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DR. D. Y. PATIL BIOTECHNOLOGY & BIOINFORMATICS INSTITUTE

TATHAWADE, PUNE

SYLLABUS FOR

M. TECH (INTEGRATED) BIOTECHNOLOGY

(BATCH 2017-18)

DR. D.Y. PATIL VIDYAPEETH, PUNE

DR. D. Y. PATIL BIOTECHNOLOGY & BIOINFORMATICS INSTITUTE, TATHAWADE, PUNE

COURSE STRUCTURE FOR M. TECH (INTEGRATED) BIOTECHNOLOGY

SEMESTER I							
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**	**Marks**
BS 101	Physics	3	0	2	5	4	150
BS 102	Organic chemistry	3	0	4	7	5	200
BS 103	Mathematics	3	1	0	4	4	100
BT 101	Introduction to Electronics & Instrumentation Engineering	3	0	2	5	4	150
BI 101	Introduction to Computers & Computer Organization	3	0	4	7	5	200
HU 101	Communication Skills	1	2	0	3	3	100
HU 102	Disaster Management	2	0	0	2	2	100
Total		**18**	**3**	**12**	**33**	**27**	**1000**
BS - Basic Sciences, HU - Humanity, BT - Biotechnology, BI - Bioinformatics							
SEMESTER II							
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**	**Marks**
BS 201	Physical Chemistry	3	1	0	4	4	100
BS 202	Introduction to Bio-molecules	3	0	4	7	5	200
BS 203	Biostatistics	3	1	0	4	4	100
BT 201	Engineering Mechanics	3	0	2	5	4	150
BI 201	C Programming	3	0	4	7	5	200
BS 204	Environmental Sciences	3	0	2	5	4	150
Total		**18**	**2**	**12**	**32**	**26**	**900**
SEMESTER III							
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**	**Marks**
BS 301	Analytical Techniques	3	0	4	7	5	200
BS 302	Cell Biology	3	0	2	5	4	150
BS 303	Microbiology	3	0	4	7	5	200
BS 304	Genetics	3	1	2	6	5	150
BS 305	Mammalian Physiology	3	1	0	4	4	100
BT 301	Plant Physiology	3	1	0	4	4	100
Total		**18**	**3**	**12**	**33**	**27**	**900**
SEMESTER IV							
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**	**Marks**
BT 401	Molecular Biology-I	3	0	4	7	5	200
BT 402	Metabolism	3	1	0	4	4	100
BT 403	Animal Tissue Cultures	3	0	2	5	4	150
BT 404	Plant Tissue Culture	3	0	2	5	4	150
BT 405	Immunology	3	0	2	5	4	150
BI 301	Concepts in Bioinformatics	3	0	4	7	5	200
Total		**18**	**4**	**14**	**33**	**26**	**950**

SEMESTER V

Course Code	Course Name	L	T	P	Hr	Cr	Marks
BT 501	Molecular Biology-II	3	0	4	7	5	**200**
BT 502	rDNA Technology	3	1	0	4	4	**100**
BT 302	Enzymology & Enzyme Technology	3	0	4	7	5	**200**
BT 503	Basic Pharmacology and Toxicology	3	1	0	4	4	**100**
BT 504	Fermentation Technology	3	0	4	7	5	**200**
BT 506 / BT 507	Elective-I	3	0	4	7	5	**200**
Total		**18**	**2**	**16**	**36**	**28**	**1000**
Elective I (BT 506 : Food Biotechnology / BT 507 : Environmental Biotechnology)							
SEMESTER VI							
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**	**Marks**
BT 601	Virology	3	1	0	4	4	100
HU 601	Principles of Managements & Entrepreneurial Development	3	0	0	3	3	100
BI 605	Introduction to Molecular Modeling and Chemo informatics	3	0	4	7	5	200
HU 602	Bio safety and Bioethics & IPR	3	1	0	4	4	100
BT 602	Genomics	3	0	2	5	4	150
BI 504 / BI 606 / BI 603	Elective-II	3	1	2	6	5	150
Total		**18**	**3**	**8**	**29**	**25**	**800**
Elective II (BI 504: Operating System / BI 603:Perl & Bioperl / BI 606:Computer Networking)							
SEMESTER VII							
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**	**Marks**
BT 701	Biomembrane and Molecular Cell Signaling	3	1	0	4	4	100
BT 705	Developmental Biology and Stem cells	3	1	0	4	4	100
HU 701	Quality Control Management in Biotechnology	3	1	0	4	4	100
BT 706	Transcriptomics	3	0	4	7	5	200
BT 603	Biochemical Engineering	3	1	4	8	3	200
BT 707 / BT 708 / BT 709 / BT 710	Elective-III	3	0	4	7	5	200
Total		**18**	**3**	**8**	**27**	**25**	**900**
Elective III (BT 707: Metabolic Engineering / BT 708 : Marine Biotechnology / BT 709 : Agricultural Biotechnology)							
SEMESTER VIII							
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**	**Marks**
BT 801	Protein Modeling and Drug Designing	3	0	4	7	5	200
BT 802	Proteomics	3	0	2	5	4	150
BT 505	Biomedical Engineering	3	1	0	4	4	100
BT 803	Nanobiotechnology	3	0	2	5	4	150
BT 804	Seminars in Biotechnology & Advances in Biotechnology	3	1	0	4	4	100
BT 805 / BT 710	Elective – IV	3	0	4	7	5	200
Total		**18**	**2**	**12**	**32**	**26**	**900**
Elective III (BT 805: Clinical Research / BT 710 : Biopharmaceuticals)							
Semester IX & X							
	Research Project (10 months)	**50 Credits**					**800**

COURSE STRUCTURE FOR M. TECH (INTEGRATED) BIOTECHNOLOGY

SEMESTER I							
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**	**Marks**
BS 101	Physics	3	0	2	5	4	150
BS 102	Organic chemistry	3	0	4	7	5	200
BS 103	Mathematics	3	1	0	4	4	100
BT 101	Introduction to Electronics & Instrumentation Engineering	3	0	2	5	4	150
BI 101	Introduction to Computers & Computer Organization	3	0	4	7	5	200
HU 101	Communication Skills	1	2	0	3	3	100
HU 102	Disaster Management	2	0	0	2	2	100
Total		**18**	**3**	**12**	**33**	**27**	**1000**
BS - Basic Sciences, HU - Humanity, BT - Biotechnology, BI - Bioinformatics							

TITLE OF THE COURSE: PHYSICS

COURSE CODE: BS-101 **L T P Hr C**

MARKS: 150 **3 0 2 5 4**

OBJECTIVE

The objective of this course is:

To create general understanding regarding basic physical principles involved in living systems.

To familiarize the student with basic concepts in physics as: classical optics used in microscopes and telescopes, thermometry and heat, mechanical, fluid and solid state properties.

To familiarize students with concepts in digital electronics, lasers, sound waves, electricity.

To introduce them to concepts in modern physics such as: production of X-ray, X-ray crystallography, quantum mechanics etc.

LEARNING OUTCOME

At the end of the course, the students will have sufficient scientific understanding of the basic concepts in classical and modern physics, laser sources, concepts and laws applicable to quantum-mechanical particles. This would enable him to understand use of physical methods in understanding Biomolecular structure and interactions

PREREQUISITES

This is an introductory course. School level knowledge of physics is sufficient. There are no prerequisites.

COURSE DESCRIPTION

Sr. No.	Topics	Detail syllabus	No. of Lectures
1	Optics: Interference Diffraction & Polarization	Introduction to optics, Principles of superposition, Constructuve & destructive Interference, Types of Interference, Newton‟s rings. Diffraction- Types of diffraction, Diffraction grating, Rayleigh‟s criterion, Resolving power of Microscope and Telescope. Polarization of light waves, Polaroid, Optical activity.	08
2	Thermometry and Heat	Principles of Thermometry, Temperature and it‟s measurements, Platinum resistance Thermometer, Thermocouple and Thermistors, Modes of Heat Transfer.	05
3	Properties of Fluid: Surface Tension & Viscosity	Surface Tension, Surface Energy, Angle of Contact, Capillarity action, Determination of Surface tension by capillary rise method, Jaeger‟s method, Temperature dependence of surface tension and its applications. Viscosity, Coefficient of viscosity, streamline and turbulent flow, Reynold‟s number, Stoke‟s law, Terminal velocity,	07

		Determination of „η" by falling sphere method.	
4	Elasticity	Stress and Strain, Hook"s law, Stress-strain curve, Young"s	03
		modulus, Determination of Young"s modulus.	
5	Solids and Semiconductor Devices	Classification of Solids (Conductor, Semiconductor and Insulators), intrinsic and extrinsic semiconductors, PN Junction Diode, Zener Diode, Junction Transistors (CE,CB mode)	05
6	Introduction to Digital Electronics	Introduction to Binary mathematics, BCD numbers, Basic logic gates, De-Morgan"s Theorem	02
7	Lasers	Properties of Lasers, Production mechanism, Ruby Laser, Helium Neon Laser, applications of Lasers.	03
8	Sound waves	Types of sound waves (Longitudinal and Transverse), Audible, Ultrasonic and Infrasonic waves, Beats, Doppler effect, Applications of Ultrasonic waves.	03
9	Electricity	Heating effect of electric current, Joule"s law, Transformers, Types of Transformers.	02
10	Modern Physics: X-rays, Crystallography, Introduction to Quantum Mechanics	Introduction to X-Rays : Introduction, Production of X-rays, X-Ray diffraction and its Applications. Introduction to crystal structure, Unit cell, seven crystal systems. Plank"s Quantum Theory, Properties of Photon, Photoelectric effect, wave particle duality of radiation, de Broglie"s hypothesis, Heisenberg"s Uncertainty principle.	07
Total Lectures			**45**

METHODOLOGY

The course will be covered through lectures supported by tutorials and practicals. In tutorials, apart from the discussion on the topics covered in lectures, assignments in the form of questions will be given. Normally a students is expected to complete the assignment by himself, however if needed, difficulties will be discussed in the tutorial classes. There will be two class tests/ and surprise test conducted during the tutorial classes.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1) Physics-David Haliday and Robert Resnik (Vol I and Vol II) [Wiley Eastern Pub] Perspectives of Modern Physics-Arthur Beiser [Mc Graw Hill]
2) Fundamensls of optics-Jenkins [Mc Graw Hill] Optics –Ajoy Ghatak [Tata Mc Graw Hill]
3) Digital Principles and Applications-Malvina and Leach [Mc Graw Hill]

PRACTICAL IN PHYSICS (TWO HOURS PER WEEK) Marks 50

The course will also have a practical component. The practical training would be in the area of optics, electronics, thermometry, calorimetry, conductivity, measurement of physical properties as: viscosity and surface tension.

LIST OF EXPERIMENTS

1. Diffraction Grating: Use of diffraction grafting for determination of wavelength of spectral lining.
2. Resolving Power: To determine the resolving power of Microscope or telescope.
3. Diode Characteristics: Study of forward and reverse characteristics of Diode.

   Transistor Characteristics: Study of characteristics of Photocell.
4. Band gap of semiconductor: Study of input and output characteristics of a transistor and determination of band gap of a semiconductor.
5. Ultrasonic Interferometer: Determination of velocity of ultrasonic waves by ultrasonic
6. Study of logic gates (OR, AND, NOT).
7. Thermocouple: Study of variation of thermo emf (electromotive force) with temperature.
8. Surface Tension: Determination of the surface tension of a given solution.
11. Viscosity: Determination the coefficient of viscosity by Stoke‟s method and its practical application.
12. Joule‟s Law: Determine of Joule‟s constant.
13. Determination of wavelength of monochromatic light by Newton‟s rings experiments.
14. Thermal Conductivity: Determination of coefficient of thermal conductivity of given specimen.

EVALUATION SCHEME PRACTICAL TRAINING

Examination	**Duration**	**Marks**
Minor test 1	1 hour	15
Continuous Assessment		10
Major test at the end of semester	3 hours	25
Total		**50**

TITLE OF THE COURSE: ORGANIC CHEMISTRY

COURSE CODE: BS 102 **L T P Hr C**

MARKS: 200 **3 0 4 7 5**

OBJECTIVE OF THE COURSE:

The objective of the course is:

To familiarize the students with basic concepts of organic chemistry.

To familiarize the students with structures of organic molecules as: alkanes, alkenes, alkynes, aliphatic and aromatic molecules

To introduce them to interactions amongst organic compounds

LEARNING OUTCOME:

At the end of this course student should be able to understand basic principles of organic chemistry and develop skills in handling organic molecules. This is essential for undertaking practical training in Biochemistry and genetic engineering at the later stage.

PREREQUISITES:

This is an introductory course. There are no prerequisites for the course.

COURSE DESCRIPTION

Sr. No	Topic	Description	Hrs
1	Introduction to organic chemistry	Functional groups	2
2	Organic compounds	Chemistry of alkanes, alkenes, alkynes (Comparative study)	5
3	Stereochemistry	Stereo isomers, Enantiomers, Chiral centers/ Optical activity, Geometric isomers Meso- isomers, Conformational isomers	8
4	Chemistry of cyclic aliphatic carbons	Nomenclature and preparation, Reactions of small ring compounds, (cyclopropane and cyclobutane), Baeyers Strength Theory, Stereochemistry of Cyclic Aliphatic compounds	8
5	Chemistry of heterocyclic compounds	Furan, Pyrrole, Thiophene, Purines, Pyrmidines (Nucleic acids), Quinoline, Isoquinoline	8
6	Chemistry of aromatic compounds	Structure of Aromatic compounds (Benzene and its derivatives), Aromatic Characters: The Huckel rule (4N+2)	8
7	Reaction mechanisms	Nucleophilic SN_1, SN_2 , Electrophilic E_1 and E_2)	5
Total Number of lectures			44

METHODOLOGY

The course would be taught through lectures, demonstrations and practical classes.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

Organic Chemistry (6^{th} Edition, 1992)- Robert Thornton Morrison and Robert Neilson Boyd (Prentice Hall)

Organic Chemistry Vol. I and II and III by I. L Finnar. 5^{th} Edition Pearson Publications

PRACTICAL IN ORGANIC CHEMISTRY (4 Hrs. PER WEEK) MARKS 100

LIST OF EXPERIMENTS:

1. 10 Quantitative analysis, 5 organic and inorganic mixtures
2. Quantitative analysis:

   Estimation of aniline, acetone, and aspirin

   Molecular weight of monobasic/dibasic acids.
3. Preparation of orange dyestuff (Sagand III)
4. Preparation of p-nitroacetanilide from actanilide
5. Preparation of acetnilide from aniline
6. Preparation 2,4 DNP derivatives
7. Estimation of Cu^{2+} from brass
8. Estimation of %q of $NH_4Cl+BaSO_4$ grarimetric analysis
9. Preparation of Std. $K_2Cr_2O_7$ solution and estimation of Fe (II) and Fe(III) from a given mixture of Fe(II) and Fe(III) using external indicators.

EVALUATION SCHEME PRACTICAL TRAINING

Examination	**Duration**	**Marks**
Minor test 1	1 hour	30
Continuous Assessment		20
Major test at the end of semester	3 hours	50
Total		**100**

TITLE OF THE COURSE: MATHEMATICS

COURSE CODE: BS-103	**L**	**T**	**P**	**Hr**	**C**
MARKS: 100	**3**	**1**	**0**	**4**	**4**

OBJECTIVE

The objective of the course is to familiarize the student with basic concepts in mathematics.

LEARNING OUTCOME

At the end of the course, the students will have sufficient understanding of different mathematics and statistical tools used in Biotechnology. This knowledge would be applicable in different industries

PREREQUISITES

Students should be familiar with school level mathematics to take up this course. In case they do not have mathematics at the 10+2 level they should have cleared the core mathematics in the first semester.

COURSE DESCRIPTION

Sr. No.	**Topics**	**Lectures Required**
1	Algebra : 1.1 Logarithms 1.1.1 Definition of Logarithm (Natural and common logarithm 1.1.2 Laws of Logarithm.	02
	1.2 Binomial Theorem: 1.2.1 Definition of factorial notation, peronntation & combinations. 1.2.2 Binomial Theorem for positive index. 1.2.3 General term, middle term 1.2.4 Binomial theorem for any index 1.2.5 Binomial Theorem for Approximation.	04
2	Trigonometry : 2.1 Trigonometric Rations (t-ratios) 2.1.1 t-ratios of any angle, Relation between t-ratios, Fundamental identities. 2.1.2 Relation between degree & radian, T-ratios of std. angles. 2.1.3 Quadrants sign of T-ratios in various quadrants, T-ratios of negative angles.	03
	2.2 T-ratios of Allied, Compound, Multiple and Submultiples angles. 2.2.1 T-ratios of Allied angles. 2.2.2 T-ratios compound angles. 2.2.3 T-ratios of multiple & sub-multiple angles. 2.2.4 Factorization formulae 2.2.5 Defactorization formulae.	08
	2.3 Inverse Trigonometric Functions. 2.3.1 Definition of Inverse t-functions. 2.3.2 Principle value of inverse t-functions.	02

3	Function and Limit 3.1 Function : 3.1.1 Definitions of variable, constant, intervals such as open, closed, semi-open etc.	02
	3.1.2 Definitions of function, value of function, domain & range of a function.	
	3.2 Limits : 3.2.1 Concepts and definition of Limit. 3.2.2 Limits of algebraic functions. 3.2.3 Limits of trigonometric functions. 3.2.4 Limits of exponential functions. 3.2.5 Limits of logarithmic function.	06
4	Derivatives 4.1 Derivatives : 4.1.1 Definition of Derivatives, notations. 4.1.2 Rules of Derivatives (without proof) 4.1.3 Derivatives of composite functions. 4.1.4 Derivatives of Inverse trigonometric function by substitution method. 4.1.5 Derivatives of Implicit functions. 4.1.6 Logarithmic differentiation. 4.1.7 Second order differentiation.	06
	4.2 Application of Derivatives 4.2.1 Geometrical meaning of the derivatives. 4.2.2 Equations of Tangent & normal to the given curve. 4.2.3 Maxima & Minima.	04
5	5.1. Integration : 5.1.1 Definition of integration, Integration of Standard function; Rules of Integration. 5.1.2 Integration of rationale functions; Trigonometric functions to determine constant of Integration,	03
	5.2. Definite Integration: 5.2.1 Definition of Definite integral, definite. 5.2.2 Definite integral with simple problems.	02
	5.3. Application of Definite Integrals 5.3.1 Area under the curves. 5.3.2 Area between two curves.	02
6	Differential Equation (D.E.)	04
	6.1. Definition of D.E., order & degree of D.E., formation of D.E for function containing single constant.	
	6.2 Solution of D.E. of first order & first degree such as: i) Variable separable type. ii) reducible to variable separable form iii) Exact D.E. iv) Linear D.E v) Bernoulli‟s D.E.	
Total Lectures		48

METHODOLOGY

The course will be covered through lectures supported by tutorials. In tutorials difficulties would be solved. Problems would be given. Students would be given assignments in the form of questions. There will be two class tests/ and surprise test conducted during the tutorial classes.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1) Mathematics for Biological Science by Jagdish Arya & Ladner.1979. Prentice Hall
2) Numerical methods by E. Balguruswamy. 1999. Tata Mc Graw Hill Publications Pvt Ltd.
3) Higher Engineering Mathematics B. S. Grewal, Khana Publication, New Delhi. 2003
4) Applied Mathematics P. N. Wartikar, Pune Vidaypeeth, Griha Prakashan, Pune
5) Introductory Methods of Numerical analysis, S. S. Sastry, Prentice Hall of India, New Delhi.2005.

TITLE OF THE COURSE: INTRODUCTION TO ELECTRONICS AND INSTRUMENTATION ENGINEERING

COURSE CODE: BT 101	**L**	**T**	**P**	**Hr**	**C**
MARKS: 100	**3**	**0**	**2**	**5**	**4**

OBJECTIVE OF THE COURSE:

Objective of the course is to familiarize students with the basic concepts of electronic engineering and electronics engineering.

This knowledge would help them in applying them in various biological techniques. Also the Knowledge of this subject will form a profound base for the instrumentation used in various advanced courses of Biotechnology and Bioinformatics.

LEARNING OUTCOME

At the end of this course student should be able to understand the engineering electronics and instruments.

PREREQUISITES

Since the course is very basic in nature, knowledge of physics and mathematics is required

COURSE DESCRIPTION

Sr. No.	Topic	Description	Hrs
	Electronics		
1	Introduction to Electronics	History and Scope of Electronics	1
2	Electronic Signals	Characteristics of electrical Signals	2
3	Electronic devices	Input & output relations, Simple electronics devices: Resistors, Capacitors, Inductors, Bias voltage.	6
4	Electronic circuits	Simple circuits for amplification, power supplies and for wave shaping .Amplification: Concept of amplification, type of amplifiers, OP-Amp and its characteristics, simple applications (Adder, substracter, integrator, differentiator), and filters.	8
5	Digital electronics	Number systems, binary codes, Boolean algebra, arithmetic operations, logic functions, combinational and sequential logic, different OR, AND, NOR, NAND, EXOR gates, flip flops, registers and counters.	8
6	Microprocessor	Introduction to Microcomputer and Microprocessor and block diagram, CPU and ALU, Timing and control unit and Block diagrams instruction and data formats.	4
7	Interfacing peripherals and applications	A to D converters, DAC, Resolution, speed, types	4
	Instrumentation		
1	Introduction	Introduction to instrumentation and definitions	1
2	Sensing elements	Types of sensors, electrodes and transducers	1
3	Electrodes:	Electrolyte interface, Sensing elements, Detectors, Signal conducting circuits, circuit models, suitability of electrode	4
		potentials, circuit models, external and internal electrodes, pH, pO2 and pcO2 electrodes, connectivity.	
4	Transducers	Definitions, types, displacement pressure, temperature, vibration, ultrasound etc, calibration, sensitivity and resolution, Flow transducers & Rota meter, venturi, orifice Plate	6
	Total Number of Lectures		**45**

METHODOLOGY

The course would be taught through lectures, demonstrations and practicals.

EVALUATION SCHEME (THEORY)

Examination	Duration	Marks
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60

Total **100**

BOOKS RECOMMENDED:

1. Digital Electronics by R. K. Jain Jain, Tata Mc Graw Hill, 3rd Edition, 2003.
2. Grob"s Basic Electronics – Mitchel E. Schultz.., Tata McGraw Hill, 10th Edition 2006.
3. Principals of electronics By V. K. Mehta , S. Chand Publisher , 1st Edition , 2010.
4. Op Amps and linear integrated circuits By Ramakant Gaikwad, McGraw –Hill publishing company limited, 4th Edition, 2002.
5. Integrated Electronics By Millman and Halkias. Mcgraw-Hill, 3rd Edition 1972 .
6. The Z 80 Microprocessor By Ramesh Gaonkar,. Penram Publisher , 3rd Edition, 1988.
7. A course in electrical and electronic measurements and instrumentation by A. K. Sawhney, Puneet Sawhney, Rai publisher, 1996.

PRACTICALS IN BASIC CONCEPTS IN ELECTRONICS AND INSTRUMENTATION ENGINEERING (2 Hrs. PER WEEK) MARKS 50

COURSE DESCRIPTION

Sr. No.	Name of the Practical	Time (Hrs.)
1.	Study of diode characteristics	4
2.	Study of operational Amplification 741 i) Inverting Amplifier ii) Non inverting amplifier	4
3.	Study of operational Amplification 741 i) Inverting Amplifier ii) Non inverting amplifier	4
4.	Study of Ph meter circuits & working	4
5.	Study of Ph electrodes & role of electrolytes	4
6.	Study of Conductivity meter, circuits & working	4
7.	Study of Conductivity meter electrodes & functions	4
8.	Pressure development & vibration DVPT	4

EVALUATION SCHEME PRACTICAL TRAINING

Examination	Duration	Marks
Minor test 1	1 hour	15
Continuous Assessment		05
Major test at the end of semester	2.5 hours	30
Total		**50**

TITLE OF THE COURSE: INTRODUCTION TO COMPUTERS AND COMPUTER ORGANIZATION

COURSE CODE: BI 101 **L T P Hr C**

MARKS: 150 **3 1 2 6 5**

OBJECTIVE OF THE COURSE:

The objective of the course is

To familiarize the students with computers and programming concepts.

To introduce basic concepts in: hardware, software and its implementation.

To introduce concepts of Networking, World Wide Web (Internet), Telnet, FTP, Etc.

Programming module is intended to familiarize them with computer logic and solution of real world problems using computers.

LEARNING OUTCOME

At the end of this course student would be able to understand basic principles of Computing, Networking and Programming.

PREREQUISITES

The course is of introductory nature and there are no prerequisites for the course.

COURSE DESCRIPTION

Sr. No.	Topic	Description	Hrs
1	Basic Organization of Computers	Introduction to Computer, historical background, Block diagram of a Computer, parts of Computer, their integration and function .	3
2	Hardware	Computer hardware, different types of I/O devices, motherboard, BIOS, Primary and Secondary Memory, different types of Printers, Storage Media, their sizes and use. Computer booting, loading operating system (OS) and execution. execution cycle (fetch and execute)	5
3	Software	Introduction to software, Application software (Packaged & Customized) and System Software (OS & Utilities). Complier & Interpreter, software loading and execution, Task management by OS for Application Software.	4
4	Types of Computer	Difference between Super Computer, Mini Computer and a Micro Computer and their applications.	2
5	Data representation in Computers	Introduction to Binary, Octal and Hexadecimal Number System	2
6	Binary Arithmetic	Basic Binary Arithmetic i.e. Addition, Subtraction,	4

		Multiplication, Division, Compliments, Subtraction by means of 2"s Compliment, Logical operations on Binary (AND, OR, NOT)	
7	Transforming Data into Information	Distinction between data and information their represented in computers.	1
8	Operating System & Interface	OS, tasks performed by OS , Introduction to DOS, Windows and Linux/UNIX	2
9	Networking Fundamentals	Computer networks (n/w), various terms associated with networks, topologies for n/w, different mediums, hardware and technologies associated with n/w, n/w protocols, introduction OSI layers, TCP/IP stack, services provided by TCP, IP Addressing	5
10	Client Server Architecture	Introduction to client, server, client-server architecture	1
11	LAN/WAN/MAN/CAN	Introduction to LAN/WAN/MAN and CAN, and their use. Different technologies used to implement them.	2
12	Telnet, FTP	History and use of Telnet based on UNIX terminals. FTP and its use. TFTP. Case study how to setup Telnet and FTP servers on LINUX	3
13	Internet, WWW, HTML	Internet, DNS and name resolution. History of Internet. IP Addressing scheme and its relation to the Internet. Basic HTML tags	4
14	Introduction to C and Programming in high level language	Data types, Decision control, Loop control, Case control, Functions, Arrays and Strings	8
Total Number of Lectures			**46**

METHODOLOGY

The course would be taught through lectures, demonstrations and practical classes.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

- Introduction to Computers by Norton
- Fundamentals of Computers by Raja Raman
- Computers Fundamentals by Sinha
- Introduction to Computers by Subramanian.

PRACTICAL IN INTRODUCTION TO COMPUTERS AND COMPUTER ORGANIZATION
(2 Hrs. PER WEEK) MARKS: 100

1. Introduction to various components of a computer.

2. Assignments on Microsoft Word

3. Assignments on Microsoft Power Point

4. Assignments on Microsoft Excel

5. Assignments on Microsoft Access

6. Learning the MS-DOS commands

7. Creating web pages in HTML (Basic formatting tags, style attribute, adding image, Lists)

8. Creating web pages in HTML (Table, Hyperlink to text and image, frames)

9. Basic C programs (5 programs)

10. C programs on Decision control (5 programs), Loop control (5 programs), Function (3 programs), Arrays (2 programs) and String (2 programs).

TITLE OF THE COURSE: COMMUNICATION SKILLS

COURSE CODE: HU-101	**L T P Hr C**
MARKS: 100	**1 2 0 0 0**

OBJECTIVE:

The objective of this course is:

To develop communication skills amongst students,

To familiarize students with communication elements,

To acquaint them with the Scientific reading , Writing & Presentation skills.

To familiarize students with concepts in plagiarism.

LEARNING OUTCOME:

At the end of the course, the students will be able to use different forms of communication, produce good document in science and avoid plagiarism of any form.

PREREQUISITES:

This is an introductory course and there are no prerequisites.

COURSE DESCRIPTION :

Sr. No.	Topics	Detail syllabus	No. of Lectures
1	Introduction to communication	Elements, definitions, scope of communication and communication as part of science	02
2	Communication elements	Verbal and nonverbal communications. Principles of effective communication, Oral presentations, Barriers to communications, Use of good English: Introduction to English Grammar: parts of speech, use of articles & prepositions, use of correct tense, spellings etc.	02
3	Scientific reading, writing & presentation	Introduction to scientific reports and writings? Compilation of experimental data, Communication methods in science, Use of good English in science, Examples of Scientific and Unscientific writing. Process of Scientific writing: thinking, planning, rough drafts and revising context. Different styles of scientific writing APA, MLA or Chicago. Writing papers, reviews and Bibliography	08
4	Plagiarism	Introduction to Plagiarism Examples of Plagiarism	04
Total Lectures			16

METHODOLOGY

The course will be covered through lectures supported by tutorials. During tutorials, students would

be made to present scientific and nonscientific data/information using different communication skills. They would be corrected as and when needed and taught how to improve their skills in reading, writing and data presentation.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

Technical Writing and Professional Communication- Thomas Huckin and Lesle Oleson London William Collins and Sons.

Business English and Communication- By Lyn Clark and Zimmer. New York Mcgraw Hill.

Developing Communications-Mohan K

TITLE OF THE COURSE: DISASTER MANAGEMENT

COURSE CODE: HU-101 **L T P Hr C**

MARKS: 100 **2 0 0 2 2**

LEARNING OBJECTIVE:

To provide student an exposure to disasters, their significance and types.

