Dr. D. Y. PATIL VIDYAPEETH, PUNE
(Deemed to be University)

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DR. D. Y. PATIL BIOTECHNOLOGY & BIOINFORMATICS INSTITUTE

TATHAWADE, PUNE

SYLLABUS FOR

M. TECH. (INTEGRATED) BIOTECHNOLOGY

2021-2022

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**
BS 101	Physics	3	0	2	5	4
BS 102	Chemistry	3	0	4	7	5
BT 101	Electronics & Instrumentation Engineering	2	0	2	4	3
BI 101	Computers & C Programming	2	0	4	6	4
HU 101	Communication Skills	1	2	0	3	3
BS 103	Maths I – Mathematics	3	0	0	3	3
Total		**14**	**2**	**12**	**28**	**22**
SEMESTER II						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT 201	Biochemistry	3	0	4	7	5
BT 202	Cell Biology	3	0	2	5	4
BS 201	Maths II -Statistics	2	0	2	4	3
BT 203	Engineering Mechanics	2	0	2	4	3
BS 202	Environmental Sciences	2	0	2	4	3
BT 102	Engineering Graphics	1	0	2	3	2
HU 201	Disaster Management*	0	1	0	1	-
Total		**13**	**1**	**14**	**28**	**20**
Audit course, attendance is must						
SEMESTER III						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT 301	Analytical Techniques	3	0	4	7	5
BT 302	Microbiology & Virology	3	0	4	7	5
BT 303	Genetics	3	0	2	5	4
BI 301	Concepts in Bioinformatics	2	0	4	6	4
BT 304	Biosafety, Bioethics & IPR	2	0	0	2	2
HU 301	Universal Human Values II	2	1	0	3	3
Total		**15**	**1**	**14**	**30**	**23**
SEMESTER IV						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT 401	Molecular Biology	3	0	4	7	5
BT 406	Animal Tissue culture	2	0	2	4	3
BT 403	Plant Biotechnology	3	0	4	7	5

BT 404	Immunology	3	0	2	5	4
BT 405	Developmental Biology	3	0	2	5	4
Total		**14**	**0**	**14**	**28**	**21**
SEMESTER V						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT 501	Environmental Biotechnology	2	0	2	4	3
BT 502	Recombinant DNA Technology	3	0	4	7	5
BT 503	Biochemical Engineering & Bioprocess Technology	3	1	4	8	6
BT 504	Enzymology & Enzyme Technology	2	0	2	4	3
HU 501	Personality & Skill Development	2	0	0	2	2
BI 501	R Programming	1	0	0	1	1
BT 505/506/507	Elective-I	3	0	2	5	4
		16	**1**	**14**	**31**	**24**
Total						
Elective I (Biopharmaceuticals/ Clinical Research/ Human Diseases and Pathobiology)						
SEMESTER VI						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT 601	Food Biotechnology	3	0	2	5	4
BT 602	Marine Biotechnology	2	0	2	4	3
BT 603	Basic Pharmacology & Toxicology	2	1	0	3	3
BI 602	Molecular Modeling & Chemoinformatics	3	0	2	5	4
BI 601	Artificial Intelligence	1	0	0	1	1
BT 605/606	Elective II	3	0	2	5	4
Total		**14**	**1**	**8**	**23**	**19**
Elective II (Perl & Bioperl / Structural Biology)						
SEMESTER VII						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT 706	Molecular Cell Signaling	2	0	0	2	2
BT 701	Nanobiotechnology and Biosensors	2	0	2	4	3
HU 701	Principles of Management & Entrepreneurial Development	2	0	0	2	2
HU 702	Quality Control Management in Biotechnology	2	0	0	2	2
BI 701	Design and analysis of Algorithms	2	0	2	4	3
BT 702	Seminars in Biotechnology	2	0	0	2	2
BT 703/704/705	Elective-III	3	0	2	5	4
Total		**15**	**0**	**6**	**21**	**18**
Elective III (Metabolic Engineering/ Agriculture Biotechnology/Cancer Biology)						
	Semester VIII					
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BI 801	Simulation and Modeling	2	0	2	4	3
BT 801	Omics Technology	3	0	4	7	5
BT 802	Biomedical Engineering	2	1	0	3	3
BT 803	Stem Cell Technology	3	0	0	3	3

BT 804/ 805	Elective – IV	3	0	2	5	4
Total		**13**	**1**	**8**	**22**	**18**
Elective III (Tissue Engineering/ Molecular Diagnostics)						
Semester IX & X						
Research Project/ Industrial Training/ Review writing (10 months)		**40 Credits**				
TOTAL CREDITS		**206**				

	SEMESTER I					
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BS 101	Physics	3	0	2	5	4
BS 102	Chemistry	3	0	4	7	5
BT 101	Electronics & Instrumentation Engineering	2	0	2	4	3
BI 101	Computers & C Programming	2	0	4	6	4
HU 101	Communication Skills	1	2	0	3	3
BS 103	Maths I – Mathematics	3	0	0	3	3
Total		**14**	**2**	**12**	**28**	**22**

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.

COURSE OUTCOME

Upon successful completion of this course, students will be able to:

- Understand the basic concepts in physics
- Understand the principles of - classical optics used in microscopes and telescopes, thermometry and heat, mechanical, fluid and solid state properties
- Demonstrate the concepts in modern physics such as- X-rays, crystallography and quantum mechanics
- Demonstrate the use of physical methods in biological applications

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, Constructive & 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 its 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, Determination of 'η' by falling sphere method.	07
4	Elasticity	Stress and Strain, Hook's law, Stress-strain curve, Young's modulus, Determination of Young's modulus.	03
5	Solids and	Classification of Solids (Conductor, Semiconductor and	05

	Semiconductor Devices	Insulators), intrinsic and extrinsic semiconductors, PN Junction Diode, Zener Diode, Junction Transistors (CE,CB mode)	
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 practicals.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	60 minutes	20
II Internal	45 minutes	15
Attendance		5
End Semester Exam	2 hours 30 minutes	60
Total		100

BOOKS RECOMMENDED:

1. Physics by D. Haliday and R. Resnik 5th edition, Wiley Eastern Pub, 2007.
2. Perspectives of Modern Physics by A. Beiser, 6th edition, Mc Graw Hill, 2003.
3. Fundamensls of optics by F. A. Jenkins and H. E. White, 4th edition, Mc Graw Hill, 1976.
4. Optics by A. Ghatak, 3rd edition, Tata Mc Graw Hill, 2006.
5. Digital Principles and Applications by A. P. Malvino, G. Saha and D. P. Leach, 7th edition, Mc Graw Hill, 2011.

PRACTICAL IN PHYSICS (TWO HOURS PER WEEK) Marks 50

The practical training would be in the area of optics, electronics, thermometry, calorimeter, 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.

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

COURSE: CHEMISTRY

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

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

OBJECTIVES:

The objective of the course is:

- The objective of this course is to familiarize the student with the different concepts of physical and organic chemistry.
- The students will learn the structures of organic molecules as: alkanes, alkenes, alkynes, aliphatic and aromatic molecules and the stereochemistry behind the molecules with its importance in day today life
- They would learn the Basic concepts and principles with respect to physical chemistry, the bioenergetics of different reactions and the principles and applications of radioactivity.

COURSE OUTCOME:

At the end of course, students will have the ability to:

- Demonstrate the structures and stereochemistry of different organic molecules
- Understand the concept of different physical chemistry aspects like osmosis that plays an important role in any biological system
- Explain and apply the concepts of pH and viscosity and to prepare buffers
- Demonstrate the principles of bioenergetics in chemical reactions and also of living systems
- Understand the formation of isotopes and their significance

PREREQUISITES

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

Course Description

Sr no	Topics	Description	Hrs.
1	Introduction to organic chemistry	Functional groups, Chemistry of alkanes, alkenes, alkynes, aromatic, alicyclic and heterocyclic compounds	7
2	Stereochemistry	Stereo isomers, Enantiomers, Chiral centers/ Optical activity, Geometric isomers Meso- isomers, Conformational isomers, Stereochemistry of Cyclic Aliphatic compounds,	8
3	Reaction mechanisms	Nucleophilic (SN1, SN2 , Electrophilic E1 and E2)	3
4	Basic concepts and principles of Physical Chemistry	Osmosis- Diffusion, Osmotic Pressure, Theories of Osmosis. Viscosity –Introduction & Types of viscometer. Colloids-Lyophilic & Lyophobic sols, Optical properties, Electrical properties of sols, Gold number. Donnan Equilibrium. Phase rule- Phase, Components & Degree of freedom. Derivation of Phase rule. Phase diagram. Water system. Acid-bases- Three concepts of acids &	11

		bases, pH meter & types of electrodes ,Buffer solution, Acid base indicator , Law of mass action, Numerical.	
5	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	6
6	Basic principles of radioactive isotopes	Isotopes in Biology- Properties, Half-life, Radioactive decay. 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. Use of Isotopes-Tritium, Iodine-131, Nitrogen-15, Oxygen-18, Carbon-14, Phosphorus-32, Sulphur-35.	9
Total Lectures			**45**

Methodology

The course will be covered through lectures, demonstration and practicals.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	**60 minutes**	**20**
II Internal	45 minutes	15
Attendance		5
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1. Organic Chemistry by R. T. Morrison and R. N. Boyd, 7th Edition, Prentice Hall, 2011.
2. Organic Chemistry by I. L Finnar, 6th Edition Pearson Publications, 2002.
3. Physical Chemistry by A. Peter and P. Julio De 7th Edition, Oxford University Press, 2010.
4. Essentials of Physical Chemistry by B.S. Bahl & A. Tuli, S Chand & Co. 2000.
5. Biophysical Chemistry by A. Upadhyay, K. Upadhyay & N. Nath., Himalayan Publishing House. 2005.

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

Sr. No.	Name of the experiment	Learning objective
1	Acid-Base Titration	To understand the concept of titration and how to calculate the strength of acid and base.
3	Back Titration	To analyze the concentration of analyte based upon chemical reaction.
4	Qualitative Analysis	The practical will help in detection of functional groups present in the chemical compound. (Can be combined with other small practicals-at least 4-5 samples)
5	Determination of optical activity using a Polarimeter	Help them to analyze the degree of rotation of plane polarised light
6	Viscosity, Osmosis and Diffusion techniques	To analyze the physical properties of compound by measuring i) hypotonic, isotonic and hypertonic nature ii)thickness, sticky and semifluid consistency
7	Demonstrate the procedure for determining Melting/Boiling point	The practical will teach them how to analyze the transition point from solid to liquid and ii) liquid to vapor phase.
8	To determine the pH of a solution using a polarimeter	It will guide them to measure the pH of a solution in terms of H+ ion concentration and to understand importance of pH in biological experiments.
9	Study of exothermic and endothermic reactions.	To understand the concept of thermodynamics of reaction based upon the absorption or release of heat energy.
10.	Conductivity meter	Measuring the electrical conductivity of a solution. Applications in hydroponics, aquaculture and freshwater systems
11	Determine the heat of combustion of ethyl alcohol	To measure the amount of heat energy released during a chemical reaction.
12	Determine the heat of neutralization of strong acid and strong base	To measure the change in enthalpy in a neutralization reaction to form water and a salt.

BOOKS RECOMMENDED:

1. Practical Organic Chemistry: Qualitative Analysis by S.P. Bhutani, A.Chhikara, ANE Books, 2009.
2. Laboratory Manuals In Biochemistry by J. Jayaraman, New Age International Private Ltd., 2000.
3. Experimental Physical Chemistry, By V. D. Athawale, P. Mathur, New Age International Private Ltd., 2000.
4. College Practical Chemistry, By V. K. Ahluwalia, S. Dhingra, Universities Press, 2005.

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	40
End semester examination:	60
Total:	**100**

COURSE: ELECTRONICS AND INSTRUMENTATION ENGINEERING

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

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

OBJECTIVE:

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.

