**FACULTY OF SCIENCE**

KHWAJA MOINUDDIN CHISTI LANGUAGE UNIVERSITY, LUCKNOW, U.P. (India)

**B.Sc. – BIOTECHNOLOGY**

Under Choice Based Credit System (CBCS)

**Regulations, Course & Curriculum Structure (As per NEP 2020)**

**First Years**

(I Semester)

**Effective from Session 2021-22**

**Bachelor of Science (Honours) in Biotechnology Programme**

# Applicability

These regulations shall apply to the programme of Bachelor of Science (Honours) in Biotechnology from the session 2021-22.

# Minimum Eligibility for Admission

An Intermediate degree under the 10+2 system with Biology group from a recognized Board/Institution, with 45% marks in aggregate for General/OBC and 40% for SC/ST candidates shall constitute the minimum requirement for admission to the programme.

# Programme Objectives

* + Bachelor course in biotechnology offers the synergism of basic concepts of biology, chemistry, biochemistry, physiology, molecular biology, microbiology, immunology, recombinant DNA technology, genomics & proteomics with technological applications.
	+ The main objective of this degree course is to produce graduates with enhanced skills, knowledge and research aptitude to carry out higher studies, entrepreneurship or research and development in the various health, agricultural and industrial areas.
	+ Develop proficiency in application of current aspects of biotechnology like biochemistry, molecular biology, immunology, recombinant DNA technology, genomics & proteomics.
	+ Students will be able to use state of the art techniques relevant to academia and industry, generic skills and global competencies including knowledge and skills that enable the students to undertake further studies in the field of biochemistry, immunology, molecular biology, genetic engineering, genomics & proteomics, microbiology or any other related field.
	+ Imparting an education that includes communication skills, the ability to work in a team with leadership quality, devoted to societal problems with an ethical attitude

# Programme Outcomes

* + Prepares the students for immediate entry to the workplace with sound theoretical, experimental knowledge in the area of health and pharmaceuticals, biochemicals, biofuels, environment related, food and dairy, cosmetics, biopolymers and related multidisciplinary fields.
	+ Overall, the course offers basic foundation in biotechnology which enables the students to understand the concepts in biochemistry, molecular biology, microbiology, genetic engineering and related industrial technology.
	+ Students will be able to design, execute, record and analyse the results of experiments in field of molecular biology, genomics,, Recombinant DNA technology, biochemistry, microbiology and genetic engineering.
	+ Students will be able to work effectively in a group in the classroom, laboratory, industries and field based situations.
	+ Become efficient in using standard operating procedures and will be well versed with the regulations for safe handling and use of chemicals as well as IPR and biosafety issues related to experiments in field of biochemistry, microbiology and genetic engineering.

# Specific Programme Outcomes

* + Critical Thinking- Students will demonstrate an understanding of major concepts in all disciplines of biology, biochemistry, biotechnology microbiology and bioinformatics. Understand the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their relevancies in the day-to-day life.
	+ Effective Communication- Development of various communication skills such as reading, listening, speaking in expressing ideas and views clearly and effectively.
	+ Social Interaction and Ethics- Development of scientific outlook not only with respect to science subjects but also in all aspects related to life besides following ethics
	+ Environment and Sustainability- Understand the issues of environmental contexts and sustainable development.
	+ Competitive Skill- Demonstrate an ability to appear for National level examination to pursue higher studies.
	+ Career opportunities- Demonstrate an ability to identify careers in biotechnology, domain like Healthcare Diagnostics, Pharmaceutical, Food Industry etc, and skills required to work in a biotechnology laboratory or manufacturing facility. Beside this, industries also employ biotechnological professionals in their marketing divisions to boost up business in sectors where their products would be required.
	+ Entrepreneurship ventures- such as consultancy and training centres can be opened.

