FACULTY OF ENGINEERING & TECHNOLOGY

KHWAJA MOINUDDIN CHISHTI LANGUAGE UNIVERSITY, LUCKNOW, UTTAR PRADESH

B.TECH. BIOTECHNOLOGY

Regulations, Study & Evaluation Scheme,

Curriculum Structure

Effective from session 2021-22

Bachelor of Technology in Biotechnology Programme

1. Applicability

These regulations shall apply to the Bachelor of Technology in Biotechnology programme from the session 2021-22.

2. Minimum Eligibility

a) For Fresh Admission

An Intermediate degree under the 10+2 system in the concerned subjects- PCM/PCB/PMCS from a recognized Board/Institution, with minimum 45% marks in aggregate for General/OBC and 40% for SC/ST candidates in three subjects (without any grace), shall constitute the minimum requirement for admission to the programme.

b) For Lateral Entry

Candidates should have passed 3-year B.Sc.(Bio group) degree & class 12^{th} with Maths or Biology as one of the compulsory subject.

3. 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.

4. 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.

5. 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.
- **Online Exposure of Certified Courses:** Understanding of the different disciplines like nutrition & biochemistry, nanotechnology, immunology through online certified courses offered under MOOCs and virtual labs by NPTEL.
- **Effective Communication-** Development of various communication skills such as reading, listening, presentation to 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.

6. Study & Evaluation Scheme (SES) with Curriculum Structure

The scheme & course structure of the B.Tech. in Biotechnology programme shall be as follows:

FACULTY OF ENGINEERING & TECHNOLOGY

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B.TECH. BIOTECHNOLOGY

STUDY & EVALUATION SCHEME

(SECOND, THIRD & FOURTH YEARS)

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B.Tech. (Biotechnology)

II Year: III Semester

S.No.	Subject code	Subject name	L	T	P	Sessional Assessment			SEE	Subject Total	Credit
						MST	TA	Total			
THEORY SUBJECT											
1	BT301	Techniques in Biotechnology	3	1	0	15	15	30	70	100	4
2	BT302	Microbiology & Immunology	3	1	0	15	15	30	70	100	4
3	BT303	Biochemistry	3	1	0	15	15	30	70	100	4
4	BT304	Environmental Science	3	1	0	15	15	30	70	100	4
5	AS301	Elementary Mathematics-III	3	1	0	15	15	30	70	100	4
6	HS301	Communication Skill	2	0	0	15	15	30	70	100	0
7	GP301	General Proficiency	-	-	-	-	-	50	0	50	0
PRACTICAL											
8	BT351	Techniques in Biotechnology Lab	0	0	2	15	15	30	70	100	1
9	BT352	Microbiology & Immunology Lab	0	0	2	15	15	30	70	100	1
10	BT353	Biochemistry Lab	0	0	2	15	15	30	70	100	1
11	BT354	Environmental Science Lab	0	0	2	15	15	30	70	100	1
12	HS301	Communication Skill Lab	0	0	2	0	0	50	0	50	0
		Total	17	5	10					1000	24

L- Lecture
T -Tutorial
P-Practical
MST- Mid Semester Test
TA-Teacher's Assessment

B.Tech.(Biotechnology)
II Year: IV Semester

S.No.	Subject code	Subject name	L	T	P	Sessional Assessment			SEE	Subject Total	Credit
						MST	TA	Total			
THEORY SUBJECT											
1	BT401	Bioprocess Engineering-I	3	1	0	15	15	30	70	100	4
2	BT402	Genetics & Molecular Biology	3	1	0	15	15	30	70	100	4
3	BT403	Enzyme Engineering	3	1	0	15	15	30	70	100	4
4	BT404	Animal Biotechnology	3	1	0	15	15	30	70	100	4
5	AS401	Industrial Sociology	3	0	0	15	15	30	70	100	3
6	GP401	General Proficiency	-	-	-	-	-	50	0	50	0
PRACTICAL											
7	BT451	Bioprocess Engineering-I Lab	0	0	2	15	15	30	70	100	1
8	BT 452	Genetics & Molecular Biology Lab	0	0	2	15	15	30	70	100	1
9	BT 453	Enzyme Engineering Lab	0	0	2	15	15	30	70	100	1
10	BT 454	Animal Biotechnology Lab	0	0	2	15	15	30	70	100	1
11	BT455	Seminar	0	0	2	15	15	30	70	100	1
		Total	15	3	8					1000	24

B.Tech.(Biotechnology)
III Year: V Semester

S.No.	Subject code	Subject name	L	T	P	Sessional Assessment			SEE	Subject Total	Credit
						MST	TA	Total			
THEORY SUBJECT											
1	BT501	Genetic Engineering	3	0	0	15	15	30	70	100	4
2	BT502	Fermentation Biotechnology	3	1	0	15	15	30	70	100	4
3	BT503	Bioinformatics-I	3	1	0	15	15	30	70	100	4
4	BT504	Metabolic Engineering	3	0	0	15	15	30	70	100	4
6	AS501	Industrial Management	3	0	0	15	15	30	70	100	3
7	GP501	General Proficiency	-	-	-	-	-	50	0	50	0
PRACTICAL											
8	BT551	Genetic Engineering Lab	0	0	2	15	15	30	70	100	1
9	BT552	Fermentation Biotechnology Lab	0	0	2	15	15	30	70	100	1
10	BT553	Bioinformatics-I Lab	0	0	2	15	15	30	70	100	1
11	BT554	Metabolic Engineering Lab	0	0	2	15	15	30	70	100	1
12	BT555	Seminar	0	0	2	15	15	30	70	100	1
		Total	15	2	8					1000	24

B.Tech.(Biotechnology)
III Year: VI Semester

S.No.	Subject code	Subject name	L	T	P	Sessional Assessment			SEE	Subject Total	Credit
						MST	TA	Total			
THEORY SUBJECT											
1	BT601	Bioprocess Engineering-II	3	0	0	15	15	30	70	100	4
2	BT602	Plant Biotechnology	3	1	0	15	15	30	70	100	4
3	BT603	Bioinformatics-II	3	1	0	15	15	30	70	100	4
5	BT061 - 063	Elective –I	3	0	0	15	15	30	70	100	4
6	AS601	Engineering Economics	3	0	0	15	15	30	70	100	3
7	GP501	General Proficiency	-	-	-	-	-	50	0	50	0
PRACTICAL											
8	BT651	Bioprocess Engineering-II Lab	0	0	2	15	15	30	70	100	1
9	BT652	Plant Biotechnology Lab	0	0	2	15	15	30	70	100	1
10	BT653	Bioinformatics-II Lab	0	0	2	15	15	30	70	100	1
11	BT654	Food Biotechnology Lab	0	0	2	15	15	30	70	100	1
12	BT655	Seminar	0	0	2	15	15	30	70	100	1
		Total	15	2	8					1000	24

Student has to undergo a SUMMER/INDUSTRIAL Training of 45 days at the end of VI Sem.

Elective-I

BT-061: Food Biotechnology
BT-062: Biomedical Instrumentation
BT-063: Pharmaceutical Biotechnology

B.Tech.(Biotechnology)
IV Year: VII Semester

S.No.	Subject code	Subject name	L	T	P	Sessional Assessment			SEE	Subject Total	Credit
						MST	TA	Total			
THEORY SUBJECT											
1	BT701	Bioseparation & DSP	3	1	0	15	15	30	70	100	4
2	BT702	Bioethics, Biosafety & IPR	3	1	0	15	15	30	70	100	4
3	BT071 - 073	Elective-II	3	1	0	15	15	30	70	100	4
4	BT074 - 076	Elective-III	3	1	0	15	15	30	70	100	4
5	GP701	General Proficiency	-	-	-	-	-	50	0	50	0
PRACTICAL											
7	BT751	Bioseparation & DSP Lab	0	0	2	15	15	30	70	100	1
8	BT752	Elective Subject Lab	0	0	2	0	100	100	0	100	1
9	BT753	Mini Project	0	0	4	0	200	200	0	200	4
10	BT754	Industrial Training	0	0	2	15	15	30	70	100	2
		Total	15	4	10					1000	24

Elective-II

BT-071: Biomarker & Diagnostics
BT-072: Industrial Biotechnology
BT-073: Entrepreneurship in Biotechnology

Elective-III:

BT074: Agriculture Biotechnology
BT075: Applications of Natural Products
BT076: Waste Treatment & Management

B.Tech. (Bio-technology)
IV Year: VIII Semester

S.No.	Subject code	Subject name	L	T	P	Sessional Assessment			SEE	Subject Total	Credit
			L	T	P	MST	TA	Total	SEE		
1	BT -851	Major Project	0	0	14	100	100	200	300	500	15
2	BT-852	SEMINAR-2			5	50	50	100	100	200	4
3	BT-853	VIVA-VOCE			6	50	50	100	200	300	5
4	GP801	General Proficiency	-	-	-	-	-	50	0	50	0
		Total	0	0	24	200	200	400	600	1000	24

ख़्वाजा मुईनुद्दीन चिश्ती भाषा विश्वविद्यालय, लखनऊ, उत्तर प्रदेश (भारत)
Khwaja Moinuddin Chishti Language University, Lucknow, U.P. (India)
U.P. STATE GOVERNMENT UNIVERSITY,
(Recognised Under Section 2(f) & 12(B) of the UGC Act, 1956 & B.Tech. Approved by (AICTE)

FACULTY OF ENGINEERING & TECHNOLOGY

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B.TECH. BIOTECHNOLOGY

Curriculum Structure

SECOND YEAR
(III & IV Semesters)

SEMESTER- III

ELEMENTARY MATHEMATICS-III

Course Objectives: The subject aims to provide the student with:

- Mathematics Fundamental necessary to formulate, solve and analyse the Engineering Problems
- An Understanding of Probability and its distributions, Measures of Central tendency and Measures of Dispersion
- An understanding of Correlation Regression, ANOVA and Statistical Quality control chart.

Course Outcomes: The student after undergoing this course will be able to :

- Solve Problems in Engineering domain related to Measures of Central tendency and Dispersion.
- Analyse and solve problems related to Correlation and Regression and Chi-Square Test, T-Test.
- Analyse and solve problems related to ANOVA and Statistical Quality control Chart.

UNIT I

Data and classification: Data type, Classification and summarization of data. Diagrams and graphs, Measures of central tendency, Measures of dispersion, Moments, Skewness, Kurtosis

UNIT II

Probability and Distributions: Definitions of probability, Additive law of probability, Conditional probability, Multiplicative law of probability, Binomial distribution, Poisson distribution, Normal distribution.

UNIT III

Correlation, Regression and Tests: Correlation, Karl Prearson's coefficient of correlation, Rank Correlation, Lines of regression, Non –Parametric tests Sign Test, Mann Whitene Wilcoxon test.

UNIT IV

Tests of Hypothesis and ANOVA: Hypothesis tests, Student's t-test, Chi-square test, F-test, One way and two way analysis of variance.

UNIT V

Design and Quality control: Principles of experimental design and analysis, completely randomized design, Randomized block design, Latin square design, Statistical quality control, Types of quality control, Control chart for variables, Control chart for attributes.

Text Books:

1. S.P Gupta, Statistical Methods, Sultan Chand and Sons Publishers.
2. Georgr W. and William G., Statistical Methods, IBH Publication.
3. Ipsen J et al., Introduction to Biostatistics, Harper and Row Publication.
4. BS Grewal, Higher Engineering Mathematics, Khanna Publisher, 2005.

Reference Books:

1. N.TJ Baily, Statistical methods in Biology, English University Press.
2. R. Rangaswami, A text book of Agricultural Statistics, New Age Int. Publication.
3. PSS Sundar Rao, An Introduction to Biostatistics, Prentice Hall.
4. Zar J, Biostatistics, Prentice Hall, London.

TECHNIQUES IN BIOTECHNOLOGY

Course objectives:

The objective is to enrich students' knowledge about various techniques used in biological research and also their implementation in various fields of research.

Course outcomes:

- Understand the concept of electromagnetic radiation, absorption spectrum, Beer's law and Lamberts law
- Understand principle, working and applications of various spectrophotometers, microscopes, centrifuges and AAS, concept of various spectrometries and can handle them.
- Know the concepts of chromatography and concept of partition coefficient and perform various chromatographic techniques
- Explain the concept of 3D bio printing and their applications
- Students will be able to justify the need for buffers, describe how buffers are prepared, and calculate the amount of buffering agent needed when making a particular buffer

UNIT I

Light microscopy, Bright & Dark Field microscopy, Fluorescence microscopy, Phase Contrast microscopy, Electron microscopy: TEM and SEM, Atomic force microscopy and con focal scanning laser microscopy. Differential interference contrast microscopy.

UNIT II

Principle and Operations of Chromatography, Thin layer chromatography, Ion Exchange Chromatography, High Performance Liquid Chromatography (HPLC), Gas Liquid Chromatography (GLC), Gel Filtration Chromatography, Affinity Chromatography**.**

UNIT III

Electromagnetic radiation and spectrum, Atomic absorption and Atomic emission spectroscopy,Principle, working and applications of UV-VIS, NMR, ESR and IR spectrometer, Principle and applications of Mass Spectroscopy, Circular Dichorism (CD) principles, Principle and applications of Positron Emission Tomography(PET), Basics of X-Ray diffraction analysis and their application in biotechnology.

UNIT IV

Theory of Electrophoresis, Factors affecting the migration of substances Gel electrophoresis, PAGE, SDS-PAGE, Agarose Electrophoresis of Nucleic Acid, Isoelectric Focusing of Protein Pulse Gel Electrophoresis and Western Blotting. Theory of centrifugation and sedimentation. Types of centrifuges, Preparative and analytical centrifugation; Density gradient centrifugation. Application of centrifugation for preparative and analytical purpose.