COURSE OUTCOME:

On successful completion of the course students will:

- Be familiarized with the basic concepts of electronics
- Understand the basic concepts of electronic circuits and be aware of the circuits in various instruments
- Have clarity over the application of concepts in digital electronics.
- Acquire the knowledge of instrumentation, for working of various analytical instruments used for biological samples

PREREQUISITES:

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

COURSE DESCRIPTION

Sr. No	Topic	Description	Hrs
1	Basics	History and scope of electronics, Electrical signals, passive electronic components, resistors, capacitors, inductors, Bio signals	2
2	Semiconductor devices	Diode circuits, P-N junction diode, biasing, half wave and full wave rectification	2
3	Linear integrated circuits	Introduction to operational –amplifiers, characteristics of op-amp, virtual short and virtual ground, concept of feedback, inverting and non-inverting amplifier, applications of op-amp, addition, subtraction, integration, and differentiation	8
4	Digital electronics	Digital circuits, AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR, Boolean algebra, half adder, full adder, multiplexers and de-multiplexers, flip-flops, shift registers, counters, block diagram of microprocessor and microcontroller	8
5	Basic instrumentation	Sensors and transducers, basic measurement system, static and dynamic characteristics of an instrument, signal conditioning circuits	6
Total Number of lectures			**30**

METHODOLOGY:

The course will be covered through lectures, demonstration and practicals**.**

EVALUATION SCHEME (THEORY)

Examination	Duration	Marks
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

BOOKS RECOMMENDED:

1. Digital Electronics by R. K. Jain, Tata Mc Graw Hill, 3rd Edition, 2003.
2. Grob's Basic Electronics – M. 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 R. 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 R. Gaonkar,. Penram Publisher , 3rd Edition, 1988.
7. A course in electrical and electronic measurements and instrumentation by A. K. Sawhney, P. Sawhney, Rai publisher, 1996.

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

Sr. No.	Name of the experiment	Learning objective	Literature/ Web links for reference and videos
1	Study of passive components in electronics Resistors, Inductors, capacitors, relay, switches, transformers and connectors.	Students should able to learn different passive components, their classification, symbol, and unit.	Principles of Electronics by V.K.Mehta and R. Mehta, S. Chand, 2005
2	Study of basic electronics measuring instruments DMM, CRO and function generator.	Students should able to operate CRO, function generator to generate different electrical signals. They should able to measure Voltage, current, frequency and time period of waveforms.	
3	Study of semiconductor devices, P-N junction Diode. Plot VI characteristics of P-N junction diode.	Students should able to learn different semiconductor devices like diode, transistors and also working of PN junction diode. They should able to plot VI characteristics graph.	
4	Study of operational amplifier Part I : Op-amp IC741 Part II: Op-amp as inverting and non-inverting amplifier.	Students should able to learn basic working principle of op-amp, pin diagram of IC 741.	
5	Study of digital logic circuits.	Students should able to learn different logic gates, their truth table and timing diagram.	
6	Study of pH electrode.	Students should able to understand operation of pH electrode for the measurement of pH.	
7	Study of resistance type temperature transducers.	Students should able to learn working principle of different resistance type temperature transducers like PRT, RTD, Thermistor, thermocouple	Basic electronics by J.S. Katre, Techmax publication, 2014
8	Study of conductivity meter electrode.	Students should able to understand the operation of conductivity meter	Theory and applications of

		electrode to measure conductivity of a solution.	conductivity http://www.evisdom.com/
9	Study of 8085 microprocessor.	Students should able to understand pin diagram, block diagram and architecture of 8085 microprocessor.	http://8085projects.info/

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

COURSE: COMPUTERS AND C PROGRAMMING

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

MARKS: 150 **2 0 4 6 4**

OBJECTIVE:

The objective of the course is

- To familiarize the students with computers and programming concepts.
- Programming module is intended to familiarize them with computer logic and solution of real world problems.

COURSE OUTCOME

At the end of this course, students will be able to:

- Understand the organization of computers and the basic principles of Computing
- Deal with the basics problems that arise while using computers
- Demonstrate the basics of C Programing and their applications
- Apply programming for solving biological problems by logic based approach

PREREQUISITES

The course requires the basic knowledge about the Computer system.

COURSE DESCRIPTION

Sr No	Topic	Description	Hrs
1	Organization of Computer	History of computer and various parts and functions performed by them	1
2	Hardware & Software	Various hardware of computer, Application software and system software	1
3	Operating System	Various functions of operating system, MS-DOS, LINUX commands	1
4	Basics of programming	Machine language, High level language, Compilation process	1
5	Introduction to C	An overview of C, C expressions, Operators, Data types	1
6	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	2
7	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
8	Case control structures	Decisions using switch The *goto* statement	1
9	Functions	What is a function? Why Use Functions	3

		Passing values between functions, Scope of functions	
10	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	3
11	Puppeting on strings	What are Strings? ,More about Strings Pointers and Strings ,Standard Library String functions ,Two-Dimensional Array of Characters, Array of pointers to Strings,	4
12	Pointers	Pointer variables ,The pointer Operators ,Pointer Expressions ,Pointers and Arrays ,Initializing Pointers ,Pointers to Functions, C's Dynamic Allocation Arrays	2
13	Structures, Union, Enumeration & type definition	Structures, Arrays of structures, Passing structures to functions, Structure Pointers,Unions, Bit-Fields Enumerations ,Typedef	2
14	File Handling in C	Opening and closing a stream, open modes, Reading and writing to/from a stream, Predefined streams: stdin, stdout and stderr, Stream manipulation: fgetc(), fputc(), fgets() and fputs() functions	3
Total Number of Lectures			**30**

METHODOLOGY:

The course will be covered through lectures, demonstration and practicals**.**

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

RECOMMENDED BOOKS:

1. The complete reference of C by H. Schildt, 4th edition, Mc Graw Hill, 2003.
2. Let us C By Y. Kanitkar, 15th edition, BPB Publication, 2017.
3. Data Structure Through C by Y. Kanitakar, 2nd edition, BPB Publication, 2003.
4. Understanding Pointers in C by Y. Kanitakar, 4th edition, BPB Publication, 2007.
5. Data Structure using C and C++ by A. M. Taneumbam, 2nd edition, PHI, 2017.
6. Computers Fundamentals by P K Sinha and P. Sinha, 6th edition, BPB publications, 2004.

PRACTICAL IN COMPUTERS & C PROGRAMMING

(4 Hrs. PER WEEK) MARKS: 100

Sr. No.	Practical Name
1	Introduction to Microsoft Word and Microsoft Power point
2	Introduction to Microsoft Excel and MS-DOS commands
3	Programs on basic programming in C
4	Programs using Decision Controls in C
5	Programs using while, do-while and for Loop
6	Programs using Case Control Structure, odd loop
7	Programs illustrating use of function
8	Programs illustrating use of arrays
9	Programs using Pointers and Structure
10	Programs illustrating use of String
11	Programs for file handling in C
12	Programs for Biological application • Finding complement of DNA • ORF finding • Inverted Repeats • Motif finding • Translation • Transcription

RECOMMENDED BOOKS

1. The complete reference of C by H. Schildt, 4th edition, Mc Graw Hill, 2003.
2. Let us C By Y. Kanitkar, 15th edition, BPB Publication, 2017.
3. Data Structure Through C by Y. Kanitakar, 2nd edition, BPB Publication, 2003.
4. Understanding Pointers in C by Y. Kanitakar, 4th edition, BPB Publication, 2007.
5. Data Structure using C and C++ by A. M. Taneumbam, 2nd edition, PHI, 2017.

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	40
End semester examination:	60
Total:	**100**

COURSE: COMMUNICATION SKILLS

COURSE CODE: HU-101	**L**	**T**	**P**	**Hr**	**C**
MARKS: 100	**1**	**2**	**0**	**3**	**3**

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.

COURSE OUTCOME:

Completion of this course will enable the students to:

- Display skills in different and appropriate ways of communication
- Demonstrate competence in different types of documentations like scientific report writing and research papers
- Demonstrate better presentation skills
- Understand the concept of plagiarism and the ways to avoid it

PREREQUISITES:

This is an introductory course and there are no prerequisites.

COURSE DESCRIPTION :

Sr. no.	Topics	Description	Hrs.
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.	03
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	07
4	Plagiarism	Introduction to Plagiarism Examples of Plagiarism	03
Total Number of Lectures			**15**

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	60 minutes	20
II Internal	45 minutes	15
Attendance		5
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1. Technical Writing and Professional Communication by T. N. Huckin and L. O. London, William Collins and Sons, 1990.
2. Business English and Communication- By L. Clark and Zimmer, New York Mcgraw Hill, 1990.
3. Developing Communications by K. Mohan and M. Banerji, Macmillan India Limited, 2000.

COURSE: Maths I - MATHEMATICS

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

OBJECTIVE

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

COURSE OUTCOME

At the end of this course, students will be able to:

- Understand basic concepts in mathematics
- Solve problems related to logarithms, trigonometry and functions
- Demonstrate mathematical methodologies to solve biological problems like pH, viscosity, buffer preparation, etc.

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.	**Topics**	**Description**	**Lectures**
1	Algebra :	Logarithms: Definition of Logarithm (Natural and common logarithm, Laws of Logarithm. Binomial Theorem: Definition of factorial notation, peronntation & combinations, Binomial Theorem for positive index. General term, middle term, Binomial theorem for any index Binomial Theorem for Approximation	06
2	Trigonometry	Trigonometric Rations (t-ratios): t-ratios of any angle, Relation between t-ratios, Fundamental identities, Quadrants sign of T-ratios in various quadrants, T-ratios of negative angles T-ratios of Allied, Multiple and Submultiples angles, Factorization formulae, Defactorization formulae. Inverse Trigonometric Functions: Definition of Inverse t-functions	03 08
3	Function and Limit	Function: Definitions of variable, constant, intervals such as open, closed, semi-open etc., Definitions of function, value of function, domain & range of a function. Limits: Concepts and definition of Limit, Limits of algebraic functions, trigonometric functions, exponential functions, logarithmic function	02 06
4	Derivatives	Derivatives: Definition of Derivatives, notations, Rules of Derivatives (without proof), Derivatives of composite functions, Derivatives of Inverse trigonometric function by substitution method, Derivatives of Implicit functions, Logarithmic differentiation, Second order differentiation Application of Derivatives: Geometrical meaning of the derivatives, Equations of Tangent & normal to the given curve, Maxima & Minima.	05 04
5	Integration	Integration: Definition of integration, Integration of	03

		Standard function; Rules of Integration, Integration of rationale functions; Trigonometric functions to determine constant of Integration. Definite Integration: Definition of Definite integral, definite, Definite integral with simple problems Application of Definite Integrals: Area under the curves, Area between two curves.	 02 02
6	Differential Equation (D.E.)	Definition of D.E., order & degree of D.E., formation of D.E for function containing single constant. 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.	03
Total Number of Lectures			**44**

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	60 minutes	20
II Internal	45 minutes	15
Attendance		05
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1) Mathematics for Biological Science by J. Arya & Ladner, Prentice Hall, 1979.
2) Numerical methods by E. Balguruswamy, Tata Mc Graw Hill Publications Pvt Ltd., 1999.
3) Higher Engineering Mathematics by B. S. Grewal, Khana Publication, New Delhi, 2003.
4) Applied Mathematics by P. N. Wartikar, Pune Vidaypeeth, Griha Prakashan, Pune, 2010.
5) Introductory Methods of Numerical analysis by S. S. Sastry, Prentice Hall of India, New Delhi. 2005.

SEMESTER II						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT 201	Biochemistry	3	0	4	7	5
BT 202	Cell Biology	3	0	2	5	4
BS 201	Maths II -Statistics	2	0	2	4	3
BT 203	Engineering Mechanics	2	0	2	4	3
BS 202	Environmental Sciences	2	0	2	4	3
BT 204	Engineering Graphics	1	0	2	3	2
HU 201	Disaster Management*	0	1	0	1	-
Total		**13**	**1**	**14**	**28**	**20**
Audit course, attendance is must						

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

OBJECTIVE OF THE COURSE:

Biochemistry is the study of chemical reactions that occur in living organisms in order to maintain the cellular and physiological activities of life. Biochemical reactions maintain a homeostasis between the synthesis and degradation of products. The objective of the course is to familiarize the students to these various structures and reactions occurring in one's own body and the other living organisms.

COURSE OUTCOME:

On successful completion of the course, students will:

- Understand the fundamental biochemical principles such as structure and functions of various biomolecules
- Know the reactions of the major metabolic pathways of carbohydrate, lipid and amino acid metabolism
- Demonstrate an understanding of the regulation of biochemical processes
- Understand the molecular basis of various pathological conditions from the perspective of biochemical reactions
- Know the significance of Biochemistry in understanding biological process and functioning of living organisms

PREREQUISITES:

The course requires that the students shall be aware about the basics of chemistry and biomolecules.