To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction

To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)

To enhance awareness of institutional process in the country and

To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity

COURSE DESCRIPTION :

Sr. No.	Topics	Detail syllabus	No. of Lectures
1	Introduction to Disasters	Concepts and definitions (Disaster, Hazard, Vulnerability, Resilience, Risks)	04
2	Disasters: Clarification, Causes, Impacts (Including social, economic, political, environmental, health, psychosocial, etc.)	Differential impacts – in terms of caste, class, gender, age, location, disability, Global trends in disasters urban disasters, pandemics, complex emergencies, Climate Change	08
3	Approaches to Disasters Risk reduction	Phases, Culture of safety, prevention, mitigation and preparedness, community based DRR, Structural – nonstructural measures, roles and responsibilities of community, Panchayati Raj Institution / Urban Local Bodies (PRIs/ULBs), states, centre and other Satke-holders	08
4	Inter-relationship between Disasters and Development	Factor affecting Vulnerabilities, differential impacts, impact of Development project such as dams, embankments, changes in Land-ude etc. Climate Change Adaptation. Relevance of indigenous knowledge, appropriate technology and local resources	04
5	Disaster Risk in India	Hazard and Vulnerability profile of India Components of Disaster Relief : Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional Arrangements (Mitigation, Response and Preparedness, DM Act and Policy, Other related policies, Plans, programmes and legislation)	06
6	Project Work	Field Work, Case Studies	06
Total Lectures			36

METHODOLOGY

The course will be covered through lectures& classroom discussion.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1. Alexander David, Introduction in "Confronting Catastrophe", Oxford University Press, 2000.
2. Andharia J. Vulnerability in Disaster Discourse, JTCDM, Tata Institute of Social Science working Paper no. 8, 2008
3. Blaikie, P, Cannon T, Davis I, Wisner B 1997, At Risk Natural Hazards, Peoples, Vulnerability and Disasters, Rutledge.
4. Coppola P Damon, 2007, Introduction to International Disaster Management,
5. Carter, Nick 1991, Disaster Management : A Disaster Manager"s Handbook, Asian Development Bank, Manila Philippines.
6. Cuny, F.1983, Development and Disasters, Oxford University Press
7. Document on World Summit on Sustainable Development 2012
8. Govt. of India : Disasters Management Act 2005. Government of India, New Delhi
9. Government of India, 2009, National Disasters Management Policy.
10. Gupta Anil K, Sreeja S. Nair, 2011, Environmental Knowledge for Disasters Risk Management, NIDM, New Delhi
11. Indian Journal of Social Work 2002, Special Issue on Psychosocial Aspects of Disasters, Vol. 63, Issue 2, April
12. Kapur, Any & Other 2005 : Disasters in India Studies of Grim reality, Rawat Publishers, Jaipur

SEMESTER II

Course Code	Course Name	L	T	P	Hr	Cr	Marks
BS 201	Physical Chemistry	3	1	0	4	4	100
BS 202	Introduction to Bio-molecules	3	0	4	7	5	200
BS 203	Biostatistics	3	1	0	4	4	100
BT 201	Engineering Mechanics	3	0	2	5	4	150
BI 201	C Programming	3	0	4	7	5	200
BS 204	Environmental Sciences	3	0	2	5	4	150
Total		**18**	**2**	**12**	**32**	**26**	**900**

TITLE OF THE COURSE: PHYSICAL CHEMISTRY

COURSE CODE: BS-201 **L T P Hr C**

MARKS: 100 **3 1 0 4 4**

OBJECTIVE

The objective of this course is to familiarize the student with the concepts and physical principles involved in Biotechnology.

They would learn topics such as: Basic concepts and principles of Osmosis, Dialysis, Viscosity, Colloids, Phase rule, Acid-bases, Photochemistry etc.

They would be made to understand the nature of Chemical Bonding, Atomic orbitals and Bioenergetics its relevance in stabilization of the molecules.

They would also learn Basic principles of radioactive isotopes.

LEARNING OUTCOME

At the end of the course, the students will be able to use different Biophysical techniques and principles used in Biotechnology.

PREREQUISITES

This is the first introductory course and there are no prerequisites.

COURSE DESCRIPTION

Sr. No.	Topics	Detail syllabus	No. of Lectures
1	Basic concepts and principles	1. Osmosis- Diffusion, Osmotic Pressure, Theories of Osmosis. 2. Dialysis-Introduction, Technique, reverse dialysis, Glass fiber dialysis. 3. Viscosity –Introduction & Types of viscometer. 4. Colloids-Lyophilic & Lyophobic sols, Optical properties, Electrical properties of sols, Gold number. Donnan Equilibrium. 5. Phase rule-Phase, Components & Degree of freedom .Derivation of Phase rule. Phase diagram. Water system. 6. Acid-bases- Three concepts of acids & bases, P^H meter & types of electrodes ,Buffer solution, Acid base indicator , Law of mass action, Numerical. 7. Photochemistry –Photochemical reactions, Light absorption, Laws of photochemistry, Photo physical processes, Einstein equation.	2 2 2 3 3 5 3
2	Chemical bonds and their roles in stabilizing the bio-molecules	1. Chemical Bonding- Different types of bonds & bond characteristics Ionic Bond, Covalent bond, coordinate covalent bond, Metallic bond. 2. Atomic orbital"s-Atomic orbital theory, Hybrid orbital"s (sp, sp2, sp3), molecular orbital theory. 3. Bioenergetics- First & Second laws of Thermodynamics, Internal energy, Enthalpy, Entropy, concept of free energy, Standard free energy change of a chemical reaction, ATP & high energy phosphates compounds. Chemical equilibrium constant, Nernst equation.	3 3 7
3	Basic	1. Isotopes in Biology- Properties, Half-life, Radioactive decay,	4

	principles of	production of isotopes, synthesis of labeled compounds, Interaction of	
	radioactive isotopes	radioactivity with matter. 2. Measurement of radioactivity-Methods based on Gas ionization (Ionization chamber, Proportional counter, Geiger counter), Photographic methods, Methods based on Excitation (Liquid & solid Scintillation counting), Quenching. 3. Tracer technique-Advantages & limitations, Labeling procedures. 4. Use of Isotopes-Tritium, Carbon-13, Nitrogen-15,Oxygen -18,Carbon-14, Sodium-24, Phosphorus-32, Sulphur-35.	6 3 2
Total lectures			48

METHODOLOGY

The course will be covered through lectures supported by tutorials. In tutorials, students would be made to analyze data related to different Biophysical techniques. They would be also made to compute molecular properties based on bonds.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1) Physical Chemistry by Atkins Peter and Paula Julio De 7th ed.2010 Oxford University Press New Delhi.
2) Principles of Physical Chemistry by David Frifelder. Jones & Bartlett Publishers; 2nd Sub edition (1984).
3) Essentials of Physical Chemistry B.S. Bahl & Arun Tuli. S Chand & Co. 2000. Biophysical Chemistry by Avinash Upadhyay, Kakoli Upadhyay & Niamalendu Nath. Himalayan Publishing House. 2005.

OURSE NAME: INTRODUCTION TO BIO MOLECULES
COURSE CODE: BS 202 **L T P Hr Cr**
MARKS: 200 **3 0 4 7 5**

OBJECTIVE OF THE COURSE:

The objective of the course is to familiarize the students with the basic concepts regarding chemical structure (2D-structure), three dimensional (3-D) structures and functions of Biomolecules: carbohydrates, lipids, proteins and nucleic acids.

This knowledge would enable them to understand structure function relationship.

Knowledge of this subject will form a profound base of forthcoming subjects like metabolism, Enzymology, molecular biology etc.

LEARNING OUTCOME

At the end of this course student should be able to understand structural features of Biomolecules and their relationship to their interactions.

PREREQUISITES

Since the course is very basic in nature there are no prerequisites.

COURSE DESCRIPTION

Sr. No.	Topic	Description	Hrs
1	Introduction to bio-molecules	Functional groups, 3D (three dimensional) structure, geometric and stereo-specificity.	4
2	Carbohydrates	Classification and stereochemistry, Structural properties, functional importance of storage and transport of structural polysaccharides: sucrose, starch, glycogen, cellulose, pectin, hemicelluloses, chitin, muco-polysaccharides etc., Biosynthesis and role of N-linked and O-linked glycoproteins and proteoglycans.	6
3	Lipids	Structure, classification and properties of lipids, Lipid assembly, model membranes, formation of liposomes and drug targeting	5
4	Vitamins and Growth factors	Classification, role, estimation deficiency and diseases	4
5	Proteins	Amino acids: classification, structure and properties, Structural features of Proteins: Primary, secondary, tertiary and quaternary structure, Motives and domains. Structural stabilization of proteins Protein function.	15
6	Nucleic Acids	Nitrogen bases: nucleosides and nucleotides. Historical basis of DNA structure Fibre X-ray diffraction and single crystal X-ray diffraction study	10

		on DNA A,B & Z form of DNA	
		Local distortion in DNA structure Structure of Nucleozome Structure of RNA Properties of nucleic acids	
Total number of lectures			48

METHODOLOGY

The course would be taught through lectures, demonstrations and practicals.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1) Text Book of Biochemistry by Nelson and Cox
2) Biochemistry By Lubert Stryer Edn 3rd, 4th, and 5th.
3) Biochemistry by Mathews.
4) Nucleic acid structure W. Sanger
5) Protein structure Schulz
6) Protein Structure, Function & Architecture, Brandon & Tooze

PRACTICAL IN INTRODUCTION TO BIO-MOLECULES (4 Hrs. per week) Marks 100

LIST OF PRACTICALS

1) Preparation of buffer solution.& demonstration of buffering action.
2) Determination of λmax & verification of Beer-Lambert‟s law; Determination of molar extinction co-efficient.
3) Preparation & standardization of laboratory reagents.
4) Qualitative detection of carbohydrates (Molish test, Benedicts test, Fehling‟s test, lead acetate test, inversion test, Seliwanoff‟s test, Osazone test).
5) Titration curve of Glycine.
6) Qualitative detection of Lipids (solubility test, Acroline test (for glycerol), and test for cholesterol
7) Quantitative detection of Proteins
8) Introduction to molecular Graphics software RasMol
9) Understanding Protein Structure using RasMol
10) Understanding DNA structure using RasMol

EVALUATION SCHEME PRACTICAL TRAINING

Examination	**Duration**	**Marks**
Minor test 1	1 hour	30
Continuous Assessment		20
Major test at the end of semester	3 hours	50
Total		**100**

TITLE OF THE COURSE: BIOSTATISTICS

COURSE CODE: BS-203	**L**	**T**	**P**	**Hr**	**C**
MARKS: 100	3	1	0	4	4

OBJECTIVE

The objective of the course is to familiarize the student with basic concepts in mathematics & statistics.

LEARNING OUTCOME

At the end of the course, the students will have sufficient understanding of different mathematics and statistical tools used in Biotechnology. This knowledge would be applicable in different industries

PREREQUISITES

Students should be familiar with school level mathematics to take up this course. In case they do not have mathematics at the twelth level they should have cleared the core mathematics in the first semester.

COURSE DESCRIPTION

Sr. No.	**Topics**	**Lectures Required**
1	Determinant & Matrices : 1.2 Determinant 1.2.1 Definition & expansion of determinant of order 2 and 3 1.2.2 Cramer‟s rule to solve simultaneous equations in 2 and 3 unknowns.	04
	1.2 Matrices: 1.2.1 Definition of Matrix of order mxn and types of Matrices. 1.2.2 Algebra of Matrices. 1.2.3 Transpose of a Matrix 1.2.4 Minor & cofactor of an element of a matrix 1.2.5 Adjoin of a Matrix. 1.2.6 Inverse of a Matrix by adjoin method 1.2.7Solution of simultaneous equations containing 2 and 2 unknowns by Matrix inversion method.	10
2	Complex Number : 2.1 Definition of Complex number, Cartesian, polar, exponential forms of complex number. 2.2 Algebra of Complex Number 2.3 De - Moiyre‟s theorem (without proof) and simple problems. 2.4 Euler‟s form of circular functions, Hyperbolic functions and relations between circular hyperbolic functions.	04
3	3.1 Numerical Solution of Algebraic Equations : 3.1.1 Bisection Method 3.1.2 Regula – Falsi Method 3.1.3 Newton-Rophson Method	06
	3.2 Numerical Solution of Simultaneous Equations : 3.2.1 Gauss elimination method. 3.2.2 Iterative Methods Gauss Seidal and Jacobi‟s Method.	04
	3.3 Numerical Methods : 3.3.1 Solution of Linear & Non-Linear equation by i) Trapezoidal Rule ii) Simpson‟s Rule	02

4	Set Theory and Probability 4.1 Set Theory	04
	4.2 Probability : 4.2.1 Definition of random experiments, sample space, events, occurrence of event and types of events. 4.2.2 Definition of probability, addition and multiplication theorem of probability.	
	4.3 Probability Distribution 4.3.1 Binominal Distribution. 4.3.2 Poisson‟s Distribution. 4.3.3 Normal Distribution.	04
5	Statistics 5.1 Frequency Distribution : 5.2 Measures of Control tendency (For Raw, Ungroup & group Data) 5.2.1 Mean 5.2.2 Median 5.2.3 Mode	 01 04
	5.3 Measures of Dispersion 5.3.1 Rauge, Variance, Coefficient of Cariance. 5.3.2 Standard Derivation.	01
6	Correlation & Regression	
	6.1 Correlation 6.2 Regression	01 01
7	Chi square Test for independent attribute in RXC Table (Special case of 2x2 Table	01
8	F-Test	01
	Total Lectures	48

METHODOLOGY

The course will be covered through lectures supported by tutorials. In tutorials difficulties would be solved. Problems would be given. Students would be given assignments in the form of questions. There will be two class tests/ and surprise test conducted during the tutorial classes.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60

BOOKS RECOMMENDED:

Fundamentals of Statistic by S. G. Gupta. 17th Ed. Himalaya Publications 2000
Statistical Method in Biology by Bailey IIIrd Ed. University of Cambridge Press 1995.

Statistics from biologist by Campbell R.C. Ed. 3. Cambridge University Press1989

Fundamentals of Mathematical Statistics S. C. Gupta and Kapoor, S. C. Hand publication, New Delhi .1987.

NAME OF THE COURSE: ENGINEERINGMECHANICS
COURSE CODE: BT 201 **L T P Hr C**
MARKS: 150 **3 0 2 5 4**

OBJECTIVES:

The objective of the course is to familiarize the students with the basic concepts of engineering mechanics.

LEARNING OUTCOME:

At the end of the course the students will have sufficient knowledge of mechanical engineering techniques which will help them to implement them in the life sciences.

PREREQUISITES:

Since the course is technical in nature the students must have the basic knowledge of Math sans Physics.

COURSE DESCRIPTION:

Sr. No.	Topic	Description	Hrs
1	Basics of mechanics	Introduction, Units and Dimensions Laws of Mechanics Vectors – Victorian representation of forces and moments, Vector operations.	5
2	Statics of particles	Coplanar Forces, Resolution and Composition of forces Equilibrium of a particle, Forces in space Equilibrium of a particle in space, Equivalent systems of forces Principle of transmissibility, Single equivalent force.	8
3	Equilibrium of rigid bodies	Free body diagram Types of supports and their reactions Requirements of stable equilibrium, Equilibrium of rigid bodies in two dimensions, Equilibrium of rigid bodies in three dimensions.	8
4	Properties of surfaces and solids	Determination of Areas and Volumes First moment of area and the centroid second and product moments of plane area Parallel axis theorems and perpendicular axis theorems Polar moment of inertia Principal moments of inertia of plane areas Principal axes of inertia Mass moment of inertia & relation to area moments of inertia.	7
5	Friction	Frictional Force Laws of Coloumb friction Simple Contact friction	5

		Rolling Resistance & Belt Friction	
6	Dynamics of particles	Displacement, Velocity, acceleration & their relationship Relative motion	8
		Curvilinear motion Newton's Law of Motion Work Energy Equation of particles. Impulse and Momentum Impact of elastic bodies	
	Total Lectures		42

METHODOLOGY:

The course would be taught through lectures, demonstrations and practicals

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60

BOOKS RECOMMENDED:

1. Beer and Johnson, “Vector Mechanics for Engineers ", Vol. 1 " Statics “and “Dynamics ", Vol. 2. McGraw Hill International Edition, 1995.
2. Merriam, “Engineering Mechanics ", Vol.1 “Statics” and Vol.2 “Dynamics” 2nd Edition, Wiley International, 1988.
3. Rajasekaran S. and Sankara Subramanian, G., “Engineering Mechanics – Statics and Dynamics ". Sangam Books Ltd., 1999.
4. Irving, H., Shames, “Engineering Mechanics - Statics and Dynamics ", 3rd Edition, Prentice-Hall of India Pvt.Ltd,, 1993.
5. Timoshenko and Young, “Engineering Mechanics ", 4th Edition, McGraw Hill, 1995.
6. M cLean, “Engineering Mechanics“ ", 3rd Edition, SCHAUM Series, 1995.
7. Mokashi, V.S., “Engineering Mechanics ", Vol.1 “Statics” and Vol.2“Dynamics ", Tata McGraw Hill Books, 1996.

PRACTICALS IN ENGINEERING MECHANICS (2 Hrs. Per Week) 50 Marks

LIST OF EXPERIMENTS:

Sr. No.	Name of the practical	Time (Hrs)
1.	Polygon law of coplanar forces.	4
2.	Non concurrent non parallel (general)	4
3.	Bell crank lever	4
4.	Support reaction for beam	4
5.	Simple / compound pendulum	4
6.	Inclined plane (to determine coefficient of friction)	4
7.	Collision of elastic bodies (Law of conservation of momentum)	4
8.	Moment of inertia of fly wheel	4
9.	Screw friction by using screw jack.	4

EVALUATION SCHEME PRACTICAL TRAINING

Examination	**Duration**	**Marks**
Minor test 1	1 hour	15
Continuous Assessment		05
Major test at the end of semester	3 hours	30
Total		**100**

NAME OF THE COURSE: C PROGRAMMING

COURSE CODE: BI 201	**L T P Hr C**
MARKS: 200	**3 0 4 7 5**

OBJECTIVE OF THE COURSE:

The objective of the course is to familiarize the students with programming concepts and apply these concepts to the real world problems.

LEARNING OUTCOME

At the end of this course student should be able to understand how Programming in C Language is done.

PREREQUISITES

Students should have obtained at least 50% marks in the course: Introduction to computers and programming concepts.

COURSE DESCRIPTION

Sr. No.	Topic	Description	Hrs
1	Introduction to C	An overview of C C expressions Operators	2
2	Data types:	Integers long and short Integers, signed and unsigned Chars, signed and unsigned Floats and doubles	2
3	The Decision controls in C:	The „if" statements within *if* Multiple statements within *if* The „*if-else'* statement The ! operator Hierarchy of Logical Operators The Conditional Operators	4
4	Loop control structures:	Loops, The „*While'* Loop, The „*for'* loop Nesting of Loops Multiple Initializations in the for loop The „*Odd'* Loop, The „*break'* statement The „*continue'* statement, The „*do-while'* statement	5
5	Case control structures:	Decisions using switch The *goto* statement	1
6	. Functions	What is a function? Why Use Functions Passing values between functions, Scope of functions	7
7	Array & strings:	Single-dimension Arrays, Generating a Pointer to an array, Passing single-dimension arrays to functions Strings Two-dimensional Arrays, Arrays of Strings Multidimensional Arrays, Array Initialization Variable-Length arrays	6
8	Puppeting on	What are Strings?	4

	strings:	More about Strings Pointers and Strings Standard Library String functions Two-Dimensional Array of Characters Array of pointers to Strings	
		Limitations of Array of Pointers to String	
9	Pointers:	What are pointers? Pointer variables The pointer Operators Pointer Expressions Pointers and Arrays Initializing Pointers Pointers to Functions C‟s Dynamic Allocation Arrays Problems with Pointers	6
10	I/O in C:	Types of I/O Console I/O Functions Disk I/O functions I/O under windows.	4
11	Structures, Union, Enumeration & type definition:	Structures Arrays of structures Passing structures to functions Structure Pointers Unions Bit-Fields Enumerations Typedef	4
Total number of lectures			45

METHODOLOGY

The course would be taught through lectures, practical assignments by giving biological problems, quizzes, programming competition and practical classes.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60

RECOMMENDED BOOKS

1) The complete reference of C 4th edition by Herbert Schildt
2) Let us C By Yashwant Kanitakar
3) C- programming by Balaguruswamy
4) Data Structure by Kanitakar
5) Pointers in C by Kanitakar, Abhyankar
6) Data Structure C and C++ by Taneumbam.
7) C programming by Keinighan and Ritchite

PRACTICAL IN C PROGRAMMING (4 Hrs. Per Week) MARKS 100

LIST OF PRACTICALS

1. 8 programs in basic programming in C
2. 8 programs using Decision Controls in C
3. 8 programs using Loop and Case Control structure
4. 8 programs illustrating use of function
5. 10 programs illustrating use of arrays and Structure
6. 5 programs using Pointers
7. 10 programs for Biological application
   - Finding complement of DNA
   - ORF finding
   - Inverted Repeats
   - Motif finding
   - Translation
   - Transcription etc.

EVALUATION SCHEME PRACTICAL TRAINING

Examination	**Duration**	**Marks**
Minor test 1	1 hour	30
Continuous Assessment		10
Major test at the end of semester	3 hours	60
Total		**100**

COURSE CODE: BS 204

COURSE NAME: ENVIRONMENTAL SCIENCE **L T P Hr Cr**

MARKS: 150 **3 0 2 5 4**

OBJECTIVE OF THE COURSE:

The objective of the course is to familiarize the students with the problems related to environmental pollution, loss of natural resources, climate change, solid waste disposal, biodiversity and social issues due to environmental degradation. It is also important for them to develop clear understanding of biodiversity and its conservation.

LEARNING OUTCOME

At the end of this course student should be able to understand importance and need of sustainable development.

PREREQUISITES

Since the course is very basic in nature there are no prerequisites.

COURSE DESCRIPTION

Seq. No	Topic	Description	Hrs
1	Natural Resources and associated problems	Land, water, food, forest, mineral and energy resources, their use, over-exploitation and conservation.	8
2	Ecosystems	Concept, structure and function of ecosystem. Producers, Consumers and decomposers, Energy flow in ecosystem. Ecological succession and pyramids, Food chains, food webs and ecological pyramids. Characteristic features of Forest, Grassland, Desert and Aquatic Ecosystems.	6
3	Environmental Pollution	Definition, Causes, Effects and control measures of Air, Water, Soil, Noise, thermal and Marine Pollution. Nuclear hazards and Solid waste management. Role of an individual in prevention of Pollution and Pollution case studies	8
4	Biodiversity and its Conservation	Genetic, species and ecosystem diversity. Value of Biodiversity: social, ethical, aesthetic and option values. India as a mega diversity nation. Hotspots of Biodiversity. Threats to Biodiversity: Habitat loss, poaching of wildlife, man wild life conflicts. Endangered and Endemic species of India. Conservation of Biodiversity: in situ and ex situ conservation of biodiversity	8
5	Social Issues and the Environment	Urban problems related to energy. Water conservation, Rain water harvesting, and watershed management. Resettlement and rehabilitation of people. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, Wasteland reclamation: Case studies. Environment protection Acts: Air (Prevention and control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife protection	7

		Act. Forest Conservation Act. Issues involved in enforcement of	
		environmental legislation. Environmental ethics: Issues and possible solutions. Public awareness	
6	Human Population and Environment	Population growth. Population explosion- family welfare programs. Environment and Human Health. Human Rights. HIV/ AIDS and Women and Child welfare. Role of Information and Technology in environment & human health.	6
7	Field work	Visit to a local area to document environmental assets River/forest/grassland/hill/mountain Visit to local polluted site- Urban/Rural/Industrial/Agricultural Study of Common plants, insects, birds. Study of simple ecosystems- pond, river, hill slopes, etc	5
Total number of lectures			48

METHODOLOGY

The course would be taught through lectures, demonstrations and field work. The students will undertake field trip to sensitive hot spots in Western Ghats to observe and collect samples of Flora and Fauna for on the spot studies, collection and identification of specimens. These would be evaluated on the basis of report presented by the students

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60

BOOKS RECOMMENDED:

- Agarwal, K.. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
- Bharucha Erach, The Biodiverstiy of India, Mapin Publishing Pvt. Ltd. Ahmedabad-380013, India, Email: mapin@icenet.net (R)
- Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill
- Inc.480p Cark R.S., Marine Pollution, Clanderson press Oxford (TB)
- Cunnigham, W.P.Cooper, T.H. Gorhani, E & Hepworth M.T. 2001

Teaching hours per week and credits for practicals only: 2 Hr 1 Cr
Marks for Practicals: 50

Sr. No.	**Name of the experiment**	**Learning objective**	**Literature/ Weblinks for reference and videos**
1.	To study physicochemical properties of soil (pH, conductivity, moisture content, carbonate content, salinity, porosity)	To know about variations of soil properties and to determine their suitability for a particular purpose	Bandyopadhyay PC. Soil Analysis, Gene-Tech books, New Delhi, India. 2007.
2.	Identification and enumeration of zooplanktons and phytoplanktons as indicator of water pollution	To differentiate polluted and non-polluted sites based on plankton data	Leo ML, Nollet, Leen SP, De Gelder. Handbook of Water Analysis, 3rd ed. CRC Press, United Kingdom, Publisher: Leen

			S. P. De Gelder, 2013.
3.	To identify and characterize normal microflora in air, water and soil	To know presence of normal microflora within environment.	Cappuccino JG & Sherman N. Microbiology, A laboratory Manual , 10th ed. Dorling Kindersley, Pearson Benjamin Cummings, 2014.
4.	Determination of MPN from water samples	Determine potability of water	Leo ML, Nollet, Leen SP, De Gelder. Handbook of Water Analysis, 3rd ed. CRC Press, United Kingdom, Publisher: Leen S. P. De Gelder, 2013.
5.	Estimation of chlorine in drinking water using colorimetric method	Understanding of residual amount of chlorine in water as a health hazard	Leo ML, Nollet, Leen SP, De Gelder. Handbook of Water Analysis, 3rd ed. CRC Press, United Kingdom, Publisher: Leen S. P. De Gelder, 2013.
6.	Estimation of relative humidity of the atmosphere	To understand relationship between weather and humidity	Mudakavi JR. Principles and Practices of air pollution analysis. I K International Publishing House Pvt. Ltd., New Delhi, India, 2010.
7.	Estimation of dissolved oxygen in the given water sample	To understand importance of BOD and COD	Leo ML, Nollet, Leen SP, De Gelder. Handbook of Water Analysis, 3rd ed. CRC Press, United Kingdom, Publisher: Leen S. P. De Gelder, 2013.
8.	Study the effects of pollutants (e.g., heavy metals) on flora	To understand effect about pollution	Leo ML, Nollet, Leen SP, De Gelder. Handbook of Water Analysis, 3rd ed. CRC Press, United Kingdom, Publisher: Leen S. P. De Gelder, 2013.
9.	Determination of NO_2 from the atmosphere by Colorimetric method using high volume sampler (Optional)	To understand more about atmospheric condition	Mudakavi JR. Principles and Practices of air pollution analysis. I K International Publishing House Pvt. Ltd., New Delhi, India, 2010.
10.	Determination of K_2O value of soil by flame photometer (Optional)	To understand about Quality of soil	Bandyopadhyay PC. Soil Analysis, Gene-Tech books, New Delhi, India. 2007.

Internal evaluation will be based on following criteria

For practicals of 1 credit and 50 marks, internal evaluation will be for 20 marks with following break-up:

Practical: 10 marks

Attendance: 5 marks (above 80% attendance gets full marks)
Journal writing: 5 marks

SEMESTER III

Course Code	Course Name	L	T	P	Hr	Cr	Marks
BS 301	Analytical Techniques	3	0	4	7	5	200
BS 302	Cell Biology	3	0	2	5	4	150
BS 303	Microbiology	3	0	4	7	5	200
BS 304	Genetics	3	1	2	6	5	150
BS 305	Mammalian Physiology	3	1	0	4	4	100
BT 301	**Plant Physiology**	**3**	**1**	**0**	**4**	**4**	**100**
	Total	**18**	**3**	**12**	**33**	**27**	**900**

TITLE OF THE COURSE: ANALYTICAL TECHNIQUES

COURSE CODE: BS-301	**L**	**T**	**P**	**Hr**	**C**
MARKS: 100	**3**	**0**	**4**	**7**	5

OBJECTIVE OF THE COURSE:

The objective of the course is to create general understanding of microscopy, electrophoresis, X-ray crystallography, Infra-red spectroscopy, Ultra-violet spectroscopy, nuclear magnetic resonance spectroscopy, mass spectroscopy, CD & ORD spectroscopy. They would also understand the importance of analytical tools in biotechnology & its applications in various industries

LEARNING OUTCOME:

At the end of the course, the students will have sufficient scientific understanding of the basic concepts in instrumentation used in Biotechnology. This is essential because he would be using these techniques in forth coming semesters.

PREREQUISITES:

This is an introductory course. School level knowledge of physics is sufficient. There are no prerequisites.

COURSE DESCRIPTION

Sr. No.	Topics	Detail syllabus	No. of Lectures
1	Centrifugation	Introduction: Basic principles of sedimentation Types of centrifuges Design of centrifuges: Types of rotors Ultracentrifuge: Analytical and Preparatory	03
2	Colorimetry and Spectroscopy	Properties of electromagnetic radiations, interaction with matter. Ultraviolet spectroscopy: Origin of UV spectra, types of transition, chromophore & related terms, effect of conjugation, choice of solvent, instrumentation and applications Infra-red spectroscopy: Origin of infra-red spectra, modes of vibrations, instrumentation, sampling technique and applications Nuclear magnetic resonance spectroscopy: Origin of NMR, continuous wave spectrometer, chemical shifts, spin-spin coupling, Karplus equation & curve, anisotropic effect, compounds containing C^{13}, P^{31} & F^{19}, applications of NMR. Mass Spectroscopy: Origin, Instrumentation, types of ions produced, interpretation and applications of mass spectra GCMS, LCMS & MSMS	02 04 04 06 06
3	Chromatography	Introduction: Chromatography theory and practice. Paper chromatography. Thin layer chromatography.	09

		Ion exchange chromatography. Affinity chromatography. Partition chromatography.	
		Adsorption chromatography. Introduction to gas chromatography and HPLC. Permeation.	
4	Electrophoresis	General principle, support media. Agarose gels, polyacrylamide gels. SDS PAGE, 2D PAGE Pulsed field gel electrophoresis Iso-electric focusing Capillary electrophoresis	05
5	Introduction to x-ray crystallography and Diffraction	Introduction, origin of x-rays, Bragg‟s equation, instrumentation and applications of x-ray absorption, instrumentation and applications of x-ray diffractions	05
6	Introduction to ORD & CD	Theory & applications of ORD & CD, the octant rule,	04
Total Lectures			48

METHODOLOGY:

The course will be covered through lectures supported by tutorials and practicals. In tutorials, apart from the discussion on the topics covered in lectures, assignments in the form of questions will be given. Normally a students is expected to complete the assignment by himself, however if needed, difficulties will be discussed in the tutorial classes. There will be two class tests/ and surprise test conducted during the tutorial classes.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

Practical Biochemistry – Wilson and Walker.