UNIT V

Principles of 3-D printing, 3-D Bioprinting of tissues, organs and bacteria. Ideal material properties for bioprinting, Biosensors: Principles and definition, characteristics of Ideal biosensors, Biochemical components of biosensors: Enzyme based biocatalyst sensors, Bioaffinity systems, Immunosensors. Principle and working of Flow Cytometry and cell sorter

Text Books/Reference Books

1. Wilson, K, Walker, J., Principles and Techniques of Practical Biochemistry. 5th Ed. - Cambridge University Press,. Cambridge 1999.
2. Sabari Ghosal & Anupama Sharma Awasthi., Fundamentals of Bioanalytical Techniques and Instrumentation, PHI learning Second edition (2018)
3. Bioanalytical Techniques by A. Shourie and S S Chapadgaonkar. TERI Press. 2015
4. Immunoassay and Other Bioanalytical Techniques. Jeanette M. van Emon. CRC press. 2006
5. 3D Bioprinting in Regenerative Engineering: Principles and Applications, Ali Khademhosseini & Gulden Camci-Unal, CRC Press (2018)

MICROBIOLOGY AND IMMUNOLOGY

Course objectives:

- Introducing the microbial world with specific reference to the metabolic, physiological and morphological characteristics of microbes besides their classification, preservation & and control control of Microorganisms
- To familiarize students with the Immune system, hypersensitivity and vaccination, Immune Effector Mechanisms, hybridoma technology and various Immunotechniques and immunodiagnosis.

Course Outcomes:

- Students would be able to understand characteristics, classification and life cycles of viruses
- To elaborate on microbial nutrition and methods of determining growth curve.
- Understand immune response in our body, both innate and adaptive, to different pathogens, tissue injury and cancer.
- Understand what happens if our immune system overreact to foreign substances (hypersensitivities and allergies)
- Understand what happens if our body recognize self as non-self (autoimmunity)
- Understand the biology of different vaccines against infectious agents and cancer and solutions to produce better vaccines

UNIT I

Morphology and Ultra structure of bacterial cell, Classification of bacteria, Culture media, Isolation of microbes and its identification, culture techniques, Preservation of cultures, Methods for the control of microbes. Enumeration of bacteria. Microbial growth kinetics.

UNIT II

Basic features of transduction, conjugation and transformation, Viruses: Classification and structure of viruses, Viral reproduction: lytic and lysogenic cycle, Overview of biological nitrogen fixation, Bacterial photosynthesis and electron transport system.

UNIT III

Introduction to immune system: Innate and Adaptive immunity, Humoral and Cell mediated immune response, Cells and Molecules of the immune system, Primary and Secondary lymphoid organs, T &B cell maturation and its activation , Characteristics and types of Antigens, Haptens, adjuvants and Epitopes, Antibodies: Structure, functions and characteristics of different classes of antibodies. Monoclonal antibodies.

UNIT IV

Antigen and antibody interactions, precipitation reactions , Serological techniques: ELISA, RIA and western blotting, RT-PCR & Antigen/Antibody Tests for COVID-19, Structure and Function of MHC molecules, Exogenous and Endogenous pathways of antigen processing and presentation, Overview of Complement system and cytokines, immune tolerance.

UNIT V

Applications of microbiology and Immunology: Mirobiology of domestic water and waste water. Microbes in bioremediation, Microbes of industrial use, Immunity against: Bacterial disease- tuberculosis, typhoid, Protozoan disease- Malaria, Amebieosis and Viral diseases - AIDS, Dengue, Chikungunya, COVID-19, Vaccines, Hypersensitivity and Immunotherapy

Reference Books:

1. Microbiology by Pelczar (W C Brown publication)
2. Genral Microbiology by stainer (Mac Millan Publication)
3. Microbiology by Pawar and Dagniwala (Himalaya publishing House).
4. Immunology and immunotechnology by Ashim K. Chakravarty (Oxford university Press)
5. Immunology by C. Fatima 3. Immunology by Kuby (Free man publication)

BIOCHEMISTRY

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
- Students will have knowledge on structure and function of biomolecules like DNA and RNA in the cell, carbohydrates, lipids, enzymes and besides their importance and classification, forces stabilizing their structures, write and relate the role of them with day to day life.
- Describe the structure of proteins, including the significance of amino acid R-groups and their impact on the three-dimensional structure of proteins.
- 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

Water - Structure, unusual properties, non-covalent interactions, role in biological processes. Ionization of Water, pH scale, Weak Acids, and Weak Bases. Buffers and buffering mechanism, Henderson Hasselbalch equation. Buffering against pH Changes in Biological Systems: Phosphate buffer, Bicarbonate buffer, Protein buffer, Amino acid Buffer & Hemoglobin Buffer System.

UNIT II

Carbohydrates – classification, structure and functions of monosaccharides, disaccharides and polysaccharides. Ring structure and mutarotation, stereo isomers and structural isomers. Metabolism – Glycolysis & oxidation of Pyruvate, TCA cycle, Gluconeogenesis, Pentose Phosphate Pathway, Oxidative phosphorylation, Disorder/ diseases of carbohydrate metabolism.

UNIT III

Fats and lipids – Classification, structure and function: Simple, Compound & Derived lipids, Essential fatty acids. Fatty acid synthesis, origin of acetyl-Co A for fat synthesis, Elongation & desaturation of Fatty Acids. Activation & transport of fatty acid from cytosol to mitochondria for oxidation. Oxidation of saturated & unsaturated fatty acids. β, α, ω oxidation. Formation and utilization of ketone bodies. Disorder/ diseases of lipid metabolism.

UNIT IV

Amino acids and proteins - Classification & structure of amino acids. Essential amino acids. Peptide bond formation, Ramachandran plot, Primary, secondary, tertiary & quaternary structure of proteins. Biosynthesis of amino acids from intermediates of Citric Acid Cycle & other major pathways. Biodegradation of amino acids: Deamination, transamination. Urea Cycle, Glucose-Alanine cycle. Disorder/ diseases of amino acids metabolism.

UNIT V

Purines and pyrimidines – Structure and properties. Metabolism of Nucleotides: Purines & Pyrimidines synthesis : de Novo & salvage pathway, Conversion of nucleoside monophosphates to nucleoside triphosphates, Formation of deoxyribonucleotides. Catabolism & salvage of Purine and Pyrimidine nucleotides. Disorder of purines and pyrimidines metabolism

Text books:

1. Principles of Biochemistry: A.L. Lehninger, Nelson and Cox, McMillan Worth Publishers.
2. Harper's Biochemistry-Rober K. Murray, Daryl K. Grammer, McGraw Hill, Lange. Medical Books. 25th edition.
3. Biochemistry : S.C. Rastogi – Third Edition ; Tata McGraw Hill Education Pvt. Ltd. New Delhi**.**

Reference books:

1. Biochemistry: Stryer, W. H. Freeman
2. Biochemistry: Voet and Voet, John Wiley and Sons, Inc. USA
3. Biochemistry: Zubey, WCB.
4. Biochemistry: Garrett and Grisham, Harcourt.

ENVIRONMENTAL SCIENCE

Course Objectives:

- This course introduces students to environment concerns. Students are expected to learn about environment, factors affecting it, environmental ethics and its protection through lectures, presentations, documentaries and field visits.
- Recognize the interconnectedness of multiple factors in environmental challenges
- Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.
- Understand key concepts from economic, political, and social analysis as they pertain to the design and evaluation of environmental policies and institutions.
- Understand the transnational character of environmental problems and ways of addressing them, including interactions across local to global scales.

Course Outcomes:

- Knowledge of the environment and the role of human beings in shaping the environment
- Understand various components of the environment and interfaces
- Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.
- Apply systems concepts and methodologies to analyze and understand interactions between social and environmental processes.
- Appreciate concepts and methods from ecological and physical sciences and their application in environmental problem solving.

UNIT I

Introduction

Introduction to environment science and its scope, Indian Scenario of Natural Resources, Conservation of natural resources.

Green Chemistry

Introduction, principles of Green Chemistry, atom economy.

Environmental Laws

Environmental laws/Acts, Environment protection Act- 1986, The Water Act- 1974, The Air Act- 1981. Tribals and Forestry Act in India

UNIT II

Ecosystem

Ecosystem and its basic concept, Structure and function of an ecosystem, Food chains, food webs and Ecological Pyramids, Ecological succession.

UNIT III
Biodiversity
Biodiversity and its conservation, types of biodiversity, Hot spots and threats to biodiversity, National and global scenario, Biodiversity conservation with special reference to in-situ & ex-situ conservation, alien species, Red data book, Threatened species, IUCN(WWF)

UNIT IV
Environmental Pollution
Environmental Pollution: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution and Nuclear hazards, World environment day, World ecology day, Ozone day

UNIT V
Social Issue
Sustainable development, Environmental ethics: Issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents, Waste and reclamation.

Text/ Reference Books:

1. A Basic Course in Environmental Studies. Deswal & Deswal. Pub. Dhanpat Rai & Sons.
2. Environmental Studies. Bharucha. Pub. University ofPress
3. Ecology. Odum. Pub. Oxford &IBH
4. Environmental Engineering. Peany et.al. Pub. McGrawHill
5. A Text Book of Environmental Engineering Venugpal Rao. Pub.PHI
6. Environmental Science by Kaushik & Kaushik.

COMMUNICATION SKILLS

Course Objectives:

The objectives of this course are:

- To provide an overview of Prerequisites to Business Communication.
- To put in use the basic mechanics of Grammar.
- To provide an outline to effective Organizational Communication.
- To underline the nuances of Business communication.
- To impart the correct practices of the strategies of Effective Business writing.

Course Outcomes:

The students will be able to

- Discuss the importance of effective communication in business Effective Communication in Business
- Be effective communicators and participate in group discussions with confidence. Also be able to make presentations in a professional context.
- Write resumes, prepare and face interviews confidently.
- Make the transition smoothly from campus to corporate.
- Identify key principles of effective public speaking
- Discuss the usefulness of visual aids and identify common presentation tools.
- Create formal reports and proposals

UNIT I

Introduction to Communication: Need for effective communication, Functions of Communication and Induction to the students

The Fundamentals of Communication: Communication Cycle, Levels of communication; Flow of communication; Communication networks; General and Technical Communication.

UNIT II

Barriers to Effective Communication: Miscommunication; Noise; Types of barriers; Communication across Culture, case Studies and Overcoming measures.

Non-verbal Communication and Body Language: Forms of Non-verbal communication; Kinesics; Proxemics; Chronemics and Effective use of body language.

Grammar and Vocabulary: Tenses, Determiners, prepositions, conjunctions, Model Auxiliaries, concord, active and passive voice, Homonyms, Homophones, Acronyms (general abbreviations).

UNIT III

Presentation Skills: 4Ps (Planning, Preparation, Practice, Presentation), Outlining; Effective use of A/V aids and Modes of Delivery

Listening Skills: Hearing Vs listening, process of listening, types, Barriers to Listening, Qualities of a Good Listener and Active Vs Passive Listening

Telephone Skills : Telephonic Communication: Do's and Don'ts

UNIT IV

Speaking Skills: Introducing yourself, Describing a person, place, situation and event, Giving instruction, Making inquiries – at a bank, post-office, air-port, hospital, reservation counter and role play

Writing Skills: Basics of Writing, Paragraph Writing, Precise Writing, Memos, Advertisements, Paraphrasing and Summarizing

Study Skills: Taking/making notes from reference Materials, Comprehending and Describing-Graphs and charts

UNIT V

Letter Writing: Informal Letter,(Formal)Business Letters: Essential and Occasional Parts of a letter, layout, Characteristic and Letter of Inquiry, Complaint and Adjustments, orders and replies of it

Report Writing: Format ,Structure and Types, Technical Reports, Description and Proposal

Reading Skills: Skimming and Scanning, Intensive and Extensive Reading, Poor habits of reading and The SQ3R Method

Computer Assisted Language Learning: Effective e-mail messages and power-point presentation

Text Books/ Reference Books:

1. Muralikrishna C., Sunita Mishra "Communication Skills for Engineers" 2nd edition, Pearson, New Delhi 2010
2. Vyas Manish A., Yogesh L. Patel, "Tasks for the English Classroom", MacMillan, New Delhi, 2012.
3. Achar Deeptha, Charul Jian and et al, English for Academic Purposes,Book-1&2 University Granthnirman Board, Gujarat, 2011
4. Michael vince, 'Advanced Language Practice', Macmillan Education, oxford,2003
5. Eisenbach Iris, "English for Materials Science and Engineering", Springer Fachmedien Wiesbaden GmbH 2011
6. Lougheed Lin, "Business Correspondence: A Guide to Everyday Writing', Longman, Pearson Education, Inc,2003

TECHNIQUES IN BIOTECHNOLOGY LAB

1. Demonstration of basic techniques involved in general instrumentation or basic concept of precision and accuracy
2. Study of Beer-Lambert's law-using Colorimeter/UV-Visible spectrophotometer.
3. To study principle and working of laboratory microscope.
4. Separation of amino acids using thin layer chromatography.
5. To study and analysis of DNA sample by agarose gel electrophoresis.
6. To study and analysis of protein sample by SDS- PAGE
7. To analyze the isolated plant pigments using paper chromatography.
8. To study the separation of biological compounds using various membrane separation.

Reference book:

1. Wilson and Walker, "Principles and Techniques of Practical Biochemistry" 4 Edn., Cambridge Knew pros 1997.
2. Biotechniques: Theory & Practice: Second Edition by SVS Rana, Rustogi Publications.
3. Biochemical Methods of Analysis: Saroj Dua And Neera Garg: Narosa Publishing House, New Delhi.
4. Bioanalytical Techniques : ML Srivastava; Narosa Publishing House, New Delhi.