COURSE DESCRIPTION

Sr. No	Topic	Description	Hrs
1.	Biomolecules and Bioenergetics	Carbohydrate: Structure and classification of Monosaccharides, Oligosaccharides and Polysaccharides. Derived sugars.	3
		Amino acids: Structure, classification and properties	2
		Protein: Classification and functions Structure: Primary, Secondary, tertiary, quaternary	3
		Nucleic acids: Structure of nucleotides, DNA and RNA	2
		Fatty acids and lipids: Structure and classification. Compound lipids	2
		Enzymes: Classification and concept of regulation	2
		Vitamins and coenzymes	2
2.	Survey of metabolism	Introduction to metabolism-catabolism, anabolism and intermediary metabolism.	1
3.	Glycolysis	Glycolytic pathway and energetics	2
		Anaerobic pathway of glucose metabolism	1
4.	Gluconeogenesis and Glycogen Metabolism	Bypass reactions, Regulation of gluconeogenesis by enzymes and hormones.	2

		Glycogenolysis and glycogenesis	4
5.	Citric acid cycle	Aerobic pathway of glucose metabolism. Balance sheet. Regulation of the cycle.	3
6.	Lipid Metabolism	Requirement of carbon dioxide and citrate for biosynthesis, FAS complex and regulation of biosynthesis	3
		β-oxidation of monounsaturated and polyunsaturated fatty acids, Energetics of β oxidation.	3
7.	Electron transport chain and Oxidative phosphorylation	Complexes I, II, III and IV, components of electron transport chain and their structure. Reactions of the electron transfer.	2
		Oxidative phosphorylation, structure of ATPase enzyme, chemiosmotic hypothesis.	2
8.	Amino acid metabolism	Transamination, deamination and decarboxylation reactions, Urea cycle	2
9.	Biosynthesis of amino acids and its regulation	Glutamate, glutamine, arginine from α- ketoglutatrate	4
Total Number of lectures			**45**

METHODOLOGY:

The course should be taught through interactive lectures and demonstrations, which will help all the students to correlate the subject to everyday activity.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	60 minutes	20
II Internal	45 minutes	15
Attendance		5
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1. The principles of Biochemistry, Lehninger by D. Nelson, and M. Cox, 7th edition, M. W.H. Freeman and Company, New York, 2017.
2. Metabolic Pathways by D. M. Greenberg, 3rd edition, Academic Press, Elsevier Science & Technology Books, 2014.
3. Biochemistry by L. Stryer, 7th edition, W.H. Freeman and Company, New York, 2012.
4. Biochemistry by J. M. Berg, J. L. Tymoczko, L. Stryer, 6th edition, W.H. Freeman and Company, New York, NY, 2007.
5. Biochemistry by G. Zubay, Addison-Wesley Educational Publishers Inc, 1983.
6. Outlines of Biochemistry by E. Conn and P. Stumpf, 5th edition, John Wiley & Sons, 2009.
7. Principles of Biochemistry by D. J. Voet, J. G. Voet, C. W. Pratt, 3rd edition, (International Student Version), John Wiley and Sons, Inc., 2008.

PRACTICAL IN BIOCHEMISTRY (4 Hrs. PER WEEK) MARKS 100

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1	Preparation of standard solutions.	To understand the concepts of Normality, Molarity, Molality and ppm.	An Introduction to Practical Biochemistry by D. T. Plummer, 3rd edition, Tata McGraw Hill Education Private Limited, New Delhi, 2011.
2	Verification of Beer Lambert's law and determination of λmax of CuSO4/KMnO4 solution.	To understand the basic principles of colorimetry	
3	To find out the pka value of glycine using titrimetric method.	Study of principles of titrimetry and understanding the concepts of pH, pKa, and pKb.	
4	Qualitative analysis of carbohydrates (Monosaccharides, disaccharides and polysaccharides)	To understand the chemistry of a compound and the importance of different reagents.	1. Experimental Biochemistry, A student Companion by B. S. Rao and V. Deshpande, I.K. International Publishing House Pvt. Ltd, 2005. 2. Qualitative testing for carbohydrates by J. O. Schreck and W. M. Loffredo, Chemical Education Resources, Inc., 1994.
5	Qualitative analysis of amino acids	To confirm the presence of amino acids based upon the presence of functional group.	Practical manual of Biochemistry by S.P. Singh, 5th edition, 2011
6	Qualitative analysis of lipids (unsaturated oils, glycerol and cholesterol)	To study the physical properties of lipids as solubility, emulsification and other chemical characteristics such as acidic nature.	3. Experimental Biochemistry, A student Companion by B. S. Rao and V. Deshpande, I.K. International Publishing House Pvt. Ltd, 2005.
7	Qualitative analysis of proteins using different tests	To understand the biochemical properties of proteins.	www.biologydiscussion.com
8	Quantitative estimation of proteins using Biuret/ Lowry method/ Bradford method	To understand the method of quantification of proteins in mg/µg.	• Hawk's physiological chemistry by B. L. Oser, 14th edition, McGraw-Hill Book Company.,New York, N. Y., 1996. • Review of Physiological Chemistry by H.A. Harper, V.W. Rodwell, P.A. Mayes, Harold Anthony, 17th edition, Lange Medical Publications, Los Altos California, 1979.
9	Estimation of reducing sugar by DNSA method	To understand the method of quantification of sugars in mg/µg.	Use of dinitrosalicylic acid reagent for determination of reducing sugar, G.L. Miller, , *Anal. Chem.*, 31, 426, 1959.

10	Isolation of starch and casein	To understand the methods for isolation of biomolecules and their quantification	Hawk's physiological chemistry by B. L. Oser, 14th edition, McGraw-Hill Book Company.,New York, N. Y., 1996.
11	Acid value of oil / saponification value	To understand the quality of and nutritional value of lipids.	An Introduction To Practical Biochemistry by D. T. Plummer, 3rd edition, Tata McGRAW-HILL Edition, 1998.

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	40
End semester examination:	60
Total:	**100**

COURSE: CELL BIOLOGY

COURSE CODE: BT 202 **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.

COURSE OUTCOME:

At the end of the course, students will have the ability to:

- Outline the structure and functions of prokaryotic and eukaryotic cells and cellular components
- Observe and correctly identify different cell types, cellular structures using different microscopic techniques
- Understand the cellular components and processes underlying cell cycle, cell division and apoptosis
- Demonstrate the significance of cell receptors and cell signaling in biological system

PREREQUISITES

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

COURSE DESCRIPTION

Sr. No.	Topic	Description	Hrs
1.	Introduction	Pre-cellular evolution: artificial evolution of cells, RNA world hypothesis, Postulates of cell theory, Endosymbiotic theory, Broad classification of cell types, Comparative study on Prokaryotic cell and Eukaryotic Cell (Animal and Plant Cell)	3
2.	Methods to study cell structure and function and model organisms used in cell biology	Light Microscopy, Electron Microscopy, Fluorescence Microscopy, Confocal Microscopy, Deconvolution Microscopy, Flow cytometry and Cell sorting, Subcellular Fractionation, Introduction to animal cell, plant cell and virus culture, Immunocytochemistry and immunohistochemistry. Model organisms: *E. coli, S. cerevisiae, D. discoideum,* Hydra. *C elegans*, *D. melanogaster*, Zebrafish, *A. thaliana,* etc. Emerging Model Organisms.	6
3.	Cell surface	Cell wall and extracellular matrix. Cell membrane: Structure and functions, Membrane proteins, lipids and sugar modifications for different membrane types. Ion channels. Transport across the membrane, Exo and Endocytosis Cell to cell interaction.	6
4.	Structure and function of cell organelles along with difference in membrane	Cytosol, Golgi bodies, ER (smooth and rough), Ribosomes, Cytoskeleton structures (Actin and cell movements, Microtubules and cell division, cytoskeleton dynamics and treadmilling), Nucleus (Structure of nuclear	10

	composition.	envelop, internal organization, nucleolus), Mitochondria (Structure, respiratory chain complexes, ETC, ATP synthase structure, Mitochondrial biogenesis, maternal inheritance, anterograde and retrograde signaling), Chloroplasts, Lysosomes, Peroxisome. Different diseases in relation to cell organelles.	
5.	Cell division (prokaryotic and eukaryotic) and cell cycle	Fission and fusion, budding. Eukaryotic Cell cycle stages (mitosis and meiosis), Nuclear organization during mitosis, Events of M phase, Regulators of cell cycle, Fertilization, Cell proliferation during development.	5
6.	Protein transport	Transportation of proteins into the nucleus and mitochondria, Vesicular transportation.	3
7.	Cell receptors and signal transduction	Signaling molecules and their receptors. Function of surface and intracellular receptors, Different pathways of signal transduction, Signaling in development and differentiation.	4
8.	Programmed cell death and Cellular senescence	Apoptosis (intrinsic and extrinsic pathways), Necrosis, Necroptosis, Autophagy (macroautophagy and microautophagy), Cellular senescence, Methods to study cell death.	4
9.	Basic Concepts in developmental biology	Cell lineage and cell-cell interaction, Embryonic induction, Types and importance of stem cells, Cell differentiation, Causes of abnormal cell division and neoplastic transformation	4
Total Number of Lectures			**45**

METHODOLOGY

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

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	60 minutes	20
II Internal	45 minutes	15
Attendance		5
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1. Molecular Biology of the Cell; B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, P. Walter; 6th Edition, Garland Sciences, 2015.
2. Molecular Cell Biology; H. Lodish, A. Berk, Chris A. Kaiser, Monty Krieger , Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey C. Martin; 8th Edition; 2016
3. The Cell: A Molecular Approach; Geoffrey M. Cooper, Robert E. Hausman; 7th Edition ; Sinauer Associates, Inc., 2015.

PRACTICAL IN CELL BIOLOGY (2 Hrs. PER WEEK) MARKS 50

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 microscopes and their uses. Students should identify the different parts of the Microscope and safe handling.	Fundamentals of Light microscopy And electronic Imaging by D. B. Murphy, John Wiley & Sons, Inc., Publication. 2001
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	
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 by A. Clarkson, 2nd edition, Science Direct, 2013. Methods in plant histology by C.Joseph, 3rd edition, The university of chicago press Chicago, Illinois, The Baker & Taylor Company, 2007
4.	Blood Smear Preparation and differential staining.	A classical method for identification of blood cell preparation.	Dacie and Lewis Practical Haematology by B. Bain, I. Bates, M. Laffan, 11th edition, Elsevier, 2016.
5.	Buccal smear – Identification of Barr Body	A quick cytological method for identification of sex in mammals- an extreme case of chromosomal condensation.	Cytological Assessment of Barr Bodies Using Aceto-Orcein and Papanicolaou Stains in Buccal Mucosal Smears and Their Sex Estimation Efficacy in an Indian Sample, D. U. Angadi P. V. Hallikerimath and S. Kale, *Acta Cytologica*, 57:516-521, 2013 (DOI:10.1159/000353216)

6.	Mitosis in Onion Root-Tip Cells	To study mitosis using Onion root tip cells.	Science Volume 61 of Methods in cell biology by Conly L. Rieder. Academic Press, 1999.
7.	Meiotic cell division in grasshopper testis/Hibiscus flower buds	To perform Meiotic cell division in the given sample	

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

COURSE: Maths II: STATISTICS

COURSE CODE: BS 201	**L**	**T**	**P**	**Hr**	**C**
MARKS: 100	**2**	**0**	**2**	**4**	**3**

OBJECTIVE

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

COURSE OUTCOME

At the end of this course, students will be able to:

- Recognize the significance of data collection and its role in determining scope of inference
- Apply and interpret results of the principal methods of statistical inference and design
- Demonstrate an understanding of hypothesis testing, by applying appropriate statistical methods for variable analysis.
- Use statistical software appropriately.
- Communicate the results of statistical analyses effectively

PREREQUISITES

Students should be familiar with school level mathematics 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	Description	Lectures
1	Determinant & Matrices :	Determinant: Definition & expansion of determinant of order 2 and 3, Cramer‟s rule Matrices: Definition of Matrix of order mxn and types of Matrices, Algebra of Matrices, Transpose of a Matrix, Inverse of a Matrix by adjoin method, Solution of simultaneous equations	06
2	Complex Number :	Definition of Complex number, Cartesian, polar, exponential forms of complex number. Algebra of Complex Number De - Moiyre‟s theorem (without proof) and simple problems.	03
3	Numerical Methods :	Numerical Solution of Simultaneous Equations : Gauss elimination method Iterative Methods Gauss Seidal and Jacobi‟s Method	03
4	Set Theory and Probability	Set Theory Probability: Definition of random experiments, sample space, events, occurrence of event and types of events, Definition of probability, addition and multiplication theorem of probability. Probability Distribution: Binominal Distribution, Poisson‟s Distribution, Normal Distribution	06
5	Statistics	Frequency Distribution Measures of Control tendency (For Raw, Ungroup & group Data) Measures of Dispersion: Rauge, Variance, Coefficient of Cariance, Standard Derivation	01 03 02
6	Correlation & Regression	Correlation & Regression	02

7	Hypothesis Testing	ANNOVA, Chi square Test	03
8	F-Test	F-Test	01
Total Number of Lectures			30

METHODOLOGY

The course will be covered through lectures supported by practicals.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

BOOKS RECOMMENDED:

1. Fundamentals of Statistic by S. G. Gupta. 17th edition, Himalaya Publications 2000.
2. Statistical Method in Biology by Bailey 3rd edition, University of Cambridge Press, 1995.
3. Statistics from biologist by R.C. Campbell, 3rd edition, Cambridge University Press, 1989.
4. Fundamentals of Mathematical Statistics by S. C. Gupta and S. C. Kapoor, Hand publication, New Delhi .1987.