A Biologist‟s guide to principle and techniques of practical biochemistry –Wilson and Golding.

Principles of Instrumentation-Skoog. Analytical Chemistry- Anand and Chatwal. Analytical Chemistry – David Friefelder Biophysical chemistry by Nath and Upadhyay. Spectrometric

analysis by P.N. Kalsi.

Instrumental methods of chemical analysis by Gurdeep Chatwal and Sham Anand.

PRACTICAL IN ANALYTICAL TECHNIQUES (4 Hrs. Per Week) MARKS : 100

LIST OF PRACTICALS

Teaching hours per week and credits for practicals: 4 hrs, 2 credits

Sr. No.	Name of the experiment	Learning objective	Literature/ Web links for reference and videos
	Lab orientation, acquaintance with infrastructure and instruments.	Developing competence and encourage hands on usage and maintenance of facilities and equipment's. SOPs and safety practices.	An introduction to practical Biochemistry, third edition by David T Plummer, Tata McGraw-Hill Edition
1.	Preparation of various common buffers such as Phosphate buffer saline (PBS), Tris buffer saline (TBS), Tris acetate buffer	To understand the preparation of various common buffers and its use in biological system, To understand the concept of molarity, normality etc., Measurement of pH, To understand, why a particular buffer is preferred for a particular range of pH	Laboratory manual in Biochemistry by J. Jayaraman, New Age International (P) Limited, Publishers An introduction to practical Biochemistry, third edition by David T Plummer, Tata McGraw-Hill Edition Calbiochem buffer booklet
2.	To study and understand the process of dialysis	Knowhow of preparation and usage of dialysis bag. Application of dialysis process, molecular weight cut off and desalting of proteins.	Physical Biochemistry by David Freifelder, Second Edition, W.H. Freeman and Company, New York Laboratory manual in Biochemistry by J. Jayaraman, New Age International (P) Limited, Publishers An introduction to practical Biochemistry, third edition by David T Plummer, Tata McGraw-Hill Edition

Sr. No.	Name of the experiment	Learning objective	Literature/ Web links for reference and videos
3.	Separation of various amino acids using paper chromatography and calculation of retention factor (R_f) value	To understand the principle of partition chromatography, technique of paper chromatography and calculation of R_f value of given unknown amino acids using the standard amino acids.	Physical Biochemistry by David Freifelder, Second Edition, W.H. Freeman and Company, New York Introductory Practical Biochemistry by S.K. Sawhney & Randhi Singh, Narosa Publishing House, Second Edition Laboratory manual in Biochemistry by J. Jayaraman, New Age International (P) Limited, Publishers
4.	Separation of various amino acids using Thin Layer chromatography (TLC) and calculation of Retention factor (R_f) value	To understand the principle of partition chromatography, techniques of thin layer chromatography and calculation of R_f value of given unknown amino acids using the standard amino acids.	Physical Biochemistry by David Freifelder, Second Edition, W.H. Freeman and Company, New York Introductory Practical Biochemistry by S.K. Sawhney & Randhi Singh, Narosa Publishing House, Second Edition Laboratory manual in Biochemistry by J. Jayaraman, New Age International (P) Limited, Publishers
5.	To study the elution profile of given proteins (e.g. BSA, ovalbumin, lysozyme) on Sephadex G-50 / G-100 column	1. To know the preparation of the matrix, column packing, calculation of the bed volume, void volume and flow rate etc. 2. To determine the elution profile of given protein by taking absorbance at 280 nm and to understand the principle of molecular-sieving. 3. Various application, desalting, protein separation etc.	Physical Biochemistry by David Freifelder, Second Edition, W.H. Freeman and Company, New York An introduction to practical Biochemistry, third edition by David T Plummer, Tata McGraw-Hill Edition Handbooks from GE Healthcare Life Sciences, Size Exclusion Chromatography Principles and Methods www.gelifesciences.com/handboos

Sr. No.	Name of the experiment	Learning objective	Literature/ Web links for reference and videos
6.	To study and determine the functioning of high performance liquid chromatography (HPLC)	1. To understand the principle of HPLC and functioning of the various parts of HPLC system. 2. To study the elution profile of the BSA using gel filtration column (on TSK-GEL gel filtration column from Tosoh Bioscience)	Physical Biochemistry by David Freifelder, Second Edition, W.H. Freeman and Company, New York
7.	Estimation of protein by various methods such as Lowry's and Bradford.	To understand the principle of method, preparation of calibration curve with standard protein and calculation of concentration of unknown protein sample.	Laboratory manual in Biochemistry by J. Jayaraman, New Age International (P) Limited, Publishers Introductory Practical Biochemistry by S.K. Sawhney & Randhi Singh, Narosa Publishing House, Second Edition An introduction to practical Biochemistry, third edition by David T Plummer, Tata McGraw-Hill Edition
8.	To find out the concentration of given bovine serum albumin (BSA) solution in mg/ml.	1. What is percent extinction coefficient? 2. What is the percent extinction coefficient of BSA and standard proteins? 3. How will you calculate the concentration of given protein solution using percent extinction coefficient in mg/ml?	Physical Biochemistry by David Freifelder, Second Edition, W.H. Freeman and Company, New York Laboratory manual in Biochemistry by J. Jayaraman, New Age International (P) Limited, Publishers Extinction Coefficients, A guide to understanding extinction coefficients, with emphasis on spectrophotometric determination of protein concentration, https://tools.thermofisher.com/content/sfs /brochures/TR0006-Extinction-coefficients.pdf

Sr. No.	Name of the experiment	Learning objective	Literature/ Web links for reference and videos
9.	To estimate the molecular weight of given protein using Sodium dodecyl sulfate - Polyacrylamide Gel Electrophoresis (SDS-PAGE)	1.To study the principle and technique of SDS-PAGE for the separation of proteins 2. To check the purity of the protein using SDS-PAGE 3. Preparation of the standard curve (using standard protein provided) for estimation molecular weight of protein.	Physical Biochemistry by David Freifelder, Second Edition, W.H. Freeman and Company, New York Laboratory manual in Biochemistry by J. Jayaraman, New Age International (P) Limited, Publishers Introductory Practical Biochemistry by S.K. Sawhney & Randhi Singh, Narosa Publishing House, Second Edition
10.	Centrifugation: Cell pelleting, sub-cellular fractionation of cell extract, handling of various type of centrifuges.	1. To understand the basics of centrifugation. 2. Demonstration of various type rotors, their function and use. 3. Demonstration of functioning of various types of centrifuges.	Physical Biochemistry by David Freifelder, Second Edition, W.H. Freeman and Company, New York

EVALUATION SCHEME PRACTICAL TRAINING

Examination	**Duration**	**Marks**
Minor test 1	1 hour	30
Continuous Assessment		10
Major test at the end of semester	2.5 hours	60
Total		**100**

TITLE OF THE COURSE: CELL BIOLOGY
COURSE CODE: BS 302 **L T P Hr C**
MARKS : 150 **3 0 2 5 4**

OBJECTIVE OF THE COURSE:

The objective of the course is to familiarize the students with basic concepts of cell Biology. This is essential for taking further courses in Biotechnology during the next couple of years.

LEARNING OUTCOME:

At the end of this course, student should be able to comprehend essentials of cell Biology useful for their understanding at the later stage.

PREREQUISITES

This is an introductory course. There are no prerequisites for the course.

COURSE DESCRIPTION

Sr. No	Topic	Description	Hrs
1	Cell as basic unit of living systems (Prokaryotes, Eukaryotes)	Pre-cellular evolution: artificial evolution of cells, Broad classification of cell types, how cells are studied	4
2	Biochemical composition of cells	Proteins, Lipids, Carbohydrates, nucleic acids and Metabolic pool	5
3	Ultra-structure of the cell	Cell membrane and special functions of membrane	3
4	Structure and function of cell organelles	Cytosol, Golgi bodies, ER (smooth and rough), Cytoskeleton structures (action, microtubules etc.), Mitochondria, Chloroplasts, Lysosomes, Nucleus	14
5	Cell-cell Interaction	Germ cells and Fertilization, Cellular mechanisms of development	3
6	Cell division and cell cycle,		5
7	Differentiated cells and the maintenance of tissues		5
8	Cell senescence and death		5
Total Number of lectures			44

METHODOLOGY

The course would be taught through lectures, demonstrations and practical classes.

EVALUATION SCHEME (THEORY)

Examination	Duration	Marks
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1) Cell and Molecular Biology by De Robertis. Molecular Biology of Cell by Bruce Alberts 2002. The cell by Cooper 2000

2) Cell Biology, Genetics, Molecular Biology, Evolution and Ecology by P. S Verma and VK Agarwaal. Publisher S. Chand and Comp. 2005
3) Cell Biology by Powar

Teaching hours per week and credits for practicals: 2 hrs per week, 1 credit

Sr. No	Name of Experiment	Learning objective	References
1.	Introduction to the instruments used in cell biology (Microscope, Biosafety Cabinets, Incubators, Centrifuges, Pipettes)	To get acquainted with the instruments and SOP for the various instruments. This Exercise focuses on how to develop a working knowledge of the Microscope and its use. Students should identify the different parts of the Microscope and safe handling.	Fundamentals of Light microscopy And electronic Imaging, Douglas B. Murphy; A John Wiley & Sons, Inc., Publication.
2.	Study of different cell types under microscope	Students should be able to differentiate between prokaryote, eukaryote cells Should be able to differentiate between plant and animal cells Should be able to differentiate between cells from different tissues	Fundamentals of Light microscopy And electronic Imaging, Douglas B. Murphy; A John Wiley & Sons, Inc., Publication.
3.	Slide preparation and staining (plant)	Cross-sectioning of monocot and dicot plant root, stem and leaf Staining and slide preparation Identification of different anatomical features Preparation of permanent slide	A Text-Book of Histology Descriptive and Practical. For the Use of Students Author(s): Arthur Clarkson ISBN: 978-1-4832-2783-2 Methods in plant histology The university of chicago press Chicago, Illinois The Baker & Taylor Company
4.	Blood Smear Preparation and differential staining.	A classical method for identification of blood cell preparation.	Dacie and Lewis Practical Haematology Eleventh Edition, Barbara Bain Imelda Bates Mike Laffan S. Lewis

Sr. No	Name of Experiment	Learning objective	References
5.	Buccal smear – Identification of Barr Body	A quick cytological method for identification of sex in mammals-an extreme case of chromosomal condensation.	Acta Cytologica 2013;57:516-521 (DOI:10.1159/000353216) Cytological Assessment of Barr Bodies Using Aceto-Orcein and Papanicolaou Stains in Buccal Mucosal Smears and Their Sex Estimation Efficacy in an Indian Sample,Datar U. · Angadi P.V.Hallikerimath S. · Kale A.D, Acta Cytologica 2013;57:516-521 (DOI:10.1159/000353216)
6.	Mitosis in Onion Root-Tip Cells	To study mitosis using Onion root tip cells.	Conly L. Rieder. Academic Press, 1999 - Science Volume 61 of Methods in cell biology, ISSN 0091-679X
7.	Meiotic cell division in grasshopper testis	To perform Meiotic cell division in the given sample	Conly L. Rieder. Academic Press, 1999 - Science Volume 61 of Methods in cell biology, ISSN 0091-679X

PRACTICAL IN CELL BIOLOGY (2 hrs per week) Marks 50

LIST OF EXPERIMENTS

1. Microscopes- Different types of microscopes
   Compound microscopes
   Stereoscopic microscope 2.

Observations of permanent slide

- Stem Transverse Section – Dicot Stem
- Transverse Section – Monocot Different
- types of Animal Cell

3. Mitosis – Slide preparation and cell division
4. Meiosis - Slide preparation and cell division.
5. Preparation of slides and staining – Leaf Transverse Section and Stem Transverse Section

EVALUATION SCHEME PRACTICAL TRAINING

Examination	**Duration**	**Marks**
Minor test 1	1 hour	15
Continuous Assessment		05
End semester Exam Viva & Spotting		30
Total		**50**

TITLE OF THE COURSE: MICROBIOLOGY

COURSE CODE: BS-303 **L T P Hr C**

MARKS: 200 **3 0 4 7 5**

OBJECTIVE OF THE COURSE:

The objective of the course is to familiarize the students with bacteria and viruses, their structures, metabolism, diseases caused by bacteria and viruses and their control.

LEARNING OUTCOME

At the end of the course, the students will have sufficient scientific understanding of bacteria and viruses and diseases caused by them.

PREREQUISITES

Since the course is very basic in nature, school level knowledge in biology is sufficient to take the course and there are no prerequisites.

COURSE DESCRIPTION

Sr. No.	Topic	Description	Hrs
1	Introduction to Microbiology	Scope and history of Microbiology. Characterization, classification and identification of microorganism. Microscopic examination (Staining and microscopic techniques)	6
2	Microorganism-Bacteria	Morphology and fine structure of bacteria. Cell wall structure in details. Cultivation of bacteria. Reproduction and growth. Growth kinetics. Isolation and preservation.	16
3	Control of Microorganisms	Control of By physical and chemical agents. Role of antibiotics and chemotherapeutic agents	4
4	Microbial Physiology/ Metabolism	Microbial metabolism: Utilization of energy in Non-synthetic pathways (bacterial motility and transport of nutrients), Biosynthetic processes. Novel bacterial pathways. Energy production	4
5	Microbial organisms and diseases	Host microbe interactions. Diseases caused by bacteria	4
6	Microbes and environments	Symbiosis and antibiosis among microbial populations. N_2 fixations in agriculture	10
7	Viruses	Classification, structure and characterization of viruses	4
Total number of Lectures			48

METHODOLOGY

The course would be taught through lectures, demonstrations and practicals.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

1) **BOOKS RECOMMENDED:**
2) General Microbiology: Vol. I & 2 by Powar & Daginawala
3) Microbiology by Pelczar
4) Microbiology by Prescott
5) General Microbiology by Stanier
6) Instant notes in Microbiology by Nicklin.
7) Principle of Fermentation technology by Stanbury & Witter

PRACTICAL OF MICROBIOLOGY (4 hours per week) Marks: 100

LIST OF EXPERIMENTS:

1. Introduction to lab apparatus (instruments and glassware).
2. Washing, plugging & sterilization of test tubes.
3. Study of microscope & observation of permanent slides (mitosis, meiosis, prokaryotic and Eukaryotic cells.
4. Preparation of media-NA (nutrient agar), NB (nutrient Broth), PDA, (Potato dextrose agar) and LB media
5. Isolation of microbes from soil sample on nutrient agar slants.
6. Isolation of microbes from soil & bacterial suspension by streak plate method. Observation of microbial growth & study of colony characteristics
7. Staining Of Microbes:
    a. Monochromal
    b. Negative Staining,
    c. Grams Staining.
8. Endospores staining by Schaeffer and Fulton‟s method).
9. Effect of Environmental parameters on growth of microorganisms.
    a. Effect of pH.

b. Effect of temperature.
c. Effect of Buffered & unbuffered media.
d. Effect of Osmotic pressure.

10. Growth curve of E.coli.
11. Testing of antiseptics & dyes in the control of microorganisms.
12. Metachromatic granules staining.
13. Counting of cells (of micro organisms by pour plate and spread plate technique/by Hemo cytometer)

EVALUATION SCHEME PRACTICAL TRAINING

Examination	**Duration**	**Marks**
Minor test 1	1 hour	30
Continuous Assessment		10
End semester Exam Viva & Spotting	2.5 hours	60
Total		**100**

TITLE OF COURSE: PLANT PHYSIOLOGY L T P Hr C
MARKS: 100 3 1 0 4 4
COURSE CODE: BT 301

OBJECTIVE:

The objective of the course is to familiarize the students with advanced research area and basic concept in Plant Physiology and metabolism.

LEARNING OUTCOME

At the end of the course, the students will have sufficient scientific understanding of plant physiology.

PREREQUISITES

Since the course is very advance in nature, student must know about different plant hormones and basic knowledge of plant anatomy and physiology.

COURSE DESCRIPTION:

Sr. No.	**Topic**	**Description**	**Hrs**
1	Introduction (special features of plants including anatomy, histology of plant tissues)		3
2	Nitrogen fixation	Historical background. Nitrogen cycle in nature. Symbiotic nitrogen fixation. Nitrogenase system, nitrate reductase.	4
3	Plant hormones	Auxin , Gibbrellins, Cytokinins, Ethylene, Abscissic acid-	8

		Discovery, effect on growth and development. Gibberilins- Discovery, effect on growth and development. Cytokinins- Discovery, effect on growth and developmeAbscisic acid Ethylene.	
4	Phytochrome action and circadian rhythms.	The photochemical and biochemical properties of Phytochrome. Localization of Phytochrome in tissues and cells. Characteristic of Phytochrome.	4
5	Biochemistry of seed germination.		2
6	Seed storage proteins.		2
7	Physiology of flowering		2
8	Physiology of fruit ripening.		2
9	Secondary metabolites	Gums, pectins, alkaloids, flavonoids, rubber, essential oils and anthocyanins.	6
10	Plant nutrition deficiency (natural and synthetic)	Micro, macro, natural and synthetic nutrients and their deficiency syndrome	3
11	Stress physiology.	Water stress, Heat Stress, Chilling and Freezing stress Salinity stress. Temperature (high/low)	6
12	Plant metabolism-Photosynthesis	Intracellular organization of photosynthetic system. Fundamental reactions of photosynthesis, photosynthetic pigments, role of light. Hill reaction and its significance, light reactions, cyclic and non-cyclic photo induced electron flow, energetics of photosynthesis, photorespiration, dark phase of photosynthesis, Calvin cycle, C-4 pathway, CAMP	6
		Total	48

METHODOLOGY

The course would be taught through lectures, demonstrations.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1) Plant Physiology by Lincon Taitz (Amazon Publication)
2) Plant Physiology by Conn and Stumpf
3) Plant Physiology by Noggle and Fritz
4) Plant Physiology by Sallisbury and Ross
5) Plant Physiology by Devlin

COURSE NAME: GENETICS

COURSE CODE: BS 304 **L T P Hr C**

MARKS: 100 **3 1 2 6 5**

OBJECTIVE OF THE COURSE:

In view of the increasing demand for training manpower in the area of Genetics, Molecular Biology, Genetic Medicine and Biotechnology, it was consensus of the committee (Faculties & experts) that this course should be broad based and should be able to give a good insight into modern biology and important component of hands-on training to the students.

COURSE DESCRIPTION

Sr. No.	Topic	Description	Contact Hours
1	Mendel‟s Principles of inheritance.	Mendel‟s experimental organism, the green pea. Monohybrid cross: The principle of dominance and segregation. Dihybrid cross: The principle of Independent assortment. Application of Mendel‟s Principles Punnett Square. Forked Line Methods, Probability Chi Square method. Mendel‟s Principle in Human Genetics. Pedigree. Mendel‟s segregation in Human families.	8
2	Extension of Mendel‟s Principles allelic variation and gene function.	Incomplete dominance and co-dominance. Multiple alleles.Allelic series. Variation among the effect of the mutation. Gene functions to produce polypeptides. Gene Action: Genotype and phenotype. Influence of the environment. Environmental effect on the expression of the Human Genes. Gene Interaction. Epistasis.	5
3	Chromosomal basis of inheritance	Chromosome Chromosome Number. Sex Chromosome. The chromosomal theory of heredity. Experimental evidence linking the inheritance of genes to chromosome. Chromosome as arrays of gene. Non-disjunction as proof of the chromosome theory. Chromosomal basis of Mendel‟s Principles of segregation and Independent assortment.	8

		Sex Linked Gene in Human Beings. Sex Chromosome and Sex Determination. Dosage Compensation of the X- linked genes.	
4	Cytogenetics	Cytogenetical techniques. Variations in chromosome structure. Variations in chromosome number.	5
5	Non-Mendelian inheritance	Evidences for Cytoplasmic factors, cytoplasmic inheritance, extranuclear inheritance (mitochondrial, chloroplast), non-chromosomal inheritance, maternal linheritance, uniparental inheritance.	6
6	Genetic analysis of development	Model organism for genetic analysis of development. Development results from differential gene expression. Genetic study: Genetic Regulation of the development of	5
		the Drosophila body plan	
7	Population genetics.	Theory of allelic frequencies. Natural Selection. Random Genetic Drift.	5
Total Lecture			42

METHODOLOGY

The course would be taught through lectures, demonstrations.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

TEXT BOOKS:

A text book of genetics by Sambhamurthy

REFERENCE BOOKS:

1) Genetics by Russell
2) Genetics by Klug
3) Genetics by Tamarind
4) Genetics by Snustad & Simmons
5) Genetics by C.B Powar
6) Genetics by B.D Singh
7) Genetics by Pierce

PRACTICAL IN GENETICS (2 Hrs. Per Week) MARKS 50

Objective of the course:
The objective of the course is to familiarize the students with Genetic Subject

List of Practical‟s

1) Model Organisms and their significance in Genetic studies:
   Mendalian inheritance in Pea plants
   Virus – TMV (Tobacco leaves)
   Bacteria – E coil (slide)
   Neurospora and Yeast (slides)
   Paramecium (slides)
   Coenorhabites elegans.
   Drosophila melanogaster – Life Cycle
   Mosquito (Anopheles and Culex) – Life cycle
   Dissected reproductive system of Rat -
   Maize, Pea, Arabiodopsis – Life Cycle
2) Induction of polyploidy in Onion root tips.
3) Methyl Green-Pyronin Staining of DNA
4) Dermatoglyphs of human fingers
5) Human Karyotype.
6) ABO Blood Gr
7) Genetic traits in population
8) Founder Effect
9) Isolation of Mitochondrial DNA
10) Plasmid DNA isolation
11) B Thalassemia
12) VNTR marker
13) Replica Plate Techniques
14) Growth curve analysis

EVALUATION SCHEME PRACTICAL TRAINING

Examination	**Duration**	**Marks**
Minor test 1	1 hour	15
Continuous Assessment		05
End semester Exam Viva & Spotting	2.5 hours	30
Total		**50**

NAME OF THE COURSE: MAMMALIAN PHYSIOLOGY

COURSE CODE: BS 305	**L**	**T**	**P**	**Hr**	**C**
MARKS: 100	**3**	**1**	**0**	**4**	**4**

OBJECTIVE OF THE COURSE:

The objective of the course is to develop insight of physiological aspects of the mammalian systems with respect to various interactions occurring with all the major organs of the body.

This course will aim to develop skills linked to the understanding of the scientific literature that are introduced through different subjects like Microbiology, Cell Biology, Immunology and Pharmacology.

The course is well equipped to deal with branches of biophysics, biochemistry and clinical applications as well.

LEARNING OUTCOME

The course would enable the student to understand the integral mechanism operating in the mammalian system along with the regulation of each system.

ALSO THE STUDENTS SHOULD:

Have an enhanced knowledge and appreciation of mammalian physiology

Have gained knowledge of a number of important physiological systems including the endocrinology, nervous system and reproductive systems

Be able to recognize and identify the principle tissue structures in those systems.

Be able to analyze and extrapolate from their knowledge of the separate systems to discuss physiological responses to challenges such as exercise, fasting and ascent of altitude.

PREREQUISITES

Since the course is very basic in nature school level knowledge in physics, chemistry & Biology is enough to take the course and there are no prerequisites.

COURSE DESCRIPTION

Sr. No.	**Topic**	**Description**	**Hrs**
1	Basic concepts and principles:	Introduction and background (homeostasis, control systems).	4
2	The Physiology of Digestive system.	Anatomy and Histology of digestive system, Movement of food and absorption, Secretary functions of alimentary canal, digestion and absorption in gut, (liver and biliary system).	7
3	Physiology of Circulatory System.	Blood composition, blood pressure, and edema. The special fluid systems of the body – cerebrospinal, ocular, pleural, pericardial, peritoneal and synovial fluids. Regulation of the	4

		circulation, mean arterial pressure and hypertension, cardiac output and venous return, circulatory shock and its physiology, cardiac failure, coronary circulation.	

4	Physiology of respiratory system	Anatomy and Histology of Respiratory organs. Pulmonary ventilation: Physical principles of gaseous exchange transport of O_2 and CO_2 in the blood and body fluids. Chloride & reverse chloride shift	4
5	Body fluids and Kidney-Physiology.	Anatomy and histology of Kidney Osmotic equilibrium between extra cellular and intracellular fluids, Formation of urine by kidney, glomerular filtration and tubular function regulation of urine concentration and auto regulation.	4
6	Endocrinology:	Histology of important glands like The pineal gland, Adrenal gland and their hormones: functions and disorders. Thyroid gland and their hormones: functions and disorders. Insulin, glucagons and related disorders. Parathyroid hormone, calcitonin and calciterol. Sex hormone: progesterone, estrogen and testosterone.	4
7.	Reproductive system-Physiology	Male and female systems, Histology of male and female reproductive organs. Maintenance of female reproductive system, Female Reproductive Cycle, Sex hormones in puberty, menstrual cycle, menopause and inhibin function.	5
8.	Nervous system-Physiology	Parts of the nervous system, Structure and function of sensory receptors, Neural circuits and Nerve conduction.	8
9.	High altitude and space physiology:	Effect of low oxygen pressure, Effect of high altitude on physiology, Artificial climate in the sealed spacecraft, Weightlessness in space.	4
10.	Physiology of deep sea diving and other hyper baric candidates.	Effect of high pressure and decompression on diver, Hyper baric oxygen therapy.	4
Total number of lectures			48

METHODOLOGY

Lectures supported with PowerPoint presentation. Lectures and in-class activities are intended to complement assignment. Thus the course will be covered through lectures supported by tutorials. Students will be given seminar topics of their own interest from their syllabus. Again students are expected to collect review and make power point presentations.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10

End Semester Exam	2 hours 30 minutes	60
Total		**100**

REFERENCE BOOKS

1) Textbook of Medical Physiology by C. Guyton.
2) Physiology by C. Chatterjee.
3) Human Anatomy & Physiology by Tortora.
4) Medical Biochemistry – Anant Narayan
5) Text Book of Biochemistry by Harper Ed. 1988
6) Medical physiology by Chaudhary.
7) Anatomy and histology by Ross and Wilson
8) Human Anatomy and Physiology by Creager

SEMESTER IV							
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**	**Marks**
BT 401	Molecular Biology-I	3	0	4	7	5	200
BT 402	Metabolism	3	1	0	4	4	100
BT 403	Animal Tissue Culture	3	0	2	5	4	150
BT 404	Plant Tissue Culture	3	0	2	5	4	150
BT 405	Immunology	3	0	2	5	4	150
BI 301	Concepts in Bioinformatics	3	0	4	7	5	200
Total		**18**	**4**	**14**	**33**	**26**	**950**

TITLE OF THE COURSE: MOLECULAR BIOLOGY I
COURSE CODE: BT-401 **L T P Hr C**
MARKS: 200 **3 0 4 7 5**

OBJECTIVE OF THE COURSE:

The objective of the course is to familiarize the students with advanced research area and basic concept in molecular biology

LEARNING OUTCOME

At the end of the course, the students will have sufficient scientific understanding of DNA structure, Replication, Transcription, Translation, Mutation, Recombination and Gene Expression .

PREREQUISITES

Since the course is very advance in nature, student must know about Gene structure and gene regulation. Student must have background with Genetics.

COURSE DESCRIPTION

Sr. No.	Topic	Description	Hrs
1	Introduction: Chemistry and Genetics	What is gene? Molecular basis of genes, DNA as genetic material, Meselson and Stahl experiment for semiconservative mode of DNA replication, What is Genetic Variation. Origin of Genetic variability Genetic information conveyed by sequences of nucleotides (central dogma), discovery of RNA, synthesis of m-RNA, what is genetic code. properties of genetic code establishment of genetic code	**4**
2	Structure and Maintenance of Genome:	Structure of DNA (Structure of purines, pyrimidines, De-oxy ribose sugar, Phosphoric acid, Nuceosides and Nucleotides) Structure of RNA What is Chromosome? Structure of chromosome, what is chromatin? Chromosome and chromatin diversity Chromosomal duplication and segregation, Nucleosome structure Higher order chromatin structure, Regulation of chromatin structure Mitochondrial genome..	6
3	Replication of DNA in Prokaryotes and Eukaryotes:	Chemistry of DNA synthesis, Mechanism of DNA polymerase, replication fork (Okazaki fragments) Termination and control of DNA replication.	7
4	Mutation and DNA repair	Types of mutations. Replication errors and their repairs. DNA damage and repair.	4
5	Recombination:	Homologous recombination at molecular level: models of	10

		homologous recombination, proteins in homologous machines, homologous recombination in prokaryotes and Eukaryotes,	
		mate typing, genetic consequences of mechanism of recombination. Site specific recombination and transposition of DNA: conservative site specific recombination, biological roles of sites recombination, transposable elements, and their regulations, V9DJ recombinants Gene conversion.	
6	Transcription & Translation	Transcription & Translation in Prokarotes (role of proteins and factors etc.) Transcription &Translation in Eukaryotes (role of proteins and factors etc.) RNA Splicing and RNA editing	6
7	Control of Gene Expression:	Prokaryotes, Lac Operon and Catabolite repression Eukaryotes, Transcription Factors Yeast , Protozoan Gene organization & expression in mitochondria and chloroplast Post translation regulation of gene expression Development and environmental regulation of gene expression	7
8	Oncogenes and Cancer:	Tumor cells, tumor suppressors genes, Transforming viruses	4

METHODOLOGY

The course would be taught through lectures and assignments.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1) Instant notes in Molecular Biology by Turne.
2) Microbial Genetics by David Freifelder.
3) Molecular Biology by David Freifelder.
4) Molecular Biology of Gene Watson, Baker et.al. 5th Edition
5) Molecular Biology of the Cell by Alberts.
6) Genes by Lewin and Benjamin.

