genetic engineering & biotechnology (AGtE09)

9.1 **Recombinant DNA technology:** Restriction and modification enzymes, Vectors – plasmids, bacteriophage and other viral vectors, bacterial and yeast artificial chromosomes, expression vectors. (AGtE0901)

9.2 Gene isolation and cloning, Transposons and gene targeting, cDNA and genomics DNA library. (AGtE0902)

9.3 **Gene integration and Expression vectors:** Analytical technique, Colony and plaque hybridization, Factors affecting expression, reporter genes fusion proteins, gene libraries. (AGtE0903)

9.4 **Molecular tools:** DNA/RNA labelling and sequencing, blotting, In-situ hybridization, RAPD, RFLP, Site- directed mutagenesis, Gene transfer technologies. (AGtE0904)

9.5 **Analytical tool:** Principles of microscopy – light electron, fluorescent and confocal; Principles of spectroscopy – UV, visible, CD, IR, fluorescence; Electrophoresis and blotting technique; Flow cytometry; Whole genome and ChIP sequencing. (AGtE0905)

9.6 **Computational tools:** Bioinformatics resources and search tools; Sequencing and structure database; Sequence analysis – sequence file formats, scoring matrices, alignment, phylogeny; Genomics, Proteomics, metabolomics; Gene prediction;Secondary structure and 3D structure prediction. (AGtE0906)

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)