PRACTICAL IN Maths II: STATISTICS **Two Hours Per Week** **Marks: 50**

Sr. No.	Name of experiment	Learning objectives
1.	Introduction to statistical computing.	Understand concepts and ideas behind mathematical and statistical computing.
2.	Exploring statistical packages such as SYSTAT/ SPSS/ SAS.	Explore statistical package environment: features, workspace, menu, and user interface.
3.	Biological data handling in statistical package.	Recognize the difference between biological and other data.
4.	Data exploration with graphs.	Draw various types of graphs.
5.	Computation of measures of central tendency.	Learn how to compute and interpret various measures of central tendency.
6.	Computation of measures of dispersion.	Learn how to compute and interpret various measures of dispersion.
7.	Computation of correlation coefficient.	Learn how to compute and interpret correlation coefficient.
8.	Curve fitting, construction of regression models and computation of regression coefficient.	Understand data modeling and learn to visualize and measure relationship between variables by constructing various models.
9.	Analysis of variance (ANOVA).	Understand and perform ANOVA test.

References:

1. Fundamental of Statistics by S.C. Gupta, 17th edition, Himalaya Publications, 2000 .
2. Fundamentals of Mathematical Statistics by S.C. Gupta and Kapoor, S. Chand Publications, 1987.
3. Fundamental of Biostatistics by B. Rosner, 7th edition, Cengage Learning Publisher, 2010.
4. Biostatistics: Bare essentials by G. R. Norman and D. L. Streiner, McGraw-Hill Medical Publisher, 2014.
5. Statistical methods in Bioinformatics by W. J. Ewens and G. R. Grant, 2nd edition, Springer, 2005.
6. The Practice of Business Statistics (w/CD) by Manish Sharma and Amit Gupta, Khanna Publishing House, 2010

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

COURSE: ENGINEERING MECHANICS

COURSE CODE: BT 203	**L**	**T**	**P**	**Hr**	**C**
MARKS: 100	**2**	**0**	**2**	**4**	**3**

OBJECTIVES:

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

COURSE OUTCOME:

By the end of the course, students will:

- Understand the basic concepts of engineering mechanics
- Know, the principles of static equilibrium
- Demonstrate the ability to illustrate the laws and kinematics of motion and their interrelationships
- Be able to identify the major factors involved in the angular kinematics of human movement.
- Identify and analyze various biomechanical problems.

PREREQUISITES:

Since the course is technical in nature the students must have the basic knowledge of Math and 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	3
2	Statics of particles	Principal of statics, force systems, Principle of transmissibility, Resolution and Composition of forces , Resultant of concurrent forces, Moment of a force, Resultant of parallel force system, Couple	6
3	Free body diagram	Free body diagram, Types of supports and their reactions, Requirements of stable equilibrium, Equilibrium of a particle, Equilibrium of a particle in space, Equilibrium of rigid bodies in two dimensions, Equilibrium of rigid bodies in three dimensions, Types of beams-Simple and compound beams	7
4	Friction	Frictional Force, Laws of Coulomb friction, Simple Contact friction	3
5	Dynamics kinematics	Basics of Kinetics and kinematics, Relative motion, Newton's Law of Motion, Conservation of energy and Work Energy Equation of particles. Impulse and Momentum, Impact of elastic bodies, Direct central impact and coefficient of restitution	6
6	Basics of Biomechanics	Basic concept of Biomechanics, Biomechanics of tissues, muscles, bones and ligaments, Applications	5
Total Number of Lectures			**30**

METHODOLOGY:

The course would be taught through lectures, demonstrations and practicals

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

BOOKS RECOMMENDED:

1. Engineering Mechanics by Sanju Unadkat, Seventh edition,Tech-Max publications, 2012.
2. Engineering Mechanics by H.J. Sawant ,sixth Edition, Technical Publication ,2012.
3. Engineering Mechanics by DS Bedi, MP Poonia, Khanna Publications, New Delhi, 2018.

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

Sr. No.	Name of the experiment	Learning objective	Literature / Web links for reference and videos
1	Study of different force systems.	Students should able to learn different types of force systems and their visual representation.	• Engineering Mechanics by S. Unadkat, 7th edition, Tech-Max publications, 2012. • Engineering Mechanics by H.J. Sawant, 6th edition, Technical Publication, 2012.
2	Study of Laws of coplanar forces a) Triangle law b) Parallelogram law c) Polygon law	Students should able to learn and prove 3 different laws for coplanar forces.	
3	Study of equilibrium of forces in space.	Students should able to understand the concept of equilibrium, requirements for stable equilibrium.	
4	Study of collision of elastic bodies.	Students should able to learn law of conservation of momentum and concept of Impact.	
5	Analysis of compound beam	Students should able to identify different supports and their reactions. They should able to draw FBD of simple and compound beams.	
6	Study of flywheel	Students should able to learn basic concepts of dynamics, Moment of inertia.	
7	Study of friction	Students should able to learn basic concept of friction, its types.	
8	To find coefficient of restitution.	Students should able to find coefficient of restitution for different materials.	https://physics.stackexchange.com/questions/172127/the-coefficient-of-restitution-of-a-bouncing-ball

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

COURSE NAME: ENVIRONMENTAL SCIENCE
COURSE CODE: BS 202 **L T P Hr Cr**
MARKS: 100 **2 0 2 4 3**

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.

COURSE OUTCOME:
On successful completion of the course students will be able to:

- Demonstrate basic understanding of natural resources, ecosystem and its structural and functional aspects
- Understand and appreciate values of biodiversity and significance of its conservation
- Demonstrate the measures to prevent environmental pollution at different levels
- Acquire understanding on effect of global warming and population growth on human health and climate change**.**
- Think critically on environmental issues and come up with sustainable solutions

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

COURSE DESCRIPTION

Sr. No	Topic	Description	Hrs
1	Natural Resources and associated problems	Land, water, food, forest, mineral and energy resources, their use, over-exploitation and conservation.	3
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.	4
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	6
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. Biodiversity act 2002	4 2
5	Social Issues and the Environment	Urban problems related to energy. Water conservation, Rain water harvesting, and watershed management. Resettlement and	4

		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 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.	3
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	4
Total number of lectures			**30**

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**
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

BOOKS RECOMMENDED:

1. Environmental Biology, K. Agarwal, Nidi Publ. Ltd. Bikaner, 2001.
2. The Biodiversity of India, B. Erach, Mapin Publishing Pvt. Ltd., 2002.
3. Hazardous Waste Incineration, R.C. Brunner, McGraw Hill Inc., 1989.
4. Marine Pollution, R.S. Cark, 5th edition, Clanderson press Oxford (TB), 2001.
5. A Textbook of Environmental Science by Rimpi Mehani Ne'e Chopra, Jyotsna, Khanna Publishers, New Delhi, 2017.
6. Environmental Studies by MP Poonia and SC Sharma, Khanna Publishers, New Delhi, 2017.
7. Elements of Environmental Polluton Control by O. P. Gupta, Khanna Publishers, New Delhi, 2016.

PRACTICAL IN ENVIRONMENTAL SCIENCE (2 Hrs. Per Week) MARKS 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	• Soil Analysis by P. C. Bandyopadhyay Gene-Tech books, New Delhi, India. 2007. • Handbook of Water Analysis by M. L. Leo, S. P. Nollet, S. P. Leen, De Gelder. , 3rd edition, CRC Press, United Kingdom, Publisher: Leen S. P. De Gelder, 2013. • A Microbiology laboratory Manual by J. G. Cappuccino and N. Sherman, 10th edition, Dorling Kindersley, Pearson Benjamin Cummings, 2014. • Principles and Practices of air pollution analysis by J. R. Mudakavi, I K International Publishing House Pvt. Ltd., New Delhi, India, 2010.
2.	Identification and enumeration of zooplanktons and phytoplanktons as indicator of water pollution	To differentiate polluted and non-polluted sites based on plankton data	
3.	To identify and characterize normal microflora in air, water and soil	To know presence of normal microflora within environment.	
4.	Determination of MPN from water samples	Determine potability of water	
5.	Estimation of chlorine in drinking water using colorimetric method	Understanding of residual amount of chlorine in water as a health hazard	
6.	Estimation of relative humidity of the atmosphere	To understand relationship between weather and humidity	
7.	Estimation of dissolved oxygen in the given water sample	To understand importance of BOD and COD	
8.	Study the effects of pollutants (e.g., heavy metals) on flora	To understand effect about pollution	
9.	Determination of NO_2 from the atmosphere by Colorimetric method using high volume sampler (Optional)	To understand more about atmospheric condition	
10.	Determination of K_2O value of soil by flame photometer (Optional)	To understand about Quality of soil	

Examination **Marks**

Practical Internal (Continuous) assessment: 20
End semester examination: 30
Total: **50**

COURSE: ENGINEERING GRAPHICS

COURSE CODE: – BT 102 **L T P Hr C**

MARKS: 100 **1 0 2 3 2**

OBJECTIVE OF THE COURSE:

Objective of the course are: To Learn basic engineering drawing formats.
Learn to take data and transform it into graphics drawings.
Learn to sketch and take field dimensions.

COURSE OUTCOME

The students will have the ability to

- Understand the basic engineering drawing formats
- Collect data and transform it into graphics drawings
- Demonstrate the sketching techniques and take field dimensions

PREREQUISITES

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

COURSE DESCRIPTION

Sr. No.	Topic	Description	Hrs
1.	Drafting Technology and Introduction to Any Drafting Software/Package	Layout of drawing sheets, sizes of drawing sheets, different types of lines used in drawing practice, Dimensioning – linear, angular, aligned system, unidirectional system, parallel dimensioning, chain dimensioning, location dimension and size dimension. Tolerances – methods of representing tolerances, unilateral and bilateral tolerances, tolerance on linear and angular dimensions, geometrical tolerances. Symbols used on drawing, surface finish symbols, welding symbols. Advantages of using Computer Aided Drafting (CAD) packages, applications of CAD, basic operation of drafting packages, use of various commands for drawing, dimensioning, editing, modifying, saving and printing/plotting the drawings. Introduction to 3D primitives.	2
2.	Curves used in Engineering Practice	Ellipse, Parabola, Hyperbola, normal and tangents to these curves, Involute, Cycloid, Epi-cycloid, Hypo-cycloid, Archimedean Spiral, Helix on cone and cylinder.	7
3.	Orthographic Projections	Reference planes, types of orthographic projections – First angle projections, Third angle projections, methods of obtaining orthographic view s by First angle method, Sectional orthographic projections – full section, half section, offset section.	2
4	Auxiliary Projections	Auxiliary planes – Auxiliary Vertical Plane (AVP), Auxiliary Inclined Plane (AIP), symmetrical auxiliary view, unilateral auxiliary view, bilateral auxiliary view.	2

5.	Isometric Projections	Isometric view, Isometric scale to draw Isometric projection, Non-Isometric lines, and construction of Isometric view from given orthographic views and to construct Isometric view of a Pyramid, Cone, and Sphere.	3
6.	Interpretation of Given Views/Missing Views	Identification of lines/edges and surfaces, visualization of given orthographic views, adding a missing/third view, adding a sectional view, to convert a given view in to a sectional view.	2
Total number of Lectures			**18**

METHODOLOGY

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

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

BOOKS RECOMMENDED:

1. Elementary Engineering Drawing, by D. Bhatt, 53rd edition, Chartor Publishing house, 2014.
2. Engineering Drawing by P.S. Gill, S.K. KAtaria & sons, 2009.
3. Engineering Graphics and Drafting by P.S. Gill, S.K. KAtaria & sons, 2009.
4. Machine Drawing by N.D. Bhatt, 50th Edition, Chartor Publishing house, 2014.