MICROBIOLOGY& IMMUNOLOGY LAB

1. Preparation of nutrient agar slants, plates and nutrient broth and their sterilization.
2. Isolation of microbes from soil samples and their determination.
3. Inoculation of agar slants, agar plate and nutrient broth
3. Culture of microorganisms using various techniques.
4. To determine the blood group of given blood sample.
5. To perform antigen-antibody binding studies by immune-electrophoresis.
6. To perform single radial immunodiffusion and double immunodiffusion.

Practical/ References Books

1. Lab Manual in microbiology by P Gunasekaran (New Age Int. Pub.).

BIOCHEMISTRY LAB

1. Preparation of solutions: 1)percentage solutions, 2) molar solutions, 3) normal solutions
2. Distinguish reducing and non-reducing sugars
3. Qualitative estimation of proteins
4. Estimation of abnormal constituents of urine.
5. Estimation of glucose by titration method
6. Quantitative estimation of carbohydrates
7. Separation of amino acids by chromatography
8. Agarose Gel Preparation

Reference books

1. Wilson and Walker, “Principles and Techniques of Practical Biochemistry”, 4 Edn., Cambridge Knew pros 1997.
2. Plummer DT, “An Introduction to Practical Biochemistry”, III Edn., Tata McGraw hill.

ENVIRONMENTAL SCIENCE LAB

1. Introduction to Glasswares/Equipments & Pipetting Method
2. Preparation of Buffer Solutions
3. Standardization of pH meter
4. Soil analysis: Determination of Salinity, pH, Alkalinity, Acidity
5. Water analysis: Determination of Salinity, pH, Alkalinity, Acidity
6. Determination of total solid, dissolve solid and suspended solid in an effluent

COMMUNICATION SKILL LAB

Course Objective:

- To improve the communication ability
- To enhance the general conversation skills in different socio- cultural scenario
- To strengthen their professional skills
- To expose the students to various spoken skills.

Course Outcome:

- Better pronunciation and accent
- Ability to use functional English
- Competency in analytical skills and problem solving skills

List of Experiments

1. Competency Test: Computer based Test
2. Interpersonal Communication : Ice Breakers, Jumble story
3. Listening Skill: Practice and Test
4. Reading Skill: practice and Test
5. Speaking Practice: Role Play and Communicative Activities
6. Letter Writing : Practice and Test
7. Functional Grammar Practice and Test
8. Technical Report Writing
9. E-mail Writing
10. Presentation Practice

Semester –IV

Bioprocess Engineering –I

Course Objectives:

- To provide the basic concepts and principles of bioprocess engineering.
- To give an ability to analyze fluid property and apply knowledge to estimate the heat and mass transfer.
- To give an ability to apply the knowledge of bioprocess engineering on engineering applications.

Course Outcomes:

- Understand the concept of fluid and its properties.
- Understanding the flow of fluid and analyzing the dimensions of quantities.
- Explaining the modes of heat transfer through various state of matter.
- Explaining the mode of mass transfer through various state of matter.
- Relate the skill of mass transfer and its application

Unit I:

Fluid Properties: Viscosity, Newton's Law of viscosity, Kinematic Viscosity, Rheological Diagram, Euler Equation and its application, Derivation of Bernoulli Equation from Euler Equation, Applications of Bernoulli's Theorem, Pascal's Law, Hydrostatic Law. Measurement of Pressure: Definition of Gauge and & Absolute Pressure, Barometer, Various Manometers (Peizometer, U-tube manometer, Single column manometers, U-tube & Inverted U-tube differential manometers) & their industrial applications. (10)

Unit II:

Flow Measuring Equipment: Head Flow Meters, Nozzel Meter, Orifice Meter, Venturi Meter, Area Flow Meters, Rotameter, Pitot Tube & Applications of these equipments. Pipe fittings, major and minor losses in pipe flow, Calculation of Pressure Drop in a Pipe, Equivalent Length & 'K' factor, Methods of finding dimensional numbers - methods of governing equations, Method of force ratios and Buckingham's π method. Reciprocating pump & its applications. Centrifugal Pumps and its applications. (10)

Unit III:

Conduction and Convection Introduction. Basic concepts of conduction in solids, liquids and gases, One and two dimensional heat conduction. Critical and optimum insulation thickness. Introduction to unsteady state heat transfer. Principles of convection, Equations of forced and free convection, Heat flow due to conduction & convection .Radiation: Basic laws of heat transfer by radiation, black body and gray body concepts, solar radiations, combined heat transfer coefficients by convection and radiation. Heat Transfer Equipments: Double pipe, Shell & tube and Plate type heat exchanger, Evaporator, Condenser (8)

Unit IV :
Diffusion: Fick's Law, steady state diffusion: Rectangular, cylindrical, spherical (1-D); diffusion with reaction, both at surfaces, and in the bulk medium.Transient conduction and diffusion: Basics of Fourier analysis, unsteady state conduction and diffusion (1-D), transient conduction/diffusion with generation/reaction.(6)

Unit V :
Mass transfer coefficients, Mass transfer in fluidized bed reactor, flow past solids and boundary layers, Simultaneous heat and mass transfer system .Mass transport in Biomedical and Biological Engineering: Haemodialysis, Diffusion and uptake of ligands by cells, oxygen transport in tissue and capillaries.(6)

Reference/Recommended Books:
1. Introduction of Fluid Mechanics by Robert W.Fox and Slan T. McDonald, John willey & sons, Ny. 4^{TH} Ed.
2. Unit Operation in Chemical Engg., McCabe Smith Vth Ed.
3. Foust A. S. et.al., "Principles of Unit Operations" John Wiley (1980)
4. Holman, J.P.: "Heat Transfer" 9 th ed. McGraw Hill (1989).
5. Treybal, R "Mass Transfer Operations", 3rd ed. New York: McGraw-Hill, (1980).

GENETICS & MOLECULAR BIOLOGY

Course Objectives:

- To strengthen the Mendelian principles along with other molecular genetics topics like recombination, pedigree analysis, transposons.
- To gain knowledge of DNA replication and regulation in prokaryotes and eukaryotes
- To learn transcription & translation in prokaryotes and eukaryotes & their regulation
- Post transcriptional and translational mechanism

Course Outcomes:

- 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.
- Learn and understand the important discoveries that are made in the field of molecular biology.
- Understand the detailed structure of the double helical nature of DNA as proposed by scientists like Watson and Crick.
- To learn different levels of organizations that regulate the condensation of DNA that leads to the compact metaphase chromosome.
- To learn key molecular events that occur during the transcription and translation processes that leads the protein synthesis from specific genes.

UNIT I

Fundamental principles of genetics, gene interaction, multiple alleles, complementation, linkage, recombination and linkage mapping, extra-chromosomal inheritance, chromosomes basis of heredity, Sex determination, sex linked, sex limited and sex, influenced inheritance.

UNIT II

Genome organization: Genome organization in prokaryotes and eukaryotes - special features of eukaryotic gene structure and organization, genome organization in mitochondria and chloroplast, DNA content and C-value paradox. Methods to measure DNA content variation - Various types of DNA sequences (simple sequences, repetitive sequences, nonsense sequences, tandem gene clusters, satellites)

UNIT III

Gene structure, DNA & RNA as a genetic material, packaging of DNA as chromosome, central dogma of molecular biology, DNA replication, DNA repair. Linkage and recombination, crossing over and genetic mapping, gene mapping by two point and three point test crosses, Cell cycle regulation and apoptosis.

UNIT IV

Genetic mutation, micro-deletion, Genetic syndrome, Techniques to detect mutation, Transcription in prokaryotes and eukaryotes, genetic code, reverse transcription, mRNA processing. Role of sigma factor in transcription, role of promoters and enhancers, mechanism and regulation of transcription in prokaryotes and eukaryotes.

UNIT V

DNA replication process in prokaryotes & Eukaryotes, Activity of DNA polymerases and topoisomerases, Reverse transcriptase, Translation in prokaryotes and eukaryotes Basic principles of gene cloning and r-DNA technology, genetic code, properties of genetic code, wobble hypothesis, Molecular chaperones

Text books:

1. Genetics a conceptual approach, 2nd Edition Benjamin A. Pierc WH freeman and, company, New York.
2. Benjamin Levin – Genes VIII, 8 th ed.

Reference books:

1. Albert B, Bray Denis et al.: Molecular Biology of The Cell, latest ed.
2. Watson, Hopkins, Roberts et al.: Molecular Biology of the Gene, 4 th ed.
3. Genetics- Strickberger, 2nd.
4. Baltimore- Molecular Biology of the Cell.
Cell & Molecular Biology 8th edition by De Robertis, LWW Publisher (Wolters Kluwer)

ENZYME ENGINEERING

Course Objectives:

- To provide a detailed knowledge about enzymes, their chemical nature, kinetics, classifications, factors affecting the coenzymes and cofactors, velocity affecting velocity of enzymes, theories of enzyme action, enzyme regulation, inhibitions, isolation, purification & characterization of of enzymes, immobilisation of enzymes
- Differentiate between equilibrium and steady state kinetics and analyzed simple kinetic data and estimatee important parameter (Km. Vmax, Kcat etc).

Course Outcomes:

- Introduce the term “enzyme” , history and classification
- Learn about proteinaceous and non proteinaceous enzymes, their purification
- Learn about enzyme catalysis, Michaelis-Menton's constant.
- Familiarise on mechanism of enzyme action-theories of enzyme action.
- Learn how to define velocity/enzyme activity/rate of a reaction and specific activity
- Familiarise on factors affecting enzyme activity & enzyme Inhibitions
- Acquire knowledge about techniques & application of immobilized enzymes
- Learn about enzyme based biosensors & bioreactors with their applications in industry & healthcare

UNIT I

Introduction to enzymes: Holoenzyme, apoenzyme, prosthetic group. Interaction between enzyme and substrate-lock and key model, induced fit model. Features of active site, activation energy, enzyme specificity and types. IUB system of classification and nomenclature of enzymes. Kinetics of single substrate reactions; Derivation of Michaelis -Menten equation, turnover number; determination of Km and Vmax (LB plot, ED plot), Importance of Km & Vmax; Numerical related to enzyme kinetics, Multi-Substrate reaction mechanisms.

UNIT II

Factors affecting the velocity of enzyme catalyzed reaction- enzyme concentration, temperature, pH, substrate concentration, inhibitors and activators. Enzyme inhibition: irreversible; reversible (competitive, uncompetitive and non competitive inhibition); Substrate and Product inhibition, Allosteric regulation of enzymes, concerted & sequential model; Deactivation Kinetics.

UNIT III

Extraction of crude enzyme from plant, animal and microbial source; some case study. Purification of enzymes by the help of different methods. Methods of characterization of enzymes; criteria of purity. Unit of enzyme activity - definition and importance. Development of enzyme assays.

UNIT IV

Enzyme Immobilization: Adsorption, Matrix entrapment, Encapsulation, Cross linking, Covalent binding and their examples; Advantages and disadvantages of different immobilization techniques. Structure & stability of immobilized enzymes, kinetic properties of immobilized enzymes- partition effect, diffusion effect. Overview of applications of immobilized enzyme systems.

UNIT V

Enzyme Biosensors: elements of biosensors, three generations of biosensors, Types of biosensors: calorimetric, potentiometric, amperometric, optical and piezoelectric. Design of enzyme electrodes and their applications as biosensors in industry, health care and environment. Design of Immobilized Enzyme Reactors- Stirred tank reactors(STR), Continuous Flow Stirred Tank Reactors (CSTR), Packed- bed reactors (PBR), Fluidized-bed Reactors (FBR); Membrane reactors.

Text books:

1. Fundamentals of enzymology by Nicolas C. price and Lewis stevens. Oxford University Press
2. Enzymes by Trevor palmer, East west Press
3. Enzyme Technology by Messing

Reference books:

1. Enzymes: Dixon and Webb. (IRL Press)
2. Enzyme technology by Chaplin and Bucke. Cambridge Univerity Press
3. Biochemical engineering fundamentals, second edition. James E Bailey, David F., Ollis, McGraw Hill Intl. Edition

ANIMAL BIOTECHNOLOGY

Course Objectives:

- To make students aware of various tissue culture techniques and their application in biotechnology for commercial purpose and to acquaint students with applications of genetic engineering like transgenic animals.
- The course will provide complete exposure as how animal cells are isolated, cultured and genetically manipulated in laboratory.
- Also the course will provide information how cell suspension cultures can be utilized for molecular farming for commercially synthesizing products such as vaccines, hormones, proteins, enzymes, etc.

Course Outcomes:

- Understand principles of animal culture, media preparation and can explain *in vitro* fertilization and embryo transfer technology.
- Students will have an insight in applications or recombinant DNA technology in production of therapeutic proteins and can describe commercial production of drugs, vaccines, enzymes and can apply them in research work.
- Know how transgenic animals, cryopreservation, apoptosis, animal cloning, cell transformation, DNA microinjection, production of vaccines is done.
- Isolate genomic and plasmid DNA from cells.
- Students can purify proteins of interest from animal cell samples and perform assay of DNA or protein samples for their concentration and purity

Unit I

Basic cell culture techniques, Types of cell culture media; Ingredients of media; Physiochemical properties; CO_2 and bicarbonates; Buffering; Oxygen; Osmolarity; Temperature; Surface tension and foaming; Balance salt solutions; Antibiotics growth supplements; Types of Primary Culture.