Teaching hours per week and credits for practicals only: 4 Hr 2 Cr Marks for Practicals: 100 Marks

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1	Preparation of glassware, plasticware, reagents and stock solutions for molecular biology	Special preparations for carrying out molecular biology experiments	Sambrook J, Edward F, Maniatis T. Molecular cloning Vol. 2. 2nd ed. New York: Cold spring harbor laboratory press; 1989.
2	To isolate DNA from a) bacteria b) animal tissues/cells c) plant material using appropriate methods	To understand the critical requirement of specific methods depending on source of DNA	
3	Quantification of DNA by UV absorption and analysis by agarose gel electrophoresis	To understand the quality, and quantity of DNA present per cell	
4	To isolate plasmid DNA from bacteria, restriction analysis and agarose gel electrophoresis	To distinguish between plasmid and genomic DNA in terms of size and migration properties in gel	
5	To isolate RNA from eukaryotic cells and analyse by denaturing formaldehyde agarose gel electrophoresis	To understand various types of RNA/RNA profile and quality of RNA preparation	
6	To find the Melting temperature of DNA	Measure temperature and estimate T_m from your data	
7	Isolation of nuclei, calcium activation of endonuclease resulting DNA ladder including the mononucleosome formation	Hands-on verification of the concept of chromatin structure	
8	Extraction of histone from nuclei and analysis by SDS-PAGE	Understanding the contribution of histones in the formation of chromatin	

Internal evaluation will be based on following criteria

For practicals of 2 credits and 100 marks, internal evaluation will be for 40 marks with following break-up:

Practical: 10 marks

Attendance: 10 marks (above 80% attendance gets full marks)
Laboratory assignment: 10 marks and Journal writing: 10 marks

TITLE OF THE COURSE: METABOLISM

COURSE CODE: BT 402 **L T P Hr C**

MARKS: 100 **3 1 0 4 4**

OBJECTIVE OF THE COURSE:

Metabolism is the set of chemical reactions that occur in living organisms in order to maintain life. These processes allow organisms to grow and reproduce, maintain their structures, and respond to their environments. The objective of the course is to familiarize the students to these various chemical reactions occurring in ones own body and the other living organisms alike.

LEARNING OUTCOME:

At the end of the course, students will have sufficient systematic and comprehensive knowledge about basic metabolism which will help them relate to the different physiological processes taking place in the cell and how inanimate chemicals cause life.

PREREQUISITES

The course requires that the students are well versed with properties and characters of biomolecules that they have learnt in their semester II, course no 202.

COURSE DESCRIPTION:

Sr. No.	Topic	Description	Hrs
1	Survey of metabolism	Introduction to metabolism-catabolism, anabolism and intermediary metabolism	1
2	Glycolysis	Two phases of glycolysis-detailed study of all the reactions Energy balance sheet, regulation of glycolysis by enzymes and hormones, Anaerobic pathway of glucose metabolism.	3
3	Gluconeogensis & Glycogen Metabolism	Bypass reactions Regulation of gluconeogenesis by enzymes and hormones. Glycogenolysis and glycogenesis	6
4	Citric acid cycle(TCA)	Aerobic pathway of glucose metabolism- detailed study of all the reactions Balance sheet. Regulation of the cycle	4
5	Alternate pathway of carbon metabolism	Pentose phosphate pathway (HMP shunt).	2
6	Lipid Metabolism	Requirement of carbon dioxide and citrate for biosynthesis, FAS complex & Regulation of biosynthesis β oxidation of monounsaturated and polyunsaturated fatty acids, Energetics of β oxidation,ketone bodies.	2
7	Oxidative phosphorylation	Oxidative phosphorylation, structure of ATPase enzyme, chemiosmotic hypothesis. Complexes I, II, III and IV-components and structure.Reactions of the electron transfer.	5
8	Biosynthesis of triglycerides and membrane phospholipids	Biosynthesis of triglycerides and its hormonal regulation, phospholipids from CDP-diacyglycerol, plasmalogens, sphingolipid, glycerophospholipid, PDGF. Cholesterol from acetyl CoA, fates of cholesterol, regulation of cholesterol	9

	cholesterol and steroid	biosynthesis, steroid hormones from cholesterol, bile salts	
	hormones		
	Integration of Carbohydrates, lipids and fats metabolism	Integration of Carbohydrates, lipids and fats metabolism	2
	Biosynthesis of amino acids and its regulation	Glutamate, glutamine, proline and arginine from α-ketoglutatrate, Serine, glycine and cysteine from 3-phosphoglycerate Oxaloacetate and pyruvate as precursors for nonessential and essential amino acids Tryptophan, Phenylalanine and tyrosine from chorismate,regulation, transamination and deamination of amino acids	6
	Biosynthesis & catabolism of nucleotides	Purimidines & pyrimidines-De-novo and salvage pathways.,metabolic disorders	4

METHODOLOGY:

The course should be taught through interactive lectures and demonstrations, which will help the students to relate the subject to everyday activity. Regular quizzing should be encouraged.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1) The principles of Biochemistry by Nelson Cox
2) Metabolic Pathways by Greenbrg
3) Biochemistry by Lubert Stryer 3 rd Edition by W.H. Freeman and Co.
4) Biochemistry by G. Zubay, Addision Wesly Publication [1988]
5) Biochemistry by Corn and Stump

TITLE OF THE COURSE: ANIMAL TISSUE CULTURE

COURSE CODE : BT 403 **L T P Hr C**

MARKS: 100 **3 0 2 5 4**

OBJECTIVE OF THE COURSE:

The objective of the course is to familiarize the students with the basics of Stem cells and Animal Tissue Culture Techniques and use of in various fields of research and human welfare.

LEARNING OUTCOME

At the end of the course, the students will have sufficient scientific understanding of the Animal Tissue Culture techniques, knowledge of aseptic handling of cell lines. Use of these techniques in various fields of research and medicine and human welfare.

PREREQUISITES

Student should have background of cell biology, cell division, basic of aseptic laboratory techniques. They should know basic concept of various laboratory media.

COURSE DESCRIPTION

Sr. No.	Topic	Description	Hrs
1	Introduction:	• History, • Cell culture techniques, • Equipment and sterilization methodology.	4
2	Introduction to animal cell cultures:	• Nutritional and physiological: Growth factors and growth parameters General metabolism	6
3	Primary cell cultures	Establishment and maintenance of primary cell cultures of adherent and non-adherent cell lines with examples.	4
4	Secondary cell cultures	Establishment and maintenance of secondary and continuous cell cultures	2
5	Characterization of cell lines	Karyotyping, biochemical and genetic characterization of cell lines.	2
6	Application of cell cultures	Use of Hybridoma for production of monoclonal antibodies.	2
7	Bioreactors in animal cells	Bioreactors for large-scale culture of animal cells	2
8	Transplantation, tissue culturing.	• Transplantation techniques. Tissue Culturing	3
9	Cryopreservation and tissue culture applications	• Cryopreservation • Tissue culture applications	2

METHODOLOGY

The course would be taught through lectures, demonstrations and LCD PowerPoint presentation

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1) Cell and Tissue Culture by John Paul.Willams & wilkins Company. 2005.

2) Basic Cell Culture Vol. 290 Protocols by Cheryl D Helgason, Cindy L Miller. Humanan Press.2005.

3) Basic Cell Culture 2nd Edition by JM Davis Oxford University Press.2002. Tissue Culture in Biological Research by G. Penso and D. Balduki.
4) Biotechnology by B. D. Singh: Expanding horizons.Kalyani Publishing. 2008.
5) .Principle of Fermentation Technology byStanbury P.F., Wittakar A. & Hall S.J. Pergamon Press. Oxford.1995.

PRACTICAL OF ANIMAL TISSUE CULTURE

(2 Hrs. Per Week) **MARKS 50**

LIST OF EXPERIMENTS

1. Laboratory set up for Animal tissue culture.
2. Equipments required for Animal tissue culture.
3. Preparation of cell medium.
4. Preparation of Calcium Magnesium free Phosphate buffer saline
5. Establishment of primary cell culture from chick embryo.
6. PBMC separation by using Ficoll density gradient method.
7. Passaging of monolayer cells using trypsinization protocol.
8. Counting of viable cells using hemocytometer.
9. Freezing and revival of cells.

EVALUATION SCHEME PRACTICAL TRAINING

Examination	**Duration**	**Marks**
Minor test 1	1 hour	15
Continuous Assessment		05
End semester Exam Viva & Spotting	2.5 hours	30
Total		**50**

TITLE OF THE COURSE: PLANT TISSUE CULTURE

COURSE CODE: BT 404 **L T P Hr C**
MARKS: 150 **3 0 2 5 4**

OBJECTIVE OF THE COURSE:

The objective of the course is to familiarize the students with advanced research area and basic concept in Plant Tissue Culture.

LEARNING OUTCOME

At the end of the course, the students will have sufficient scientific understanding of different types of cell culture and new techniques used in Plant tissue culture.

PREREQUISITES

Since the course is very advance in nature, student must know about Sterilization techniques and basic knowledge of Plant tissue culture. Student must have background with Agriculture.

COURSE DESCRIPTION

Sr. No	Topic	Description	Hrs
1	History.	Cell theory, Concept of cell culture,Development of Tissue Culture,Discovery of Auxins and cytokinins, cellular totipotency, history, various terminologies	2
2	Organization of plant tissue culture Laboratory	Aseptic Laboratory:Media preparation , Sterilization and Storage room, Different work areas:Media preparation room,Culture room Transplantation area Equipments and instruments required..	4
3	Aseptic techniques	Washing of glassware, Media sterilization Aseptic workstation, Precautions to maintain aseptic conditions.	4
4	Culture medium	Nutritional requirements of the explants, PGR‟s and their in vitro roles, Media preparation	3
5	Callus culture technique	Introduction, principle, protocols Genetic variation and applications	3
6	Suspension culture technique	Introduction, principle, protocols, Types, growth and growth measurement, Synchronization, application and limitations.	3
7	Organ culture technique	Introduction, principle, protocols Root tips culture, leaf culture, shoot tip and meristem culture, ovary and ovule culture.	3
8	Anther and pollen culture technique	Introduction, principle, protocols, Haploids and its application	3

9	Protoplast culture	Define protoplast What is protoplast culture How protoplast fusion is done Stages of protoplast cuylture, Requirement and application	7
10	Micro propagation	Concept, requirements, stages, explants, mention of somaclonal variation Different pathways of micropropagation: Axillary bud proliferation Somatic embryogenesis Organogenesis. Meristem culture	6
11	Secondary metabolites production and biotransformations.	Introduction, principal, optimization of yield. Commercial aspects, applications and limitations.	3
12	Plant tissue culture production of:	Agricultural crops Forest tree Ornamental plants Medicinal plants. Endangered plant species.	3
13	Applications of Plant Tissue Culture:	Somatic hybridization Somaclonal variation Germplasm preservation Genetic transformations Production of artificial seeds. Bioreactor:-Industrial application of tissue culture	4
		Total no. of lectures	48

METHODOLOGY
The course would be taught through lectures, demonstrations and practicals.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		*100*

BOOKS RECOMMENDED:

- Plant tissue culture by A. C. Deb.
- Plant tissue culture by Dodds and Roberts.

- Biotechnology by H. D. Kumar.
- Biological science by Taylor.
- Biotechnology by B. D. Singh.

PRACTICALS IN PLANT TISSUE CULTURE (2 hrs. Per Week) MARKS 50

LIST OF PRACTICALS

1. Setting up of a plant tissue culture laboratory
2. To maintain aseptic conditions in Plant tissue culture laboratory
3. Preparation of stock solution and MS Media
4. To develop callus culture from excised tap root of carrot
5. To culture embryo from Dicot seeds.
6. Cell suspension culture of Azadirachta indica

EVALUATION SCHEME PRACTICAL TRAINING

Examination	**Duration**	**Marks**
Minor test 1	1 hour	15
Continuous Assessment		05
End semester Exam Viva & Spotting	2.5 hours	30
Total		**50**

TITLE OF THE COURSE: IMMUNOLOGY
COURSE CODE: BT 405 **L T P Hr C**
MARKS: 150 **3 0 2 5 4**

OBJECTIVE OF THE COURSE:

The objective of the course is to familiarize the students with the immune system and it‟s function and the advances in the immunology.

LEARNING OUTCOME

At the end of the course, the students will have sufficient scientific understanding of immune system, molecular biology of antibody formation, various immunological assay and function of immune system in various microbial infections.

PREREQUISITES

Student should have background of cell biology. They should know basic concept of molecular biology also to understand expression off immunoglobulin gene. They should know some basic assays.

COURSE DESCRIPTION

Sr. No	Topic	Description	Hrs
1	Introduction to immunology	Overview of Immune system: History and scope of Immunology, Types of immunity: innate, acquired, Comparative immunity. Immune dysfunction and its consequences. b) Cells and Organs of Immune system: Cells of the immune system lymphoid cells: B, T and null cells, Primary lymphoid organs, secondary lymphoid organs-lymph nodes, spleen mucosal associated lymphoid tissues	6
2	Generation of B-cell and T- cell response:	• Antigens: Immunogenicity vs. antigenicity • Epitopes (properties of B-cell and T-cell epitopes)	4
3	Immunoglobulins Structure and Function:	Basic and fine structure of immune-globulin: light chains, heavy chains and sequences Antigen determinants on Immunoglobulin: Isotopic, allotypic, Idiotypic • Immunoglobulin super family	6
4	Immunoglobulin Classes and Biological Activity:	• Immunoglobulin mediated effectors functions optimization • Activation of complement • Antibody dependent cell mediated cytotoxicity. • Clinical focus: Passive antibody therapy (IgG, IgM, IgA, IgE and IgD), hypersensitivity and immunological disorder	6

5	Organization and Expression of Immunoglobulin Genes:	• Genetic model compatible with Ig structure • Multigene organization of Ig genes • Variable region gene rearrangements • Mechanism of variable region DNS rearrangements • Generations of antibody diversity • Class switching among constant regions genes • Expression of Ig genes • Regulation of Ig-gene transcription • Antibody and genes and antibody engineering • Clinical focus	8
6	Antigen Antibody Interactions:	• Strength of antigen and antibody interactions: Antibody affinity, antibody avidity • Cross reactivity • Precipitation reactions, agglutination reactions (immunodiffusion and immunoelectrophoretic technique) • Radioimmunoassay • Enzyme linked Immunosorbant./Assay(ELISA) • Western Blotting • Immuno precipitation • Immunofluorenscence • Flow cytometery and Fluorescence	6
7	MHC-Major Histo-compatibility complexes	• MHC molecules and genes	4
8	Immune System in Health and Disease:	• Immune response to infectious disease (viral, bacterial and protozoan) • Vaccines (whole organism, purified macromolecules, recombinant vaccine, synthetic polypeptide etc. • AIDS, and other acquired or secondary immuno deficiency orders • Autoimmunity • Transplantation immunology: graft rejections, graft vs host response • Cancer and immune system	8

METHODOLOGY

The course would be taught through lectures, demonstrations and LCD powerpoint presentation.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**

I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1. Immunology 5th edition by Janis Kuby (W.H Freeman and company)*
2. Essentials of Immunology by Ivan M. Roitt 5th Edition Blackwell Scientific Publ.
3. Cellular and Molecular Immunology, 3rd edition, by Abbas
4. Molecular Biology of the Cell by Bruce Alberts

Teaching hours per week and credits for practicals only: 2 Hr 1 Cr Marks for Practicals: 50

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1.	To determine Blood Group antigens by hemagglutination assay	To understand about the various blood group antigens present in a population; principle of agglutination	Luttmann W, Bratke K, Kupper M, Myrtek, Immunology, The experimental Series - II, USA, Elsevier, Academic Press; 2006
2.	Detection of syphilis using RPR card test	Immunological detection of specific bacterial infections by indirect agglutination	Rose NR, Hamilton RG, Detrick B. Manual of clinical laboratory Immunology. 6th ed: ASM Press; 2002 Hay FC, Olwyn MR. Practical immunology. 4th ed: Westwood. Blackwell Publishing Company; 2002. Judith A. Owen JA. Punt J, Sharon A. Kuby Immunology. 7th ed. USA: Susan Winslow; 2013
3.	Detection of typhoid infection by WIDAL test	Immunological detection of specific bacterial infections by direct agglutination	Rose NR, Hamilton RG, Detrick B. Manual of clinical laboratory Immunology. 6th ed: ASM Press; 2002 Judith A. Owen JA. Punt J, Sharon A. Kuby Immunology. 7th ed: USA, Susan Winslow; 2013
4.	Density gradient separation of PBMCs using	Principle of density gradient separation of immune cells	Male D, Brostoff J, Roth DB, Roitt I, Immunology; 7th ed: Elsevier, 2007

	Histopaque-1077		Luttmann W, Bratke K, Kupper M, Myrtek, Immunology, The experimental Series - II, USA, Elsevier, Academic Press; 2006 Cell Separation Media Methodology and Applications 18111569, handbook GE Healthcare Isolation of mononuclear cells Methodology and Applications 18-1152-69, handbook GE Healthcare
			http://www.gelifesciences.com/handbooks/
5.	To study interaction of antigen and antibody by Ouchterlony double diffusion assay	To learn about precipitin phenomena at equimolar concentrations of antigen and antibody	Talwar GP, Gupta SK, A handbook of practical and clinical immunology. 2nd ed. Vol. I & II; 2006 Rose NR, Hamilton RG, Detrick B. Manual of clinical laboratory Immunology. 6th ed: ASM Press; 2002 Hay FC, Olwyn MR. Practical immunology. 4th ed: Westwood. Blackwell Publishing Company; 2002. Judith A. Owen JA. Punt J, Sharon A. Kuby Immunology. 7th ed: USA. Susan Winslow; 2013
6.	Determination of antibody titre by ELISA	To learn about different types of ELISA method and their applications	Rose NR, Hamilton RG, Detrick B. Manual of clinical laboratory Immunology. 6th ed: ASM Press; 2002 Talwar GP, Gupta SK, A handbook of practical and clinical immunology. 2nd ed. Vol. I & II; 2006 Judith A. Owen JA. Punt J, Sharon A. Kuby Immunology. 7th ed: USA. Susan Winslow; 2013
7.	Production of polyclonal antibodies in mouse	Principle of immunization, collection and analysis of serum for antibody	Talwar GP, Gupta SK, A handbook of practical and clinical immunology. 2nd ed. Vol. I & II; 2006
8.	Purification of IgG from serum	Single step purification of IgG by affinity chromatography	Freifelder D, Physical Biochemistry, 2nd ed. W.H. Freeman and Company, New York; 1982 Affinity Chromatography, Vol. 1: Antibodies, 18103746, handbook GE Healthcare http://www.gelifesciences.com/handbooks/

Internal evaluation will be based on following criteria

For practicals of 1 credit and 50 marks, internal evaluation will be for 20 marks with following break-up:

Practical: 10 marks

Attendance: 5 marks (above 80% attendance gets full marks)
Journal writing: 5 marks

TITLE OF THE COURSE: CONCEPTS IN BIOINFORMATICS

COURSE CODE: BI-301 **L T P Hr C**

MARKS: 200 **3 0 4 7 5**

OBJECTIVE

The objective of the course is to familiarize the student with basic concepts in Bioinformatics

LEARNING OUTCOME

At the end of the course, the students will have sufficient understanding of Internet basics, Biological databases, warehousing of Biological data etc. This knowledge would be applicable in subsequent courses in Bioinformatics in the coming years.

PREREQUISITES

Students should be familiar with school level mathematics and Biology to take up this course. In case they do not have mathematics at the twelfth level they should have cleared the core mathematics in the first semester.

COURSE DESCRIPTION

Sr. No.	Topics	Detailed syllabus	No. of Lectures
1	Overview of Bioinformatics	Scope and fields of Bioinformatics Contribution to different problems in biology	04
2	Data acquisition, Database content, structure and annotation:	File formats Annotated sequence databases Genome and Organism specific database	06
3	Retrieval of Biological Data	Data retrieval with Entrez and DBGET/ LinkDB , Data retrieval with SRS etc.	06
4	Introduction to nucleic acid and protein databases	NCBI, EMBL, DDBJ, EBI NBRF-PIR, SWISSPROT, PDB etc.	08
5	Database similarity searches	BLAST , FASTA PSI-BLAST algorithms	03
6	Pairwise sequence allignment	Clustering algorithm PRAS Other MSA	04
7	Multiple sequence	Clustering algorithm,PRAS, Other MSA	04

	alignment		
8	Patterns Motifs, and Profiles	Derivation and searching, Derived Databases of patterns, motifs and profiles Prosite, Blocks, Prints, Pfam etc.	04
9	Introduction to phylogenesis	Phylogenetics, cladistics and ontology Building phylogenetics trees Evolution of macromolecular sequences	04
10	Introduction to structural Bioinformatics	Amino acids, Polypeptide Composition, Secondary Composition	04
		Backbone flexibility ϕ & ψ Angles, Ramchandran Plot Tertiary & Quaternary Structure Hydrophobicity, Disulphide bonds Active Sites	
11	Introduction to	Homology, Analogy, Orthology Paralogy, Xenology	02
Total Lectures			**45**

METHODOLOGY

The course will be covered through lectures supported by tutorials. In tutorials difficulties would be solved. Problems would be given. Students would be given assignments in the form of questions. There will be two class tests/ and surprise test conducted during the tutorial classes. Students would be asked to do presentations and assessed on the basis of their presentations.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED

1) Introduction to Bioinformatics Kothekar V.

2) Introduction to Bioinformatics By T. K.Attawood & D.J. Parry-smith

3) Bioinformatics By Arthur Lesk.

4) Instant notes in Bioinformatics by S. Sundara rajan & R. Balaji

PRACTICAL IN BIOINFORMATICS (4 Hrs. Per Week) MARKS : 100

LIST OF PRACTICALS

1. Introduction to Nucleic Acid and Protein Sequence Data Banks
   - NCBI
   - EMBL
   - DDBJ
   - EBI
   - NBRF-PIR,
   - SWISSPROT,
     PDB etc.

2. Database Similarity Searches:
   - BLAST
   - FASTA
   - PSI-BLAST algorithms

3. Multiple sequence alignments –
   - Clustering algorithm
   - PRAS
   - Other MS

4. Patterns, motifs and Profiles in sequences:
   - PROSITE
   - BLOCKS
   - Prints
   - Pfam etc.

5. Data Structure Algorithms

EVALUATION SCHEME PRACTICAL TRAINING

Examination	**Duration**	**Marks**
Minor test 1	1 hour	30
Continuous Assessment		10
End semester Exam Viva & Spotting	2.5 hours	60
Total		**100**

SEMESTER V

Course Code	Course Name	L	T	P	Hr	Cr	Marks
BT 501	Molecular Biology-II	3	0	4	7	5	**200**
BT 502	rDNA Technology	3	1	0	4	4	**100**
BT 302	Enzymology & Enzyme Technology	3	0	4	7	5	**200**
BT 503	Basic Pharmacology and Toxicology	3	1	0	4	4	**100**
BT 504	Fermentation Technology	3	0	4	7	5	**200**
BT 506 / BT 507	Elective-I	3	0	4	7	5	**200**
Total		**18**	**2**	**16**	**36**	**28**	**1000**
Elective I (BT 506 : Food Biotechnology / BT 507 : Environmental Biotechnology)							

TITLE OF THE COURSE: MOLECULAR BIOLOGY – II
COURSE CODE: BT 501 **L T P Hr C**
MARKS: 200 **3 0 4 7 5**

OBJECTIVE OF THE COURSE:

The objective of the course is to familiarize the students with Structural details of the cellular anatomy, genetic material of prokaryotes and eukaryotes, transcription and translation of the genetic material, protein localization, regulation of genes in Prokaryotes and Eukaryotes, Gene families, movable genes and cancer.

LEARNING OUTCOME:

At the end of the course, the students will have sufficient scientific understanding of DNA, the processes of transcription and translation and Gene regulation.

PREREQUISITES:

Since the course is an advanced level course, the student should have sufficient knowledge of DNA and its structure, basics of protein structure, cell anatomy and its compartmentalization and basics of microbiology.

COURSE DESCRIPTION:

Sr. No.	Topic	Description	Hrs
1	Introduction to course	Review of structure of DNA and RNA, arrangements of Genetic material.	02
2	Transcription in prokaryotes and eukaryotes	.Transcription cycle in bacteria, role of proteins and factors of transcription, Transcription in eukaryotes, role of proteins and factors of transcription, RNA splicing and RNA editing.	10
3	Translation in prokaryotes and eukaryotes	Steps of translation, Initiation of translation, initiation factors, role of Met-tRNA, elongation and its factors, termination and protein stability	08
4	Post translational controls and protein localization in different organelles such as Mitochondria and lysosomes	Protein modifications, protein folding patterns, role of enzymes, protein transport of proteins in different organelles such as Mitochondria and lysosomes.	08
5	Gene Regulation	Gene regulation in prokaryotes, operon models, Gene regulation in eukaryotes, gene activators, enhancers and silencers, gene regulation during development with emphasis on Drosophila and plants.	08
6	Multigene families and clusters	Justification of the large nature of the genome, genome complexity, tandem repeats, micro and mini satellites.	05
7	Oncogenes and Cancer	Tumor cells, tumor suppressor genes, oncogenic viruses and transforming viruses.	05
8	Transposons and retroposons	Mechanism of action of transposons and retroposons,	02

		replication of transposons and retroposons and applications.	
Total number of Lectures			**48**

METHODOLOGY:

The course would be taught through lectures and demonstrations.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1 Instant notes in Molecular Biology by Turner.
2 Microbial Genetics by David Freifelder.
3 Molecular Biology by David Freifelder.
4 Molecular Biology of Gene by Watson, Baker et.al. 5th edition
5 Molecular Biology of the cell by Alberts.
6 Genes VII and VIII by Lewin and Benjamin.

PRACTICAL IN MOLECULAR BIOLOGY – II

(4 Hrs. Per Week) **MARKS: 100**

LABORATORY DESCRIPTION

Sr. No.	**Laboratory exercise**	**Hrs**
1	DNA extraction from Plant materials	4
2	Agarose gel electrophoresis of DNA	4
3	Bacterial DNA extraction & Gel electrophoresis	4
4	Plasmid DNA extraction & Gel electrophoresis	4
5	Quantification of DNA by UV spectrophotometer	4
6	Demonstration of SDS-PAGE	4
7	Restriction digestion analysis	4
8	Preparation of competent cells & transformation	4
9	Replica Plate Techniques	4

METHODOLOGY:

The course will be covered through lectures supported by tutorials and laboratory practicals. Students will be evaluated based on two class tests, lecture and laboratory attendance, class participation.

EVALUATION SCHEME PRACTICAL TRAINING

Examination	**Duration**	**Marks**
Minor test 1	1 hour	30
Continuous Assessment		10
End semester Exam Viva & Spotting	2.5 hours	60
Total		**100**

BOOKS RECOMMENDED

Molecular Cloning - Sambrook

TITLE OF THE COURSE: RECOMBINANT DNA TECHNOLOGY

COURSE CODE: BT-502 **L T P Hr C**

MARKS: 100 **3 1 0 4 4**

OBJECTIVE

To familiarize the student with emerging field of biotechnology i.e. Recombinant DNA Technology As well as create understanding and expertise in wet lab techniques in genetic engineering.

LEARNING OUTCOME

At the end of the course, the students will have sufficient scientific understanding of the subject and have good knowledge of application of Recombinant DNA techniques in Life Sciences Research.

PREREQUISITES

Knowledge of molecular biology is sufficient.

COURSE DESCRIPTION

Sr. No.	**Topics**	**Detail syllabus**	**No. of Lectures**
1	Introduction	Landmarks in Molecular biology and biotechnology, Advantages of using microorganisms, What is genetic engineering and recombinant DNA technology, Control of gene expression and gene complexity in prokaryotes and eukaryotes., Genetic engineering in *Ecoli* and other prokaryotes, yeast, fungi and mammalian cells,	10
2	Tools in genetic engineering	Enzymes- DNA polymerases, restriction endonucleases, ligases, reverse transcriptases, nucleases, terminal transferases, phosphatases etc. Cloning vectors-plasmids, bacteriophage vectors,cosmids,phagemids,vectors for plant and animal cells, shuttle vectors, YAC vectors, expression vectors etc..	6
3	Gene cloning	Isolation and purification of DNA (genomic, plasmid) and RNA,, Isolation of gene of interest- restriction digestion, electrophoresis, blotting,, Cutting and joining of DNA,, Methods of gene transfer in prokaryotic and eukaryotic cells,	10

		Recombinant selection and screening methods- genetic, immunochemical, South-western analysis, nucleic acid hybridization, HART, HRT, Expression of cloned DNA molecules and maximization of expression, Cloning strategies- genomic DNA libraries, cDNA libraries, chromosome walking and jumping.	
4	Recombinant DNA techniques	Blotting Techniques, Autoradiography, Hybridization, Molecular Probes and Nucleic acid labeling, DNA sequencing, PCR, Mutagenesis, Analysis of gene expression, DNA fingerprinting, RAPD, RFLP, AFLP.	10
5	Applications	Applications of Recombinant DNA technology	02
6	Protein interaction technology	Two-hybrid and other two component systems ,Detection using GST fusion protein, co-immunoprecipitation, FRE etc.	04
7	Gene therapy	In vivo approach, ex-vivo approach Antisense therapy, Transgenics.	02
8	Genetic disorders- Diagnosis and screening	Prenatal diagnosis, Single nucleotide polymorphisms, DNA microarrays, Future strategies.	02
9	The Human Genome Project	The Human Genome Project details.	02
Total Lectures			48

METHODOLOGY

The course will be covered through lectures supported by tutorials, PowerPoint presentations, research articles and practical. In tutorials, apart from the discussion on the topics covered in lectures, assignments in the form of questions will be given. Normally a students is expected to complete the assignment by himself, however if needed, difficulties will be discussed in the tutorial classes. There will be two class tests/ and surprise test conducted during the tutorial classes.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1 Biotechnology-Fundamentals and Applications- SS Purohit
2 Principles of gene manipulation-Old and Primrose
3 Gene Biotechnology-Jogdand

4 Molecular Biology-Twyman
5 Principles of genetics-Klug
6 Molecular Biology of the gene-Watson
7 Molecular Cloning (Vol 1,2,3)-Sambrook and Russell

TITLE OF THE COURSE: ENZYMOLOGY AND ENZYME TECHNOLOGY

COURSE CODE : BT 302 **L T P Hr C**

MARKS: 200 **3 0 4 7 5**

OBJECTIVE:

The objective of the course is to familiarize the student with enzymes, their kinetics, purification and applications in different fields

LEARNING OUTCOME:

At the end of the course, the students will have sufficient scientific understanding of the enzymalogy. This knowledge would be applicable in different industries

PREREQUISITES:

This is an introductory course in enzymology. School level knowledge of organic chemistry and Biology is sufficient. There are no prerequisites.