# Course Structure

The course structure of the Biotechnology programme shall be as follows-

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Sem.** | **Course Opted** | **Course Name** | **Theory/ Practical/ Project** | **Credits** | **Cumulative Minimum Credits required for Award of****Certificate/ Diploma/ Degree** |
| 1 | I | Core Course 1 | Biochemistry & Metabolism | Theory | 4 | **(46)****Certificate in Biotechnology** |
| Core Course 1Practical | Biochemistry & Metabolism | Practical | 2 |
| Core Course 2 | Cell Biology | Theory | 4 |
| Core Course 2 Practical | Cell Biology | Practical | 2 |
| Core Course 3 | Environmental Science | Theory | 4 |
| Core Course 3 Practical | Environmental Science | Practical | 2 |
| GE 1 | Generic Elective - 1 | Theory | 4 |
| SEC 1 | Molecular Diagnostics | Theory | 3 |
| AECC 1 | Food Nutrition and Hygiene | Theory | 0 (Qualifying) |
| **Total Credit** |  |  |  | **25** |
| 1 | II | Core Course 4 | Mammalian Physiology | Theory | 4 |
| Core Course 4 Practical | Mammalian Physiology | Practical | 2 |
| Core Course 5 | Plant Physiology | Theory | 4 |
| Core Course 5 Practical | Plant Physiology | Practical | 2 |
| Core Course 6 | Animal Biotechnology | Theory | 4 |
| Core Course 6 Practical | Animal Biotechnology | Practical | 2 |
| GE 2 | Generic Elective - 2 | Theory | 4 |
| SEC 2 | Enzymology | Theory | 3 |
| AECC 2 | First Aid and Health | Theory | 0(Qualifying) |
| **Total Credit** |  |  |  | **25** |
| 2 | III | Core Course 7 | Genetics | Theory | 4 | **(92)****Diploma in Biotechnology** |
| Core Course 7 Practical | Genetics |  | 2 |
| Core Course 8 | General Microbiology | Theory | 4 |
| Core Course 8 Practical | General Microbiology |  | 2 |
| Core Course 9 | Chemistry – 1 | Theory | 4 |
| Core Course 9 Practical | Chemistry – 1 |  | 2 |
| GE 3 | Generic Elective - 3 | Theory | 4 |
| SEC 3 | Industrial Fermentations | Theory | 3 |
| AECC 3 | Human Values andEnvironmental Studies | Theory | 0(Qualifying) |
| **Total Credit** |  |  |  | **25** |
| 2 | IV | Core Course 10 | Molecular Biology | Theory | 4 |
| Core Course 10 Practical | Molecular Biology | Practical | 2 |
| Core Course 11 | Immunology | Theory | 4 |
| Core Course 11 Practical | Immunology | Practical | 2 |
| Core Course 12 | Chemistry – 2 | Theory | 4 |
| Core Course 12 Practical | Chemistry – 2 | Practical | 2 |
| GE 4 | Generic Elective – 4 | Theory | 4 |
| SEC 4 | Basics of Forensic Science | Theory | 3 |
| AECC 4 | Physical Education & Yoga | Theory | 0(Qualifying) |
| **Total Credit** |  |  |  | **25** |

|  |  |
| --- | --- |
|  |  |
| 3 | V | Core Course 13 | Bioprocess Technology | Theory | 5 | **(132)****Degree in “Bachelor of Science Honors in Biotechnology”** |
|  |  | Core Course 14 | Recombinant DNA Technology | Theory | 5 |
|  |  | Core Course 15 | Medical Microbiology | Theory | 5 |
|  |  | Core Course 16 | Food Biotechnology | Theory | 5 |
|  |  | AECC 5 | Analytic Ability and Digital | Theory | 0(Qualifying) |
|  |  |  | Awareness |  |  |
|  |  | Industrial Training | Industrial Training | Project | 0(Qualifying) |
| **Total Credit** |  |  | **20** |
| 3 | VI | Core Course 17 | Bio Analytical Tools | Theory | 5 |
|  |  | Core Course 18 | Genomics and Proteomics | Theory | 5 |
|  |  | Core Course 19 | Agriculture Biotechnology | Theory | 5 |
|  |  | Core Course 20 | Biostatistics | Theory | 5 |
|  |  | AECC 6 | Communication Skill and | Theory | 0(Qualifying) |
|  |  |  | Personality Development |  |  |
|  |  | Research Project | Research Project | Project | 0(Qualifying) |
| **Total Credit** |  |  | **20** |
| **Grand Total Credit** |  |  | **140** |

**Semester I**

**BIOCHEMISTRY AND METABOLISM**

# Course Objectives:

* To make students aware and to give them the basic knowledge of different macromolecules like carbohydrates, nucleic acids protein which are the basis of existence of the cell.
* To acquaint students with the concept of bioenergetics and various metabolic processes taking place inside the human body.
* Students can apply the reaction mechanisms in the domains of metabolism, enzyme technology, structural biology, molecular biology and bioinformatics

# Course Outcomes

* Describe the structure and function of DNA and RNA in the cell
* Describe the structure of proteins, including the significance of amino acid R-groups and their impact on the three-dimensional structure of proteins.
* Students will have knowledge on biomolecules, like carbohydrates, lipids, enzymes and coenzymes besides their importance and Classification, forces stabilizing their structures, write and relate the role of them with day to day life.
* Develop an understanding of various metabolisms in cell
* Know the formation and the breakdown of different biomolecules and the places where it took place
* Various physiological and pathological aspects of by products of metabolic pathways and their regulations and relate with various industrial processes.

# UNIT I:

Introduction to Biochemistry: A historical prospective. **(5 Periods)**

Amino acids & Proteins**:** Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins.

UNIT II: **(5 Periods)**

# Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein’s and their biological functions

# UNIT III (5 Periods)

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.

**UNIT IV ( 5 Periods)**

Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines,. Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA.

**UNIT V** **(10 Periods)**

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria.

**UNIT VI** **(5 Periods)**

Role of: NAD+, NADP+, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate,lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions.