Unit II

Cell line development; Characterization and Maintenance of cell lines. Common cell culture contaminants. Cryopreservation of cell lines. Expressing cloned proteins in animal cells. Over-production and processing of chosen proteins: the need to express in animal cells

Unit III

Application of animal cell culture for *in vitro* testing of drugs; Testing of toxicity of environmental pollutants in cell culture; Application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins. Cell culture products.

Unit IV

Cell culture reactors; Scale-up in suspension; Scale and complexity; Mixing and aeration; Rotating chambers; Perfused suspension cultures; Fluidized bed reactors for suspension culture; Scale-up in monolayers; Multisurface propagators; Multiarray disks, spirals and tubes; Roller culture; Microcarriers; Perfused monolayer cultures;

Unit V

In-vitro fertilization and Embryo transfer: In-vitro fertilization in humans; Selection of sperm, Selection of Ova, Super ovulation strategy; embryo transfer; Artificial insemination Application of Embryo transfer technology, Biotechnology in fertility control

Texts/Reference Books:

1. B. Hafez and E.S.E Hafez, Reproduction in farm animals, 7th Edition, Wiley Blackwell, 2000
2. G.E. Seidel, Jr. and S.M. Seidel, Training manual for embryo transfer in cattle (FAO Animal Production and Health Paper-77), 1st Edition, W.D. Hoard and sons FAO, 1991
3. I. Gordon, Laboratory production of cattle embryos, 2nd edition, CAB International, 2003.
4. Louis-Marie Houdebine, Transgenic Animals: Generation and Use 5th Edition, CRC Press, 1997.
5. R . Ion Freshney : Culture of Animal cell ; 6th edition 2010' Wiley –Blackwell.
6. John R.W. Masters, Animal Cell Culture: A Practical Approach 3rd edition, 2000.

INDUSTRIAL SOCIOLOGY

Course Objective

The objectives of this course are:

- To enable potential managers to understand the influence of the wider societal context on the operations within their organizations
- to provide you with an understanding of the ways in which the process of industrialization has shaped societies
- to foster the development of the following skills: comprehension; application; analysis; and synthesis of information.
- To understand the nature of relations among workers, and between workers and management.

Course Outcome

The students will be able to

- To understand work and industry
- To understand the Problems faced by Labour in Organized and Unorganized Sector.

Unit	Topic
I	Industrial Sociology: Nature, Scope and Importance of Industrial Sociology. Social Relations in Industry, Social Organisation in Industry- Bureaucracy, Scientific Management and Human Relations. .
II	Rise and Development of Industry: Early Industrialism – Types of Productive Systems – The Manorial or Feudal system. The Guild system, The domestic or putting-out system, and the Factory system. Characteristics of the factory system. Causes and Consequences of industrialization. Obstacles to and Limitations of
III	Industrialization in India. Industrial Policy Resolution- 1956.Science. Technology and Innovation Policy of India 2013.
IV	Contemporary Issues: Grievances and Grievance handling Procedure. Industrial Disputes: causes, Strikes and Lockouts. Preventive Machinery of Industrial Disputes: Schemes of Workers Participation in Management- Works Committee, Collective Bargaining, Bi-partite & Tri-partite Agreement, Code of Discipline, Standing Orders. Labour courts & Industrial Tribunals.
V	Visualizing the future: Models of industrialization- Collectivist, anarchist, free market, environmentalist, etc. Cultural issues, consumer society and sociological concerns.

Bioprocess Engineering Lab-I

1. To find the thermal conductivity of liquid / gases
2. To determine the local velocity pressure with the help of pilot tube
3. To find out the thermal conductivities of Metal rod
4. To study the characteristics of a centrifugal pump.
5. To determine the viscosity of a given viscous liquid by capillary tube flow method.
6. To differentiate between laminar and turbulent flow using Reynolds experiment.
7. To determine velocity through orifice meter, venture meter
8. To determine the overall heat transfer coefficient in Parallel flow heat exchanger/counter flow heat exchanger
9. To determine the drying characteristics of given sample
10. To determine the minimum fluidization velocity in a fluidized bed and verify experimentally

GENETICS & MOLECULAR BIOLOGY LAB

1. How to calculate genetics and allelic frequencies numeric problem analysis.
2. Isolation of Plasmid DNA
3. Isolation of Plant DNA
4. Estimation of DNA content in the given sample by spectrophotometer
5. Determination of Tm of DNA.
6. Isolation of bacterial genomic DNA.
7. Purification of DNA through Electrophoresis & visualization under UV transilluminator.
8. Polyacrylamide gel electrophoresis of DNA.
9. PCR amplification of DNA and visualization by gel electrophoresis.
10. Isolation and study of polytene chromosome in Drosophila.

ENZYME ENGINEERING LAB

1. Production of commercially important enzymes from microbial sources.
2. Isolation of alpha amylase from plant source
3. Determination of enzyme activity and specific activity.
4. Partial purification of isolated enzymes.
5. Method of checking the purity of the enzyme -SDS-PAGE
6. Characterization of enzymes-effect of pH , temperature and inhibitors on enzyme activity etc.
7. Identification of Enzyme by different assay
8. Purification of enzymes by different methods

Reference books

5. “An Introduction to Practical Enzyme Engineering”, Tata McGraw-Hill.
6. R. Eisenthal and M.J. Dansen, “Enzyme Assays –A Practical Approach”, IRL Press, Oxford University Press, Oxford, 1993

ANIMAL BIOTECHNOLOGY LAB

1. Introduction to media, other relevant reagents and equipments required for various cell lines.
2. Basic and sophisticated methods of handling animal cells in culture.
3. Freezing and reviving the cell lines and maintaining them in culture.
4. Extraction of culture and preparing the samples for DNA/RNA/PROTEIN.
5. Staining of animal cells and counting in microscope.

FACULTY OF ENGINEERING & TECHNOLOGY

KHWAJA MOINUDDIN CHISHTI LANGUAGE UNIVERSITY, LUCKNOW, UTTAR PRADESH

B.TECH. BIOTECHNOLOGY

Curriculum Structure

THIRD YEAR

(V & VI Semesters)

SEMESTER- V

GENETIC ENGINEERING

Course Objectives:

The course has been designed to make students aware of

- DNA manipulative enzymes and Gene cloning vectors
- Screening and selection of recombinants & Application of r-DNA techniques
- Techniques used as Polymerase chain reaction (PCR), Site directed mutagenesis (SDM), Nucleic acid sequencing

Course Outcomes:

- Get proper knowledge about the DNA manipulative enzymes: Restriction enzymes and DNA ligases, and Gene cloning vectors.
- Gain knowledge about In vitro construction of recombinant DNA molecules, passenger and vector DNA, and Transformation & Gene expression in prokaryotes & eukaryotes
- Learn about the basics of Polymerase chain reaction (PCR), Site directed mutagenesis (SDM), molecular markers, Nucleic acid sequencing: Blotting techniques.
- Knowledge of Application of r-DNA technique in human health, Production of Insulin, Production of recombinant vaccines: Hepatitis B, Production of human growth hormone.

Unit I

Gene cloning- concept and basic steps; Restriction modification enzymes used in recombinant DNA technology, endonucleases, ligases and other enzymes useful in gene cloning; Vectors: plasmid, bacteriophage and other viral vectors, cosmids, artificial chromosomes, yeast artificial chromosome, Bacterial Artificial Chromosome, Ti plasmid, shuttle vectors, expression vectors; DNA delivery methods; Construction of genomic and cDNA libraries; Techniques for selection, screening and characterization of transformants (hybridization based techniques, expression & interaction based techniques).

Unit II

Concept of PCR; DNA polymerases; primer designing, linkers, adapters, setting up PCR reactions; Various types of PCR; Applications of PCR in disease diagnostics, forensic sciences and genetic engineering.

Unit III

Gene expression in prokaryotes & eukaryotes, Tissue specific promoter, wound inducible promoters, Strong and regulatable promoters, promoter analysis (EMSA and DNA footprinting), gene expression profiling (real time PCR, SAGE, differential display, Microarray); DNA sequencing methods; Molecular markers: RAPD, RFLP, AFLP, SNP; Site directed mutagenesis, gene silencing techniques.

Unit IV

Applications of genetic engineering; Creation of recombinant microorganisms, transgenic plants and animals; cloning of sheep (Dolly) & other mammals; applications in conservation; therapeutic vs. reproductive cloning; ethical issues and the prospects for human cloning; Gene therapy; DNA drugs and vaccines.

Unit V

Basic concepts of cell signaling, Extracellular signal molecule and their receptors, Operation of Signaling molecules over various distances, Cellular response to specific combinations of extracellular signal molecules; Nuclear receptor; Ion channel linked, G-protein mediated receptors, Relay of signal by activated cell surface receptors via intracellular signaling proteins, Intracellular Signaling proteins as molecular switches.

Text Books/Reference Books

1. T.A Brown (2006). Gene cloning and DNA analysis, WILEY-BLACKWELL
2. Genetic Engineering by Dr Smita Rastogi & Dr Neelak Pathak, Oxford University Press
3. S.B Primrose (2001). Molecular biotechnology. Panima Publishing corporation, 2nd edition
4. Molecular Cloning, A laboratory Manual. Sambrook, J., Fritsch, E.F., Mariatis.3rd edition
5. Genetic Engineering, Priciples & Practice by Sandhya Mitra, McGraw Hill Educat

FERMENTATION BIOTECHNOLOGY

Course objectives:

- Understand the basic skills applied in fermentation biotechnology and use of biological resources as input to biobased processes which are economically and environmentally sustainable
- To give an insight and advanced learning of application of fermentation technology in research development in various field.

Course outcomes:

- Learn the history of fermentation process, types of fermentation, examples of fermentation industry and production of primary and secondary metabolites.
- Describe how fermentation biotechnology is used to understand and protect the environment, treat sewage and understand the concept of biodegradation, bioremediation and biotransformation, Domestic waste water treatment.
- Know about different fermenters, isolation of industrially important microbes and their screening, production of cheese, and study quality assurance in food and pharmaceutical industry.
- Familiarize with microbial analysis of industrial production of food viz. cheese, bread etc., antibiotics, enzymes and biopharmaceuticals so that students can perform these things while they go to any industry further.
- Gain knowledge about industrial awareness on quality control and good practices in manufacturing processes in industry.

Unit I

Introduction to fermentation technology: Interaction between Bio-chemical engineering, Microbiology and Biochemistry. History and development of fermentation industry: Introduction to submerged and solid state fermentation, Microbial culture selection for fermentation processes. Primary and Secondary metabolites.

Unit II

Raw material availability, quality, processes and pretreatment of raw materials. Major alcoholic raw materials. Applications of the nonconventional raw materials (cellulosic material and hydrocarbons).

Unit III

Different regulatory mechanisms involved in controlling the catabolic and anabolic processes of microbes. Induction, nutritional repression, carbon catabolite repression, crabtree effect, feedback inhibition and feedback repression.

Unit IV

Creation/procedures for developing mutants of the desired microbes with the stable capacity of producing desired metabolites. Isolation and preservation of different types of mutants induction resistant, feedback inhibition resistant. Concept for over production of primary and secondary metabolites.

Unit V

Details of the process, parameters and materials -for the industrial manufacture of Antibiotics (β-lactum), Solvents (acetone) Amino acid (Lysine), Organic acids (Citric acid), Alcohols (Ethanol), Ind. Enzymes (Protease/Amylase) and Biopharmaceuticals (Insulin/Interferon etc.)- Microbial Transformations, Microbial leaching.

Text Books/Reference Books

1. Murray Moo -Young , Comprehensive Biotechnology, Vol. 1 & III-latest ed.
2. Microbes & Fermentation, A. Lel and Kotlers Richard J. Mickey, Oriffin Publication
3. Industrial Fermentations- Leland, N. Y. Chemical Publishers.
4. Prescott and Dunn's- Industrial Microbiology, 4 th, ed.
5. Biotechnology Series, Rehm, Reed & Weinheim, Verlag-Chemie.
6. Biochemical Engg., Aiba, Humphrey & Miller, Academic Press.
7.Fermentations & Enzyme technology,Wang & Humphrey, Wiley & Inter Scienceiotechnology

BIOINFORMATICS-I

Course objectives:

- To introduce to the field of bioinformatics via an array of publically available tools and resources.
- To study and deduce the molecular characterization of human genome.
- To study the techniques involved in structural and functional proteomics.
- To utilize the bioinformatic tools to design and development of novel drugs.

Course outcomes:

- Students should be able to apply basic bioinformatics tools for the studies and research in other areas of their biotechnology and microbiology programs, such as finding gene/protein homologs, designing primers, identifying mutations, etc.
- Commemorating the molecular techniques involved in characterization of genomes and proteomes
- Recognizing and interpret the techniques involved in genomics, proteomics, bioinformatics
- Administering the principles of genomics, proteomics, bioinformatics to discovery novel drug development
- Analyzing the molecular markers and its applications.

Unit I

Introduction to Bioinformatics; Biological databases: Nucleotide databases, Protein databases, Specialized databases; Laboratory data submission and data retrieval; Various file formats for biomolecular sequences: Genbank, EMBL, Fasta, GCG, msf, nbrf-pir etc.; Basic concepts of sequence similarity: identity and homology, definitions of homologues, orthologues, paralogues; Sequence patterns and profiles: Basic concept and definition of sequence patterns, motifs, domains and profiles; various types of pattern representations viz. consensus, regular expression (prosite-type) and profiles.

Unit II

Sequence Alignment: Pairwise sequence alignments: Dot matrix for sequence alignment, Dynamic programming for Local and Global alignment; Multiple sequence alignment: progressive method and Iterative method; Applications of pairwise and multiple sequence alignment; Tools for multiple sequence alignment: CLUSTALW and Pileup (Algorithmic concepts).