COURSE DESCRIPTION

Sr. No.	Topics	Detail syllabus	No. of Lectures
1	Enzymes	Classification: Trivial & EC system, Properties of enzymes. Enzyme substrate interactions, enzyme substrate complex, concept of active site, transition state theory, Effect of pH, temperature & substrate concentration on reaction rate.	08
		Enzyme Catalysis: Factors affecting catalytic efficiency - proximity and orientation effects, distortion or strain, acid-base, covalent & metal ion. Chemical modification of enzymes. Isoenzymes and multiple forms of enzymes.	2
2	Enzyme Kinetics & regulation of Enzyme action	Michaelis Menten equation, Significance of Km & Vmax. Enzyme inhibition- types and their kinetics. Enzyme activity, international units, specific activity, turnover number. Structure-Function Relations: chymotrypsin, lysozyme, metalloenzyme and the role of metals in catalysis with reference to carboxypeptidases. Ribozymes.	10 5
3	Allosteric interactions & Enzyme Regulations	Types, positive & negative cooperativity, theory of concerted & sequential models, kinetics of Allosteric enzymes.Enzyme Regulation: Feed back, covalent & Zymogen activation, Allosteric regulation.	4
4	Immobilization of enzymes &	Various methods of immobilization - ionic bonding, adsorption, covalent bonding (based on R groups of amino acids) ,	8

	applications	microencapsulation and gel entrapment, kinetics of immobilized enzyme. Applications of enzymes: Food processing, Medicine, Diagnostics, Production of new compounds, As research tools (ELISA method) Leather industry, textile industry.	
5	Enzyme Technology	Recent advances in enzyme technology, Use of unnatural' substrates, Enzyme engineering, Artificial enzymes, Coenzyme-regenerating systems.	8
Total Lectures			45

METHODOLOGY:

The course will be covered through lectures supported by tutorials. In tutorials would discuss different applications of enzymes and methods of their extractions and purification. Students would be given assignments in the form of questions. Normally a students is expected to complete the assignment by himself, however if needed, difficulties will be discussed in the tutorial classes. There will be two class tests/ and surprise test conducted during the tutorial classes.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1) Fundamentals of Enzymology. Nicolas C. Price and Lewis Stevens. Oxford University press. 2000.
2) Enzymes. Trevor Palmer.Horwood Publishing. 2001.
3) Lehninger Principles of Biochemistry by David L. Nelson and Michael M. Cox.Vth Ed.Palgrave Macmillan Pblication.2008.
4) Biochemistry by Stryer(4th edn) Fundamentals of Biochemistry by A. C. Deb. Biochemistry by Zubay.

PRACTICAL IN ENZYMOLOGY AND ENZYME TECHNOLOGY
(4 Hrs. Per Week) MARKS: 100

Teaching hours per week and credits for practical only: Teaching Hours-4; Credit-2

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1	Handling of enzymes and estimation of specific activity of an enzyme (e.g. amylase, phosphatase, protease)	To understand enzyme substrate reactions, quantification of enzyme activity, concept of unit of enzyme, role of inhibitors, activators etc	Bernfeld P. Amylases α and β. Methods in Enzymology Volume I. Elsevier, Science Direct. G; 1955, Page 149-158. Plummer DT. Introduction to Practical Biochemistry, third edition. Tata McGraw-Hill Edition; 1998.
2	Isolation of β-amylase from sweet potato (*Ipomoea batatas*)/ barley (*Hordeum vulgare*) and determination of enzyme activity using specific substrate	To learn procedures for isolation of crude enzyme from the given biological source and determine its activity To learn optimum conditions for isolation and activity analysis of enzymes from their biological source	Bernfeld P. Amylases α and β. Methods in Enzymology Volume I. Elsevier, Science Direct. G; 1955, 149-158 p.
3	Purification of enzyme by ammonium sulphate precipitation	Fractionation of protein using ammonium sulphate Learning the technique of enzyme concentration based upon salting in and salting out principle. Comparative study on the purity of crude and purified enzyme	Jakoby WB. [23] Crystallization as a purification technique. Methods in Enzymology. 1971 Dec 31; 22:248-52.
4.	Effect of physicochemical parameters (pH, temperature) on the activity of enzyme	To understand the role of physicochemical factors for optimum activity of enzyme	Seligman AM, Chauncey HH, Nachlas MM, Manheimer LH, Ravin HA. The colorimetric determination of phosphatases in human serum. Journal Of Biological Chemistry. 1951; 190:7-15.

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
5.	In situ enzyme activity staining on SDS-Polyacrylamide gel. (Amylase, Lactate dehydrogenase)	Principles of negative staining, positive staining.	Laemmli UK. Cleavage of structural proteins during the assembly of the head of bacteriophage T4. Nature. 1970 Aug 15; 227(5259):680-5. Raymond S, Weintraub L. Acrylamide gel as a supporting medium for zone electrophoresis. Science. 1959 Sep 18; 130(3377):711-711.
6.	Immobilization of enzyme by gel entrapment and cross linking method	Increasing the industrial significance of enzyme by enhancing its reusability and shelf life	Methods in Biotechnology, Vol 1, Immobilization of Enzymes and Cells Edited by Bickerstaff G. F., Humana Press, Inc, Totowa, N. J. 2006. Meena K, Raja TK. Immobilization of yeast invertase by gel entrapment. Indian Journal of Biotechnology. 2004; 3: 606-608.
7.	Study on enzyme inhibition.	Understand the role of catalytic amino acid residues in enzyme reaction mechanism	Strelow J, Dewe W, Iversen PW, Brooks HB, Radding JA, McGee J, Weidner J. Mechanism of Action assays for Enzymes. 2012. Eisenthal R, Danson MJ, editors. Enzyme assays: a practical approach. Practical Approach (Paperback); 2002.

EVALUATION SCHEME PRACTICAL TRAINING

Examination	**Duration**	**Marks**
Minor test 1	1 hour	30
Continuous Assessment		10
End semester Exam Viva & Spotting	2.5 hours	60
Total		**100**

TITLE OF THE COURSE: BASIC PHARMACOLOGY AND TOXICOLOGY
COURSE CODE: BT-504 **L T P Hr C**
MARKS: 100 **3 1 0 4 4**

OBJECTIVE:

The objective of the course is to familiarize the students with aspects of Pharmacology and toxicity of different chemical compounds.

LEARNING OUTCOME:

At the end of the course, the students will have sufficient scientific understanding of quantitative and qualitative role and mechanisms of toxic chemical compounds.

PREREQUISITES:

Since the course is very basic in scientific world, student must know about graphical relation between doses is to response relationship with biological cell.

COURSE DESCRIPTION

Seq. No	Topic	Description	Hrs
1.	Pharmacology Introduction	Organized drug discovery and development. Pharmacological, microbial, recombinant, biochemical and molecular level	02
2.	Clinical Developments	Screening systems and their construction strategies Alternative strategies in lead identification, lead optimization, pre-clinical development: Clinical trials, patenting and clearance for application	04
3.	Mechanism of action	Receptor versus enzyme mediated drug action, SAR and its quantitative description Molecular principles in agonist and antagonist action. Peptide and protein mimicry Morphines verses enkephalins	06
4.	Chemical Kinetics	Principles and practice of transition state mimicry Illustrative examples, collected substrate analogue inhibitors ,and design strategies	06
5.	Aspects of Pharmacology	Combinatorial approach to compound libraries, current status and future Prospects, synthetic peptide libraries, peptide libraries through phage display.	05
6.	Toxicology Introduction	Definition and derivation of toxicology Sister sciences, endocrinology and pharmacology Definition of toxins and toxicants Key features of toxicology and study of toxicants Modes of exposure, elimination, bioavailability, partition	5
7.	Dose Response	Toxicant targets	5

		Physiologic dose-response The role of intercellular chemical communication: hormone, receptor, transducer, effectors Agonist, antagonist Interconnections of transduction mechanisms	
8.	Metabolism	Biochemistry of toxicant metabolism Enter hepatic circulation Toxic dynamics and toxic kinetics	3
9.	Dosage	Stress and dose interactions Diet as modulator or mode of exposure Developmental status/age and toxicity Predispositions to toxic risk Moderators of toxic risk Carcinogenesis	5
10.	Models	Adequacy of models for developmental toxicity; Steroid disruptors: oestrogen, androgen, progestin, corticoid; Thyroid, retinoid and other disruptors.	4
		Total	**45**

METHODOLOGY

The course would be taught through lectures, demonstrations.

Evaluation Methodology theory

Minor Test 1	**1 Hour**	**15**
Minor test 2	**1 Hour**	**15**
Seminars		**10**
End Semester Examination	**3 hours**	**60**
Total		**100**

BOOKS RECOMMENDED:

1. Comprehensive medicinal chemistry-VolI & VolVI by C. Hansch.
2. Design of enzyme inhibitors as drug by M.sandle & H. J. Smith
3. Computer aided drug design by T.J.Pexin & C.L. Propst Dekk14e.
4. Klaassen. McGraw-Hill:New York, NY. 2001. 1236 pp.
5. Casarett & Doull's Toxicology: The Basic Science of Poisons, 6th Ed.

COURSE NAME: FERMENTATION TECHNOLOGY L T P Hr C
COURSE CODE: BT 503 3 0 4 7 5
MARKS: 200

OBJECTIVE OF THE COURSE:

The objective of the course is to familiarize the students with the experimental tools used in Industrial microbiology and fermentation technology. The students would learn industrial techniques as: Isolation, improvement, maintenance and preservation of microbial cultures, Design of media, bioreactors and downstream processes along with production studies during the tenure of their study.

LEARNING OUTCOME

At the end of this course student would be able to understand basic principles of fermentation technology as used in Biotechnology.

PREREQUISITES

Since the course is very basic in nature, school level knowledge in physics, chemistry & Biology is enough to take the course and there are no prerequisites.

COURSE DESCRIPTION

Sr. No.	Topic	Description	Hrs
1	Introduction to fermentation technology	-Historical background -Important industrial biotechnologically derived products	2
2	Fermentation Design	-Design of fermenter and its components (construction, impellers, valves, spargers, other attachments of the system) -Layout of Fermenter unit and laboratory -Operation details of fermentation and trouble shooting -Bioreactor types for products of microbial, plant and animal origin -Role of computers in fermentation processes	**8**
3	Sterilization	-Sterilization of Fermenter (batch and continuous processes) -feed sterilization -sterilization of liquid wastes -Filter sterilization	4
4	Isolation of microbes and Strain improvement	-Isolation and preservation of industrially important microbes -Strain improvement by recombinant DNA techniques, isolation of mutants, etc	4
5	Design of media and inoculum development	-Nutritional media for microorganisms, their formulation, sterilization, screening and economy for proper growth of industrial microbes - identification of variables important for fermentation -Medium optimization using conventional and statistical designs - Inoculum development for bacterial, fungal and yeast strains	7

		-Aseptic inoculation in fermenter	
6	Microbial Growth Kinetics	Kinetics of growth -in batch culture	6
		-in continuous culture -fed-batch culture	
7	Downstream processing	-Cell separation techniques -Concentration of metabolites -Purification of metabolites -Crystallization and drying	9
8	Biosynthesis of metabolites with examples	-Industrial production of Antibiotics , enzymes, organic acids ,vitamins, amino acids, solvents, beverages and single cell protein	8
Total number of lectures			**48**

METHODOLOGY

The course would be taught through lectures, demonstrations, tutorials and practical training.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED

TEXT BOOKS

1. Principles of fermentation technology by P F STANBURY, S. Hall, A. Whitaker., Pergamon Press, USA.
2. W Cruger and A Cruger A Textbook of Industrial Microbiology 2nd Edition Sinauer Associates Sunderland US 2004
3. A.H. Patel. Industrial Microbiology. MacMillan. 2000.
4. Casida, L E JR 1984 Industrial Microbiology. Wiley Eastern (revised editions)

PRACTICAL IN FERMENTATION TECHNOLOGY

(4 Hrs. Per Week) **MARKS: 100**

Teaching hours per week and credits for practicals only: 4 hours/week, 2 credits

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos *
1.	Isolation of industrially important microorganisms by screening methods, enzyme producer, antibiotic producer etc	To understand the concept of Primary and secondary screening.	3,4
2.	Preservation of industrially important organisms by different methods such as glyceol stock, dry soil culture and lyophilization.	To understand the importance of preservation of culture.	3
3.	Study of bacterial and yeast growth kinetics. Determination of specific growth rate and generation time.	To know the principle of bacterial growth curve and different phases.	1
4.	Production of alpha amylase by solid state fermentation, determination of enzyme activity/g of substrate and DSP methods for recovery of enzyme.	To understand the concept of solid state fermentation (SSF)	1 and 4
5.	Production of streptomycin/penicillin antibiotic by fed batch fermentation and determination of antibiotic activity.	To learn upstream and downstream processing in antibiotic fermentation. To learn antibiotic assays.	2 and 4
6.	Production of bioethanol from sugarcane juice and molasses by fermentation using *Saccharomyces cerevisiae*.	To understand industrial process of alcohol fermentation.	2
7.	Downstream processing for recovery of ethanol by simple distillation and detection by Chemical method and GC	To know simple and advanced method for alcohol recovery.	2, 1
8.	Production citric acid using *Aspergillus niger* by surface and submerged process and estimation of citric acid/ml of broth.	To know the basics of submerged fermentation process, To understand cell separation technique by centrifugation	2 and 4
9.	The recovery of citric acid by precipitation method and determination of yield of production.	To know product concentration by precipitation method. Purification by TLC /paper chromatography method.	2,1
10	Industrial visit to fermentation industry.	To learn different units in industry such as production. Quality control, Quality assurance, R & D, and Lab. To study unit operations in industry.	

*** References:**

1. Manual of Industrial Microbiology and Biotechnology
   (2nd Edition by Arnold L. Demain and Julian E. Davies, Ronald M. Atlas, Gerald Cohen, Charles L. Hershberger, Wei-Shou Hu, David H. Sherman, Richard C. Willson and J. H. David Wu)
2. Industrial Microbiology-An introduction
   (By Michael J. Waites, Neil L. Morgan, John S. Rockey and Gary Higton)
3. Principles of Fermentation Technology
   (2nd edition, by Peter F. Stanbury, Allan Whitaker and Stephen J. Hall, Butterworth-Heinemann, An imprint of Elsevier Science
4. Fermentation and Enzyme Technology By D.I.C. Wang, C.L. Cooney, A.L. Demain, P. Dunnill, A.E. Humphrey & M.D. Lilly John Wiley and sons, New York

EVALUATION SCHEME PRACTICAL TRAINING

Examination	**Duration**	**Marks**
Minor test 1	1 hour	30
Continuous Assessment		10
End semester Exam Viva & Spotting	2.5 hours	60
Total		**100**

TITLE OF THE COURSE: ELECTIVE 1 FOOD BIOTECHNOLOGY

COURSE CODE: BT-506 **L T P Hr C**

MARKS: 200 **3 0 4 7 5**

OBJECTIVE OF THE COURSE:

The objective of the course is to familiarize the students with advanced research area and basic concept in Food Biotechnology

LEARNING OUTCOME

At the end of the course, the students will have sufficient scientific understanding of different types of biotechnological methods to improve the value of different food and new techniques used in Food Biotechnology.

PREREQUISITES

Since the course is very advance in science, student must know about the new biotechnological and molecular genetics method which to apply in food. Student must have background with Biotechnological aspects and molecular genetics.

COURSE DESCRIPTION

Seq. No	Topic	Description	Hrs
1	Introduction to Food Biotechnology	Biotechnology application to food stuffs Career in Food Biotechnology Activities of Food Biotechnologist	02
2	Biotechnology in Food Processing	Unit Operation in Food Processing Quality Factors in Preprocessed Food Food deterioration and its control Rheology of Food products	14
3	Molecular methods and Production	Methods And application of molecular cloning in foods Developmental technique for new plant verities	06
4	Application of Biotechnology to Food products	Microbial role in food products Yeast, Bacterial and other microorganisms based process and products	16
5	Modification and Bioconversion of food raw materials	Bioconversion of whey, molasses and starch and other food waste for value addition	06
6	Regulatory and Social aspects of Food Biotechnology	Modern Biotechnological regulatory aspects in food industries Biotechnology and Food : A Social Appraisal	04
Total number of Lectures			48

METHODOLOGY

The course would be taught through lectures, demonstrations and practical.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1 Food Biotechnology: Dietrich Knorr,Inc.New York and Basel
2 Food Science: Potter N.N. CBS publication
3 Handbook of Food Biotechnology : NIIR Board of Consultants and Engg., NIIR
4 Food Science and Technology: B.S.Khattar,Daya Publishing House,Delhi
5 Biotechnology: B.D.Singh,Kalyani Publishers
6 Food Microbiology: Frazier

PRACTICALS IN FOOD BIOTECHNOLOGY (ELECTIVE I)

(4 Hrs. Per Week) **MARKS: 100**

OBJECTIVE:

Objective of course is to familiarize the students with basic aspects of food microbiology, estimation of minerals from food products, chemical preservatives.

LEARNING OUTCOME:

At the end of the course, the students will be able to study & correlate the quality of food and food products on the basis of chemical & microbial analysis.

PREREQUISITES:

This is a basis course regarding study of food products parameters.

COURSE DESCRIPTION

Sr. No.	Topics	No. of Lectures
1	Determination of quality of milk by MBRT test	04
2	Detection of number of bacteria by SPC method	04
3	Microscopic determination of microbial flora from yoghurt and lactic acid determination	04
4	Microbial examination of food	04
5	Detection of pathogenic bacteria from food samples	04
7	Preparation of Cheese	04
8	To determine mineral salt concentrations in fruit juices by using flame photometer	04
9	To check the food efficacy testing of chemical preservatives	04
10	Preparation of Bread	04

METHODOLOGY

The course will be covered through practical work supported by field study. Students would be made to gain scientific data information using various food products resources. They would be taught how to improve quality and useful microbial flora to food products.

EVALUATION SCHEME PRACTICAL TRAINING

Examination	Duration	Marks
Minor test 1	1 hour	30
Continuous Assessment		10
End semester Exam Viva & Spotting	2.5 hours	60
Total		**100**

BOOKS RECOMMENDED:

1) Practical in Food Microbiology
2) Practical in Microbiology : Kannan

TITLE OF THE COURSE: ELECTIVE 1 ENVIRONMENTAL BIOTECHNOLOGY

COURSE CODE: BT-507	**L**	**T**	**P**	**Hr**	**C**
MARKS: 200	**3**	**0**	**4**	**7**	**5**

OBJECTIVE OF THE COURSE:

The objective of the course is to familiarize the students with advanced research area and basic concept in Environmental Biotechnology

LEARNING OUTCOME

At the end of the course, the students will have sufficient scientific understanding of different types of biotechnological methods to improve environment value and new techniques used in Environmental Biotechnology.

PREREQUISITES

Since the course is very basic in science, student must know about the new biotechnological methods which to apply in environment. Student must have background with Biotechnological aspects and molecular genetics.

COURSE DESCRIPTION

Sr. No.	**Topic**	**Description**	**Hrs**
1	Environment	Introduction and History Global warming Depletion of ozone layer	03
2	Environmental Pollution	Types of Pollution Water pollution, Soil Pollution, Air Pollution, Noise Pollution Sources of pollution Collection of samples from different sources	04
3	Air pollution and its control	Active trace gases in air Aerosols in air Control of air pollution through biotechnology	03
4	Microbiology of waste water treatment	Aerobic System Biological processes for domestic and industrial waste water treatments; Aerobic systems - activated sludge process, trickling filters, biological filters, rotating biological contractors (RBC), Fluidized bed reactor (FBR), expanded bed reactor, Inverse fluidized bed biofilm reactor (IFBBR) packed bed reactors air- sparged reactors. Anaerobic System Anaerobic biological treatment - contact digesters, packed column reactors, UASB.	06
5	Microbiology of degradation of xenobiotics	Xenobiotics in environment Decay behavior of xenobiotics	04

6	Bioremediation	Bioremediation I Introduction, constraints and priorities of Bioremediation, Biostimulation of Naturally occurring microbial activities, Bioaugmentation, in situ, ex situ intrinsic & engineered bioremediation, Bioremediation-II, Solid phase bioremediation - land farming, prepared beds, Phytoremediation, Composting, Bioventing & Biosparging, Liquid phase bioremediation - suspended bioreactors, fixed biofilm, reactors. Role of genetic engineering	06
7	Mining and Metal biotechnology – with special reference to Copper & Iron.	Sources Microbial transformation, accumulation and concentration of metals, metal leaching, extraction, biosorption and future prospects.	04
8	Bio Fuels	Microorganisms and energy requirements of mankind, Production of nonconventional fuels - Methane (Biogas), Hydrogen, Alcohols and algal hydrocarbons, Use of microorganisms in augmentation of petroleum recovery.	06
9	Hazardous Waste Management	Biotechnology application to hazardous waste management - examples of biotechnological applications to hazardous waste management - cyanide detoxification - detoxification of oxalate, urea etc. - toxic organics - phenols.	6
10	Advances in Environmental Biotechnology	GIS in Environmental Management Computer based Environmental modeling Design of ETPs	06
Total number of Lectures			48

METHODOLOGY

The course would be taught through lectures, demonstrations and practical.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1 Textbook of Biotechnology-H.K.Das
2 Textbook of Biotechnology-Purohit
3 Stanier R. Y., Ingram J.L., Wheelis M.L., Painter R.R., General Microbiology, McMillan Publications, 1989.
4 Foster C.F., John Ware D.A., Environmental Biotechnology, Ellis Horwood Ltd., 1987.

5 Karrely D., Chakrabarty K., Omen G.S., Biotechnology and Biodegradation, Advances in Applied Biotechnology Series, Vol.4, Gulf Publications Co. London, 1989.
6 Bioremediation engineering; design and application 1995 John. T. cookson, Jr. Mc Graw Hill, Inc.

PRACTICALS IN ENVIRONMENTAL BIOTECHNOLOGY
(4 Hrs. Per Week) MARKS: 100

1) **Methods of sampling for pollution measurement**
   a) Statistical design for collection of samples from site
   b) Air sampling (Impaction)
   c) Soil sampling (soil probes/auger)
   d) Water sampling (Niskin type or equivalent depth sampling)

2) **Methods of Pollution Measurement (as per Indian and global recommendations)**
   a) Air pollution by measurement of SOX (sulphur oxides-di), NOX (nitrous oxide-di) and suspended particulate matter.
   b) Water pollution by measurement of water conductivity, pH, dissolved oxygen, and turbidity.
   c) Soil pollution by measurement of metals and organic compounds.
   d) At least one representative biological indicator for each of air (lichens), water (Macroinvertebrate) and soil (Moss) pollution.
   e) Graphical representation of the data collected after analysis of samples and comparison of values with Indian and Global standards.

3) **Community analysis of polluted and non-polluted sites by PCR based methods** (eukaryotic and prokaryotic domain primers). Comparison of polluted versus non-polluted sites to ascertain the possible alteration in community structure introduced due to pollutant.

4) **Microbial biodegradation (aerobic and anaerobic) of any one pollutant** (e.g. hydrocarbon) or any xenobiotic and study of its decay behaviour.

5) **Bioremediation –** Monitoring uptake of heavy metals using biological methods- organisms.

6) **Demonstration** for biogas production/ visit to wastewater plant/ biogas plant.

Note: Wherever it is not possible to perform the experiment due to limitation of equipment or other reasons, a demonstration will be arranged, however no more than 10% practical's will be demonstrations.

Semester VI

Course Code	Course Name	L	T	P	Hr	Cr
BT601	Virology	3	1	0	4	4
HU601	Principles of Management and Entrepreneurial Developments	3	0	0	3	3
HU 602	Biosafety, Bioethics & IPR	3	1	0	4	4
BT 602	Genomics, Transcriptomics & Proteomics	3	1	2	6	5
BT 603	Biochemical Engineering	3	0	4	7	5
BI 504 / BI 606/ BI 603	Elective II	3	0	2	5	4
Total		**18**	**3**	**8**	**29**	**25**

Elective II:

BI 504: Operating Systems
BI 603: Perl & Bioperl
BI 606: Computer Networking

TITLE OF THE COURSE: VIROLOGY **L T P Hr C**
COURSE CODE: BT 601 **3 1 0 4 4**
MARKS: 100

OBJECTIVE OF THE COURSE:

The objective of the course is to familiarize the students with Viruses, their structure, Plant and Animal viruses and Molecular Virology.

LEARNING OUTCOME:

At the end of the course, the students will have sufficient scientific understanding of types of viruses and the various diseases caused by viruses.

PREREQUISITES:

Since the course is an advanced level course, the student should have sufficient knowledge of Microbiology, DNA, and RNA.

COURSE DESCRIPTION:

Sr. No.	Topic	Description	Hrs
1	The Viruses	Discovery, virus structure, classification, viral replication cycle, detection and enumeration of viruses, virus cultivation in lab, viriods, prions.	10
2	Bacteriophages	Morphology, life cycle of viruses, reproduction of ds DNA phages, ss DNA phages and RNA phages, Lysogeny.	10
3	Plant Viruses	Nomenclature and classification, viruses of fungi, algae and protozoa, viruses infecting fruits and vegetables.	09
4	Animal Viruses	Viruses containing ss(+) RNA, ss(-) RNA, ds RNA and DNA and ssDNA, RNA tumor viruses requiring DNA intermediate for synthesis, Miscellaneous viruses.	13
5	Molecular Virology	Retroviruses and influenza viruses, interferons.	06
Total number of Lectures			48

METHODOLOGY:

The course would be taught through lectures and demonstrations.

EVALUATION SCHEME (THEORY)

Examination	Duration	Marks
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1 Microbiology by Pelczar.
2 Microbiology by Atlas.
3 Field‟s Virology.
4 Virology by Biswas and Biswas.
5 Microbiology by Prescott.

TITLE OF THE COURSE: PRINCIPLES OF MANAGEMENT AND ENTREPRENEURIAL DEVELOPMENTS

COURSE CODE: HU 601 **L T P Hr C**

MARKS: 100 **3 0 0 3 3**

OBJECTIVE OF THE COURSE:

The objective of the course is to prepare students competent in the field of quality control management of drugs and biopharmaceutical. The aim of the course is to create a general motivation amongst students to critically analyze the problem and how to apply the knowledge of quality management in their future endeavor. To prepare them to think independently for making newer project through literature survey, writing a review article on a topic aned 15 min. presentation to the class.

LEARNING OUTCOME

At the end of the semester it is expected that student understood the basics of quality control management practice in the industry and research labs., It is expected that they will be more confident to develop and implement the same policies in their research projects either for pursuing their higher education or for industrial application

PREREQUISITE

This is an advance level course. Students must have an understanding of introduction chemistry, Biology, Biochemistry , Microbiology, Pharmacology and toxicology of drugs, plant and animal biology,

COURSE DESCRIPTION

Sr. No	Topic	Description	Hrs
1	Management Principles:	Role of managers and leaders in biotechnology companies Innovative problem solving strategies Diverse and global work force Developing partnerships with other businesses Customers and competitors Utilization of technology Current challenges in organization Leadership skills, communication, conflict resolution, goal integration	20
2	Creating Biotechnology Enterprise:	Market assessment of innovative technology Patents and licensing Corporate law	25

		Raising money from venture capitalists Government grants Strategic alliances Sales and marketing Real estate Human resources Regulatory affairs Preparation of business plan for biotech start-up	
		Total lecture	45

METHODOLOGY

The course would be covered through lectures, supported by quizzes and case history discussion. A visit to pharma industry after the study will help their understanding om the sinkect. The students will be evaluated based pm twp c;ass test, lecture attendance, class participation, Write-up and power point presentation.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1 Principles of management byEllen A Benowitz
2 Greatest management principles in world by Michael Leboeuf
3 Management-principles and practices by Garry Dessler

TITLE OF THE COURSE: INTRODUCTION TO MOLECULAR MODELING AND CHEMO INFORMATICS

COURSE CODE : BI-605 **L T P Hr C**

MARKS: 100 **3 1 4 8 6**

OBJECTIVE OF THE COURSE:

The objective of the course is to familiarize the students with molecular modeling concepts and molecular modeling softwares.

LEARNING OUTCOME

At the end of the course, the students will have sufficient knowledge of how the molecules could be built and what are the various details associated with the field.

PREREQUISITES

Since course deals with molecular modeling students should have basics of Maths, Physics and Chemistry of molecules.