PRACTICAL IN ENGINEERING GRAPHICS (2 Hrs. PER WEEK)
MARKS 50

Five A2 (594X420mm) (Half imperial) size drawing sheet as detailed below:

1. Sheet No. 1: CURVES
   - To draw any four curves mentioned in the detailed syllabus.
2. Sheet No. 2: ORTHOGRAPHIC VIEWS
   - To draw two principal views, one sectional view for two objects.
3. Sheet No. 3: AUXILIARY VIEWS
   - To draw auxiliary views from the given views for any two objects.
4. Sheet No. 4: ISOMETRIC VIEWS
   - Two problems on Isometric views.
   - *(minimum one problem by using CAD software/package)*
5. Sheet No. 5: INTERPRETATION OF GIVEN VIEWS/MISSING VIEWS
   - Two problems on Interpretation of given views.
   - *(minimum one problem by using CAD software/package)*

EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

COURSE: DISASTER MANAGEMENT

COURSE CODE: HU-102 **L T P Hr C**

MARKS: 50 **0 1 0 1 -**

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 OUTCOME:

By the end of course, students will be able to:

- Understand about disasters, their types and significance
- Demonstrate the relationship between vulnerability, disasters, disaster prevention and risk reduction
- Acquire preliminary understanding of approaches of Disaster Risk Reduction
- Demonstrate rudimentary ability to respond to their surroundings with potential disaster response and will have 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	06

		Preparedness, DM Act and Policy, Other related policies, Plans, programmes and legislation)	
6	Project Work	Field Work, Case Studies	06
Total Number of Lectures			**36**

METHODOLOGY

The course will be covered through lectures, project work & classroom discussion.

EVALUATION SCHEME (THEORY)

This course attendance is mandatory but university examination may not be conducted.

BOOKS RECOMMENDED:

1. Introduction in "Confronting Catastrophe' by A. David Oxford University Press, 2000.
2. Vulnerability in Disaster Discourse, by Andharia J. JTCDM, Tata Institute of Social Science working Paper no. 8, 2008
3. At Risk Natural Hazards, Peoples, Vulnerability and Disasters by Blaikie, P, Cannon T, Davis I, Wisner B, Rutledge. 1997
4. Introduction to International Disaster Management, C. P. Damon, 2007,
5. Disaster Management : A Disaster Manager's Handbook, Carter and Nick, Asian Development Bank, Manila Philippines, 1991.
6. Development and Disasters, Cuny, F., Oxford University Press, 1983.
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, National Disasters Management Policy, 2009.
10. Environmental Knowledge for Disasters Risk Management, A. K. Gupta, S. S. Nair, NIDM, New Delhi, 2011.

SEMESTER III						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT 301	Analytical Techniques	3	0	4	7	5
BT 302	Microbiology & Virology	3	0	4	7	5
BT 303	Genetics	3	0	2	5	4
BI 301	Concepts in Bioinformatics	2	0	4	6	4
BT 304	Biosafety, Bioethics & IPR	2	0	0	2	2
HU 301	Universal Human Values II	2	1	0	3	3
Total		**15**	**1**	**14**	**30**	**23**

COURSE: ANALYTICAL TECHNIQUES
COURSE CODE: BT-301 **L T P Hr C**
MARKS: 200 **3 0 4 7 5**

OBJECTIVE OF THE COURSE:

The objective of the course is to create general understanding of centrifugation, chromatographic techniques, various spectroscopic techniques like absorption spectroscopy, fluorescence spectroscopy, Infra-red spectroscopy, Optical Rotatory Dispersion (ORD) & Circular Dichroism (CD) spectroscopy, Nuclear Magnetic Resonance (NMR) Spectroscopy, Electrophoretic techniques, and X-ray crystallography. They would also understand the importance of analytical tools in biotechnology & its applications in various industries.

COURSE OUTCOME:

Upon completion of this course, students will be able to:

- Understand the basic concepts and principles of the major analytical techniques including instrumentation, sample preparation and standardization.
- Evaluate the proper application of various analytical techniques for problem solving in biological sciences.
- Demonstrate the ability to plan and execute experiments, and analyze and interpret the outcomes.
- Design an analytical regimen to obtain data relevant to their research problem

PREREQUISITES:

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

COURSE DESCRIPTION

Sr. no.	Topic	Description	Hrs
1.	Centrifugation	Introduction: Basic Principle of Sedimentation Types of centrifuges: Desktop, High Speed and Ultracentrifuge (Preparatory and Analytical), Design and their working principle Types of Rotors, Wall-effect	4
2.	Spectroscopy : (i) Absorption Spectroscopy	Simple theory of absorption of light by molecules, Chromophore and terminologies associated with absorption of molecules The Beer-Lambert Law and its deviations Single and double beam spectrophotometers for measuring Visible and Ultraviolet light: Instrumentation and Parameters measured in absorption Spectroscopy Factors affecting the absorption properties of a chromophore Empirical rule for the absorption spectra of biological macromolecules Chemical Analysis by absorption spectroscopy using Visible and Ultraviolet light Structural studies of Proteins using absorption of Ultraviolet light Structural studies of DNA using absorption of Ultraviolet light	4
	(ii) Fluorescence Spectroscopy	Simple theory of Fluorescence Instrumentation and Technology of Fluorescence Spectroscopy Intrinsic Fluorescence measurements for information about the conformation and binding sites of proteins Extrinsic fluorescence measurements for information about the conformation and binding sites of proteins	2

	(iii) Infrared Spectroscopy (iv) Optical Rotatory Dispersion (ORD) & Circular Dichroism (CD) (v) Nuclear Magnetic Resonance (NMR) Spectroscopy (vi) Mass spectrometry	Infrared Spectroscopy: Basic Principle Instrumentation and Technology of Infrared Spectroscopy Information in Infrared Spectra and Applications of Infrared spectroscopy Theory of Optical Rotatory Dispersion (ORD) & Circular Dichroism (CD) Relative values of ORD and CD measurements, Advantages of CD over ORD Instrumentation for measuring ORD and CD Applications of ORD and CD Nuclear Magnetic Resonance (NMR) Spectroscopy : Principle Basic Instrumentation of NMR Spectrometer Applications of NMR Spectroscopy Mass spectrometry: Basic Principle Instrumentation and main components of mass spectrometers Ionization source, Mass analyzers, and Detectors 4. Applications of Mass Spectrometry	2 2 2 2
3.	Chromatography	Partition Chromatography: Simple Theory, Concept of theoretical plates Adsorption Chromatography: Simple Theory & Types Operations of columns : Terminologies and concept Elution : Types of elution methods Supports : Concept of mesh size and mesh screen Paper Chromatography : Principle, Experimental Procedure, R_f value calculation, Ascending and Descending paper chromatography, 2-D paper chromatography Thin Layer Chromatography: : Principle, Experimental Procedure, R_f value calculation, Advantages of Thin layer chromatography over paper and column chromatography Gas-Liquid Chromatography: Principle, Basic set up of Gas-liquid chromatography system, Detectors and Uses of Gas-Liquid chromatography Gel Chromatography (molecular-sieve chromatography): Simple Theory, Materials (dextran, agarose and polyacrylamide gels), Advantages of gel chromatography, Estimation of molecular weight and applications of gel chromatography Ion-Exchange Chromatography: Principle, Properties of Ion Exchangers, Choice of Ion Exchangers, Technique and application of Ion Exchange chromatography. High-Performance of Liquid Chromatography (HPLC): Principle, Application of pressure in HPLC, Advantages and uses of HPLC. Affinity Chromatography: Principle, Methods of Ligand immobilization (Cyanogen-bromide-activated agarose, Aminoethyl- and hydrazide-activated polyacrylamide), uses of affinity chromatography	10
4.	Electrophoresis	Electrophoresis : General Principle, Agarose and Polyacrylamide gels	4

		Sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE), Principle of separation, Techniques and molecular weight estimation via SDS-PAGE Iso-electric focusing (IEF): Principle, Technique and application 2-D PAGE: Steps involved in 2-D PAGE, application in proteomics Pulse-field gel electrophoresis: Principle, Technique and Application Capillary electrophoresis: Principle, Technique and Application	
5.	X-ray crystallography	Interaction of X-ray with matter: Absorption, Scattering and diffraction (Bragg' s Law) Preparation of crystals : Hanging and sitting drop vapor diffusion methods X-ray diffraction methods Application of X-ray Diffraction in Crystal structure	2
6.	Techniques for Intermolecular Interactions	Surface Plasmon Resonance (SPR) Spectroscopy : Principle, Technique & Application Isothermal Titration Calorimetry (ITC) : Principle, Technique & Application	2
Total Number of Lectures			**38**

METHODOLOGY:

The course will be covered through lectures supported by Practicals.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	60 minutes	20
II Internal	45 minutes	15
Attendance		5
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1. Physical Biochemistry, Applications to Biochemistry and Molecular Biology, D. Freifelder, 2nd edition, W.H. Freeman and Company, New York, 1992.
2. Biophysical Chemistry Principles and Techniques by A. Upadhyay, K. Upadhyay & N. Nath, 4th edition, Himalayan Publishing House. 2005.
3. Instrumental Methods of Chemical Analysis, G. R. Chatwal and A. K. Sham, 5th edition Himalaya Publishing House, 2005.
4. Instrumental Analysis, D. A. Skoog, F. J. Holler, S. R. Crouch, 11th edition, Brooks/Cole, a part of Cengage Learning, 2012.

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

Sr. No.	Name of the experiment	Learning objective	Literature/ Web links for reference and videos
1	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.	1. Physical Biochemistry, Applications to Biochemistry and Molecular Biology, D. Freifelder, 2nd edition, W.H. Freeman and Company, New York, 1992. 2. An introduction to practical Biochemistry, 3rd edition by D. T. Plummer, Tata McGraw-Hill, 2004. 3. Laboratory manual in Biochemistry by J. Jayaraman, New Age International (P) Limited, Publishers, 2011. 4. Introductory Practical Biochemistry by S.K. Sawhney and R. Singh, 2nd edition, Narosa Publishing House, 1999. 5. Calbiochem buffer booklet
2.	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	
3.	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. REFER:	
4.	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.	
5.	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.	
6.	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.	
7.	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)	
8	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.	

Sr. No.	Name of the experiment	Learning objective	Literature/ Web links for reference and videos
9.	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?	
10.	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.	
11.	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.	

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	40
End semester examination:	60
Total:	**100**

COURSE: MICROBIOLOGY AND VIROLOGY

COURSE CODE: BT 302 **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 microorganisms and viruses, their structures, diseases caused by bacteria and viruses and their control.

COURSE OUTCOME:
By the end of the course, students will have sufficient scientific understanding and will be able to:

- Understand the basic microbial & viral structure and function and comparative characteristics of prokaryotes and eukaryotes.
- Demonstrate the processes in microorganisms and viruses for their replication, survival, and interaction with their environment, hosts, and host populations
- Know how viruses can be used as tools to study biological processes, as cloning vectors and for gene transfer.
- Demonstrate practical skills in the use of technologies, tools, and approaches common to microbiology & virology

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)	7
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.	7
3	Control of Microorganisms	Control of By physical and chemical agents. Role of antibiotics and chemotherapeutic agents	7
4	Micro –organisms and Human diseases	Multiple drug resistant bacteria and their biofilm lifestyle. Microbial diseases of skin and eye, nervous system, cardiovascular & lymphatic system, respiratory, and digestive system.	5
5	The Viruses	Discovery, virus structure, classification, viral replication cycle, detection and enumeration of viruses, virus cultivation in lab, viriods, prions.	5
6	Bacteriophages	Morphology, reproduction of ds DNA phages, ss DNA phages and RNA phages.	4
7	Plant Viruses	Nomenclature and classification, viruses infecting fruits and vegetables	4

8	Animal Viruses	Viruses containing ss(+) RNA, ss(-) RNA, ds RNA and DNA and ssDNA, RNA tumor viruses requiring DNA intermediate for synthesis.	4
9.	The major group of Eukaryotic micro-organism-Fungi.	Growth and differentiation in fungi, Industrial application of fungal cultures.	2
Total Number of lectures			**45**

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

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	60 minutes	20
II Internal	30 minutes	15
Attendance		5
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1) Microbiology: An introduction, G.J. Tortora, B.R. Funke, C.L. Case, 5th Edition, Benjamin Pub. Co. NY, 1992.
2) Medical Bacteriology, N.C. Dey, and T. K. Dey, Allied Agency, Calcutta, 17th Edition, 1988.
3) Text book of microbiology, R. Ananthnarayana, and C.E, Jayaram Panikar, 5th edition, Orient Longman, 1996.
4) Fields Virology D. Knipe and P. Howley. Vol.1 and 2- 4th Edition. Lippincott-Raven Publishers, 2006.
5) Fundamentals of Molecular Virology, N. H. Acheson 2nd Edition. Wiley Publisher, 2011.