Unit III

Scoring Matrics: Basic concept of a scoring matrix, Similarity and distance matrix, Substitution matrices: Matrices for nucleic acid and proteins sequences, PAM and BLOSUM series, principles based on which these matrices are derived; Sequence-based database searches: Need of sequence based database search, BLAST and FASTA algorithms, Various versions of basic BLAST and FASTA, Advance version of BLAST: PHI-BLAST and profile-based database searches using PSIBLAST.

Unit IV

Phylogenetics: Phylogeny and concepts in molecular evolution; nature of data used in taxonomy and phylogeny; definition and description of Phylogenetic trees and various types of trees; Different methods of Phylogenetic tree construction: UPGMA and Fitch-Margoliash Algorithm; case studies in phylogenetic sequence analysis.

Unit V

Protein structure prediction: Secondary structure prediction (Statistical method: Chou Fasman and GOR method, Neural Network and Nearest neighbor method) and Tertiary structures prediction (Homology Modeling); Structure visualization methods (RASMOL, CHIME etc.); Protein Structure alignment and analysis. Application of bioinformatics in drug discovery and drug designing.

Text Books/Reference Books

1. D.W.Mount; Bioinformatics- Sequence and genome analysis; Cold Spring Harbour Labpress.
2. B.N.Mishra; Bioinformatics: Concept and application, Pearson Education
3. O' Reilly; Developing Bioinformatics computer skills-1st Indian edition, SPDpublication.
4. Westhead, P; instant notes in bioinformatics; viva publications.
5. Stephen Misner & Stephen Kraeetz;bioinformatics-Methods and protocols,Humana press.
6. Hooman H Rasid; Bioinformatics basics-Application in biol. sci.& medicine; CRC press.

METABOLIC ENGINEERING

Course objectives:

The course is designed to understand the metabolic pathways, their energetic and regulatory mechanism inside the cell.

Course outcomes:

- Students should be able to understand and depict the metabolic pathways of glucose including glycolysis, gluconeogenesis, citric acid cycle, ETC, ATP synthesis, and photosynthesis and pentose phosphate pathway and metabolism of Fatty Acids.
- Energetics and Regulatory aspects of these pathways will be analysed.
- Various physiological and pathological aspects of by products (metabolites) of metabolic pathways and their regulations and relate with various industrial processes
- Familiarise with signal transduction & protein targetting

UNIT I
Concept of metabolism, anabolism & catabolism, General Principles of Intermediary Metabolism, Regulation of Pathways, Strategies for Pathway Analysis.

UNIT II
Glycolysis: Electron and ATP Tracking, Regulation of glycolysis; Gluconeogenesis: Reaction basis, Regulation of gluconeogenesis; Pentose Phosphate Pathway: Control of Pentose Phosphate Pathway. The Tricarboxylic Acid Cycle: Discovery of the TCA Cycle, Steps in the TCA Cycle, Stereochemical Aspects of TCA Cycle Reactions, Regulation of TCA Cycle Activity.

UNIT III
Electron Transport and Oxidative Phosphorylation : The Mitochondria Electron - Transport Chain, Oxidative Phosphorylation, Transport of Substrates, Pi, ADP and ATP into and out of Mitochondria, Electron Transport and ATP Synthesis in Bacteria.

UNIT IV
Photosynthetic Processes Involving Light: Photosynthesis, Other Biochemical Processes Involving Light. Metabolism of Fatty Acids: Fatty Acid Degradation, Biosynthesis of Saturated Fatty Acids, Regulation of Fatty Acid Metabolism.

UNIT V
Metabolic Organization and Regulation of metabolism, Signal Transduction, Regulation of Metabolism for the production of Primary and Secondary Metabolites with Case studies, Plasma Membrane: Structure and Transport, Protein Targeting

Reference Book:

1. Wang D. I. C., Cooney C. L., Demain A. L., Dunnil P., Humphrey A. E., Lilly M. D., Fermentation and Enzyme Technology, John Wiles and Sons., 1980.
2. Stanbury P. F. and Whitaker A., Principles of Fermentation Technology, Pergamon Press, 1984.
3. Zubay G., Biochemistry, Macmillan Publishers, 1989.
4. Metabolic engineering edited by Sang Yup Lee and Eleftherious T. Papoutsakis
5. Metabolic engineering - Principles and Mehodologies by Gregory N. stephanopoulos, Aristos A. Ariostidou and Jens Nielsen.

INDUSTRIAL MANAGEMENT

Course Objectives:

The objectives of this course are:

- To help the students gain understanding of the functions and responsibilities of managers.
- To provide them tools and techniques to be used in the performance of the managerial job.
- To enable them to analyze and understand the environment of the organization.
- To help the students to develop cognizance of the importance of management principles.

Course Outcomes:

- The students will be able to
- Understand the concepts related to Business.
- Demonstrate the roles, skills and functions of management.
- Analyze effective application of PPM knowledge to diagnose and solve organizational problems and develop optimal managerial decisions.
- Understand the complexities associated with management of human

Unit	Topic
I	Introduction: Concept, Development, application and scope of Industrial. Management. Productivity: Definition, measurement, productivity index, types of production system, Industrial Ownership. .
II	Management Function: Principle of Management – Time and motion study, work simplification – process charts and flow diagrams, Production Planning.
III	Inventory Control: Inventory, Cost, Deterministic Models, Introduction to supply chainmanagement.
IV	Quality Control: Process control, SQC, Control charts, Single, Double and Sequential Sampling, Introduction to TQM.
V	Social Relations in Industry, Social Organization in Industry- Bureaucracy, Scientific Management and Human Relations, Early Industrialism – Types of Productive Systems – The Manorial or Feudal system. The Guild system, The domestic or putting-out system,and the Factory system. Characteristics of the factory system. Causes and Consequences of industrialization. Obstacles to and Limitations of Industrialization.

GENETIC ENGINEERING LAB

1. Estimation of DNA by diphenylamine reaction
2. Determination of RNA by orcinol method
3. To isolate plant DNA using CTAB.
4. Elution of plant DNA fragment from agarose gel
5. To perform restriction digestion of λ DNA
6. Dephosphorylation of restriction enzyme digested vector pUC18.
7. To make bacterial cells competent for transformation
8. To perform of transformation of the desired bacterial strain with plasmid DNA
9. SDS-PAGE of proteins under reducing conditions (SDS-PAGE)
10. To perform Southern Hybridization
11. To perform ligation of λ *EcoR*I digest using T_4 DNA *ligase*

FERMENTATION BIOTECHNOLOGY LAB

1. Fermentative production of Ethanol using *Saccharomyces cerevisiae.*
2. To study the induction effect of β-galactosidase enzyme in *E.coli.*
3. Upstream and Downstream of bioprocess for the production of Citric acid by *Aspergillus niger*
4. Fermentative production of Penicillin Antibiotics using *Penicilium chrysogenum.*
5. Microbial production of enzymes by (a) solid state and (b) submerged fermentation.
6. Wine Fermentation.
7. Microbial production of Biopolymer using suitable Strain.

BIOINFORMATICS-I LAB

1. Get five nucleotide and five protein sequences in FASTA format from NCBI and EMBL.
2. To find out five similar sequences for any nucleotide and protein query sequence using BLAST and FASTA.
3. Access and use of different online nucleotide and protein alignment tools (Pairwise and Multiple sequence alignment).
4. Genes and Exons identification related search for a given genome sequence in order to predict the gene.
5. ORF prediction in the given nucleotide sequence.
6. Secondary structure prediction for given amino acid sequences of a given protein using Chou Fasman, GOR method and Neural Network method.
7. Visualize tertiary structure of any given protein sequence.
8. Carry out the alignment of genomes of given organisms.
9. Predict the homology model of any protein sequence.

Text/ References Books

1. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Andreas D. Baxevanis
2. Structural Bioinformatics by Philip E Bourne, John Wiley & Sons
3. Analytical Tools for DNA, Genes & Genomes: by Arseni Markoff, New Age.

METABOLIC ENGINEERING LAB

1. Molecular techniques to enhance the product yield
2. Generalized knowledge on the principles and regulation of metabolic pathways
3. Processes for ATP synthesis & utilization
4. Analyze different methods to obtain improved production strains
5. Various methods to synthesize primary and secondary metabolites

SEMESTER- VI

BIOPROCESS ENGINEERING II

Course objectives:

- To learn the concepts of screening, optimization and maintenance of cultures and to introduce the students to the various concepts of microbial growth kinetics, fermentation and bioprocess engineering.
- To understand the basics of fermentation techniques and to enable the students to learn about the design of fermenters.
- To know about the principals involved in transport mechanisms and techniques involved in Upstream and downstream bioprocessing.

Course outcomes:

- Recognizing the basic principles of bioprocess technology and different types of fermenters
- Understanding the different processes involved in bioprocess technology
- Integrating scientific and technological knowledge on the use of bioprocesses for industrial products on the cell and process level
- Developing and assessing the conditions for efficient and sustainable design of bioprocesses.

Unit I

Media Preparation, Media design and optimization. Microbial growth patterns and kinetics in batch culture, Microbial growth parameters, Environmental conditions affect growth kinetics, Kinetics of thermal death of microorganisms, Heat Generation by microbial growth, Quantitative analysis of microbial growth by direct & indirect methods.

Unit II

Sterilization: concept and methods. Type of Sterilizations, Batch heat sterilization of liquids, Estimation of sterilizer efficiency, Continuous heat sterilization of liquids, Sterilization of air: Methods &Mechanism, Design of depth filter and estimation of its efficiency. Stoichiometric calculations, Theoretical prediction of yield coefficients, Stoichiometry of growth and product formation, Maximum possible yield, Theoretical oxygen demand, Stoichiometry of single-cell protein synthesis.

Unit III

Ideal Reactor Operation: Batch, Fed Batch & Continuous operation of mixed bioreactors, Microbial pellet formation, Kinetics and dynamics of pallet formation. Chemostate with immobilized cells, Chemostate with cell recycle, substrate utilization and product formation in bioreactor, Scale up of Bioreactors

Unit IV

Role of diffusion in Bioprocessing, Convective mass transfer, Gas-liquid mass transfer, Oxygen uptake in cell cultures, Factor affecting cellular oxygen demand, Oxygen transfer in bioreactors, Measurement of volumetric oxygen transfer coefficient, Oxygen transfer in large bioreactor.

Unit V

Bioreactor control mechanism, Physical, Chemical and Biological environment of bioreactor, Manual control system, Role of physical, chemical & biological sensors, Advanced control strategies viz. PID controllers, Fuzzy logic based controllers and artificial neural network based Controllers. Basic concepts of computer modeling and optimization in bioprocess applications.

Text Books and Reference Books

1. Bioprocess Engineering Principles – P. M. Doran, 5th ed.
2. Biochemical Engg. Bailly & Ollis, Academic Press
3. Biochemical & Biological Engg. Science, N. Blakebraugh, Academic Press
4. 7."Principles of fermentation technology" by P F Stanbury and A Whitaker, Pergamon press.
5. "Bioprocess Technology - Kinetics & Reactors" by A Moser, Springer-Verlag.
6. "Biochemical Engineering and Biotechnology Handbook" by B. Atkinson & F. Mavituna, 2nd Ed.Stockton Press.
7. Bioreactors in Biotechnology: A Practical approach by Scragg

PLANT BIOTECHNOLOGY

Course objectives:

- To make students aware of various tissue culture techniques and their application in biotechnology for commercial purpose and to acquaint students with applications of genetic engineering like transgenic plants
- Provide complete exposure as how plant and animal cells are isolated, cultured and genetically manipulated in laboratory
- Have an understanding about plant secondary metabolites and its applications

Course outcomes:

- Understand principles of plant culture, media preparation and can explain *in vitro* fertilization and embryo transfer technology, meristem culture and clonal propagation of plants
- Students can give specific examples of agricultural and horticultural biotechnology applications, including genetically modified organism (GMO) crops, hydroponics, and plant-made pharmaceuticals
- Students can purify proteins of interest from plant samples and perform assay of DNA or protein samples for their concentration and purity
- Students describe the role that *Agrobacterium tumefaciens* plays in producing genetically modified plant crops will know the methods used to produce transgenic plants, and explain the selection processes for identifying transformed plant cells
- Appreciate the plethora of plant secondary metabolites and its benefits

UNIT-I

Introductory history of plant biotechnology: Laboratory organization; Principles of Plant Tissue Culture. Concepts of totipotency, competency, determinism, explants, inoculums, Acclimatization.. Nutrition of plant cells; Nutrient media: Composition of commonly used nutrient culture media with respect to their contents like inorganic chemicals, organic constituents. An appraisal of different media, selection of media, Sterilisation of the media. Hormones: Auxins, cytokinins, Gibberellins, Abscisic Acid, ethylene etc. Explant preparation and Surface sterilization. Basic procedure for Aseptic Tissue transfer.

UNIT-II

Culture of plant materials- explants selection and technique of culturing. Organogenesis, Embryogenesis, Somaclonol variation, germiclonal variation Establishment, growth and maintenance of Callus and cell suspension culture, Methods of sub culturing and transfer of regenerated plants to the field. Tissue and organ culture; Cellular differentiation and regulation of morphogenesis;. Somatic embryogenesis; Control of organogenesis and embryogenesis; Single cell culture

Unit III

Haploid production -Androgenesis; Anther and microspore culture; Gynogenesis; Embryo culture and rescue in agricultural and horticultural corps; Protoplast isolation; Culture–regeneration; Somatic hybrid-cybrids; *In vitro* selection of mutants – mutants for salts, disease, cold, drought, herbicide and other stress conditions; Micropropagation: Application of micropropagation in agriculture and forestry . Meristem culture and virus elimination; Shoot tip culture.