COURSE DESCRIPTION

Sr. No.	Topic	Description	Hrs
1	Introduction to molecular graphics	What are different coordinate systems? Basic principle of molecular graphics and structure visualization. Different molecular graphics packages. Protein Data Bank.	8
2.	Building of small molecules	Building of small molecules Methods used in building small molecules using crystal, cartesian, polar and chemical internal coordinates. Building of Biopolymers DNA & oligopeptides in different secondary structure	14
3.	Optimization of geometries of small molecules	Energy minimization by systematic search method Plotting conformation energy contours (Ramachandran plot), and finding out minimum energy conformation Gradient based Energy minimization Molecular mechanics approach Molecular Dynamics method Monte Carlo method Genetic algorithm	12
4.	Use of Quantum chemical methods for geometry optimization	Schrödinger equation Basic Formalism in quantum mechanics Schrödinger equation for a multi- electron atom Schrödinger equation for a molecule Hartree- Fock Method Different MO methods Molecular electrostatic potential Optimization of geometries of small molecules Quantum chemical indices	14

Total hours	48

METHODOLOGY

The course would be taught through lectures, practicals and assignments.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

Molecular modeling by Andrew Leach

Molecular Modeling, Holtje and Folkers G Weinheim New York

Subject name: Introduction to molecular modelling and chemoinformatics Teaching hours per week and credits for practicals only: 4 Hrs and 4 credits Marks for Practicals: 100

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1.	Exploring of Small Molecule database	To extract molecules from database	1.PubChem Home Page. Available from: https://www.pubchem.ncbi.nlm.nih.gov 2.Irwin JJ, Shoichet BK, ZINC-a free database of commercially available compounds for virtual screening. J Chem Info & Model. 2005;45(1):177-82. Available from: https://www.zinc.docking.org.
2.	To explore the protein data bank and the file format	To extract information related to proteins from the file	1. Berman HM, Westbrook J, Feng Z, Gilliland G, Bhat TN, Weissig H, *et al*. The Protein Data Bank Nucleic Acids Res. 2000;28:235-42. Available from: http://www.rcsb.org
3	Visualization and Analysis of Molecules	To learn different aspects of visualizing a molecule	1. The PyMOL Molecular Graphics System, Version 1.8 Schrödinger, LLC. Available from: https://www.pymol.org
4	Molecular drawing of small molecules by fragment based method and 2D based.	Chemoinformatics tool and software handling,Drawing of molecules with softwares and file formats generation	1.CS Chem3D Pro and CS MOPAC Pro 5.0 CambridgeSoft Corporation, Cambridge, MA; 1999. 2.Hanwell MD, Curtis DE, Lonie DC, Vanderm -eersch T, Zurek E, Hutchison GR, Avogadro: an advanced semantic chemical editor, visualization,and analysis platform. J Cheminf., 2012;4(17). Available from: http://avogadro.cc/wiki/Main_Page 3.DeepView – The Swiss-PdbViewer User Guide ver 3.7; 2001. Available from: http://www.expasy.org/spdbv/
5	To calculate the bond distance and bond angles for given molecules	For understanding the importance of bond length and bond angle for stability of molecules in nature	
6	To perform the energy minimization of given compounds	Energy minimization process and methods as well as importance for modeling	
7	To perform molecular	Understanding of dynamics	
	dynamics of given molecules	behaviour of molecules in solvent system	
8	To calculate the molecular electrostatic potential of molecules and proteins	Understanding the distribution charges on molecular surface	1. DeepView – The Swiss-PdbViewer User Guide ver 3.7; 2001. Available from: http://www.expasy.org/spdbv/ 2. The PyMOL Molecular Graphics System,

		of molecules and its importance	Version 1.8 Schrödinger, LLC. Available from: https://www.pymol.org 3. Hyperchem (Froimowitz M, B*ioTechniques*, 1993, 14, 6: pp. 1010-1013 HyperChem: a software package for computational chemistry and molecular model)
9	Conversion of Molecular file formats	To about different file formats and their conversions	Baoilleach, Open babel ver 2.4.1, 2016. Available from: http://openbabel.org/wiki/Main_Page

Internal evaluation will be based on following criteria

For practicals of 2 credits and 100 marks, internal evaluation will be for 40 marks with following break-up:

Practical: 10 marks

Attendance: 10 marks (above 80% attendance gets full marks) Laboratory assignment: 10 marks

Journal writing: 10 marks

TITLE OF THE COURSE: BIOSAFETY, BIOETHICS AND INTELLECTUAL PROPERTY RIGHTS

COURSE CODE: HU 602 **L T P Hr C**

MARKS: 100 **3 1 0 4 4**

OBJECTIVE:

The objective of the course is to make students learn about the legal, safety and public policy issues raised due to the rapid progress in Biotechnology and development of new products. The biotechnology students suppose to understand and follow the regulatory framework important for the product safety and benefit for the society. The students are given case history to discuss and express their views.

LEARNING OUTCOME

At the end of the course, it is expected that students have understood the basic issues of Biosafety, Bioethics and IPR.IT is expected that they will be more confidant to practice and implement all these policies in their future endeavor.

PREREQUISITES

This is an advance level course. Students must have an understanding of introductory undergraduate level course such as chemistry, biology, microbiology, plant and animal biology and molecular biology.

COURSE DESCRIPTION

Sr. No	Topic	Description	Hrs
1	Biosafety	Introduction and Development of Biosafety Practices Principles General lab requirements Definitions and Biosafety levels: 1,2,3,4 Summery Biological safety cabinets: centrifuges, Shipment of biological specimens, Biological waste management, Decontamination, Biosafety manuals, Medical surveillance, Emergency response	18
2	Bioethics	History and Introduction Ethics and genetic engineering Genetic Privacy Patent of genes Human races Trading Human Life Human Cloning Stem Cells Eugenics Biotechnology and Christian faith Human genome and religious considerations Case Studies Final Considerations	16
3	Intellectual Property Rights	Introduction Types of Intellectual Property Rights Plant and Animal growers rights Patents	14

		Trade secretes, Copyrights, Trademarks IPR and plant genetic recourses GATT and TRIPS and Dunkels Draft	
		Patenting of biological materials International conventions and cooperation Current Issues Patents for higher animal and higher plants Patenting of transgenic organisms and isolated genes Patenting of genes and DNA sequences Indian scenario.	
Total number of Lectures			48

METHODOLOGY

The course will be covered through lectures. The students will be given problems and case histories to discuss and clear their problems. The students will be evaluated based on two class tests, lecture and lab attendance, class participation, write up and quizzes.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1 Understanding Biotechnology by Borem
2 Biotechnology an Introduction: Barnum S.R.
3 Biosafety and Bioethics : Joshi
4 Introduction to Bioethics : Bryant
5 Legal Aspects of Business : Pathak
6 Intellectual Property Rights : Raju
7 Patent Law : Narayan
8 Intellectual Property Management: Jungham

TITLE OF THE COURSE: GENOMICS
COURSE CODE: BT-604 **L T P Hr C**
MARKS: 150 **3 0 2 5 4**

OBJECTIVE OF THE COURSE:

The objective of the course is to familiarize the students with advanced research area and basic concept in protein study and drug discovery.

LEARNING OUTCOME

At the end of the course, the students will have sufficient scientific understanding of Genome organization and new techniques used in genomics that are PCR,DNA Chips, Sequencing.

PREREQUISITES

Since the course is very advance in nature, student must know about DNA different Forms of DNA, there structure and Basic separation and visualization techniques for nucleic acids.

COURSE DESCRIPTION

Sr. No.	Topic	Description	Hrs
1	Introduction to Genomics.	History, What is genome, structural and organization of genome/	5
2	DNA sequence determination	DNA Sequencing and its accuracy	4
3	Polymerase Chain Reaction	History ,use, application.	4
4	Genome Centers and their organization.	Gene order and its aplication	2
5	High-throughput DNA sequencing technology, robotics and automation.identification	Automated DNA sequencing	3
6	Potentials and limitations of existing software and hardware tools and their relationship with sequencing methods.	Computing BAsics	2
7	Genome analysis and annotation.	ESTs and Finding Function from sequence.	4
8	Phylogenetic analysis	Clustering methodology ,strategy, and its application	7
9	Internet resources.	Bioinformatics Useful sites:- ENSEMBL, TIGR,	4
10	Genomic mapping and single nucleotide polymorphism (SNP).	SNPs and its application	3
11	Micro array gene expression analysis.	Microarray Technique and analysis	4
12	Introduction to biological data modeling.	Homology modelling	3
13	Vocabulary and Foundations		3
Total number of Lectures			**48**

METHODOLOGY

The course would be taught through lectures, demonstrations and practicals.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

REFERENCES BOOKS:

Bioinformatics: A practical guide to analysis of genes and protein By Baseman‟s A., D & Ouellette B.F.F Wiley

Bioinformatics Methods and Protocols (Methods in Molecular Biology, Vol. 132) by Stephen Misener (Editor), Stephen A. Krawetz (Editor

Gene cloning IV by T.A. Brown, Genomes II T.A. Brown, cell biology

PRACTICALS IN GENOMICS (4 Hrs.) MARKS : 100

OBJECTIVE:

The objective of the course is to familiarize students with the basic principles and the advancement in the field of genome analysis and gene expression. The practical‟s intents to give students knowledge and hands on experience of genome expression analysis techniques.

LEARNING OUTCOME:

The students will have hands on knowledge of techniques of genome analysis, high throughput gene expression analysis by protein profiling, and its applications at the end of the course.

PREREQUISITE:

Students should have basic knowledge of molecular biology and Recombinant DNA techniques, cell biology and bioinformatics.

LIST OF EXPERIMENTS:

Sr. No.	Name of practical	Hrs
1	Nested PCR	4
2.	Multiplex PCR	4
3.	Nucleotide sequencing	4
4.	mRNA isolation	4
5.	Reverse transcriptase (RT) PCR	4
6.	Real time PCR	4
7.	Probe labeling by nick translation	4
8.	*in-vitro* transcription	4
9.	Isolation and characterization of Expressed Sequence Tag (ESTs)	4
10.	Proteome analysis by 2D gel electrophoresis	4
11.	BLAST analysis	4
12.	Bioinformatics analysis of promoter, splice site, and termination site	4

EVALUATION SCHEME PRACTICAL TRAINING

Examination	**Duration**	**Marks**
Minor test 1	1 hour	30
Continuous Assessment		10
End semester Exam Viva & Spotting	2.5 hours	60
Total		**100**

REFERENCE BOOKS :

Molecular Cloning by Sambrook and Russel, practical manual,Cold Spring Harbor Lab. CSHL) Publication,2004 Vol I,II and III

TITLE OF THE COURSE: C# .NET (ELECTIVE-II)
COURSE CODE: BI-606 **L T P Hr C**
MARKS : 150 **3 0 2 5 4**

OBJECTIVE:

The objective of the course is to create understanding amongst the students in the subject of C# .Net through the practical and theory

LEARNING OUTCOME:

At the end of the semester, it is expected that students understood how to make Database & webpage designing, windows form design using C# .Net. It is expected that they will be more confident to use the aspects of C# .Net in pursuing their higher education or for Software Industries.

COURSE DESCRIPTION:

Sr. No.	Topics	Detail syllabus	No. of Lectures
1	Introduction/Overview of .Net	Introduction to .Net Platform for the future Drawbacks of Current Trend Net Framework – BCL & CLR l Key design goals CLR, CTS, MSIL & other tools. Multiple Language Interaction & support l Moving from Project to Assemblies… Security in .NET – CAS Advantages/Disadvantages Features of .Net Assemblies in Detail GAC, Strong Names	4
2	Visual C#.Net Language	Advantages/Disadvantages Why C#/ Why Not C# Where does C# Fit in C, C++ to Visual C# Features of C .NET Namespaces .NET Versions – 1.1/2.0/3.0/3.5 Beta Visual Studio.NET 2003/2005/Orcas/2008 Windows Vista – New Look Gadgets/SideBars/UAC – relation with .NET Hardware/Software Requirements	5
3	Programming Using Visual C#.Net	The start of the application C#.Net Program Design Variables and types Value types and reference types (CTS) Strings and arrays The Console class String formatting	5

		Statements and flows Programming Structures Command-line arguments VS.NET to Create C#.NET Apps C# 3.0/3.5 features – Implicit types , Extention Methods and more	
4	Introduction To Windows Form	Windows Forms – I Windows forms library – WinForms Layout Enhancements Forms and controls – Hierarchy Creating simple GUI by hand Event handling Basic controls Windows forms – buttons, check boxes, radio buttons, panels, group boxes, list boxes, picture boxes… Windows Forms – II Menus Built-in dialog boxes and printing Extender Controls ToolStrips, StatusStrips and progress bars A new MDI forms strategy Inheritance with forms New Controls – Web Browser, Property Grid etc	5
5	Object Oriented Concepts (Basic)	Classes & objects Abstract & override methods Creating and using your own classes l Data members and member methods l Instantiate an object This keyword Properties – Read Only Write Only… Build process using windows class library l Generate classes for other clients How to use classes as part of project	4
6	Object Oriented Concepts (Advanced)	Accessibility levels, specifiers Constructors Method overloading Class (static) variables & methods Object destruction „ref“ and „out“ parameters Constant values Enumerations Inheritance and Polymorphism The root of all classes Creating derived classes Method overriding and hiding Polymorphism and virtual functions Casting objects Abstract classes Sealed classes Static classes	6
7	Error Handling	Unstructured error handling support Structured error handling	4

		Error categories Debugging the application Debug and Trace classes Code Optimization Testing and strategies	
8	Ado.Net	Ado.Net Components Data Sources And .Net Data Providers	7
		Accessing Data In The Connected Environment Accessing Data In Disconnected Environment Sorting, Searching And Filtering	
9	ASP.Net	Introduction to web technologies Web Forms Architecture ASP.Net and HTTP Web application developing using Visual Studio State Management and Web Applications ASP.Net Server-side controls Caching in ASP.Net ASP.Net application configuration Debugging, Diagnostics of application Connectivity with Database using ADO.Net/Entity Framework Data Access Controls Personalization and Security	8
Total Lectures			48

BOOKS RECOMMENDED:

C Sharp.Net Complete Reference, McGrawHill

C# 2010 Programming: Author: Kogent Learning Solutions Inc. Publisher: Dreamtech

- Press Beginning ASP.NET 4.5 in C# and VB (Author :Imar Spaanjaars)
- C# and the .Net Platform (second edition) by Andrew Troelsen, Aprèss
- publication. Beginning ASP.NET 3.5 in C# 2008 by Matthew MacDonald, Apress publication.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

PRACTICAL'S IN C#.NET(2 Hrs. Per Week)
MARKS : 50

LIST OF PRACTICAL'S

1. Windows Form designing**.**
2. Windows Forms Layout
3. Windows forms – buttons, check boxes, radio buttons
4. Windows forms – panels
5. Windows forms – group boxes, list boxes.
6. Windows forms -picture
7. MySQL Database connectivity
8. Sql Server Database connectivity
9. Oracle Database connectivity
10. MS excel Database connectivity
11. MS access Database connectivity
12. Error Handling(based on the syllabus)
13. Oop"s basic & advanced
    i. Creating classes,
    ii. Objects, passing values,
    iii. Creating method,
    iv. Method overloading,
    v. Method overriding,
    vi. Inheritance,
    vii. Abstract classes,
    viii. Static classes,
    ix. Constructors,
    x. Virtual functions.
14. Webpage designing. (based on the syllabus)
15. Database designing(based on the syllabus)

EVALUATION SCHEME PRACTICAL TRAINING

Examination	**Duration**	**Marks**
Minor test 1	1 hour	15
Continuous Assessment		05
End semester Exam Viva & Spotting	2.5 hours	30
Total		**50**

Elective II

TITLE OF THE COURSE: COMPUTER NETWORKING

COURSE CODE:BI-606 **L T P Hr C**

MARKS: 200 **3 0 4 7 5**

OBJECTIVE

1 To create general understanding regarding basic knowledge of networking in computers, which are the protocols used for transmission of data, devices used in networking.
2 To familiarize the student with the models used in networking like OSI model.
3 To increase the knowledge of student about cryptography, digital signatures, e-mails, etc.

LEARNING OUTCOME

At the end of the course, the students will have sufficient understanding of the basic knowledge of networking in computers, which are the protocols used for transmission of data, devices used in networking, bit transmission, cryptography, etc.

PREREQUISITES

Students should know the basics in networking like LAN, MAN, WAN concepts, HTML.

COURSE DESCRIPTION

Sr. No.	Topics	Detail Syllabus	No. of Lectures
1	Introduction:	Uses of computer Networks Network Hardware Network Software Reference Models Network Examples Network standardization	06
2	The Physical Layer	The theoretical basis for data communication Guided transmission media Wireless transmission Communication satellites The public switched telephone network The mobile telephone system Cable television.	06
3	The data Link Layer:	Data link layer design issues Error detection & correction Elementary data link protocols Sliding window protocols Protocol verification Examples of data link protocols	06
4	The medium access control sub-layer	The channel allocation problem Multiple access protocol Ethernet Wireless LANs Broadband wireless Bluetooth	06

		Data link layer switching	
5	The network layer	Network layer design issues Routing algorithms Congestion control algorithms	06
		Quality of service Internetworking The network layer in the Internet	
6	The transport layer	The transport service Elements of transport protocol The internet transport protocols: UDP The internet transport Protocol: TCP Performance issues	06
7	The application layer	DNS- the domain name system Electronic mail The World Wide Web Multimedia	06
8	Network Security	Cryptography Symmetric key algorithms Public key algorithms Digital signatures Management of public keys Communication security Authentication protocols E-mail security Web security Social issues	06
		Total Lectures	48

METHODOLOGY

The course will be covered through lectures supported by tutorials and practicals. In tutorials, apart from the discussion on the topics covered in lectures, assignments in the form of questions will be given. Normally a students is expected to complete the assignment by himself, however if needed, difficulties will be discussed in the tutorial classes. There will be two class tests/ and surprise test conducted during the tutorial classes. The topics which are difficult & important will be given in the question bank, which is to be solving before the semester ending.

Evaluation Scheme (Theory)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

Teaching hours per week and credits for practical only: 2 hours, 1 credit

Sr. No.	**Name of the experiment**	**Learning objective**	**Literature/ Weblinks for reference and videos**

1	Study of network Connections, Cables, NICs, RJ45	Learning purpose, features, and functions of a network components.	Computer Networks by Tanenbaum, Andrew S, Prentice Hall of India, New Delhi
2	Study of Switch, Hub, Router, Repeater, Bridge and Gateway	Learning purpose, features, and functions of a network components.	Computer Networks by Tanenbaum, Andrew S, Prentice Hall of India, New Delhi
3	Establishing a local area network	To establish a local Area Network consisting of minimum three personal computers running the Linux and windows operating system, in order to share information and resources.	Computer Networks by Tanenbaum, Andrew S, Prentice Hall of India, New Delhi
4	Network IP Address	Learning the classification of IP address, assigning IP addresses to computers present in a network. Identify subnet address.	Computer Networks by Tanenbaum, Andrew S, Prentice Hall of India, New Delhi, Data Communications and Networking by Foronzan, Tata McGraw Hill, New Delhi
5	Network commands	Use command prompt instead of GUI	1 http://whirlpool.net.au/wiki/windows_nw_diag_cmds 2 https://www.tecmint.com/linux-network-configuration-and-troubleshooting-commands/
6	Install and use internet based remote access software	Learn how to remotely control one computer from another computer	Data Communications and Networking by Foronzan, Tata McGraw Hill, New Delhi

RECOMMENDED BOOKS

1. Computer Networks by Tanenbaum, Andrew S, Prentice Hall of India, New Delhi
2. Data Communications and Networking by Foronzan, Tata McGraw

Elective II

TITLE OF THE COURSE: OPERATING SYSTEM

COURSE CODE: BI 504 **L T P Hr C**

MARKS: 200 **3 0 2 5 4**

OBJECTIVE

1 To create general understanding regarding basic knowledge of Operating system, concept of process, responsibilities of Operating System, management of disk, job scheduling etc.
2 To familiarize the student with Deadlock, Semaphores.

LEARNING OUTCOME

At the end of the course, the students will have sufficient understanding of the Deadlock:

prevention, Memory organization and management, Virtual memory concepts, paging and segmentation, address mapping, Overview of the Linux OS.

PREREQUISITES

Students should know the basics in Computer, what is operating system

COURSE DESCRIPTION

Sr. No.	Topics	Detail syllabus	No. of Lectures
1	Overview	Operating systems, Functionalities and characteristics of OS. Hardware concepts related to OS, CPU states, I/O channels, memory hierarchy, microprogramming, Structure of Disk, Disk Storage Allocation Schemes for File Allocation Table The concept of Process, operations on processes, process states, concurrent processes, process control block, process context	3
2	File Systems Responsibilities of OS	File operations, attributes, extensions, types Access Methods Directory Organization Single Level Two Level Tree Structured Acyclic Graph Directory General Graph Directory Protection Consistency Semantics File System Implementation Management of Free Space Disk Scheduling Algorithms	3
3	History Using Windows OS	OS Features, capabilities, limitations UNIX process control and management, PCB, signals, forks and pipes	2
4	operating system organization	Interrupt processing, operating system organization, OS kernel FLIH and Dispatcher Job and processor scheduling, scheduling algorithms, process hierarchies Problems of concurrent processes, critical sections, mutual exclusion synchronization, deadlock Mutual exclusion, process co-operation, producer and consumer processes	4
5	Semaphores	definition, init, wait, signal operations Use of semaphores to implement mutex, process synchronization implementation of semaphores	3
6		Critical regions, Conditional Critical Regions, Monitors, Ada Tasks. Interprocess Communication (IPC), Message Passing, Direct and Indirect. 16.Deadlock: prevention, detection, avoidance, banker's algorithm	4
7	Memory management	Memory organization and management, storage allocation Virtual memory concepts, paging and segmentation, address mapping Virtual storage management, page replacement strategies	4
8	File organization	blocking and buffering, file descriptor, directory structure File and Directory structures, blocks and fragments, directory tree, inodes, file descriptors, UNIX file structure	4

9	Overview of the Linux OS	History Architecture Features and capabilities Kernel, shell & applications File System / Directory Structure Multitasking and Multi-user system Operating modes (RC scripts, Init levels)	4
10	Important concepts in a Linux environment	Login Login scripts & profiles X window system, the GUI under Linux Different window manager Linux Installation Linux Shell Programming Vi Text Editor, Shell Variables Examples Piping and redirection copy, rename, delete and move directory listing, file handling and IO redirection	5
11	Users and Groups	Concept of users and groups Owner creator Primary and secondary group types of file and directory permission	3
12	Basic commands and using GUI	Miscellaneous other commands cat, cal, date, passwd, less, grep, wc, bc uname, etc KDE Editors (Kwrite, Kedit) Office Applications (word processors, spreadsheets) Internet related applications (browsers, mail , clients) Multimedia applications	4
13	Command Line Interface	Additional text manipulation commands. e.g. cut, grep, split, paste, basename and various other gnu utils etc. Working with bash Login scripts and profiles Shell scripting Introduction to regular expressions Process management	4
14	Trouble Shooting	Tips and Tricks Getting help	1
		In silico viruses	
		Total Lecture	48

METHODOLOGY

The course will be covered through lectures supported by tutorials and practicals. In tutorials, apart from the discussion on the topics covered in lectures, assignments in the form of questions will be given. Normally a students is expected to complete the assignment by himself, however if needed, difficulties will be discussed in the tutorial classes. There will be two class tests/ and surprise test conducted during the tutorial classes. The topics which are difficult & important will be given in the question bank, which is to be solve before the semester ending.

EVALUATION SCHEME (THEORY)

Examination	Duration	Marks
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1 Introduction to Parallel Computing Second Edition by Grama et al. Addison-Wesley, Inc., 2003, ISBN 0-201-64865-2.
2 Modern Operating Systems (second edition), Andrew S. Tanenbaum, Prentice Hall Publishers, 2001, ISBN 0-13-031358-0.
3 William Stallings, Operasting Systems, Prentice Hall.
4 Harvey M. Deitel, An introduction to operating systems. Addison-Wesley.
5 Andrew Tanenbaum & Albert Woodhull, Operating Systems: Design and Implementation.Prentice-Hall.
6 Douglas Comer, Operating System Design - The XINU Approach. Prentice-Hall.
7 A.M. Lister, Fundamentals of Operating Systems. Macmillan (1979

Teaching hours per week and credits for practical only: 2 Hrs and 1 Credit Marks for Practical: 50

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1.	Installation of Linux	To learn the booting process, creating partition, making dual boot system	Gordon W. Getting started with linux: installing linux on your computer. Gizmodo Media Group; March 2011. Available from: http://lifehacker.com/5774997/getting-started-with-linux-how-to-install-linux-on-your-computer
2.	Studying directory structure	Learn how Linux manages files and directories	Operating systems lab manual. Rajlakshmi Engineering College; 2012. Available from: http://www.rajalakshmi.org/Dept/IT/CS2257-LM.pdf
3.	Creating a Virtual Machine	Understanding the concept of virtualization and effectively using the hardware	Hargrave V. How to create a Linux virtual machine with VirtualBox; March 2013. Available from: http://vichargrave.com/how-to-create-a-linux-virtual-machine-with-virtualbox/
4.	Learning Linux commands	Work confidently with Linux environment	Linux commands; Media college. [cited December 2016] Available from: http://www.mediacollege.com/linux/command/linux-command.html
5.	Gcc compiler	Compiling C and C++ programs	How to create a first C program on Linux. The Linux information project; March 2016.

			http://www.linfo.org/create_c1.html https://www.youtube.com/watch?v=y2fagvbda9I
6.	Implementation of Scheduling algorithm	Learnhow waiting time and turnaround time is calculated for the given burst time of processes	Operating systems laboratory programs, LINUX shell and C programs. Source code solutions; 2015. Available from: http://www.sourcecodesolutions.in/2010/09/cs1254-operating-system-lab.html
7.	Shell Scripting	Writing scripts to automate various task	Basak U. Linux shell scripting (writing and executing a shell script). YouTube video; June 2013. https://www.youtube.com/watch?v=xbx9wZhroM8

Internal evaluation will be based on following criteria

For practicals of 1 credit and 50 marks, internal evaluation will be for 20 marks with following break-up:

Practical: 10 marks

Attendance: 5 marks (above 80% attendance gets full marks)
Journal writing: 5 marks

Elective II

TITLE OF COURSE : PERL AND BIOPERL

COURSE CODE: BI 603 **L T P Hr C**

MARKS: 150 **3 0 2 5 4**

COURSE CONTENT:

1. **Introduction and Installation:** 4
   Introduction to perl
   Use of Perl in Bioinformatics
   History, Availability, Support and Basic Concepts

2**. Scalar Data:** 4
   Number, ,String, Scalar Operators, Scalar Variables
   Scalar Operators, Functions

3. **Arrays and List Data:** 4
   Introduction, Literal Representation, Variables
   Array Operators and Functions, Scalar and List context

4. **Control Structure**: 4
   Data types: Arithmetic and logical operators
   Conditions and loops

5. **Hashes:** 4
   Hash variables, Literal Representation of hashes, Hash function

6. **Basic I/O:** 4

7. **Regular Expressions:** 4
   Use of regular expression, , Patterns, Matching operators
   Substitution, Split and Join functions

8. **Subroutine**: 4
   - System and user function, The local Operator
   - Variable length Parameter list

9. **Advanced features in Perl:** 4
   - Advanced features in Perl, Advanced functions, operators files and directories
   - System Interaction, Using Perl‟s command line tool.
   - References and Structures, Using Modules

10. **Using Perl for CGI** 6

11. **Using Bioperl Modules** 6

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED

1) Solutions & Examples for Perl Programmers by Nathan Torkington and Tom Chistiansen. Network Programming with Perl(1st edition) by Lincoln Stein.
2) Beginning Perl for Bioinformatics by James Tisdall,O-Reilly
3) Developing Bioinformatics Computer Skills by Cynthia Gibas, Per Jamberk, O-Reilly Developing Bioinformatics Computer Skills by Cynthia Gibas, Per Jamberk,O-Reily Learning Perl by Randal
4) Programming Perl by Larry Wall
5) Programming the Perl DBI by Alligator Descartes
6) Advanced Perl Programming

Teaching hours per week and credits for practical's only: 02 Hr 1
Cr Marks for Practical's: 50

Sr. No.	Name of the Experiment	Learning objective	Literature/ Weblinks for reference and videos
1	Installation of Perl and BioPerl.	Learning installation process.	1. Tisdall James, *Beginning Perl for Bioinformatics*, 1st edition, O'Reilly Media, 2001.
2.	Scripting to understand the scalar data representation.	Declaration of variables and use of operators.	
3.	To write scripts using control structures.	Application of control	

		structures.	
4.	Write scripts using arrays and lists with biological example.	Use of arrays and lists.	2. Tisdall James, *Mastering Perl for Bioinformatics*, 1st Edition, O'Reilly Media, 2003. 3. Schwartz Randal, Phoenix Tom and Foy Brian d, *Learning Perl*, 6th edition, O'Reilly Media, 2011.
5.	Write scripts using hashes with biological example.	To know about data structure hash.	
6.	Write scripts for Basic I/O with biological example	Handling user input and output.	
7.	Writing regular expressions for motifs and pattern findings.	Learning to write regular expression.	
8.	Write scripts using subroutines with biological example.	Organizing script using subroutines.	
9.	Scripting to create and delete directories and providing various rights.	Learning directory operation	
10.	Script writing for file handling.	Learning file operation.	
11.	Write scripts using CGI with biological example.	Learning CGI.	
12.	Write scripts using BioPerl modules with biological example.	Using Perl modules for biological application.	

Internal evaluation will be based on following criteria

For practicals of 1 credit and 50 marks, internal evaluation will be for 20 marks with following break-up:

Practical: 10 marks

Attendance: 5 marks (above 80% attendance gets full marks) Journal writing: 5 marks

SEMESTER VII

Course Code	Course Name	L	T	P	Hr	Cr	Marks
BT 701	Biomembrane and Molecular Cell Signaling	3	1	0	4	4	100
BT 705	Development of Biology and Stem Cells	3	1	0	4	4	100
HU 701	Quality Control Management in Biotechnology	3	1	0	4	4	100
BT 706	Transcriptomics	3	0	4	7	5	200
BT 603	Biochemical Engineering	3	1	4	8	3	200
BT 707 / BT 708 / BT 709 / BT 710	Elective-III	3	0	4	7	5	200
Total		**18**	**3**	**8**	**27**	**25**	**900**

Elective III:

BT 707 : Metabolic Engineering

BT 708 : Marine Biotechnology

BT 709 : Agricultural Biotechnology

TITLE OF THE COURSE: BIOMEMBRANES AND MOLECULAR CELL SIGNALING

COURSE CODE: BT 701 **L T P Hr C**

MARKS: 100 **3 1 0 4 4**

OBJECTIVE OF THE COURSE:

The objective of the course is to familiarize the students with the interactions between cells, the pathways and mechanisms of cellular communications.

LEARNING OUTCOME:

At the end of the course, the students will have sufficient scientific understanding of the cellular receptors, their types and their role in cell-cell interactions.

PREREQUISITES:

Since the course is an advanced level course, the student should have sufficient knowledge of enzymes, receptors, cellular transport and its machinery.