PRACTICAL IN MICROBIOLOGY AND VIROLOGY

(4 hrs per week) **Marks 100**

Sr. No.	Name of the experiment	Learning objective
	Introduction to Microscopy	
1	Introduction to Microscopy	a) To study the microscope and to observe different microorganisms like bacteria, protozoa, fungi and yeasts, algae – from natural habitat. b) Demonstration: Students will get familiar with different microscopic techniques such as TEM, SEM, Confocal-Microscopy, Flow cytometry and applications of these microscopic techniques in observation of bacterial biofilms.
	Introduction to Microbiology	
2	Introduction to Microbiology Lab instruments	To understand the principle and use of different microbiology lab instruments such as incubator, oven, colorimeter, autoclave, pH meter, water-bath, analytical balance, biosafety cabinet, refrigerator, deep freezer (-80^{o}C), magnetic stirrer, vortex mixer.
3 (a)	Introduction to Microbiology Lab practices- Preparation and autoclaving of different type lab media	➢ To become familiar with the necessary nutritional and environmental factors for culturing microorganisms in the laboratory. ➢ To understand the decontamination or sterilization process using an autoclave. ➢ To learn the procedures used in preparing media needed for culturing microorganisms.
3 (b)	Preparation of Petri plate and slant. Handling and Examining Cultures	➢ To learn the procedure used in preparing plate and slant for culturing microorganisms. ➢ To make aseptic transfers of pure cultures and to examine them for important gross features.
4	Isolation of bacteria and study bacterial colony characteristics	➢ To isolate pure cultures from a specimen containing mixed flora by using streak and spread plate technique. ➢ To study the different bacterial colony characteristics and to be able to differentiate between the general morphological types of bacteria.
5	Microbial staining techniques- (a) Simple and (b) differential staining	➢ To learn the value of simple stains in studying basic microbial morphology ➢ To learn the Gram-stain technique and to understand its value in the study of bacterial morphology
	Control of Microorganisms	
6	Antimicrobial activity (natural and synthetic) testing using - Disc Diffusion Assay, Well diffusion assay.	To learn the agar disk and well diffusion technique for antimicrobial susceptibility testing of different synthetic drugs and plant derived natural compounds against different Gram positive and Gram negative bacteria.
7	MIC and MBC of antibacterial compounds.	To learn MIC and MBC assay for antimicrobial susceptibility testing of different synthetic drugs and natural compounds against different Gram positive and Gram negative bacteria.
8	Biofilm inhibition activity of	To learn the anti-biofilm activity of different drugs against

	synthetic antibiotics and plant derived natural compounds by microtitre plate assay.	different antibiotic resistance biofilm forming Gram positive and Gram negative bacteria by using crystal violate microtitre plate.
9	Oligodynamic action of heavy metals.	To understand a biocidal effect of metals against different microorganisms, especially heavy metals, that occurs even in low concentrations.
10	Growth curve and how curve is disrupted by an antimicrobial agent.	To understand the growth pattern of bacterial cells and the effect of antimicrobial agents on its growth.
11	Personal Hygiene – Effect of soap and disinfectant washing.	To study the activity of some disinfectants and to learn the importance disinfectant in skin cleaning.
Microbial organisms and diseases		
12 (a)	Isolation, identification of pathogens from clinical samples (urine, stool, pus)	To understand the clinical microbiology (Physical, chemical and microscopic examination of clinical samples). Isolation and identification of pathogens such as *E. coli, Salmonella* spp., *Pseudomonas* spp., *Proteus* spp., *Klebsiella* spp., *Shigella* spp., *Staphylococcus, Streptococcus* spp., etc.
12 (b)	Demonstration of permanent slides of parasites	To identify and study parasites such as *Entamoeba histolytica*, *Ascaris* spp. *Plasmodium* spp. and *Leishmania* spp.
Mycology		
13 (a)	Distinguish between beneficial and harmful fungi and yeast.	To become familiar with essential and disease causing fungi and yeasts.
13 (b)	Isolation and microscopic observation of fungal cultures.	To become familiar with mycological culture techniques. To visualize and identify the structural components of fungi.
14	Enumeration of yeast cells by Neubaeur chamber. (Source of yeast – Oral thrush or vaginal thrush).	To determine the concentration of yeast cells in a given sample by Neubaeur chamber method.
15	Demonstration of permanent slides – Tissue section with fungal infection.	To become familiar with fungal infection to different human tissue.
Virology		
16	Isolation of bacteriophages by Plaque method	This assay is the most widely used technique for the isolation of virus and its purification, and to optimize the viral titers.
17	Viral infection diagnosis - Cytopathic effect (CPE)	To become familiar with morphological changes in cells caused by viral infections; the responsible virus is said to be cytopathogenic effect.

18	Visit to a viral research institute – such as NARI or NIV, Pune	To become familiar with the research on animal viruses and viral diseases of human Preparation and production of antigens, diagnostic sera, vaccines, nucleic acid probe/s, etc.

References:

1) Basic Practical Microbiology: A manual 2006 Society for General Microbiology (SGM), 2006.
2) Medical Laboratory Technology by K. L. Mukherjee, Vol III, 10th Edition, Tata Mc. Graw-Hill Pub Co., 1988.
3) Antimicrobial Chemotherapy by D. Greenwood, 3rd Edition, Oxford University Press, 1995.
4) Laboratory Manual and Workbook in Microbiology Applications to Patient Care by J. A. Morello, P. A. Granato, and H. E. Mizer, 7th Edition, The McGraw Hill Companies, 2003.
5) Textbook of Medical Laboratory Technology by P. B. Godkar and D. P. Godkar Vol 1 and 2 Bhalani Publishing, 2005.
6) Bergey's Manual of Systematic Bacteriology, Vol 1 and 2 Published by Springer, New York, 2015.

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	40
End semester examination:	60
Total:	**100**

COURSE: GENETICS
COURSE CODE: BT 303 **L T P Hr C**
MARKS: 150 **3 0 2 5 4**

OBJECTIVE OF THE COURSE:
The students would understand Mendelian Genetics, its extensions, Non-Mendelian genetics, Sex determination, Genetic diseases, Syndromes, Chromosomal Aberrations, and Population Genetics

COURSE OUTCOME:
On completion of this course, the students will be able to:

- Describe the molecular principles of Mendelian genetics and chemical basis of heredity.
- Understand the effect of different factors such as environment & physical factors on regulation of gene expression.
- Gain knowledge about the chromosomal basis of inheritance and pedigree analysis.
- Demonstrate the basics of genetic mapping and sex determination.
- Explain the key concepts of population and quantitative genetics

PREREQUISITES:
Since the course comes under Basic sciences, school level knowledge of molecular biology and chemistry is required by the students to take up this course.

COURSE DESCRIPTION

Sr. No	Topic	Description	Hrs
1	History of Genetics	Historical views of heredity	2
2	Mendelian Genetics	• Mendel's experimental design. • Mendelian laws and its application • Punnett Square and forked line method. • Probability Chi Square method.	7
3	Extension of Mendelian laws	• Incomplete dominance and co-dominance. • Multiple alleles. • Gene Interactions that modifies Mendelian ratios: different type of epistasis, complementation analysis. • Environmental effect on the expression of genes. • Penetrance and expressivity, Pleiotropy. • Position effect and genomic imprinting.	7
4	Non-Mendelian inheritance	• Rules and examples of Non-Mendelian Inheritance: mitochondrial, chloroplast • Maternal and uniparental inheritance. • Infectious heredity • Contrast to non-Mendelian inheritance o (Maternal Effect)	5
5	Chromosomal basis of inheritance	• Evidences for chromosome theory of inheritance: Sex chromosomes, Sex linkage and non-disjunction of X chromosomes. • Analysis of sex-linked and autosomal traits in humans. Mendelian inheritance in Human ; Pedigree analysis	7

6	Cytogenetics and linkage mapping	• Cytogenetic techniques. • Variations in chromosome structure and number and associated disorders. • Linkage and crossing over and gene mapping in eukaryotes.	6
7	Sex determination	• Genotypic (Mammals, *Drosophila, C. elegans*), genic and environmental mechanisms. • Mechanisms of dosage compensation in Mammals, *Drosophila, C. elegans*	6
8	Population genetics	• Genetic structure of population: genotype and allele frequencies • The Hardy-Weinberg Law. • Genetic variation: mutation, migration, natural selection and random genetic drift.	5
Total Number of Lectures			**45**

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

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	60 minutes	20
II Internal	45 minutes	15
Attendance		5
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1. Genetics A molecular approach, P. J. Russell., Pearson Benjamin Cummings, San Francisco Boston, New York, 2006.
2. Principles of genetics by Tamarin, 7th edition, The McGraw Hall Companies USA, 2002.
3. Essentials of genetics. By W. S. Klug, M. R. Cummings, Prentice-Hall Inc. USA, 1999.

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

Sr. No.	Name of the experiment	Learning objective	Literature/ Web links for reference and videos
1	To study different model organisms (*Escherichia coli, Drosophila melanogaster, Caenorhabditis elegans, Mus musculus, Saccharomyces cerevisiae and Arabidopsis thaliana)*	To understand the importance of usage of model organisms systems in genetic studies	Genetics, A Conceptual Approach by B. A. Pierce, 5th edition, , W. H. Freeman & Company, 2013. Human Molecular Genetics by A. P. Read and T. Strachan, 4th edition, Taylor & Francis, 2011.
2	Estimation gene frequency in population / To study distribution of dominant and recessive traits in the population	To understand Mendelian inheritance patterns in Humans	
3	Mutants in *Drosophila*, monohybrid and dihybrid crosses in *Drosophila*,	To understand Mendelian inheritance patterns	
4	Preparation of ideogram of human chromosomes and its analysis	To identify chromosomal anomalies	
5	To study the effect of genetic drift on sample population (Founder effect)	Understanding genetic drift in populations	
6	Sex Linked lethal in Drosophila	To understand sex linked inheritance	
7	To identify auxotroph mutants in bacteria	To understand recombination in Bacteria	

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

COURSE: CONCEPTS IN BIOINFORMATICS

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

MARKS: 150 **2 0 4 6 4**

OBJECTIVE:

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

COURSE OUTCOME:

On completion of the course students will be able to:

- Apply knowledge of the working concepts of different computational tools.
- Describe the information and application of different databases and effective data retrieval for solving research problem.
- Develop basic understanding of different techniques of sequence alignment and their utilization in phylogenetic analysis.
- Predict the secondary and tertiary structures of proteins and their active sites.
- Investigate specific contemporary biological questions *in silico* and critically analyze & interpret the results.

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.	Overview and scope of Bioinformatics, Computers in biology, medicine & different problems in biology.	02
2	Introduction to nucleic acid and protein databases.	NCBI, EMBL, DDBJ, UNIPROT, PDB, SCOP, CATH.	05
3	Data acquisition, Database content, structure and annotation.	File formats: GenBank, EMBL, PDB, PIR, ALN Types of database: flat file, relational, hierarchical, network, object-oriented. Annotated sequence databases, Genome and Organism specific databases.	03
4	Retrieval of Biological Data.	Data retrieval tools: Entrez, SRS etc.	02
5	Pairwise sequence alignment.	Sequence comparisons & alignment concepts, Global Alignments – Needleman-Wunsch Algorithm Local Alignments – Smith-Waterman Algorithm Introduction to Homology, Analogy, Orthology Paralogy, Xenology.	04
6	Multiple sequence alignment.	Methods of multiple sequence alignment, CLUSTALW & MUSCLE Algorithms, Applications of MSA.	03
7	Database similarity	FASTA, BLAST, PSI-BLAST algorithms.	02

	searches.		
8	Patterns, Motifs, and Profiles.	Derivation and searching, Derived Databases of patterns, motifs and profiles Prosite, Blocks, Prints, Pfam etc.	03
9	Introduction to Phylogenetic analysis.	Methods of phylogenetic analysis, cladistics, Building phylogenetic trees, evolution of macromolecular sequences.	03
10	Introduction to structural Bioinformatics.	Levels of protein structure, Analyzing secondary structure, Ramachandran Plot, Protein structure prediction, RNA structure prediction, visualization tools.	03
Total Lectures			**30**

METHODOLOGY

The course will be covered through lectures and supported by practical.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

BOOKS RECOMMENDED

1. Bioinformatics – A Practical Guide to the Analysis of Genes and Proteins by Andreas Baxevanis, Francis Ouellette, Wiley-Interscience, 2005.
2. Introduction to Bioinformatics by T. K. Attawood & D.J. Parry-smith, 8th reprint, Pearson education, 2004
3. Bioinformatics: Sequence and genome analysis by D. W. Mount, 2nd edition, CBS Publication, 2005.
4. Fundamental Concepts of Bioinformatics by D. E. Krane and M. L. Raymer, Pearson Publication, 2006.
5. Bioinformatics: Tools & Applications by D. Edward, J. Stajich and D. Hansen, Springer, 2009.
6. Bioinformatics: Databases, Tools & Algorithms by O. Bosu and S. K. Thurkral, Oxford University Press, 2007.
7. Bioinformatics: Methods and Applications - Genomics, Proteomics and Drug Discovery by S.C. Rastogi, N. Mendiratta, P. Rastogi, PHI Learning Pvt. Ltd., 2015.