Unit IV

Improved crop varieties through somaclonal variation in *in vitro* cultures -- Causes- stability and utilization – genetic and epigenetic basis; Establishment of cell lines and evaluation. Application of tissue culture for crop improvement in agriculture, horticulture and forestry. Cryopreservation and slow growth cultures, Freezing and storage, thawing, reculture. Application of plant tissue culture in transgenic plants and production of secondary metabolites and industrial products.

Unit V

Genetic transformation using Ti plasmid Manipulation of gene expression in plants; Production of marker free transgenic plants. Developing insect-resistance, disease-resistance, herbicide resistance; stress and senescence tolerance in plants. Genetic manipulation of flower pigmentation, Developing quality of seed storage, Provitamin A, iron proteins in rice, Modification of food plant taste and appearance, yield increase in plants

References:

1. H.S. Chawla. Plant Biotechnology, Oxford IBH publications
2. Hudson T Hartmann: Plant Propagation-Principle and Practices
3. Principles of Plant Biotechnology- An Introduction of Genetic Engineering in Plants by S.H. Mantell, J.W. Mathews and R.A. Mckee, Blackwell Scientific Publications.
4. Chopra V L, Sharma R P & Swaminathan M S: Agricultural Biotechnology
5. Razdan M K: An Introduction to Plant Tissue Culture

BIOINFORMATICS-II

Course objectives:

- To introduce to the field of bioinformatics via an array of publically available tools and resources.
- To study and deduce the molecular characterization of human genome.
- To study the techniques involved in structural and functional proteomics.
- To utilize the bioinformatic tools to design and development of novel drugs.

Course outcomes:

- Students should be able to apply basic bioinformatics tools for the studies and research in other areas of their biotechnology and microbiology programs, such as finding gene/protein homologs, designing primers, identifying mutations, etc.
- Commemorating the molecular techniques involved in characterization of genomes and proteomes
- Recognizing and interpret the techniques involved in genomics, proteomics, bioinformatics
- Administering the principles of genomics, proteomics, bioinformatics to discovery novel drug development
- Analyzing the molecular markers and its applications.

Unit I

Inference problems and techniques for molecular biology. Overview of key inference problems in biology: Homology identification, Genomic sequence annotation (Genes and ORFs identification), Protein structure prediction (Secondary and Tertiary structure prediction), Protein function prediction, Biological network identification, Next generation sequencing, Microarray data analysis.

Unit II

Basics of RNA Structure prediction and its limitations, Features of RNA Secondary Structure, RNA structure prediction methods: Based on self-complementary regions in RNA sequence, Minimum free energy methods, Suboptimal structure prediction by MFOLD, Prediction based on finding most probable structure and Sequence co-variance method. Application of RNA structure modeling.

Unit III

Machine learning: Decision tree induction, Artificial Neural Networks, Hidden Markov Models, Genetic Algorithms, Simulated Annealing, Support vector machines; The relation between statistics and machine learning; Evaluation of prediction methods: Parametric and Non-parametric tests, cross-validation and empirical significance testing (empirical cycle), Clustering (Hierarchical and K-mean).

Unit IV

Basic concept of Force field in molecular modeling (Potential energy calculation); Overview of key computational simulation techniques: Introduction to simulation, Computer simulation techniques, Types of computer simulation (Continuous, Discrete-event and Hybrid simulation), Differential equation solvers, Parameter estimation, and Sensitivity analysis.

Unit V

Overview of key techniques for the management of large document collections and the biological literature: Document clustering, Information retrieval system; Natural Language Processing: Introduction, Major areas of NLP, Natural language information extraction; Insilico Drug Designing: Major steps in Drug Designing, Ligand and Structure based drug designing, Protein-ligand docking, QSAR Modeling, Pharmacodynamics (Efficacy & Potency) & Pharmacokinetics (ADME), Lipinski's rule of five, Pharmacogenomics.

Text/References Books

1. Computational Methods in Biotechnology – Salzberg S. L. et al., Elsevier Science.
2. D.W.Mount; Bioinformatics- Sequence and genome analysis; Cold Spring Harbour Lab

FOOD BIOTECHNOLOGY

Course objectives:

- To impart an insight into the classification, ingredients and additives of food.
- Providing latest information of food processing and preservation techniques.
- The students will acquire knowledge about the production of fermented food and beverages.

Course outcomes:

- Students will be able to recognize sources of microorganisms and food borne illness.
- Know causes of food spoilage, Spoilage of fruit, Vegetables, Dairy product
- Basic knowledge of food Preservation –Chemical Method, Physical method and apply them in food industries further.
- Gain knowledge about industrial awareness on quality control and good practices in manufacturing processes in industry.

Unit-I

History of Microorganisms in food: Historical Developments. Role and significance of microorganisms in foods. Intrinsic and Extrinsic parameters of foods that affect microbial growth. Basic principles of the equipment involved in the commercially important food processing methods and unit operations.

Unit-II

Microorganisms in food: spoilage of fresh meats and poultry, processed meats, seafood's, fruits and vegetables. Fermented food products, Medical foods, Probiotics and health benefits of fermented milk and foods products. Dehydrated Foods, Enteral Nutrient Solutions (Medical Foods), Single-Cell Protein. Starter cultures, Production process of cheeses, beer, wine and distilled spirits. Process of Brewing, malting, mashing, primary & secondary fermentation. Problems in food industry: catabolic repression, High gravity brewing, B-glucan problem, getting rid of diacetyl.

Unit-III

Determining Microorganisms and/or their Products in Foods: Microbiological Examination of surfaces, Air Sampling, Metabolically Injured Organisms. Enumeration and Detection of Food-borne Organisms. Bioassay and related Methods. Common Food borne diseases. Nutritional boosts and flavor enhancers: Emerging processing and preservation technologies for milk and dairy products.

Unit-IV

Food Preservation: Food preservation by various methods especially Irradiation, Characteristics of radiations in food preservation, principles underlying the destruction of microorganisms by Irradiation. Application of radiations in food (processing for irradiation). Radappertization, Radicidation, and Radurization of Foods. Effect of Irradiation on Food quality and storage ability. Miscellaneous Food Preservation Methods: High- Pressure Processing, Pulsed Electric Fields, Aseptic Packaging, Manothermosonication (Thermo-ultrasonication).

Unit-V

Indicators of Food Safety and Quality: Indicators of Food microbial quality, product quality and food safety. Fecal Indicator Organisms, Predictive Microbiology/Microbial Modeling. The Hazard Analysis Critical Control Point System (HACCP System), Microbiological Criteria. Food borne intoxicants and mycotoxins.

Text / Reference Books:

1. Frazier, W.S. and Weshoff, D.C., 1988. Food Microbiology, 4th Edn., McGraw Hill Book Co., New York.
2. Mann &Trusswell , 2007. Essentials of human nutrition. 3rd edition .oxford university press.
3. Jay, J.M., 1987. Modern Food Microbiology, CBS Publications, New Delhi.
4. Lindsay, 1988. Applied Science Biotechnology. Challenges for the flavour and Food Industry. Willis Elsevier.
5. Roger, A., Gordon, B. and John, T., 1989. Food Biotechnology.

PHARMACEUTICAL BIOTECHNOLOGY

Course objectives:

To acquire knowledge of steps involved in new drug discovery, drug designing, development and production of biopharmaceuticals, mechanism of action of drugs, approval process and their quality control in pharmaceutical industry.

Course outcomes:

Students will be able to:

- explain the process of new drug discovery.
- apply the concepts of production of biopharmaceuticals in pharmaceutical industry.
- apply the knowledge of pharmaceutical manufacturing in the production of biopharmaceuticals.
- carry out quality control of pharmaceuticals.
- comprehend the regulatory aspects involved in the development of biopharmaceuticals.

Unit I

Introduction: Therapeutic categories such as vitamins, laxatives, analgesics, Antibiotics, biologicals, hormones. non-steroidal contraceptives, male contraceptives, Use and applications of female contraceptives, Ethical aspects.

Unit II

Bulk drug manufacturers, Type of reactions in bulk drug manufacture and processes. Special requirement for bulk drug manufacture.

Unit III

Compressed tablet, wet granulation-dry granulation or slugging-direct compression-tablet presses, coating of tablets, capsules, sustained action dosage forms-parental solution-oral liquids-injections-ointment-topical applications

Unit IV

Preservation, analytical methods and test for various drug and pharmaceuticals, packing-packing techniques, Development of Drug and Pharmaceutical Industry: Therapeutic agents, their use and economics;

Unit V

Drug metabolism: physico-chemical principles, radio activity pharmacokinetic action of drugs in human bodies. Regulatory aspects, quality management, GMP

Reference Books:

1. Leon Lachman et al Theory and Practice of Industrial Pharmacy, 3 Edition, Lea and Febiger, 1986
2. Remington's Pharmaceutical Science, Mark Publishing and Co.

BIOMEDICAL INSTRUMENTATION

Course objectives:

This course will help students to venture in to the different types of invasive & non-invasive diagnostic & monitoring instruments used in biomedical sciences.

Course outcomes:

- Hands-on experience with regard to different instrumentations and techniques.
- Understand the Instrumentation and Control of different types of Biomedical techniques.
- Understand the basic principles of engineering knowledge to solve a critical problem.

UNIT I
History and development of biomedical instrumentation, biometrics, Basic transducer principles: active and passive transducers, tranducers for biomedical applications; origin of biopotential and its propagation, sources of bioelectric potentials, electrocardiogram, electro encephalogram, electromayogram and other bioelectric potentials. Biopotential Electrodes: types of electrodessurface, needle and microelectrodes, biochemical tranducers.

UNIT II
The Cardiovascular system, Cardiovascular measurements: electrocardiography, measurement of blood pressure, measurement of blood flow and cardiac output, plethymography, measurement of heart sounds; Patient care and monitoring: elements of intensive care unit, pacemakers and defibrillators ,Measurements in the respiratory system: mechanics of breathing, gas exchange and distribution, respiratory therapy equipment.

UNIT III
Non-invasive diagnostic instrumentation: Temperature measurements ultrasonic measurements, the nervous system and neuronal communication measurement in nervous systems, Instrumentation for sensory measurements and the study of behaviors, pshycophysiological measurements, Biotelemetry.

UNIT IV
Instrumentation for the clinical laboratory, Automation of chemical tests, Biomedical instruments for surgery, Haemodialysis machines. X-ray machines and digital radiography.

UNIT V
Medical Imaging equipments, the computer in biomedical instrumentation and applications, microprocessors, Electrical safety of medical equipment, physiological effects of electric current.

Recommended books:

1. Biomedical Instrumentation and Measurement by Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer
2. Biomedical Instrumentation: Technology and Applications by Raghbir Singh
3. Medical Instrumentation for Health Care by Leslie Cromwell
4. Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation by Robert B. Northrop
5. Introduction to Bioinstrumentation: With Biological, Environmental, and Medical Application by Clifford D. Ferris.

ENGINEERING/MANAGERIAL ECONOMICS

Course Objectives

The objectives of this course are:

- To provide knowledge about Managerial Economics.
- To provide knowledge about Demand Analysis.
- To Determine Production and cost analysis.
- To make aware with pricing and profit management.
- To familiarize the students with the basic concept of microeconomics.

Course Ooutcomes

The students will be able to

- To understand the concepts of cost, nature of production and its relationship to Business operations.
- To apply marginal analysis to the "firm" under different market conditions.
- To analyse the causes and consequences of different market conditions.
- To integrate the concept of price and output decisions of firms under various market structure.

Unit	Topic
I	The Scope and Methods of Managerial Economics, Risk, Uncertainty and Probability Analysis.Optimization techniques: Total, Average and Marginal Relationships, Optimization Analysis. Multivariate Optimization – Partial Derivatives; Contraint Optimization – by substitution, by Lagrangion Multiplier Method. Approach to Managerial Decision Making and the theory of firm.
II	Demand Analysis, Basic Concepts, and tools of analysis for demand forecasting. Use of business indicators; Demand forecasting for consumer, Consumer Durable and Capital Goods. Concepts in resource allocation, cost analysis; break even analysis, short run and long run cost functions; production functions; cost-price output relations – Capital Investment Analysis.
III	Market Structure, Pricing and output; General Equilibrium. Pricing – Objectives – Pricing Methods and Approaches Product Line Pricing – Differential Pricing.Advertising – Contribution of Economic Theory, Methods of Determining Total Advertising Budget, Cyclical Fluctuations of Advertising, Measuring the Economic Effects of Advertising
IV	Capital Budgeting – Capital Management and Financial Policy – Monopoly Policy – Restrive Agreements – Price Discrimination – Measurement of Economic Concentration – Policy against Monopoly and Restrictive Trade Practices.
V	National Income and Product; Saving, Consumption, Investment, the theory of income determination.