COURSE DESCRIPTION:

Sr. No.	Topic	Description	Hrs
1	Overview of cell-cell and intracellular signaling mechanisms	Endocrine transmissions, Paracrine transmissions, Autocrine transmissions, Synaptic transmissions	01
2	Cell-cell recognition	Molecules involved in recognition, their functions and the mechanisms of recognition.	02
3	Cell-adhesion molecules	CAMs, their properties and types.	02
4	Concepts of receptors (extracellular, intracellular):	Receptor ligand interactions (concepts of agonist and antagonist) Receptor characterizations Receptor functions Extra cellular receptors Coupling of Receptors to different signal transducing machinery	07
5	G-proteins	Structure and their function	02
6	Ion channels and catalytic proteins	Justification of the large nature of the genome, genome complexity, tandem repeats, micro and mini satellites.	04
7	Adenylate cyclase system	cAMP-PK and CREB proteins	04

8	Calcium channels	Types of calcium channels, their structure, location and mechanism of transport.	02
9	Oscillations of calcium concentration as signals	Consequence of low and high calcium concentrations in the cell and its effects.	03
10	Receptors with protein tyrosine kinase activity	Structure and function	02
11	Intercellular receptors	Steroid receptors, structure and function	02
12	Second messengers	Phosphoinositides, inositol1,4,5, tris phosphate,	06
		diacyl glycerol, camp, cGMP, arachidonic acid, prostaglandins and NO	
13	Mechanism(s) of signal transduction	Coupling of activation receptors to intracellular signal transducing machinery; protein kinase(s) cascade	06
14	Receptor modifications, adaptation of cells.	Different structural and functional modifications in the receptors. Cellular adaptations.	02
15	Developmental abnormalities due to defective signaling pathways	Abnormalities during growth and development.	01
16	Signal transducing machinery as targets for potential drugs	Different molecules in cell signaling, action of drugs on them.	02
Total number of Lectures			**48**

METHODOLOGY:

The course would be taught through lectures and demonstrations.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1 Genes VII by Lewin and Benjamin
2 Molecular cell biology by Lodish, Baltimore
3 Molecular Biology of the cell by Bruce Alberts

TITLE OF THE COURSE: DEVELOPMENTAL BIOLOGY AND STEM CELLS

COURSE CODE: BT 705 **L T P Hr C**

MARKS: 100 **3 1 0 4 4**

OBJECTIVE OF THE COURSE:

The objective of the course is to familiarize the students with advanced research area and basic concept in stem cell biology

LEARNING OUTCOME

At the end of the course, the students will have sufficient scientific understanding of different types of stem cells and new techniques used in stem cell biology.

PREREQUISITES

Since the course is very advance in nature, student must know about cell-cell interaction and cell signaling. Student must have background with cell biology.

COURSE DESCRIPTION

Sr. No.	Topic	Description	Hrs
	Developmental Biology		
1	Introduction to Developmental Biology	Origins and History**,** Early Beliefs Gametogenesis, Fertilization, Mechanisms of Preventing Polyspermy, Fertilized-Egg, Activation	4
2	Cleavage	Mechanisms of Cleavage, Cleavage Patterns, Holoblastic, Cleavage: Isolecithal and Mesolecithal; Meroblastic Cleavage: Telolecithal and Centrolecithal; Cleavage Patterns in Major Groups of Organisms; Cell Specification	4
3	Gastrulation	Cell Movements, Germ Layers, Gastrulation in Major Groups of Organisms	4
4	Later Embryonic Development	The Central Nervous System (CNS) and Epidermis, Mesoderm, Endoderm differentiation, Cell Death, Front Limb vs. Hind Limb Formation	4
5	Genetic basis of Development	Differential Gene Expression and various developmental stages, Genetic Knockouts	3
	Stem cells		
6	Stem cell basics	Stem cell terminology Stem Cells from Early Mammalian Embryos Introduction to ES cells, EC cells, EG cells and TS cells. Their origin and characteristics.	4
7	Embryonic Stem cells	Isolation of ES cells	3

		Salient features of ES cells	
		Application of ES cells.	
8	Germline Stem Cells	Types of GSC‟s. GSC‟s in mammals, Drosophila and C. elegans. Establishment of GSC‟s Stem cell niche.	4
9	Stem Cells and Cloning	Therapeutic and reproductive cloning Nuclear Transfer method Application of NT ES cells. Safety of NT ES cells.	3
10	Bone Marrow Mesenchymal Stem Cells	History Embryonic origin of MSC‟s Harvesting, Isolation and Characterization. Differentiation studies of MSC‟s	4
11	Hematopoietic Stem Cells	Identfication of HSC‟s Characterisation of HSC‟s Mouse HSC‟s assay- In vitro and In vivo	4
12	Neurons, Stem Cells, and Potential Therapies	Neural stem cell Neural crest stem cell Alternative source for neural precursor	3
13	Stem cell applications	Role in cancer and other diseases Ethical and Regulatory aspects of stem cell technology Role of Stem Cells in Cell signaling	4
Total number of Lectures			48

METHODOLOGY

The course would be taught through lectures, demonstrations and practicals.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1. Developmental Biology, Eighth Edition, Scott F. Gilbert, Susan Singer, Publisher: Sinauer Associates Inc.; ISBN-13: 978-0878932504
2. Developmental Biology: A Very Short Introduction, Lewis Wolpert, Publisher: Oxford University, ISBN-13: 978-0199601196
3. Essential Developmental Biology, Jonathan M. W. Slack Publisher: Wiley-Blackwell; 3 edition, ISBN-13: 978-0470923511
4. Stem cell handbook, by STEWART SELL, MD

5. Stem cell Biology by Robert Lanza.

TITLE OF THE COURSE: QUALITY CONTROL MANAGEMENT IN BIOTECHNOLOGY

COURSE CODE: HU 701 **L T P Hr C**

MARKS: 100 **3 1 0 4 4**

OBJECTIVE OF THE COURSE:

The objective of the course is to prepare students competent in the field of quality control management of drugs and biopharmaceutical. The aim of the course is to create a general motivation amongst students to critically analyze the problem and how to apply the knowledge of quality management in their future endeavor. To prepare them to think independently for making newer project through literature survey, writing a review article on a topic and 15 min. presentation to the class.

LEARNING OUTCOME

At the end of the semester it is expected that student understood the basics of quality control management practice in the industry and research labs., It is expected that they will be more confident to develop and implement the same policies in their research projects either for pursuing their higher education or for industrial application

PREREQUISITE

This is an advance level course. Students must have an understanding of introduction chemistry, Biology, Biochemistry , Microbiology, Pharmacology and toxicology of drugs, plant and animal biology,

COURSE DESCRIPTIONS:

Sr. No.	Topic	Description	Hrs
1	Introduction	General introduction about drugs manufacturing process and policies	2
2	TQM	Details of the total quality management.	2
3	Industrial standard	ISO 9000 series, ISO 140000 series	3
4	Pharmacopeias	Indian Pharmacopeias, British Pharmacopeias US Pharmacopeias, Extra Pharmacopeias	1
5	Good manufacturing processes	Introduction GMP and CGMP, GXP and GCP	3
6	Key requirement of C GMP	C GMP for API manufacturing Quality management, Personel Building and facilities, Documentation Material management, Production and Inprocess control Packaging Storage and distribution Laboratory control Validation, Change control Rejection and reuse of material, Complaints and recall Contract manufacturers, Agents, Brokers, Traders, Distributors, Repacker and retailer	15
7	Good Laboratory Practices	History, Present Status Indian scenario	4
8	ICH	ICH guidelines History and Introduction, Necessity of ICH International scenario and Indian scenario	4

9	SOP	Standard operating procedures	2
10	MVP	Master Validation Plan in labs and industry	2
11	Accredition & Registration with	National Accreditition Board for Testing & Calbbration(NABL)	2
	various Regulatory Authorities	Registration with FDa of other countries for expoting formulations, API & NCE‟s.	
		Total number of Lectures	**45**

METHODOLOGY

The course would be covered through lectures, supported by quizzes and case history discussion. A visit to pharma industry after the study will help their understanding om the sinkect. The students will be evaluated based pm twp c;ass test, lecture attendance, class participation, Write-up and power point presentation.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1 Quality control assurance Anjaneyulu
2 Pharmaceutical management by Itkar
3 Pharmaceutical master validation plan by Haider
4 Handhook of microbiological Quality Control by Baird.

TITLE OF THE COURSE: TRANSCRIPTOMICS
COURSE CODE: BT-706 **L T P Hr C**
MARKS: 100 **3 0 4 7 5**

OBJECTIVE:

Objective of the course is to familiarize the students with basic principles and the advancement in the field of genome and gene expression analysis. The course also introduces the students to various techniques of gene expression profiling in prokaryotes and eukaryotes.

LEARNING OUTCOME:

The students will have knowledge of high throughput methods of genome analysis and gene expression profiling at the end of the course.

PREREQUISITE:

Students should have basic knowledge of molecular biology of transcription in prokaryotes and eukaryotes, recombinant DNA technology, cell biology and bioinformatics.

COURSE DESCRIPTION:

Sr. No.	Topics	Detail	Hrs
1.	Introduction	Concepts of transcriptomics and its scope. Transcription and post-transcriptional modifications. Differential gene expression. RNA splicing/xport RNA stability Translational control (miRNA)	2 3 3
2.	Tools and Techniques for transcriptome analysis	Global expression profiling and expression analysis by DNA microarray,cDNA microarray, Gene chip synthesis spotted array and *in -situ* hybridizarion of oligonucleotides Gene chips for transcriptional profiling in human, mouse, plant, yeast, bacteria etc. Human brain transcriptome. Yeast meiotic transcriptome Expressed sequence tags (ESTs) and sampling of ESTs from cDNA libraries. ESTs database. Serial Analysis of gene expression (SAGE). Massively parallel signature sequencing (MPSS)	6 4 2 2 4 2 2
3.	Applications in expression profiling in human diseases	Gene chips for disease profiling. Identification of novel tumor supressor genes, insulin resistance, and asthma. Expression profiling for class prediction and class	7

		discovery in similar types of cancer.	
4.	Introduction to Bioinfomatic tools and internet resources	Gene expression omnibus (GEO). Center for information Biology Gene Expression Database (CIBEX).	6
		EPCLUST programme.Microarray and gene expression (MAGE). MGED (Microarray gene expression database) Bioinformatic analysis of promoter prediction, splice site termination site.	3
		Total	46

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

REFERENCES BOOKS :

1. Transcriptomics: Expression pattern analysis by Virendra Gomase and Somnath Tagore,VDM Verlag.2009

2. Genome Transcriptome and Proteome Analysis by Alain Bernot, John Wiley and Sons Ltd.2004

3. Principles of gene manipulation and Genomics S.B.Primrose and R.M Twymann, Blackwell publishing VII edition, 2006

4.Bioinformatics Sequence and Genome Analysis by David W. Mount, Cold Spring Harbour Laboratory Press (CSHLP),II edition,2004

PRACTICALS IN TRANSCRIPTOMICS (4 Hrs.) MARKS : 100

OBJECTIVE:

The objective of the course is to familiarize students with the basic principles and the advancement in the field of genome analysis and gene expression. The practicals intents to give students knowledge and hands on experience of genome expression analysis techniques.

LEARNING OUTCOME:

The students will have hands on knowledge of techniques of genome analysis, high throughput gene expression analysis by protein profiling, and its applications at the end of the course.

PREREQUISITE:

Students should have basic knowledge of molecular biology and Recombinant DNA techniques, cell biology and bioinformatics.

Sr. No.	Name of practical	hrs
1.	Nucleotide sequencing	**4**
2.	Nested PCR	**4**
3.	Multiplex PCR	**4**
4.	mRNA isolation	**4**
5.	Reverse transcriptase (RT) PCR	**4**
6..	Nucleic acid labeling by nick translation	**4**
7.	*in -vitro* transcription	**4**
8.	Size fractionation of RNA using denaturing agarose gel electrophoresis.	**4**
9.	Differential gene expression by real time PCR	**4***
10.	PCR-based Method for Detection and Quantification of Small RNAs (SnRNA)	**4**
11.	Isolation and characterization of Expressed Sequence Tag (ESTs)	**4***
12.	Proteome analysis by 2D gel electrophoresis	**4***
13	Nucleotide and amino acid sequence analysis by using bioinformatic tools.	**4***

*The time allotted in the syllabus is as per slot given for each practical. It can be adjusted according to the respective practical requirement.

EVALUATION SCHEME PRACTICAL TRAINING

Examination	**Duration**	**Marks**
Minor test 1	1 hour	30
Continuous Assessment		10
End semester Exam Viva & Spotting	2.5 hours	60
Total		**100**

TITLE OF THE COURSE: BIOCHEMICAL ENGINEERING **L T P Hr C**
COURSE CODE BT - 603 **3 1 4 8 6**
MARKS: 200

OBJECTIVE:

The objective of the course is to create general understanding amongst the students in the subject of Biochemical Engineering through in-depth lectures. The objective of the course is create an understanding of concepts and basic principles in the subject with emphasis on how to apply the knowledge in industrial processes involving Biochemical Engineering.

LEARNING OUTCOME:

At the end of the semester, it is expected that students understood the basic principles of engineering knowledge to solve a critical industrial biotechnology problem. It is expected that they will be more confident to use the knowledge in pursuing the knowledge in production of useful metabolites.

PRE-REQUISITES:

This is an introductory level course. Students are expected to have an understanding of introductory knowledge in Physics, Chemistry and Biology.

COURSE DESCRIPTION

Sr. No.	Topics	Detail syllabus	No. of lectures
1	Introduction to Biochemical Engineering	-Fundamentals of biochemical engineering -Biotechnology and Bioprocess engineering	2
2	Stoichiometry & Energetic	-Principles of thermodynamics -Stoichiometry for metabolic pathways: Carbon metabolism, biosynthesis of molecules, Stoichiometry of cell growth and product synthesis, theoretical predictions of yield coefficients with examples	6
3	Bioprocess Kinetics	Reactors for measurement of Kinetics, Structured Kinetic Models, Balanced and transient growth kinetics, Kinetics of product formation, Death kinetics during fermentation process	6
4	Biological reactors	Ideal & non-ideal bioreactors, reactor operations: Batch, Fed-batch & Continuous. Growth, Substrate utilization and Product formation: Mass & Heat Balances, Structured and unstructured models Bioreactor design & configurations, microbial reactors-aerobic and anaerobic reactors, Immobilized enzyme & cell reactor systems, Animal cell culture systems	8
5	Transfer reactions	Mass transfer concepts in Gas-liquid systems, mass transfer across free surface, KLa and oxygen transfer rate, rheology and its relation to mass transfer, non-Newtonian fluids, factors affecting Kla, heat transfer correlations	8
6	Bioreactors: Operation and control	Sensors for measurement of different parameters, on-line sensing and measurement systems, computational methods,	7

		data analysis during process, Process control: regulatory and cascade, continuous and advanced systems	
7	Scale up, process economics and applications	Consideration of parameters for scale up, process economics: one example from laboratory to market and economic considerations, mathematical modeling of one system like anaerobic digester and simulation studies	6
8	Case Studies	Case studies (Product or technology based) - Microbial system - Animal system - Recent developments	5
	Total		48

METHODOLOGY:

The course will be covered through lectures supported by tutorials and laboratory practicals. Students will be evaluated based on two class tests, lecture and laboratory attendance, class participation.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED

1 P. F. Stanbury, A. Whitaker and S. J. Hall. 'Principles of Fermentation Technology', Pergamon Press, Oxford and revised editions.1995.

2 J. E. Bailey, D. F. Ollis Biochemical Engineering Fundamentals, 2nd edition, McGraw-Hill, New. York) and revised editions. 1986

3 Pauline Doran, Bioprocess Engineering Principles, Academic Press (1995) and revised editions.

4 Shuler, ML and F. Kargi. Bioprocess. Engineering: Basic Concepts (Second Ed.). Prentice Hall, Englewood Cliffs, NJ. 2002.

PRACTICALS IN BIOCHEMICAL ENGINEERING
(4 Hrs. Per Week) **MARKS : 100**

LIST OF PRACTICALS

1. Study of bioreactor design in laboratory.
2. Microbial Growth kinetics: Determination of specific growth rate (μ), Saturation constant (KS) and growth yield (Yx/S), Sp. product formation rate (Q1) and substrate consumption rate for the given microorganism in batch culture.
3. Study of Growth curve by optical density method. Determination of cell dry mass, and its co-relation with N for *E.coli/S.cerevisiae*.
4. Determination of KLa by sulphite oxidation method.
5. Control of bioreactor and operation of biosensors for the control of pH, temperature, aeration and agitation rate in the bioreactor.
6. Determination of thermal death point and thermal death time for *E. coli* and for *Saccharomyces cerevisiae.*
7. Disruption of microbial cells (Baker's yeast) for the release of the intracellular proteins.
8. Immobilization of enzyme for demonstration of biological activity and immobilization efficiency.
9. Study of rheology of fermentation broth. Determination of viscosity and Packed cell volume (PCV)
10. Estimation of substrate consumption rate in fermenter batch based on glucose concentration in the broth.

EVALUATION SCHEME PRACTICAL TRAINING

Examination	**Duration**	**Marks**
Minor test 1	1 hour	30
Continuous Assessment		10
End semester Exam Viva & Spotting	2.5 hours	60
Total		**100**

Elective III

TITLE OF THE COURSE: METABOLIC ENGINEERING **L T P Hr C**

COURSE CODE: BT 707 **3 0 4 7 5**

MARKS: 100

OBJECTIVE OF THE COURSE:

The objective of the course is to familiarize the students with the

LEARNING OUTCOME:

At the end of the course, the students will have sufficient scientific understanding of the different biotechnological methods

PREREQUISITES:

Since the course is an advanced level course, the student should have sufficient knowledge

COURSE DESCRIPTION:

Sr. No.	Topic	Description	Hrs
1	Course Description	Learning the basic biochemical concepts of metabolic pathways Understanding the role of Bioinformatics in the study of metabolic pathways Learning the Bioinformatics-based approaches for predicting and engineering metabolic pathways Classification of Enzymes Classification of Metabolic Pathways	15
2	Metabolic Pathway database	KEGG, EMP Malaria Parasite Metabolic Pathways ECoCYC aetaCyc Boerhringer Mannheim- Biochemical Pathways	15
3	Enzymes, Compounds and Reaction databases	LIGAND-Biochemical Compound and Reaction ENZYME-Enzymes BRENDA- Comprehensive Enzyme Information System Full Genome Annotation through knowledge of Metabolic Pathways Organism Specific Metabolic Pathways, Comparison of Metabolic Pathways, Engineering of Metabolic pathways, Representation of Metabolic Pathways Generation and Dynamic Representation of Metabolic Pathways Knowledge Deriving Common Principles from the Metabolic Pathways knowledge	15
Total number of Lectures			45

METHODOLOGY:

The course would be taught through lectures and demonstrations.

EVALUATION SCHEME (THEORY)

Examination	Duration	Marks
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1. Metabolic engineering edited by Sang Yup Lee and Eleftherious T. Papoutsakis
2. Metabolic engineering - Principles and Mehodologies by Gregory N. Stephanopoulos, Aristos A. Ariostidou and Jens Nielsen.

Elective III

PRACTICAL IN METABOLIC ENGINEERING (4 Hrs.) MARKS: 100

Teaching hours per week and credits for practicals: 2 Cr 4 Hrs

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1.	Exploration and retrieval of metabolic pathway enzymes from Expasy	Understanding pathway databases and retrieval methods	http://enzyme.expasy.org/
2.	To Explore LIGAND-Biochemical Compound and Reaction database	Learns about biochemical component role through metabolic pathway and reaction database	http://www.genome.jp/ligand/
3.	To explore BRENDA metabolic pathways	Retrieval and exploration of BRENDA database for enzyme information in metabolic pathways	http://www.brenda-enzymes.org/tutorial.php
4	To explore Malaria parasite Metabolic pathways	Understanding the Malaria parasite database construction and retrieval system	http://mpmp.huji.ac.il/

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
5.	Identification of potential drug target for a given metabolic metabolic pathway	To make familiar with methodology to identify potential drug target in given metabolic pathway	http://www.genome.jp/kegg/pathway.html
6.	Exploring comparative metabolic pathways by KEGG database and Biocyc	Tools give an idea to compare metabolic pathways in different species	https://biocyc.org http://www.genome.jp/kegg/pathway.html
7	To construct metabolic pathway, PathoLogic and SBW	Learns construction and reconstruction of metabolic pathway with the help of offline tools	http://brg.ai.sri.com/ptools/
8.	Analysis of metabolic pathways by MetaFlux and Pathway editor	Understanding of Flux importance in the metabolic pathway analysis	http://brg.ai.sri.com/ptools/
9.	Genome annotation through metabolic pathways	Learns about genome annotation through metabolic pathways	1. Metabolic Engineering - Principles and Methodologies by Stephanopoulos (2005) Elsevier publications 2. http://david.abcc.ncifcrf.gov/
10.	MATLAB application in metabolic pathway	Learns utilization of MATLAB for analysis of metabolic pathways	http://kikollan.github.io/PFA-Toolbox/

EVALUATION SCHEME PRACTICAL TRAINING

Examination	**Duration**	**Marks**
Minor test 1	1 hour	30
Continuous Assessment		10
End semester Exam Viva & Spotting	2.5 hours	60
Total		**100**

Elective III

TITLE OF THE COURSE: MARINE BIOTECHNOLOGY **L T P Hr C**

COURSE CODE: BT 708 **3 0 4 7 5**

MARKS: 100

Objective:

The objective of the course is to give an overview of marine environment and its living and nonliving resources. Further the utility of the resources for overall benefit of humans and other biota is also covered.

Pre-requisites:

Students are expected to have a basic understanding in Biology.

Course Description:

Sr.No	Topics	Detail syllabus	No. of lectures
1	Marine Science Fundamentals	• *Oceanography:* Physical and chemical properties of sea water, Ocean winds and tides- Coriolis effect, El Nino, La Nina, Ekman motion, tsunami, submarines to study marine environment • *Bathymetry:* Ocean basins, tectonics and sediments • *Marine biology and ecology:* Biodiversity, benthos, food chain, non-cultivable life forms	7
2	Marine Microbiology	• *Microbial diversity*: Non-culturable microbes, extremophiles, metagenomics • *Methods for assessment of microbial life forms:* sampling, identification, community structure analysis • *Role of Microbes in marine ecosystem*: beneficial and harmful effects, interactions with other flora and fauna	6
3	Marine resources-Bioprospecting	• *Marine Natural Products*: screening using advanced high-throughput systems, isolation and identification techniques using genomics, proteomics or transcriptomics approaches • *Bioactive compounds and Biomaterials*: antibiotics, enzymes, alkaloids, biominerals, biocomposites, biopolymers	8
4	Marine culture	• *Aquaculture:* Methods, ponds, cultivation systems, examples- Gastropod, Bivalve and Crustacean production • *Marine life poisoning:* marine toxins • *Aquatic animal health management:* diseases of commercial fishes, spoilage, control methods • *Broodstock development*: Maintenance of important broodstock	10

Sr.No	Topics	Detail syllabus	No. of lectures
5	Advanced technologies and products	• *Transgenic fish:* development and applications • *Probing technologies:* biochemical, molecular, bioindicators • *Biosensors*: role in marine environment • *Examples*: of successfully commercialized products	7
6	Marine models of regenerative medicine	• *Principles of organ regeneration:* Xenopus and Zebrafish as models for regeneration • *Examples of marine biomaterials in regeneration*: tissues, bone, orthodental, optical systems, cardiovascular devices, cochlear implants, etc • *Challenges and ethical issues*	5
7	Marine Conservation	• *Pollution in the marine environment*: endangered species, dead zones, impact of pollution on marine and human life • *Marine protection acts and laws:* for conservation, Coastal Zone Management, Coastal Aquaculture Act, Fisheries Act • *Marine life conservation strategies*: databases, maintenance of marine life	5
	Total		48

Methodology:
The course will be covered through lectures supported by tutorials and laboratory practicals. Students will be evaluated based on two class tests, lecture and laboratory attendance, class participation.

Books Recommended:
1. Marine Biotechnology I, Le Gal, Yves, Ulber, Roland (Eds.), Springer (2005) pp. 287.
2. Marine Biotechnology II, Le Gal, Yves, Ulber, Roland (Eds.), Springer (2005) pp. 261.
3. Handbook of Marine Biotechnology, Kim, Se-Kwon (Ed.), Springer (2015) pp. 1512.

METHODOLOGY:
The course would be taught through lectures and demonstrations.

EVALUATION SCHEME (THEORY)

Examination	Duration	Marks
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1) Micro Algae : Biotechnology & Microbiology,E.W.Becker Cambridge University Press.

2) Aqua Culture – An Introduction, Lee & Newman, Interstate Publishers Biotechnology an Introduction, Susan R.Barnum, Vikas Publishing House

Elective III

PRACTICAL IN MARINE BIOTECHNOLOGY (4 Hrs.) MARKS: 100

Teaching hours per week and credits for practicals: 4 hours/ week; 2 credits

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1	Identification of phytoplanktons and zooplanktons using permanent slides	Introduce the students with different types of marine organisms.	Lab Manual Introduction to Marine Biology, (4th Edition) by George Karleskint, Richard Turner, James Small (Brooks Scole Publication)
2	Isolation and identification of important marine yeast/fungi/bacteria	Learn the techniques of isolation of marine yeast/fungi/bacteria	Isolation and identification of important marine yeast/fungi/bacteria. *Indian Journal of Geo Marine Science*, 2011; 40(3), 391-397.
3	Enumeration of marine microbes using fluorescence, dark field and phase contrast microscopy	Identify number and different types of microbes from marine system	Lab Manual Introduction to Marine Biology, (4th Edition) by George Karleskint, Richard Turner, James Small (Brooks Scole Publication)
4	Study of microbial diversity in a marine system using metagenomics and community analysis	Learn the techniques for rapid identification of marine microbial system.	16S rDNA-Based Metagenomic Analysis of Bacterial Diversity Associated With Two Populations of the Kleptoplastic Sea Slug *Elysia chlorotica* and Its Algal Prey *Vaucheria litorea*. 2012; Biol. Bull. 223: 138–154.
5	Function or molecular screening for potential bioactive compounds from marine bacteria (enzyme, polysaccharide/biofilm, biosurfactant or bioemulsifier)	Identify bioactive compounds from marine organisms and their applications	Lab Manual Introduction to Marine Biology, (4th Edition) by George Karleskint, Richard Turner, James Small (Brooks Scole Publication)
6	Bioindicators for detection of marine pollutants	Use of organisms to detect the marine pollution.	Bioindicators: the natural indicator of environmental pollution. *Frontiers in Life Science*, 9:2, 110-118
7	Study of quality control parameters for edible marine/fresh water fishes using molecular diagnostic	Quality control measures for edible marine/fresh water food	Comparison of selected methods of assessing freshness quality and remaining storage life of iced gilthead sea bream.

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
	techniques		*Food Research International* 36 (2003) 551–560
8	Optimization of different media for growth of algae	Preparation of media and its screening for optimum growth of algae	Culturing Algae (2nd Edition) by Daniel E. James. Carolina Biological Supply Company.
9	Algal Cell Culture and bio-fuel production from algal biomass	Learn the production of bio-fuel from algae	Micro Algae : Biotechnology & Microbiology,E.W.Becker Cambridge University Press
10	Preparation of different types of ponds and aquaponics chambers used in aquaculture	To learn preparation of ponds and aquaponics chambers for growing marine organisms	http://www.fao.org/3/a-i4021e/index.html
11	Visit to Marine Research Institute.	To learn the research as well as institutional activities carried out by institute	_

E***VALUATION SCHEME PRACTICAL TRAINING***

Examination	**Duration**	**Marks**
Minor test 1	1 hour	30
Continuous Assessment		10
End semester Exam Viva & Spotting	2.5 hours	60
Total		**100**

Elective III

TITLE OF THE COURSE: AGRICULTURAL BIOTECHNOLOGY **L T P Hr C**

COURSE CODE : BT 709 **3 0 4 7 5**

MARKS : 200

OBJECTIVE OF THE COURSE:

The objective of the course is to familiarize the students with basic concepts and advanced molecular biology applications in Agriculture Biotechnology

LEARNING OUTCOME

At the end of the course, the students will have sufficient scientific understanding of different biotechnological methods to improve the crop production and sustainable agriculture.

PREREQUISITES

The course is an application science, hence the student must have a background with knowledge in the basics of Plant Physiology, Plant Tissue culture and Molecular Biology.

COURSE DESCRIPTION:

Sr. No.	Perticulars	Hrs.
1.	Introduction: Agriculture and Agricultural Biotechnology	2
2	Clonal Germplasm Micro propagation In vitro production of pathogen and contaminant free plants	 4 3
3	Biotechnology- Methods of Crop Improvement Genetic Engineering of Crop Plants	3 3
4	Transgenic Plants Molecular Markers QTL Mapping	4 3 3
5	Metabolite Production Production of Secondary Metabolites Production of foreign compounds in transgenic plants	 5
6	Biofertilizers and Bioremediation Microbial Biopesticides , Biofungicides, Herbicides and Agricultural antibiotics	7
7	Biotechnology in Agriculture Ethical Aspects and Public Acceptance	3
8	Animal farming, Animal farming with organic concept, Animal Breeding & Genetically modified animal products.	5
	TOTAL	45

METHODOLOGY

The course would be taught through lectures, demonstrations and practical.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOK RECOMMENDED:

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

PRACTICALS IN AGRICULTURE BIOTECHNOLOGY
(4 Hrs. Per Week) **MARKS: 100**

LIST OF PRACTICALS

1. Use of bioreactors in plant secondary metabolite production
2. Application of Polymerase Chain reaction – Marker based selection by using PCR
3. *Agro-bacterium*-mediated transformation protocol and selection of transformed regenerated plants (Laboratory visit)
4. Visit to micro-propagation and Molecular Biology laboratory - a laboratory with automated Genotyping/sequencing facility.
5. Green house technology: Visit to functional green house. Climate: Measurement of temperature, humidity, air velocity, CO2, inside the green house. Calculation of environment indices inside green house. Fertigation, Post harvest.