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

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1.	Introduction to Nucleic Acid and Protein Sequence Data Banks.	Explore and Search Nucleic acid Sequence Database NCBI, EMBL, DDBJ.	www.ncbi.nlm.nih.gov/genbank/ https://www.ebi.ac.uk/embl/ www.ddbj.nig.ac.jp/
2.	Introduction to Protein Sequence Data Banks.	Explore and Search and use analysis tools at Protein Sequence Database: UNIPROT	http://web.expasy.org/docs/swiss-prot_guideline.html http://pir.georgetown.edu/
3.	Database Similarity Searches.	•BLAST •FASTA	https://blast.ncbi.nlm.nih.gov/ https://www.ebi.ac.uk/Tools/sss/fasta/
4	Database Similarity Searches.	PSI-BLAST,PHI-BLAST algorithms	https://blast.ncbi.nlm.nih.gov/
5	Multiple sequence alignments.	Clustering algorithm CLUSTALW, Tree View, MUSCLE	www.genome.jp/tools/clustalw/
6	Patterns, motifs and Profiles in sequences.	Study Derived Databases: PROSITE, BLOCKS, Prints Pfam etc.	https://prosite.expasy.org/prosite_link.html https://www.ncbi.nlm.nih.gov/pmc/articles/PMC102408/
7	Genome Databases.	Ensemble, TIGR, Flymine	http://plantta.jcvi.org/ www.flymine.org/
8	Protein Structure Databases.	PDB, SCOP, CATH	http://www.rcsb.org/pdb/home/home.do scop.mrc-lmb.cam.ac.uk/scop/
9.	Structure Visualization and Manipulation	Structure Visualization Tools: Pymol, RASMOL	https://pymol.org/
10	Data Structure Algorithms	Data Structure Algorithms for gene, protein sequence analysis.	https://www.perl.org/

BOOK RECOMMENDATION:

Bioinformatics: A practical guide to Analysis of Genes & Proteins by A. D. Baxevanis and B. F. Francis Ouellette, 3rd edition, John Willey and sons, 2005

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	40
End semester examination:	60
Total:	**100**

COURSE: BIOSAFETY, BIOETHICS AND INTELLECTUAL PROPERTY RIGHTS

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

MARKS: 50 **2 0 0 2 2**

OBJECTIVES:

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 supposed 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.

COURSE OUTCOME:

On completion of the course students will have:

- Adequate knowledge about the safety and risk of the use of genetically modified organisms and their effect on human health
- Insights into the regulatory affairs linked with biosafety and bioethics
- Knowledge regarding ethics to be followed during biological experiments and research
- Awareness about the concepts and significance of Intellectual Property Rights and take measures to protect their innovative ideas

PREREQUISITES:

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

COURSE DESCRIPTION

Sr. No	Topic	Description	Hrs
1	Biosafety	Introduction and Development of Biosafety Practices and Principles 1 General lab requirements Definitions and Biosafety levels: 1,2,3,4 & Summery 2 Biological safety cabinets: centrifuges, Shipment of biological specimens, Biological waste management, Decontamination, Biosafety manuals, Medical surveillance, Emergency response 3 Risks and Assessment of Risks 1 Biosafety at small scale and large-scale processes 1 Biosafety for genetically engineered microbes, plants and animals 1 National biosafety committees 1 Biosafety and environment protection 1 International conventions 1	12

2	Bioethics	History and Introduction 1 Ethics and genetic engineering 1 Genetic Privacy 1 Patent of genes Human races, Trading Human Life, Human Cloning 1 Stem Cells, Eugenics, Christian faith, Human genome and religious considerations 1 Case Studies and Final Considerations 1	06
3	Intellectual Property Rights	Introduction and Types of Intellectual Property Rights 1 Patents 2 Copyrights, Trademarks, Industrial designs, Trade secrets, Geographical Indications and Farmers rights & Plant variety Protection. 4 IPR for Biotechnology, Patenting of transgenic organisms and isolated genes, microbes etc 2 International conventions and cooperation 2 Current status of IPR in India 1	12
Total Number of Lectures			**30**

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**
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

BOOKS RECOMMENDED:

1. Understanding Biotechnology by A. Borem, D. E. Bowen and F. R. Santos, 1st edition, Pearson Education Inc., 2003.
2. Biotechnology an Introduction by S. R. Barnum, Brooks/Cole; International Edition 2004
3. Biosafety and Bioethics by R. Joshi, Isha Books, Delhi, 2006.
4. Introduction to Bioethics by J. A. Bryant and L. B. la Velle Bryant, 1st edition, Wiley Blackwel Publishing, 2005.
5. Intellectual Property Rights by C.B. Raju, 1st edition, Serials Publications, 2007.
6. Law Relating to Intellectual Property by B. L. Wadehra, Universal Law Publishing CO., Fourth Edition, 2007.

TITLE OF THE COURSE: UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY

COURSE CODE: HU 301	**L**	**T**	**P**	**Hr**	**C**
MARKS: 100	**2**	**1**	**0**	**3**	**3**

HUMAN VALUES COURSES: During the Induction Program, students would get an initial exposure to human values through Universal Human Values – I. This exposure is to be augmented by this compulsory full semester foundation course.

OBJECTIVE: The objective of the course is four fold:

1. Development of a holistic perspective based on self- exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

PRE-REQUISITES: None. Universal Human Values 1 (Desirable)

***COURSE TOPICS: The course has 28 lectures and 14 practice sessions in 5*modules:**

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

1. Purpose and motivation for the course, recapitulation from Universal Human Values-I.
2. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration.
3. Continuous Happiness and Prosperity- A look at basic Human Aspirations
4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority.
5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

Module 2: Understanding Harmony in the Human Being - Harmony in Myself!

1. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'.
2. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility.

3. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer).

4. Understanding the characteristics and activities of 'I' and harmony in 'I'.

5. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail.

6. Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life.

Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.

Module 3: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship

1. Understanding values in human-human relationship; meaning of Justice

(nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship

2. Understanding the meaning of Trust; Difference between intention and competence

3. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship

4. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals

5. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

Module 4: Understanding Harmony in the Nature and Existence - Whole existence as Coexistence

1. Understanding the harmony in the Nature

2. Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature.

3. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space.

4. Holistic perception of harmony at all levels of existence.

5. Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Module 5: Implications of the above Holistic Understanding of Harmony on Professional Ethics

1. Natural acceptance of human values

2. Definitiveness of Ethical Human Conduct

3. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order

4. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.

5. Case studies of typical holistic technologies, management models and production systems

6. Strategy for transition from the present state to Universal Human Order:

a) At the level of individual: as socially and ecologically responsible engineers, technologists and managers

b) At the level of society: as mutually enriching institutions and organizations

7. Sum up.

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions e.g. to discuss the conduct as an engineer or scientist etc.

READINGS: Text Book

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

REFERENCE BOOKS :

1. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.

2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.

3. The Story of Stuff (Book).

4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi.

5. Small is Beautiful - E. F Schumacher.

6. Slow is Beautiful - Cecile Andrews

7. Economy of Permanence - J C Kumarappa

8. Bharat Mein Angreji Raj - PanditSunderlal

9. Rediscovering India - by Dharampal

10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi

11. India Wins Freedom - Maulana Abdul Kalam Azad

12. Vivekananda - Romain Rolland (English)

13. Gandhi - Romain Rolland (English)

MODE OF CONDUCT (L-T-P-C 2-1-0-3 or 2L:1T:0P 3 credits): Lectures hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them.

Tutorial hours are to be used for practice sessions.

While analysing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.

In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self- observation, self-reflection and self-exploration.

Scenarios may be used to initiate discussion. The student is encouraged to take up "ordinary" situations rather than" extra-ordinary" situations.

Such observations and their analyses are shared and discussed with other students and faculty mentor, in a group sitting.

Tutorials (experiments or practical) are important for the course. The difference is that the laboratory is everyday life, and practical are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignment and/or activity are included. The practice sessions (tutorials) would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to development of commitment, namely behaving and working based on basic human values.

It is recommended that this content be placed before the student as it is, in the form of a basic foundation course, without including anything else or excluding any part of this content. Additional content may be offered in separate, higher courses.

This course is to be taught by faculty from every teaching department, including HSS faculty.

Teacher preparation with a minimum exposure to at least one 8- day FDP on Universal Human Values is deemed essential.

ASSESSMENT:

This is a compulsory credit course. The assessment is to provide a fair state of development of the student, so participation in classroom discussions, self-assessment, peer assessment etc. will be used in evaluation.

Example:

Assessment by faculty mentor: 10 marks

Self-assessment: 10 marks

Assessment by peers: 10 marks

Socially relevant project/Group Activities/Assignments: 20 marks

Semester End Examination: 50 marks

The overall pass percentage is 40%. In case the student fails, he/she must repeat the course.

OUTCOME OF THE COURSE: By the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.

They would have better critical ability. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). It is hoped that they would be able to apply what they have learnt to their own self in different day-to- day settings in real life, at least a beginning would be made in this direction.

This is only an introductory foundational input. It would be desirable to follow it up by

a) faculty-student or mentor-mentee programs throughout their time with the institution

b) Higher level courses on human values in every aspect of living. E.g. as a professional

SEMESTER IV						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT 401	Molecular Biology	3	0	4	7	5
BT 402	Animal Tissue culture	2	0	2	4	3
BT 403	Plant Biotechnology	3	0	4	7	5
BT 404	Immunology	3	0	2	5	4
BT 405	Developmental Biology	3	0	2	5	4
Total		**14**	**0**	**14**	**28**	**21**

COURSE: MOLECULAR BIOLOGY

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 the basic concept in molecular biology.

COURSE OUTCOME:

Upon completion of this course students will be able to:

- Discuss regarding significant discoveries through the historical progress and their impacts on the development of molecular biology
- Demonstrate the mechanisms of DNA replication, damage and repair in applied molecular genetics.
- Understand storage of genetic information and its transcription, translation and regulation at molecular level in prokaryotic and eukaryotic systems.
- Demonstrate a clear understanding on basic concepts of molecular biology and will be able to apply in different fields of Biotechnology

PREREQUISITES:

Since the course is advance in nature, student must know about biochemistry of nucleic acids, chromosomes and gene structure. Student must have background with Genetics.