BIOPROCESS ENGINEERING LAB

1. Determine the growth patterns and specific growth rate of *E.coli*
2. Determine the effect of peptone concentration on *E.coli*. growth
3. Determination of specific thermal death rate constant (k_d) for *E.Coli*
4. Determine the effects of temperature & pH on *Pseodomonas putida*
5. Upstream and Downstream of bioprocess for the production of Citric acid by *Aspergillus niger*
6. Citric acid production from whey with glucose as supplementary carbon source by *Aspergillus niger*
7. Upstream and Downstream of bioprocess for the production of α-amylase by *Aspergillus nudulans*
8. Estimation of volumetric liquid mass transfer coefficient (K_La) using sodium sulphite method.
9. Preparation of immobilized enzymes & cells and evaluation of kinetic parameters.
10. Computational Design of Fermentative Process for l-Lysine production

PLANT BIOTECHNOLOGY LAB

1. Preparation of Stocks solution for plant tissue culture media.
2. Preparation of MS/B5 medium (semi-solid) and sterilization.
3. Explant selection, preparation and surface sterilization.
4. To learn culturing, sub culturing and maintenance using selected explants.
5. Initiation of *in vitro* cultures through axillary bud induction
6. Initiation of callus cultures from different explants.
7. Preparation of artificial seed/synthetic seed for conservation of germplasm
8. Extraction of DNA/RNA from plants and its estimation.
9. Isolation and characterization of plant secondary metabolites from selected medicinal plants.
10. Extraction of proteins from plants and its estimation

BIOINFORMATICS-II LAB

1. Identification of Distantly related homologous sequences of a given query protein sequence using PSI-BLAST.
2. Construct Phylogenetic tree of five evolutionary related protein/nucleotide sequences.
3. Prediction of secondary structure of RNA using any web server.
4. Construction and analysis of Ramachandran Plot using any suitable web server.
5. Align two homologous protein structure and calculation the RMSD for the superposition result.
6. Comparative assessment of best available tools for genome annotation.
7. Construction of restriction maps for various vectors used in genetic engineering using tool "NEBcutter".
8. Primer Design: Construct primers for the given DNA sequence using any suitable web based tool.
9. Generate 2D QSAR model of a set of legend descriptor data using any web based tool.

Text/References Books

1. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Andreas D. Baxevanis
2. Structural Bioinformatics by Philip E Bourne, John Wiley & Sons
3. Analytical Tools for DNA, Genes & Genomes: by Arseni Markoff, New Age

FOOD BIOTECHNOLOGY LAB

1. Estimation of starch adulteration in milk.

2. Estimation of lactose from milk

3. Estimation of ascorbic acid from given food sample.

4. Microscopic examination of Food/Milk by breed method.

5. To judge efficiency of pasteurization of milk by Phosphatase test.

6. Determination of Minimum Inhibitory Concentration (MIC) of Antibiotic.

7. Analysis of mycotoxin (Aflatoxin) in fungus contaminated food material.

FACULTY OF ENGINEERING & TECHNOLOGY

KHWAJA MOINUDDIN CHISHTI LANGUAGE UNIVERSITY, LUCKNOW, UTTAR PRADESH

B.TECH. BIOTECHNOLOGY

Curriculum Structure

FOURTH YEAR
(VII & VIII Semesters)

Semester-VII

BIOSEPARATION & DOWN STREAM PROCESS (DSP)

Course Objectives:

- To study about the principles and application of various separation & purification techniques involved in bioproducts
- Learn about the differences in recovery processes of intracellular and extracellular products recovery
- To know about the financial importance of Downstream Processing of bioproducts

Course Outcomes:

- Knowledge of various separation techniques used in downstream processes
- Familiarise with the requirements for successful operation of downstream processes
- Apply the principles of major unit operations used in downstream processing for the purification and formulation of final products obtained from fermentation technology
- know the importance and financial considerations of downstream processing in comparison to upstream processing

UNIT I - INTRODUCTION TO BIOSEPARATION PROCESS

Role and importance of bioseparation in biotechnological processes: RIPP scheme, Problems and requirements of bioproducts purification - Properties of Biomolecules - Characteristics of fermentation broth - Biological activity, Analysis of purity-Process economics: Capital and operating cost analysis.

UNIT II - REMOVAL OF INSOLUBLES

Cell disruption methods for intracellular products: Physical, chemical and mechanical - Removal of insolubles: Biomass and particulate debris separation techniques - flocculation - sedimentation - centrifugation and filtration methods.

UNIT III - ISOLATION OF PRODUCTS

Adsorption: Principles - Langumir - Freundlich isotherms - Extraction: Basics- Batch and continuous, aqueous two-phase extraction - supercritical extraction - *in situ* product removal - Precipitation: Methods of precipitation with salts - organic solvents and polymers - Membrane based separations: Micro and ultra filtration - theory - design and configuration of membrane separation equipments and its applications.

UNIT IV - PURIFICATION OF BIOPRODUCT

Basic principles of Chromatographic separations: GC-HPLC - gel permeation - ion-exchange -affinity - reverse phase and hydrophobic interaction chromatography - Electrophoretic separation techniques: capillary - isoelectric focusing-2D gel electrophoresis - Hybrid separation technologies: GC-MS and LC-MS.

UNIT V - PRODUCT POLISHING (8) Crystallization: Principles-Nucleation-Crystal growth-Kinetics-Batch crystallizers: Scale-up and
design, Drying: Principles-Water in biological solids- Heat and mass transfer-Drying equipments: description and operation-Vacuum shelf - rotary dryer-Freeze dryer-Spray dryer.

Biomolecules of Commercial importance Ethanol, citric acid, lysine, steroids, penicillin, dextran, trehalose, subtilisin, chymosin, vitamin B12, hepatitis B vaccine, insulin, erythropoietin, monoclonal antibodies.

TEXT BOOKS

1. Belter PA and Cussler E, "*Bioseparations*", Wiley, 1985.
2. Protein: Biochemistry and Biotechnology by Gary Walsh (2002 John Wiley & Sons Ltd.)
3. Process Biotechnology Fundamentals by S.N. Mukhopadhyay (2001). Viva Books Private Limited.
4. Keith Wilson and John Walker, Practical Biochemistry—Principles and Techniques, Cambridge,5th Ed.2000
7. Bailey & oils, Biochemical Engg. Fundamentals, McGraw-Hill, 1990

Bioseperation & Downstream Process Lab

1. Characteristics of Bioproducts: Flocculation and conditioning of broth
2. Mechanical separation: Filtration and Centrifugation
3. Cell disruption
4. Membrane based seperation
5. Protein precipitation and its seperation: Aqueous two phase extraction, Ultra filtration and Adsorption
6. Chromatography seperation based on size, charge, hydrophobic interaction
7. Gel analysis/ assay for dialysed product
8. Product crystallization and drying

BIOSAFETY, BIOETHICS, IPR &PATENTS

Course Objectives:

Develop the understanding of Intellectual property, IPR, Biosafety, GMO and bioethics

Course Outcomes:

- Would have a knowledge of Biosafety, GMOs and various Institutional committees
- Would demonstrate a clear understanding of Bioethics and its legal implications
- Develop an understanding of concept of Intellectual Property and its types
- Would have broad knowledge on of various types of IPRs, its protection and infringement
- Would demonstrate the understanding of International treaties and case studies

Unit I: BIOSAFETY-REGULATORY FRAMEWORK FOR GMOS IN INDIA

Regulatory framework in India governing GMOs-Recombinant DNA Advisory Committee (RDAC), Institutional Biosafety Committee (IBC), Review Committee on Genetic Manipulation, Genetic Engineering Approval Committee (GEAC), State Biosafety Coordination Committee (SBCC), District Level Committee (DLC). Recombinant DNA Guidelines (1990), Revised Guidelines for Research in Transgenic Plants (1998), Seed Policy (2002), Prevention Food Adulteration Act (1955), The Food Safety and Standards Bill (2005), Plant Quarantine Order (2003), Regulation for Import of GM Products Under Foreign Trade Policy (2006-2007), National Environment Policy (2006). Rules for the manufacture, use/import/export and storage of hazardous microorganisms/genetically engineered organisms or cells (Ministry of Environment and Forests Notification, (1989).

Unit II: BIOSAFETY-REGULATORY FRAMEWORK FOR GMOS AT INTERNATIONAL LEVEL

Convention of Biological Diversity (1992) – Cartagena Protocol on Biosafety – Objectives and salient features of Cartagena Protocol – Advanced Information Agreement (AIA) procedure – procedures for GMOs intended for direct use-risk assessment-risk management-handling, transport, packaging and identification of GMOs- Biosafety Clearing House-unintentional transboundary movement of GMOs-Benefits of becoming a party to the Cartagena Protocol- status of implementation in India.

Unit III: BIOETHICS

Distinction among various forms of IPR, ,Prior art for a patent, Patenting live microorganism, Human Genome project and ethical issues, Animal cloning, human cloning and their ethical issues, Experimenting on animals. Public education of producing transgenic organism, legal and socioeconomic impacts of biotechnology, testing drugs on human volunteers, Hazardous materials used in biotechnology, their handling and disposal.

Unit IV: INTELLECTUAL PROPERTY RIGHTS

Concept of property, rights, duties and Jurisprudential definition, Introduction to patent, copy right, trademarks, Design, geographical indication. History and evolution of IPR, Economic importance of IPR, Indian patent act 1970 (amendment 2000), Distinction among various forms of IPR, invention step, biopiracry and bioprospecting- Appropriate case studies. Infringement/violation of patent, remedies against infringement (civil, criminal, administrative)

Unit V: PATENTS AND PATENT LAWS

Plant and Animal growers rights patents trade secrets, and plant genetic recourses GATT and TRIPS, Dunkels Draft Patenting of biological materials, Current Issues of Patents for higher animal and higher plants, patenting of transgenic organisms, isolated genes and DNA sequences.

REFERENCE/TEXT BOOKS:

1. Beier, F.K., Crespi, R.S. and Straus, T. *Biotechnology and Patent protection*-Oxford and IBH Publishing Co. New Delhi.
2. Intellectual property rights and Bio-Technology (Biosafety and Bioethics), Anupam Singh, Ashwani Singh, NPH, New Delhi
3. Sasson A, *Biotechnologies and Development*, UNESCO Publications.
4. Singh K, *Intellectual Property rights on Biotechnology*, BCIL, New Delhi
5. *Regulatory Framework for GMOs in India* (2006) Ministry of Environment andForest, Government of India, New Delhi

BIOMARKER & DIAGNOSTICS

Course Objectives:

- To familiarize the students with the principles & applications of the latest state-of-the-art biomarker discovery & bio-molecular diagnostic techniques used in laboratories the world over.
- The course will explore that how technological innovations fostered by the Human Genome Project, will lead to significant advances in our understanding of genetic diseases.

Course Outcomes:

- The students would be able to identify and analyze what biomarker based approach and methodology should be used for diagnostic purpose in different settings, their comparative advantages and limitations.
- Identification & Utilisation of biomarkers in diseases like cancer & neurodegenration.
- The students would have in-depth knowledge of quality control and assurance considerations used in the industry for diagnostics.
- Able to apply the knowledge of function genomics in public health.

Unit – I

Introduction to Molecular Diagnostics: History of diagnostics, Age of molecular diagnostics, Significance, Scope, Rise of diagnostic industry in Indian and global scenario, **Cellular Complexity:** Cell components, Cell Differentiation, Cellular communication – endocrine signalling, paracrine signalling and autocrine signalling, contact dependent and synaptic communications, Intracellular networks – transport pathways, signalling pathways and metabolic networks. Eukaryotic Cell Control System and their Components, Intracellular cell cycle control system, Extracellular Cell Cycle Control System, Regulation of Cell Growth and Apoptosis, Genetic and epigenetic factors that regulate these pathways, their abnormalities that alter the pathways and cellular functions.

Unit – II

Molecular Oncology & Mitochondrial disorders: Cancer – Benign and Malignant neoplasms, multifactorial disposition, Cancer pathogenesis, positive and negative mediators of neoplastic development, Proto-oncogenes, Oncogenes and Tumor suppressors. Allele loss and loss of Heterozygosity. Mitochondrial inheritance, Mitochondrial myopathy, lactic acidosis, MELAS, LHONs, identity testing.

Unit – III

Biomarkers in disease diagnostics: FDA definition of disease markers, Role of markers in Disease diagnosis. Approaches and methods in the identification of disease markers, predictive value, diagnostic value, emerging blood markers for sepsis, tumour & cancer markers, markers in inflammation and diagnosis of cytoskeletal disorders.

Unit – IV

Chromosomes, Human disorders, and Cytogenetic analysis : Structure, types and organization; Chromosome organization, Euchromatin and heterochromatin and Histone modifications. Chromosome banding and nomenclature**;** Nomenclature and functional significances of chromosome bands. GC and AT rich isochores. Structural and Numerical aberrations and its consequences. X-chromosome dosage compensation and inactivation mechanism. Sex determination and Y chromosome; function, and diseases. Uniparental disomy, Genomic Imprinting and disorders. FISH, CGH, Flow cytometry techniques and clinical diagnostics.

Unit – V

Genomic instability, Chromosome mapping & Genome plasticity: Common fragile sites and methods of induction, Heritable fragile sites and FXS. Genomic Instability, mechanism and diseases. Trinucleotide Repeats;Mechanism of expansion and triplet repeats and related disorders.Genetic linkage maps, Relation to the probability of recombination, Pedigree analysis with genetic markers and overview of human genome project.

Text/References Books:

1. Introduction to Tissue engineering, applications and challenges. Ravi Birla. Wiley Publications.
2. Principles of tissue engineering. Robert Lanza. Elsevier Publications.
3. Molecular Cell Biology: Darnell J, Lodish H and Baltimore D
4. Cell and Molecular Biology: De Robertis EDP and De Robertis EMF
5. Molecular Biology of the cell by Alberts et al., Garland Press
6. Genes IX, by Lewin B, Pearson India
7. Cell and Molecular Biology by De Robertis and De Robertis, Lipincott &Wilkins

Industrial Biotechnology

Course Objectives:
Develop the understanding of industrial aspects of biotechnology.

Course Outcomes:

- Familiarise with the calculation related to industrial aspects of biotechnology.
- Types of Bioreactor. Study the difference in design and functioning of different types of Bioreactor. Understand the advantages and disadvantages of different types of Bioreactor
- Mode of Bioreactor operation. Covers the basic concepts of microbial growth kinetic and stoichiometry in different bioreactor operational modes.
- Design of a Bioreactor. Understand basic design of a fermenter. Important parts and materials required for aseptic operation and containment practice in a fermenter.
- Understand the production of Industrial products like metabolites, enzymes, biofuels.