EVALUATION SCHEME PRACTICAL TRAINING

Examination	**Duration**	**Marks**
Minor test 1	1 hour	30
Continuous Assessment		10
End semester Exam Viva & Spotting	2.5 hours	60
Total		**100**

SEMESTER VIII

Course Code	Course Name	L	T	P	Hr	Cr	Marks
BT 801	Protein Modeling and Drug Designing	3	0	4	7	5	200
BT 802	Proteomics	3	0	2	5	4	150
BT 505	Biomedical Engineering	3	1	0	4	4	100
BT 803	Nanobiotechnology	3	0	2	5	4	150
BT 804	Seminars in Biotechnology & Advances in Biotechnology	3	1	0	4	4	100
BT 805 / BT 710	Elective – IV	3	0	4	7	5	200
Total		**18**	**2**	**12**	**32**	**26**	**900**

Elective III (BT 805: Clinical Research / BT 710 : Biopharmaceuticals)

TITLE OF THE COURSE: PROTEIN MODELING AND DRUG DESIGNING

COURSE CODE: BT 801 **L T P Hr C**

MARKS: 100 **3 1 4 8 6**

OBJECTIVE

1. To create general understanding regarding basic principles involved in modern medicinal/structural chemistry systems.
2. To familiarize the student with basic concepts in molecular modeling as: how to build the molecule, how to find out the coordinates of the molecule, how to use the programs that are available in graphics designing.
3. To familiarize students with concepts in molecular mechanics and dynamics and to study the energy minimization algorithms
4. To introduce them to concepts in quantum chemistry and methods for calculating the energies, that are required in energy minimization and docking studies
5. To understand the methodology involved in structure based drug designing, and enzyme inhibition strategies

LEARNING OUTCOME

At the end of the course, the students will have sufficient scientific understanding of the basic concepts in classical and modern molecular modeling and drug designing, concepts and laws applicable to quantum-mechanics particles. This would enable him to understand the entire concepts in computerized drug designing and interaction concepts

PREREQUISITES:-

This is an introductory course for the students who want to understand the concepts in molecular modeling and drug designing and should make a compulsory subject

COURSE DESCRIPTION

Sr. No.	Topics	Detail syllabus	No. of Lectures
1	Introduction to molecular graphics:	Cartesian, and crystal coordinate system, Reducing molecular coordinates to fit Computer monitor Basic principle of molecular graphics and structure visualization Small molecular structural data bases (Chembridge data base) Protein structural data base (PDB) Different molecular graphics packages, Graphics Programs: HAMOG, RASMOL,MOLMOL	08
2	Building of small molecules	Building of small molecules Internal and cylindrical polar co-ordinate system Methods used in building small molecules using crystal, Cartesian, polar and chemical internal	10

		coordinates. Building of Biopolymers DNA & oligopeptides in different secondary structure	
3	Optimization of geometries of small molecules:	Energy minimization by systematic search method plotting conformation energy contours	10
		(Ramachandran plot), and finding out minimum energy conformation • Gradient based Energy minimization methods • Molecular mechanics approach • Molecular Dynamics method • Monte Carlo method • Genetic algorithm	
4	Use of Quantum chemical methods for geometry optimization:	• Schrödinger equation • Basic Formalism in quantum mechanics • Schrödinger equation for a multi- electron atom • Schrödinger equation for a molecule • Hartree- Fock Method • Different MO methods • Molecular electrostatic potential • Optimization of geometries of small molecules • Quantum chemical indices	10
5	Drug designing	• Pharmacophore identification and novel drug designing, structure based drug design enzyme inhibition strategies	06
Total Lectures			**36**

METHODOLOGY

The course will be covered through lectures supported by tutorials and practicals. In tutorials, apart from the discussion on the topics covered in lectures, assignments in the form of questions will be given. Normally a student‟s is expected to complete the assignment by himself, however if needed, difficulties will be discussed in the tutorial classes. There will be two class tests/ and surprise test conducted during the tutorial classes.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1. Molecular Modeling, Holtje and Folkers G Weinheim New York
2. Essentials of Drug designing, V. Kothekar Dhruv Publications 2005
3. Molecular modeling: principles and applications, Leach.A.R
4. Molecular modelling and drug design, Andrew Vinter A.and Gardner, M Boca Raton: CRC Press, 1994

PRACTICAL IN PROTEIN MODELING AND DRUG DESIGNING
(2 Hrs .per week) MARKS 50

The course will also have a practical component. The practical training would be in the area of building molecules drawing molecules visualizing the Diffraction Grating: Use of diffraction grafting for determination of wavelength of spectral lining.

BUILDING MOLECULES

- glycine
- glycine-glycine
- alanine
- glycine-alanine
- phenylalanine
- benzene
- SPDBV
- calculate the electrostatic potential using spdbv software
- analysis of Ramachandran plot using spdbv software

HYPERCHEM

Use of molecular modeling software HYPERCHEM for building small molecules.

Computation of quantum chemical parameters using HYPERCHEM
Creating database for small molecular indices using HYPERCHEM

MOE

- Use of molecular modeling software MOE for building small molecules
- Use of molecular modeling software MOE for building oligopeptides and
- oligonucleotides Computation of force field parameters using MOE
- Computation of conformation map of a small molecule using MOE
- Optimization of geometries of small molecules using MOE
- Creating database for small molecular indices using MOE

EVALUATION SCHEME PRACTICAL TRAINING

Examination	**Duration**	**Marks**
Minor test 1	1 hour	15
Continuous Assessment		05
End semester Exam Viva & Spotting	2.5 hours	30
Total		**50**

TITLE OF THE COURSE: PROTEOMICS

COURSE CODE : BI 708 **L T P Hr C**
MARKS: 100 **3 0 0 3 3**

OBJECTIVE OF THE COURSE:

The objective of the course is to familiarize the students with advanced research area and basic concept in protein study and drug discovery**.**

LEARNING OUTCOME

At the end of the course, the students will have sufficient scientific understanding of proteins to proteomics and new techniques used in proteomics that are MALDI-TOF, 2DE, NMR, ESI and various databases SCOP, CATH, PIR etc.

PREREQUISITES

Since the course is very advance in nature, student must know about Protein structure 20 different amino acids, there structure and Basic separation and visualization techniques for nucleic acids.

COURSE DESCRIPTION

Sr. No	Topic	Description	Hrs
1	General introduction to the proteomics.	History, What is proteome, structural of amino acids in protein physiological complexity of genome/proteome?	**5**
2	2D gel electrophoresis data, mass spectrometry and protein characterization	What is 2D-PAGE, protein microarrey-MALDI-TOF, NMR, ESI, Affinity chromatography protein protein interaction, m-RNA splicing.	**7**
3	ESTs, sequence dependent properties of proteins, and post translational modifications Protein folding and evolution.	Expressed Sequence Tags, Amino acid structure, Acylation , Methylation, Alkylation etc	**8**
4	Hierarchical nature of Protein Structure	Pri,sec,ter,quat structure,,Ramchandran plot	**6**
5	Fold classification and identification	SCOP	**7**
6	3D structure of protein and its relation to function	Protein structure prediction and its application.	**7**
7	Computational resources Internet tools	NCBI,EMBL,PDB,Ensembl	**8**
Total lectures,			**48**

METHODOLOGY

The course would be taught through lectures, demonstrations and practicals.

EVALUATION SCHEME (THEORY)

Examination **Duration** **Marks**

I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

Protein to proteomics by J. Simpson,Genomes II T.A. Brown,Protein Structure by Brandent & Tooz

Bioinformatics A practical guide to analysis of genes and protein By Baxevanis A. D & Ouellette B.F.F Wiley

Developing Bioinformatics Computer Skills by Cynthia Gibas, Per Jambeck (Paperback)

Bioinformatics Methods and Protocols (Methods in Molecular Biology, Vol 132) by Stephen Misener (Editor), Stephen A. Krawetz (Editor)

Bioinformatics Basics Applications in Biological Science and Medicine by Hooman H. Rashidi, Lukas K. Buehler

Teaching hours per week and credits for practicals only: 2 Hr 1 Cr

Marks for Practicals: 50

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1.	2D gel electrophoresis	Usage of a major tool for determining the proteome of a cell	1. Liebler (2001)Introduction to Proteomics: Tools for New Biology: Humana Press 1st Edi. Chapter 6 2. Brandon and Tooze 1999 Introduction to protein structure Garland science Publishing 2nd Edi. Chapter 6 3. Bioinformatics by David Mount Sequence and Genome Analysis 2nd Edi Cold Spring Harbour Publishing
2.	Gel extraction of proteins/in situ digestion of proteins for identification by Mass spectrometry analysis	Protein identification	
3.	Database searching for protein identification	Protein identification	
4.	Co-immunoprecipitation analysis for determining protein-protein interactions	To understand interacting proteins	
5.	Bioinformatics approach for determining interactome (protein-protein interaction network) using BIND, DIP & GRID	To understand interacting proteins in a pathway or carrying out similar function	

Internal evaluation will be based on following criteria

For practicals of 1 credit and 50 marks, internal evaluation will be for 20 marks with following break-up:

Practical: 10 marks

Attendance: 5 marks (above 80% attendance gets full marks)
Journal writing: 5 marks

TITLE OF THE COURSE: BIOMEDICAL ENGINEERING
COURSE CODE: BT 505 **L T P Hr C**
MARKS: 100 **3 1 0 4 4**

OBJECTIVE

Biomedical engineering integrates physical, chemical, mathematical, and computational sciences and engineering principles to study biology, medicine, behavior, and health. It advances fundamental concepts; creates knowledge from the molecular to the organ systems levels; and develops innovative biologics, materials, processes, implants, devices, and informatics approaches for the prevention, diagnosis, and treatment of disease, for patient rehabilitation, and for improving health.

LEARNING OUTCOME

The students will be able to apply knowledge of mathematics, science, and engineering to design a system, component, or process to meet desired biotechnology needs. They will be able to develop a biomedical product considering realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

PREREQUISITES

Understanding of animal physiology, physics, engineering and biochemistry is a prerequisite.

COURSE DESCRIPTION

Sr. No.	Topics	Detail syllabus	**No. of Lectures**
1	Introduction	-History of Biomedical engineering -Integration of biology, biochemistry, and engineering to create new biomedical products -Biomimicry and its role in biomedicine	02
2	Biomedical Instrumentation	-Regular optical methods and imaging systems, electro-mechanical probes -Bioelectric amplifiers -Patient monitoring systems -Impedance techniques in physiological measurements	06
3	Diagnostic equipments	- Blood Flow meters - Pulmonary function analyzers - Blood gas analyzers -Cell counters - Endoscopy -Biophysical activity of organs -Electrical simulation, ultrasonic waves, magnetic waves in diagnosis and therapy	07

		- Robotics in diagnosis and therapy	
4	Tissue Biomechanics	- Biological processes in tissue organization (molecular, cellular, extracellular, and organ levels of hierarchy) - scaling laws (architectural) and continuum mechanics with respect to material properties of tissues and their organization	06
5	Biomaterials	-Molecular and structural properties of biological materials like collagen, silk, bone, protein adhesives, self-assembling peptides -Molecular structural properties of biomaterials of microbial, plant or other natural origin - Methods for biomaterials surface characterization; matrix synthesis, degradation, and contraction -materials science and cell biology principles for the design of medical implants, artificial organs, and matrices for tissue engineering -artificial organs	07
6	Regenerative medicine	-Principles of organ regeneration -Implants and their coherence with biological systems/biocompatibility -Biological processes involved in wound healing and tissue remodeling following implantation in various organs -Examples of biomaterials in regeneration in tissues, bone, orthodental, optical systems, cardiovascular devices, cochlear implants, etc -Challenges and ethical issues	08
7	Drug delivery systems	- Principles of Controlled Drug Delivery, controlled release devices, Biomaterials in drug delivery - Biomaterial based drug delivery system efficacy and challenges	03
8	Biosensors	-Components and properties of a typical biosensor -Types of biosensors (Calorimetric, Potentiomentric, amperometric, optical, Piezo-electric, Immuno based sensors) -Representative design of each type of biosensor -Biomarkers and their role in development of medical biosensors - Applications related to healthcare, bio-defense and food and water safety	07
	Personalized medicine	-Concept and applications - Concerns and market response	02
Total Lectures			48

METHODOLOGY

The course will be covered through lectures supported by tutorials and practicals. In tutorials, apart from the discussion on the topics covered in lectures, assignments in the form of questions will be given. Normally a students is expected to complete the assignment by himself, however if needed, difficulties will be discussed in the tutorial classes. There will be two class tests/ and surprise test conducted during the tutorial classes.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

RECOMMENDED BOOKS:

1. J B Park, Biomaterials - Science and Engineering, Plenum Press , 1984.
2. Sujata V. Bhat, Biomaterials, Narosa Publishing House, 2002.
3. D N Ghista, Biomechanics of Medical Devices, Macel Dekker, 1982
4. Khandpur R S, Handbook of Medical Instrumentation, Tata Mc Graw Hill
5. D. L. Wise , “Applied Bio Sensors“, Butterworth, London.
6. Cromwell, Weibell & Pfeiffer, “Biomedical Instrumentation & Measurement”, Prentice Hall, India
7. Carr & Brown, “Introduction to Biomedical Equipment Technology” Pearson Education, Asia.
8. Robbinson C.J., Rehabilitation Engineering. CRC press 1995
9. Weiss, Thomas Fischer. Cellular biophysics. Cambridge, Mass., MIT Press.
10. Peter J. Carrington, John Scott and Stanley Wasserman, eds., *Models and Methods in Social Network Analysis Cambridge University Press, 2005*

COURSE NAME: NANOBIOTECHNOLOGY **L T P Hr C**
COURSE CODE: BT 803 **3 0 2 5 4**
MARKS : 150

OBJECTIVE:

The objective of the course is to create general understanding amongst the students in the subject of Core nanotechnology and its applied parts such as nanobiotechnology and bionanotechnology through in-depth lectures & laboratory practicals. The objective of the course is to understand them a general overview, concepts and basic principles in the subject of nanobiotechnology with emphasis for project in the field of nanotechnology.

LEARNING OUTCOME:

At the end of the semester, it is expected that students understood the basic principles of core nanotechnology and bionanotechnology. It is expected that they will be more confident to use the basic knowledge for their short term projects during the semesters.

PRE-REQUISITES:

This is an advanced level course. Students are expected to have an understanding of introductory knowledge in Physical science, material science, polymer science, micro-fabrication, organic and synthetic chemistry and molecular biology.

COURSE DESCRIPTION

S. No	Topic	Description	Hrs
1	**Introduction and Basics**	Introduction Definition of Nanotechnology, nanobiotechnology and bionanotechnology Nanotechnology and Today'sWorld Importance of Nanoscale Science and Technology	**2**
2.	**History and Evolution**	Contribution of Different Scientist in Nanotechnology o Richard Feynman o K. Eric Drexler o Gerd Binnig and Heinrich Rohrer o Don Eigler and Erhard Schweizer o Professor Richard Smalley Different Timelines of Nanotechnology development	**4**
3	**Nanoparticles and nanomaterials**	Introduction Types of nanoparticles o Pure metals :Gold, Silicon, Silver, Cobalt o Metal oxides: Silica,Zinc oxide, Iron oxideAlumina, Titania Properties of nanomaterial and nanomaterial Toxic effects of nanomaterials	**6**

		• Significance of nanoparticles	
4	**Synthesis of nanoparticles**	• Bottom up and Top down approach • Chemical methods: Gas phase and liquid phase synthesis Chemical precipitation and co precipitation Metal nanocyrstals by reductions, sol-gel synthesis Microemulsion or Reverse micelle Solvothermal synthesis Thermolysis route Sonochemical synthesis Electrochemical synthesis Biological methods Synthesis of nanoparticles by using bacteria, yeast, fungi, and actinomycetes, plant extract.	**8**
5	**Nanotubes and Nanocomposites**	Introduction and studies in carbon nanotubes Chemistry of carbon nanotubes Types of carbon nanotubes Introduction to nanocomposites Polymers used as matrix for nanocomposites	**6**
6	**Biomaterials**	Introduction and historical background First generation biomaterials Metal & metal alloys, Ceramics, Polymers, Composites Second generation biomaterials Biodegradable polymers, Hydrogels, Third generation biomaterials Biomaterials in tissue engineering	**5**
7	**Nanostructures and nanodevices**	Liposomes Niosomes Micelle and reverse micelle Quantum dots Nanosphres and microspheres Nanopowder Nanowires and Nanorods Nanoshells Dendrimers	**6**
8	**Applications of Nanobiotechnology**	Nanotechnology in medicine Drug delivery Gene delivery Drug encapsulation Nanopharmacology Nanocapsule and Medibots	**8**

		• Tissue repair and implantation • Bioresorable materials • Biochips • Environmental Management	
		Total Lecture	**45**

METHODOLOGY

The course would be taught through lectures, demonstrations and practicals.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1) Bionanotechnolgy: Lesson from Nature, David S. Goodsell, Willey-Liss, First edition, 2004
2) Nanoscale technology in Biological Systems by Ralph Creco, Fritz Prinz and R. Lane Smith; CRC Press, First edition, 2005.
3) Nanobiotechnology: Concepts, applications and Perspectives, Christof M. Niemeyer (editor), Clad AMirkin (Editor), Wiley VCH, First edition, 2004.
4) Nanobiotechnology: Bioinspired Devices and Material of Future by OdedShoseyov and Ilan levy, Human Press, First edition, 2007.
5) Nanobiotechnology protocols (Methods in Molecular biology) by Sandra J Rosenthal David W. Wright, Human Press, First edition, 2005
6) The Nanobiotechnology Handbook, YubingXie, CRC press,
7) Introduction to Nanoscience, S.M. Lindsay, Oxford universal Press, First Edition, 2010 Nanotechnology: Understanding small system, Ben Rogers, SumitaPennathur and Jesse Adams, CRC Press, Second edition, 2011
8) Introduction to Nanotechnology, Charles Poole and Frank Owen, Wiley, First Edition, 2006 Nanocomposites Science and Technology Pulickel M. Ajayan, Linda Schadler, Paul Braun, Wiley-VCH Verlag, 2003.

PRACTICAL IN NANOBIOTECHNOLOGY (2 Hrs.) MARKS : 50

PRACTICAL COURSE:

1. Preparation of silver nanoparticles by chemical methods.
2. Characterisation of ZnS nanoparticles by optical methods.
3. Templeted synthesis of Fe_3O_4 nanoparticles.
4. Synthesis of ZnS nanoparticle by using bacteria.
5. Biological synthesis of silver nanoparticles using plant extract.
6. Study of antimicrobial activity of silver nanoparticles.
7. Protein tagging of nanoparticles.
8. Internalization of nanoparticles in mammalian cells.
9. Synthesis of quantum dots.
10. Drug attachment to nanoparticles.
11. DNA attachment to nanoparticles.

EVALUATION SCHEME PRACTICAL TRAINING

Examination	**Duration**	**Marks**
Minor test 1	1 hour	15
Continuous Assessment		05
End semester Exam Viva & Spotting	2.5 hours	30
Total		**50**

COURSE NAME: SEMINARS IN BIOTECHNOLOGY AND ADVANCES IN BIOTECHNOLOGY

COURSE CODE: BT 804	**L**	**T**	**P**	**Hr**	**C**
MARKS: 100	**3**	**0**	**0**	**3**	**3**

OBJECTIVE OF THE COURSE:

In view of the increasing knowledge in the field of biotechnology student should be made aware of the latest advancements in biotechnology.

LEARNING OUTCOME:

After the presentation the student get trained in performing literature survey and presenting a scientific paper.

METHODOLOGY:

Student will be presenting the seminar every week as per the schedule and will be assessed by the experts.

COURSE DESCRIPTION

Advanced topics will be taught by outside experts and senior faculty of the institute. The student will be assigned one Seminar on any advanced topic of Biotechnology.

EVALUATION METHODOLOGY:

The student seminars will be assessed for evaluation

Elective IV

TITLE OF THE COURSE: BIOPHARMACEUTICALS

COURSE CODE: BT 710	**L**	**T**	**P**	**Hr**	**C**
MARKS: 100	**3**	**0**	**4**	**7**	**5**

OBJECTIVE OF THE COURSE:

To create general understanding regarding basic knowledge of Biopharmaceuticals to familiarize the student with the production techniques, mode of action and therapeutic uses of Biopharmaceuticals.

LEARNING OUTCOME:

At the end of the course, the students will have sufficient understanding of the current status of Biopharmaceuticals.

PREREQUISITES

Students should know the basics of Microbiology, Biochemistry.

COURSE DESCRIPTION

Sr. No.	**Topics**	**Detail syllabus**	No. of Lectures
1	Overview	Introduction and current status of Biopharmaceuticals in the pharmaceutical industry How are Biopharmaceuticals different from Pharma ceutical products	4
2	The drug manufacturing process	Good Manufacturing Practices, Source of Biopharmaceuticals, production, analysis and immunological approaches for the detection of contaminants in the final product.	6
3.	Hormones of therapeutical interest	Insulin, Insulin receptors, production of human insulin by rDNA technology, insulin formulation, Glucagon, Human growth factors(hCG) – biological effect, recombinant hCG- production and uses, Gonadotrophins, FSH , LH.	6
3	Blood Products and Therapeutic Enzymes	Blood cells, blood substitutes, serum protein isolation, haemostatic, coagulation pathway, blood factor isolation for transfusion, anticoagulants, thrombolytic agents, enzymes of therapeutical value	6
5	Growth Factors	Growth factors and wound healing, Insulin like growth factors (IGFs)- biochemistry, receptors, binding proteins, biological effects, IGFII and effect on fetus development and reproduction neuronal, Epidermal growth factor (EGF), Platelet derived growth factors (PDGF).	6
6.	Haemopoietic growth factors	Erythropoietin (EPO) - receptors, transduction regulation therapeutic applications.	4
	Antibodies,	Polyclonal antibodies, Monoclonal antibodies and their	4

7.	vaccines and adjutants	production by hybridoma technology, applications of Monoclonal antibodies Vaccine Technology, traditional vaccine production, impact of	
		genetic engineering on vaccine technology, Vaccine adjuvant.	
8	Nucleic acid therapeutics	Basic approach to gene therapy, vectors used in gene therapy, manufacturing plasmid DNA, antisense technology, and ribozymes.	4
9	Cytokines, Interleukins and Interferon	Biological effects, biochemistry, production and therapeutic applications	5
		Total lectures	45

METHODOLOGY

The course would be taught through lectures, demonstrations and practicals.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1. Biopharmaceuticals- Biochemistry and Biotechnology. Second Ed. Garry Walsh. John Wiley and Sons. 2003

eaching hours per week and credits for practicals only: 4 Hr 2 Cr

Marks for Practicals: 100

Hands-on practicals as listed below shall be performed or small research projects in this area can be undertaken based on the availability of faculty

Sr. No.	**Name of the experiment**	**Learning objective**	**Literature/ Weblinks for reference and videos**
1	Chemical assay for estimation of penicillin /streptomycin/tetracycline antibiotics	To know the simple assay for antibiotic determination. To understand chemical composition and reactivity. To know the mode of action of antibiotics	1. Kayser O, Warzecha H. Pharmaceutical biotechnology: drug discovery and clinical applications. John Wiley & Sons; 2012. 2. Beale JM, Block J, Hill R. Organic medicinal and pharmaceutical chemistry. Philadelphia: Lippincott Williams & Wilkins; 2010.
2	Bioassay to determine the antifungal activity of standard Aureofungin/ clotrimazole/ fluconazole/	To know the simple assay for determination of antifungal compounds. To know the mode of action of antifungal	

		compounds. To understand the structure of antibiotic	3. Foye WO. Foye's Principles of Medicinal Chemistry. Lemke TL, Williams DA, editors. Lippincott Williams & Wilkins; 2008 4. Lachman, Leon et al. "The Theory and Practice of Industrial Pharmacy", 3rd Edition, Varghese Publishing House, 1986. 5. Godkar PB, Godkar DP, Textbook of Medical Laboratory Technology Bhalani Publishing House**,** 2014 by 6. Husain A, Practical Pharmaceutical Analytical Techniques, Darshan Publishers, 2015 7. Indian Pharmacopeia, 2007, Volume 1, Published by The Indian Pharmacopeia Commission, Ghaziabad; Tests for pyrogens
3	Bioassay to determine the antibacterial activity of standard penicillin, streptomycin, tetracycline antibiotics by standard disc/well method	To know the role of bioassay in pharmaceuticals. To understand the disc and well diffusion assay method	
4	Sterility testing of commercial injectable such as saline water, eye drops or ear drops	To determine the quality of pharma products with respect to microbial contamination. To understand the commercial significance of sterility testing in biopharmaceutical products	
5	Extraction and detection of antimicrobial compounds from plant origin	To understand different method of extraction. To know antimicrobial compounds from plant origin. To know the diffusion of antibiotic and factors affecting it	
6	Determination of glucose in serum/plasma by GOD/POD method	To estimate the concentration of glucose in samples. The correlation of glucose concentration with different clinical conditions	
7	Determination of endotoxin in the therapeutic formulation (WFI, gentamycin injection ampicillin injections) by using LAL test reagent	To know endotoxin of bacterial origin, its structure and their role. To learn Significance of LAL test at commercial level	
8	Determination of SGPT/SGOT activity in serum / plasma sample by chemical method	To estimate the concentration of SGOT and SGPT in samples. To learn importance of SGPT and SGOT activity with functional test The correlation of glucose concentration with different clinical conditions	
9	LIMIT test for chloride, sulphates, iron and heavy metals in pharmaceutical products.	To learn threshold level of ions in the pharmaceutical products. To understand the	

		significance of LIMIT test at commercial level	
10	One day industrial visit to a pharmaceutical company	To understand the commercial production of biopharmaceutical products	

Internal evaluation will be based on following criteria
For practicals of 2 credits and 100 marks, internal evaluation will be for 40 marks with following break-up:

Practical: 10 marks

Attendance: 10 marks (above 80% attendance gets full marks)
Laboratory assignment: 10 marks

Journal writing: 10 marks

(Elective IV)
TITLE OF COURSE: CLINICAL RESEARCH **L T H Hr C**
COURSE CODE MT 806 **3 0 0 3 3**
MARKS: 100

OBJECTIVE OF COURSE:

The primary objective of this course is to familiarize the students about higher educational areas after their graduation. The course also aware students about current situation of clinical research in India and future for clinical research in India topics required for clinical research establishment.

LEARNING OUTCOME:

At the end of the course students should be able to understand various disciplines in the field of clinical research and it will help them for selecting their dissertation in final year.

PREREQUISITE:

No prerequisite is required for the course.

COURSE DESCRIPTION:

Sr. No.	Topic	No. of Lectures
1	Introduction	02
2	History	01
3	Drug development process	01
4	GLP and GCP in clinical research	02
5	ICH in relation to clinical research	02
6	SOP in clinical research trials	01
7	Basic terminology in CR	02
8	Ethical theories and principles	03

9	Ethics committees	01
10	Audits and inspection in CR	02
11	FDA audit- role of investigators and sponsors	03
12	FDA protecting consumers and protecting public health	02
13	Role of biostatistics in CR	02
14	Clinical trial protocol design and development	02
15	Data base closure	01
16	Data cleaning	01
17	Designing case report forms (CRF)	02
18	EMEA European Medicines Agency	02
19	EMEA committees	02
20	Fraud and misconduct in CR	02
21	INDA(Investigational new drug application) and NDA (New drug application)	04
22	Informed consent process	01
23	Medical writing	01
24	Pharmacoepidemiology	01
25	Pharmacovigilance	01
26	Schedule Y and its application	01
27	Project management	02
28	Current status of CR in India	01
TOTAL LECTURES		**48**

METHODOLOGY

The course would be taught through lectures, demonstrations.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

Teaching hours per week and credits for practicals only: 4 Hr 2 Cr

Marks for Practicals: 100

Hands-on practicals as listed below shall be performed or small research projects in this area can be undertaken based on the availability of faculty

Sr. No.	**Name of the experiment**	**Learning objective**	**Literature/ Weblinks for reference and videos**
1	Visit to clinical research laboratory to	To understand about the importance of ethics, biological safety and	1. Principles and Practice of Clinical Research, 3rd Edition, Editors: John Gallin Frederick Ognibene, Hardcover

	study the requirement of a clinical lab, biosafety measures and collection and safe handling of clinical samples	handling in clinical research set up	ISBN: 9780123821676, eBook ISBN: 9780123821683. Publisher: Academic Press. 2. Manual of clinical laboratory Immunology- 6th Edition. Noel R Rose, Robert. G. Hamilton, Barbara Detrick. ASM Press. 3. Textbook of Clinical Trials, 2nd Edition David Machin (Editor), Simon Day (Co-Editor), Sylvan Green (Co-Editor). ISBN: 978-0-470-01014-3. Publisher: Willey. 4. http://www.mayoclinic.org/tests-procedures/complete-blood-count/details/results/rsc-20257186 5. https://www.nhlbi.nih.gov/health/health-topics/topics/bdt/types 6. http://www.fcswp.org/st-francis-memorial-hospital/education/common-blood-tests-and-their-meanings/ 7. http://www.precisionnutrition.com/all-about-blood-work
2	Drafting of patient consent form and questionnaire for recruitment of subjects for clinical studies	To know about the patient consent form and ways to exchange information with patients and medico-legal requirements	
3	To perform histopathological procedures and tests for clinical samples	To know about the histopathology protocols and understanding the structure and organization of normal versus pathological tissues	
4	Molecular diagnostics of pathological samples using PCR, etc	To understand the more updated molecular diagnostics procedures	
5	To perform biochemical investigation of pathological samples (blood chemistry, lipid profile, etc)	To understand the principle of various diagnostic procedures routinely used in clinical investigations	

Internal evaluation will be based on following criteria

For practicals of 2 credits and 100 marks, internal evaluation will be for 40 marks with following break-up:

Practical: 10 marks

Attendance: 10 marks (above 80% attendance gets full marks)
Laboratory assignment: 10 marks

Journal writing: 10 marks

SEMESTER IX & X

SR. NO.	PROJECT	CREDITS
1	Industrial Posting or Research	**50**
2	Project Preparation	
3	Monthly review of the work	
4	End Semester Evaluation of the Project report and Presentation and Viva voce	