# UNIT VII (10 Periods)

Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance,

**UNIT VIII (10 Periods)**

Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. ß-oxidation of fatty acids, Amino acid catabolism

# PRACTICALS

1. Introduction to Glasswares /Equipments & Pipetting Method
2. Qualitative tests for Carbohydrates, proteins and lipids
3. Preparation of buffers.
4. Standardization of pH meter
5. To study activity of any enzyme under optimum conditions.
6. To study the effect of pH, temperature on the activity of salivary amylase enzyme.
7. Principles of Colorimetry**:** Beer's law

# SUGGESTED READING

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. 6th Edition. W.H Freeman and Co.
2. Satyanarayana U. and Chakrapani U. (2008). Biochemistry, 5th Edition, Books & Allied Ltd (Elsevier)
3. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants.American Society of Plant Biologists.
4. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.

**Semester III**

**GENETICS**

# Course Objectives:

* Genetics is the study of heredity and genes. The aim of this course is to strengthen the Mendelian principles along with other molecular genetics topics like recombination, pedigree analysis, transposons.
* This course will help students to venture in to the different areas of biomedical sciences.

# Course Outcomes

* To communicate the pivotal role of Mendelian concepts in the development of the science of genetics and also the fact that nature is full of examples that deviate from Mendelian laws starting from linkage groups.
* Understanding of genetics will provide a perception of how forward genetics has been used to understand the basis of continuity of information transfer that is applicable to not only to the simple life forms but also to humans.
* To understand the molecular basis of genotype to phenotype correlation.

**UNIT I (6 Periods)**

Introduction: Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance.

Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast. Role of meiosis in life cycles of organisms.

**UNIT II (6 Periods)**

Mendelian genetics : Mendel’s experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity.

**UNIT III (9 Periods)**

Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes.

Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition – unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, middle repetitive sequences- VNTRs & dinucleotide repeats, repetitive transposed sequences- SINEs & LINEs, middle repetitive multiple copy genes, noncoding DNA.

**UNIT IV (9 Periods)**

Genetic organization of prokaryotic and viral genome.

Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function.

**UNIT V (8 Periods)**

Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants, variations in chromosomes structure - deletion, duplication, inversion and translocation (reciprocal and Robertsonian), position effects of gene expression, chromosomal aberrations in human beings, abonormalities– Aneuploidy and Euploidy.

**UNIT VI (7 Periods)**

Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory, Fragile-X- syndrome and chromosome, sex influenced dominance, sex limited gene expression, sex linked inheritance.

**UNIT VII (8 Periods)**

Genetic linkage, crossing over and chromosome mapping: Linkage and Recombination of genes in a chromosome crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Crossing over at four strand stage, Multiple crossing overs Genetic mapping.

**UNIT VIII (7 Periods)**

Extra chromosomal inheritance: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting.

Evolution and population genetics: In breeding and out breeding, Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection.

# PRACTICALS

* 1. Permanent and temporary mount of mitosis.
	2. Permanent and temporary mount of meiosis.
	3. Mendelian deviations in dihybrid crosses
	4. Demonstration of - Barr Body *-Rhoeo* translocation.
	5. Karyotyping with the help of photographs
	6. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.
	7. Study of polyploidy in onion root tip by colchicine treatment.

# SUGGESTED READING

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co.

# Semester V BIOPROCESS TECHNOLOGY

**Course Objectives:**

* The objective of this course is to understand the basic skills applied in fermentation technology and use of biological resources as input to biobased processes which are economically and environmentally sustainable.
* Develop the understanding of industrial aspects of bioprocess technology.

# Course Outcomes:

* An introduction to fermentation process. Learn the history of fermentation process, types of fermentation, and examples of fermentation industry.
* Design of a fermenter. Understand basic design of a fermenter. Important parts and materials required for aseptic operation and containment practice in a fermenter.
* Types of Culture & fermenter operation. Covers the basic concepts of microbial growth kinetic in different bioreactor operational modes.
* Understand the process development, upstream and downstream processing & relate the skill of mass transfer and its application
* Understand the techniques involved in the extraction and purification of high quality fermentation products.
* Effluent treatment. Understand the importance of proper waste treatment plant for fermentation industry

**UNIT I (5 Periods)**

Introduction to bioprocess technology. Range of bioprocess technology and its chronological development. Basic principle components of fermentation technology.

**UNIT II (5 Periods)**

Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture.

**UNIT III (10 Periods)**

Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes.

**UNIT IV (10 Periods)**

Principles of upstream processing – Media preparation, Inocula development and sterilization

**UNIT V (8 Periods)**

Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa.

**UNIT VI (7 Periods)**

Bioprocess measurement and control system with special reference to computer aided process control.

**UNIT VII (8 Periods)**

Introduction to downstream processing, product recovery and purification.

**UNIT VIII (7 Periods)**

 Effluent treatment. Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.

# SUGGESTED READING

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.