UNIT I. Introduction to Engineering Calculation
Introduction to engineering calculations; unit conversion, measurement conventions, Errors in Data and Calculations, Presentation of Experimental Data, Data Analysis, General Procedures For Plotting Data, Process Flow Diagrams.

UNIT II. Bioreactor Types and operation control
batch reactors, fed-batch reactors, CSTR reactors, various types of bioreactors for microbial, animal , plant cell culture, fluidized bed reactor, bubble column, air lift fermenter, packed bed, trickle bed etc. parallel and series bioreactor. Impellers, stirrer, glands and bearings, packed gland seal, mechanical seal, magnetic drives, baffles, different types of spargers, computer based advance controllers for bioreactors.

UNIT III. Bioreactor Design
Introduction, general design information, design of bioreactors, basic function of a bioreactor design, mass and energy balance, materials of construction for bioprocess plant, mechanical design of process equipment, utilities for biotechnology production plants.

UNIT IV. Reactor engineering
Ideal reactors, concept of holding and space time, performance equations for single reactors; multiple reactor systems, design of multiple reactors: kinetics of series and parallel reaction, residence time distributions (RTD), exit age distribution, **r**ecycle reactors, recycle ratio for auto catalytic reactions.

UNIT V. Applications
Process technology for the production of cell biomass and some primary metabolites, e.g. ethanol, acetone-butanol, citric acid, dextran and amino acids. Microbial production of industrial enzymes-glucose isomerase, cellulase & lipases. Applications of bioconversion, transformation of steroids and

sterols. Transformation of non-steroidal compounds, antibiotics and pesticides. Bioenergy-fuel from biomass, production and economics of biofuels. Metal recovery and microbial desulfurization of coal.

Text / Reference Books:

1. Biotechnology: A Text Book of Industrial Microbiology: T.D. Brock, Smaeur Associates, 1990.
2. Industrial Microbiology: L.E. Casida, Willey Eastern Ltd., 1989.
3. Industrial Microbiology: Prescott & Dunn, CBS Publishers, 1987.
4. Bioprocess Technology- fundamentals and applications, S O Enfors & L Hagstrom (1992),RIT, Stockholm.
5.Biotechnology, Economic & Social Aspects: E.J. Dasilva, C Rutledge & A Sasson, Cambridge Univ.Press, Cambridge.
5. Biotechnology - a handbook of industrial microbiology: W. Crueger and A. Crueger.
6. Microbial Biotechnology: Channarayaappa, University press, Hyderabd, 2003
7. Biochemical engineering by Aiba, Humphrey and Mells, Academic press.
8. Bioseparations Science and Engineering by Roger. H. Harrison., Oxford University press.
10. Bioseparations -Downstream processing for Biotechnology by Paul. A. Belter, E.L.Cussler and Wei-Shou Hu., John Wiley and sons.

Entrepreneurship in Biotechnology

Course Objectives:

- Understanding basic concepts in the area of entrepreneurship
- Understanding the role and importance of bio-entrepreneurship for economic development, developing personal creativity and entrepreneurial initiative,
- Adopting of the key steps in the elaboration of funding of the biotech business
- Understanding the stages of the entrepreneurial process and the resources needed for the start-up, successful development, quality control & export possibilities of biotech enterprises.

Course Outcomes:

- Analyze the business environment in order to identify business opportunities,
- Identify the elements of success of bio-entrepreneurial ventures, consider the legal and financial conditions for starting a business venture,
- Evaluate the effectiveness of different bio-entrepreneurial strategies, specify the basic performance indicators of entrepreneurial activity,
- Explain the importance of marketing and management in small biotech businesses venture
- Interpret their own biotech business plan from start-up to setting-up to control to export

Unit-I

Introduction: Entrepreneur, Creativity & Entrepreneurial personality and Entrepreneurship in Biotechnology, pillars of bio-entrepreneurship and major start-ups in Biotechnology, Concept and theories of Entrepreneurship, Entrepreneurial traits and motivation, Nature and importance of Entrepreneurs, Government schemes for commercialization of technology (eg. Biotech Consortium India Limited)

Unit-II

Project management: Search for a business idea, concept of project and classification, project identification, project formulation, project design and network analysis, project report, project appraisal.

Unit-III

Financial analysis: Ratio analysis, Investment process, Break even analysis, Profitability analysis, Budget and planning process.

Unit-IV

Funding of biotech business(Financing alternatives, Venture Capital funding, funding for biotech in India, Exit strategy, licensing strategies, valuation), support mechanisms for entrepreneurship (Bio-entrepreneurship efforts in India, difficulties in India experienced, organizations supporting biotech growth, areas of scope, funding agencies in India, biotech policy initiatives)

Unit-V

Biotech enterprises: Desirables in start-up, Setting up Small, Medium & Large scale industry, Quality control in Biotech industries, Location of an enterprise, steps for starting a small industry, incentives and subsidies, exploring export possibilities

Recommended Books:

1. The Business of Biotechnology: From the Bench of the Street: By Richard Dana Ono Published Butterworth- Heinemann, 1991.
2. Entrepreneurship in Biotechnology: Managing for growth from start-up By Martin Gross Mann, 2003
3. Innovation and entrepreneurship in biotechnology: Concepts, theories & cases by D. Hyne & John Kapeleris, 2006
4. Dynamics of Entrepreneurial Development and Management by Vasant Desai, Himalaya Publishing House, 2005.
5. Projects Planning Analysis, Selection, Implementation & Review by Prasannan.
6. Best Practices in Biotechnology Education: By Yali Friedman, Published by Logos Press, 2008.

AGRICULTURE BIOTECHNOLOGY

Course Objectives:

- To give the details of plant cells and its functions
- To provide the basics of agrobacterium and applications of plant biotechnology
- The concept of Genetically modified organisms.
- Direct and indirect gene transfer methods in plants
- Transgenic plants: herbicide, pest and disease resistant, abiotic stress resistant, nutritional enhancement and traits for improved quality- Detection of GMOs – regulations and biosafety.

Course Outcomes:

- Students learn about the setup of plant tissue culture lab their maintenance and preparation of tissue culture media (Both and solid and liquid media).
- In this student learn practically about surface sterilization techniques.
- Students practically handles the Induction of Root and Shoot and maintenance of callus.
- Students acquire knowledge in strain improvement which will be a demo experiment.
- Students handle practically in production of haploids.

UNIT I

Agriculture and Agricultural Biotechnology, Clonal Germplasm: Micro propagation, In vitro production of pathogen and contaminant free plants

UNIT II

Biotechnology- Methods of Crop Improvement: Genetic Engineering of Crop Plants, Transgenic Plants, Molecular Markers, QTL Mapping

UNIT III

Microbes in Agriculture and Food: Applied Microbiology in the future of mankind, moving frontiers of applied microbiology, microbial enzymes and their applications in food processing and agro-chemical industries, agro-waste utilization, biodegradable polymers and their applications, microbial polysaccharides; Production and utilization of essential amino-acids, chemicals from micro-algae.

UNIT IV

Metabolite Production: Production of Secondary Metabolites, Production of foreign compounds in transgenic plant, Achievements and recent developments of genetic engineering in agriculture

UNIT V

Biofertilizers and Bioremediation: Microbial Biopesticides, Biofungicides, Herbicides, and Agricultural antibiotic Biotechnology in Agriculture: Ethical Aspects and Public Acceptance, Animal farming

Reference Books:

1. Biotechnology by B.D.Singh, Kalyani Publication
2. Biotechnology – Fundamentals and applications by S.S.Purohit, Student Edition
3. Agricultural Biotechnology-Arie Altman, CRC Press
4. Biotechnology- An Introduction by Susan R. Barnum, Vikas Publishing House

APPLICATIONS OF NATURAL PRODUCTS

Course Objectives:

- To give the details of herbal plants
- To give details of diversity and conservation of natural resources
- Basic concepts of Ethnobotany & Ethnopharmacology in drug discovery process
- Concept and application of secondary metabolites from plants

Course Outcomes:

- To know about what is the role of an individual in Conservation of Natural Resources.
- Herbal science and their Science.
- Classification of Medicinal Plants, Phytochemistry, Carbohydrates, Lipids,
- Terpenes, Polyphenols, Alkaloids, Pharmacology, Toxicity, Formulations and Preparations of HerbalMedicines.
- How herbs influence our physiology and can be helpful against several disorders.
- RelationsbetweenPhyto -therapy and the Elderly, Phytotherapy and Children, Understanding Herbal Action, and Understanding the MateriaMedica.
- The recognition of medicinal plants, identification of adulteration and Contamination.
- Ethnobotany&Ethnopharmacology in drug discovery process.

Unit-I

Sources of crude drug: Biological, marine, Mineral and plant tissue culture as source of natural products. Various methods of extraction and isolation of phytopharmaceuticals namely infusion, decoction, maceration, percolation, hot continuous extraction, successive solvent extraction, supercritical fluid extraction, steam distillation, Counter-current Extraction, Ultrasound Extraction (Sonication). Parameters for selection of suitable extraction process.

Unit-II

Phytochemical Screening: Screening of alkaloids, saponins, cardenolides and bufadienolides, flavonoids and leucoanthocyanidins, tannins and polyphenols, anthraquinones, cynogenetic glycosides, amino acids in plant extracts. Important therapeutic classes: antimicrobial, antidiabetics, hepatoprotectives, immmunomodulators, anti-cancer.

Unit-III

Herbal cosmetics: Importance of herbals as shampoos (soapnut), conditioners and hair darkeners, (amla, henna, hibiscus, tea), skin care (aloe, turmeric, lemon peel, vetiver); Colouring and Flavouring agents from plants; Utilization of aromatic plants and derived products with special reference to sandalwood oil, mentha oil, lemon grass oil, vetiver oil, geranium oil and eucalyptus oil.

Unit-IV

Nutraceuticals and Health Foods: Classification of Nutraceuticals, Health foods: Source, Chemical constituents, uses, actions and commercial preparations of health foods, Alfalfa, Bran, Angelica, Chamomile, Corn oil, Fenugreek, Ferverfew, Garlic, Ginseng, Ginkgo, Honey, Hops, Safflower oil, Soyabean Oil, Turmeric. Concept and examples of Adaptogens

Unit-V

Quality control of herbal drugs as per WHO, AYUSH and Pharmacopoeial guidelines-Extractive values, ash values. Determination of heavy metals, insecticides, pesticides and microbial load in herbal preparations.

Text / Reference Books:

1. Manual K. Lindsey, Plant Tissue Culture, Springer U.K. Wagner.
2. Wagner and Bladt, Plant Drug analysis, Springer U.K.
3. A.R.Kashi, Industrial Pharmacognosy, Universities press
4. S.S.Agrawal, Herbal drug technology, Universities press
5. Quality Standards of Indian Medicinal Plants, Vol 10, (ICMR), New Delhi, 2012.
6. Indian Herbal Pharmacopoiea, K. M. Varghese Co.Bombay.
7. Craker L., Herbs, Spices And Medicinal Plants, CBS Publishers
8. N.R. Krishnaswamy Chemistry of Natural Products: A Unified Approach, University Press (India) Ltd., Orient Longman Limited, Hyderabad, 1999.

WASTE TREATMENT AND MANAGEMENT

Course Objectives:

- To give the details of water pollution
- recognize the properties of the basic industries and the environmental impact of waste generated is able to compare.
- define the characteristics of industrial waste water.
- explain the principles of industrial waste water refining.
- determine the appropriate treatment methods for textile industry waste water.
- recognize the food industry,the properties of wastes and waste resources.
- explain the food industry wastes treatment methods.
- compare the methods used in wastewater treatment and waste containing heavy metals such as metal plating and refinery.

Course Outcomes:

- Compare the methods of textile industry wastewater treatment.
- Make the selection process for high organic load of waste water treatment needed.
- Have information about treatment methods, pharmaceutical industry and the chemical (phenol) facilities which produces of wastewater properties of, operational problems.
- To find and implement scientific, technological, economic solutions to environmental problems.
- To know about the interrelationship between living organisms and environment.
- To know about the various social issues.

UNIT I

Waste management: the definition of waste, and its classification in the context of EU legislation, policy and other drivers for change, including the planning and permitting regime for the delivery of waste management solutions.

UNIT II

Waste treatment technologies including waste incineration and energy from waste, advanced conversion technologies of pyrolysis and gasification, anaerobic digestion, composting and mechanical biological treatment of wastes.

UNIT III

Health considerations in the context of operation of facilities, handling of materials and impact of outputs on the environment; Advances in waste recycling and recovery technologies to deliver added-value products; Landfill engineering and the management of landfill leachate and the mining of old landfills.

UNIT IV

Specific waste streams including healthcare wastes, food wastes, mineral and mining wastes, hazardous wastes and producer responsibility wastes; Sustainability and resource efficiency with consideration for materials flow through the economy, steps towards designing out waste and maximizing the value of outputs from waste treatment processes;

UNIT V

Interface of waste and resource management and civil engineering in the context of sustainable waste management in global cities and developing countries; and Use of decision support tools including multi-criteria analysis, carbon foot-printing and life-cycle analysis, as appropriate.

TEXT BOOKS

1. George Tchobanoglous et.al., “Integrated Solid Waste Management”, McGraw-Hill Publishers, 1993.
2. B.Bilitewski, G.HardHe, K.Marek, A.Weissbach, and H.Boeddicker, “Waste Management”, Springer, 1994.