COURSE DESCRIPTION:

Sr. No	**Topic**	**Description**	**Hrs**
1	Introduction:	Concept of genes, Central dogma of Molecular Biology DNA as the genetic material Structure of DNA and RNA	2
2	Genome and its organization:	• Genome, cot analysis, C value paradox, • Repetitive DNA, Satellite DNA, Gene families and gene clusters • Nuclear and organelle genome	3
3	Chromatin and Chromosome organization:	• Nucleosome structure, Higher order chromatin structure • Chromosome structure in prokaryotes & eukaryotes	3
4	DNA damage DNA Repair Recombination:	• Types of mutations. Replication errors and their repairs. • DNA damage • DNA repair – Single step and multistep • Models of homologous recombination in eukaryotes and prokaryotes • Non homologous and end joining (NHEJ) recombination • Genetic consequences of mechanism of recombination. • Site specific recombination and transposition of DNA: conservative site specific recombination, biological roles of sites recombination • Gene conversion.	10
5	Replication of DNA	• Models of DNA replication	5

		• Replication fork, continuous and discontinuous DNA synthesis. • Enzymes and proteins in replication • Replication of DNA and different models of replication • Telomeres. Inhibitors of DNA replication.	
6	Transcription and mRNA processing, maturation	• Components of transcriptional machinery in prokaryotes and eukaryotes: Promoters and Enhancer sequences and transcription units • RNA polymerases - E. *coli* and eukaryotic RNA polymerases. • Transcription process: Chromatin remodeling, Initiation, elongation and termination of RNA synthesis. • Monocistronic and polycistronic RNAs • Posttranscriptional modifications/processing of eukaryotic RNA: • Capping and poly-adenylation, RNA splicing and splicing mechanisms. RNA editing • Inhibitors of transcription	8
7	Translation and post translational modifications:	• General features of genetic code • tRNA & aminoacyl tRNA synthetases, Ribosomes • Translation process- Initiation, Elongation & termination of translation in prokaryotes and eukaryotes, Translational factors • Inhibitors of protein synthesis – antibiotics and other inhibitors. • Post-translational modifications: Covalent and enzymatic modification of proteins • Protein folding, Proteolysis	8
8	Regulation of gene expression:	• Regulation of gene expression in prokaryotes: The operon model- lac, trp operons. Transcriptional control by attenuation in trp operon. • Regulation of gene expression in eukaryotes • Regulatory proteins (Transcription factors)- DNA-binding motif of regulatory proteins. Role of zinc fingers, leucine zippers, helix-turn-helix.	5
9	Molecular evolution:	• DNA based phylogenetic trees and their applications.	1
Total Number of Lectures			**45**

METHODOLOGY

The course would be taught through lectures lectures supported by tutorials and assignments.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	60 minutes	20
II Internal	45 minutes	15
Attendance		5
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1. Instant notes in Molecular Biology by Turner, Viva Publication, 1997.
2. Microbial Genetics by D. Freifelder, Jones & Bartlett, 2004.
3. Molecular Biology by D. Freifelder, Jones & Bartlett, 2008.
4. Molecular Biology of Gene Watson, by Baker et.al. 7th Edition, Pearsons Publication, 2013.
5. Molecular Biology of the Cell by B. Alberts, Talor & Francis, 2008.
6. Genes by Lewin and Benjamin, Editions IX, Jones & Bartlett, 2010

PRACTICAL IN MOLECULAR BIOLOGY (4 hrs. Per Week) MARKS 100

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	Molecular cloning by J. Sambrook, F. Edward and T. Maniatis, 2nd edition, New York: Cold spring harbor laboratory press, 2012.
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	

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	40
End semester examination:	60
Total:	**100**

COURSE: ANIMAL TISSUE CULTURE

COURSE CODE: BT 406 **L T P Hr C**

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

OBJECTIVE OF THE COURSE:

Complete understanding of the science of Animal Tissue Culture, with emphasis on Mammalian Cell Culture.

COURSE OUTCOME:

By the end of the course, students will have sufficient scientific understanding and will be able to:

- Understand the basics of animal tissue culture techniques
- Understand the usefulness of *in-vitro* cell culture model for various biological questions
- Know the preparation of media, assessment of cell growth and cryopreservation
- Demonstrate the ability to establish and maintain animal cell lines in culture
- Demonstrate the precautions to be taken to maintain aseptic cell cultures

PREREQUISITES:

Students should have undertaken a course in Cell Biology before taking this course on Animal Tissue Culture. Students should be aware of good laboratory practices.

COURSE DESCRIPTION

Sr. No	Topic	Description	Hrs
1	Introduction and essentials of animal tissue culture	History of animal tissue culture Sterilization methodologies Aseptic technique Laboratory set-up for ATC Equipment and materials used in ATC Terminology used in ATC. Safety & bioethics in ATC Types of tissue culture Cell culture techniques/methods (Subculturing, Cell quantitation, , Cell separation, Cell transfection, special techniques) Contamination in cell culture Cryopreservation The art of animal cell culture;	6
2	Growth, metabolism & biology of cultured cells	Energy metabolism Nutritional and physicochemical factors Culture media and components Growth parameters Cell adhesion and migration; cell culture substrates Cell proliferation, cell cycle, inhibition of growth Cell senescence, cell death Cell signaling, Growth factors Cell differentiation & dedifferentiation wrt Animal Tissue Culture	4
3	Primary cell culture	Establishment & maintenance of primary cell cultures:- General principles and methods Examples of adherent cell primary cultures including mammalian and insect cell cultures Examples of non-adherent primary cell cultures Characteristics of various specialized cell types	4

4	Secondary cell culture	Establishment and maintenance of secondary and continuous cell cultures of mammalian cells Culture evolution Transformation and immortalization Cell cloning and selection	3
5	Characterization of cell lines	Karyotyping & chromosome analyses Biochemical characterization Genetic characterization. Growth characteristics & tumorigenicity Protein markers	3
6	Large-scale animal cell culture	Large scale culture of adherent and suspension cells Bioreactors for large-scale culture Use of microcarriers Cell factories; automation	3
7	Applications of cell culture: *in vitro*	Hybridoma technology :Monoclonal Abs Production of therapeutic proteins & vaccines using cell culture *In vitro* cytotoxicity assays and tissue-engineered *in vitro* tissue models Cell migration assay, *In vitro* tumorigenicity, Cell invasion assay	4
8	Applications of cell culture: *in vivo*	Types of cells for transplantation, culture of ESCs *In vitro* induction of cellular differentiation Three-dimensional cell culture & methods Tissue engineering/cell-based therapies Examples of commercialized cell-based products	3
Total Number of lectures			**30**

METHODOLOGY: The course will be taught through lectures, exercises, participative learning, videos.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

BOOKS RECOMMENDED:

1. Culture of Animal Cells – A manual of basic technique and specialized applications by R. I. Freshney, 6th edition, Wiley-Blackwell, 2010.
2. Animal Cell Technology: From Biopharmaceuticals to Gene Therapy. L. R. Castilho et. al. Taylor & Francis Group, 2008.
3. Animal Biotechnology, by A. Akbarsha et. al., 1st edition, Pearson Education 2012.
4. Basic Cell Culture by J. M. Davis, 2nd Edition, Oxford University Press, 2002.

PRACTICAL IN ANIMAL TISSUE CULTURE (2 Hrs. Per Week) MARKS 50

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference
1	Laboratory set-up and Equipment used in ATC	To understand the functions of ATC Laboratory and use of equipment in ATC	Culture of Animal Cells – A manual of basic technique and specialized applications by R. Ian Freshney, 6th edition, Wiley-Blackwell 2010 Development of 3D Alginate Encapsulation for Better Chondrogenic Differentiation Potential than the 2D Pellet System, T. Debnath et. al., J Stem Cell Res Ther 5:276. 2015 Apoptosis mediated cytotoxicity induced by isodeoxyelephantopin on nasopharyngeal carcinoma cells, A.K. Farha et. al., Asian J Pharm Clin Res, Vol 6, Suppl 2, 51-56, 2013.
2	Preparation of Ca^{++}-Mg^{++}-free phosphate buffered saline	The uses and method of preparation of PBS	
3	Preparation of cell culture medium	Composition and preparation of cell culture medium	
4	The practice of aseptic technique	Importance and practical knowledge of aseptic technique in ATC	
5	Subculturing of adherent cell line, with counting & viability staining of cells	Procedure, principle and nuances of passaging adherent cells, use of hemocytometer, Trypan Blue staining	
6	Cryopreservation and thawing of cells	Principle, procedure and critical steps in freezing and thawing cells	
7	Isolation of peripheral blood mononuclear cells	Method of density gradient centrifugation for PBMC isolation	
8	Isolation and culture of primary cells.	Technique and importance of primary cell culture	
9	Encapsulation of cells in alginate beads and MTT staining	Use and method for preparation of cell-laden alginate beads	
10	Cytotoxicity testing using cultured cells	Application of cultured cells for cytotoxicity testing	

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

COURSE: PLANT BIOTECHNOLOGY
COURSE CODE: BT 403 **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 and advanced research areas in plant biotechnology.

COURSE OUTCOME:
By the end of the course, students will have sufficient scientific understanding & will be able to:

- Demonstrate various sterilization techniques applied in plant biotechnology laboratory and know the components and preparation of media for tissue culture
- Establish and maintain plant cells in tissue culture and understand micropropagation
- Demonstrate different methods for transformation of plant cells or plants
- Understand the significance and perform in vitro production of valuable plant secondary metabolites for medicinal/commercial purposes

PREREQUISITES
Since the course is advance in nature, student must know about sterilization techniques and basic knowledge of plant sciences and molecular biology.

COURSE DESCRIPTION

Sr. No	Topic	Description	Hrs
1	Introduction	Introduction to Plant Biotechnology	1
2	Plant development	Embryo development, meristem development, differentiation and organ formation	3
3	Growth Hormones	Auxins, Cytokinins, Gibberellins, ABA and Ethylene as regulators of plant development	3
4	Plant Tissue culture Techniques	Totipotency, differentiation, redifferentiation, Techniques- explants, nutrient media, aseptic manipulations, incubation Callus culture, Suspension culture	6
5	Micropropagation	Pre-existing meristems Direct and indirect Organogenesis Somatic embryogenesis Different stages of micropropagation & Applications Germplasm conservation	2 2 2 4 2
6	Plant genetic engineering	Agrobacterium as a natural genetic engineer Agrobacterium based vectors (selectable and screenable markers) Transformation methods a) Agrobacterium b) Direct gene transfer	2 2 3

		Selective analysis of transgenics Applications	2 1
7	Plant Natural Products	Secondary Metabolites, Types, Pathways In vitro production of secondary metabolites Hairy root culture Elicitors & biotransformation Bioreactors.	2 4 2 2 2
Total Number of lectures			**45**

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

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	60 minutes	20
II Internal	45 minutes	15
Attendance		5
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1. Plant tissue Culture : Theory and Practice by S.S. Bhojwani and M.K. Razdan, Elsevier, Amsterdam, 1996.
2. An Introduction to Plant Biotechnology by H. C. Chawla, Oxford and IBH, 2002.
3. Gene Transfer to Plants by I.Potrykus and G. Spangenberg, Springer Lab Manual, Springer Verlag, 1997
4. Plant Biotechnology: New Products and Applications by J. Hammond, P. McGarvey, V. Yusibov, Springer Verlag, 1999.
5. Plant Biotechnology: The Genetic Manipulation of Plants by A. Slater, N. Scott and M. Fowler, Oxford University Press Inc. (2008)
6. Plant Physiology by Lincoln Taiz and Eduardo Zeiger. Panima Publishing Corporation, 2003
7. Plant Physiology by L. Taitz , 3rd edition & 5th edition, Sinauer Associates Inc., Publishers Sunderland, Massachusetts U.S.A. 2002 & 2014.

PRACTICALS IN PLANT BIOTECHNOLOGY (4 hrs. Per Week) MARKS 100

Sr. No	Name of the experiment	Learning objective	Literature/ Weblinks for reference
1	Aseptic culture techniques for establishment and maintenance of *in vitro* cultures	To learn the aseptic manipulation techniques for successful plant tissue culture experiments.	1) Plant Tissue Culture, K. K. Dey, New CentralBook Agency, 2007 2) Plant tissue Culture: Theory and Practice by S.S. Bhojwani and M.K. Razdan, Elsevier, Amsterdam, 1996. 3) Plant Biotechnology and its applications in Plant tissue culture by A. Kumar and S. Roy, I. K. International Publishing House, 2006. 4) Molecular cloning: a laboratory manual. J. Sambrook, D.W.Russell, 3rd edition, New York: Cold Spring Harbor Laboratory,. II, P 125 – 127, 2012.
2	Preparation of stock solutions of MS basal medium and plant growth regulators	To understand need of stock solution for media and growth regulators stock preparation and calculation of the same.	
3	Preparation of Nutrient media	Preparation of PTC media using media and growth regulators stock solutions	
4	Callus culture by using Carrot explant/ Leaf explants and somatic embryogenesis	To understand procedure of surface sterilization of explant and perform callus culture and embryogenesis	
5	Establishment of suspension culture by using callus/ isolated cells	Understand procedure and importance of suspension culture	
6	*In vitro* embryo culture	To learn embryo rescue through *in vitro* method	
7	Micropropagation by using axillary bud /apical meristem	To study micropropagation for regeneration of plants for various fields.	
8	Isolation and purification of active compounds from plants by column chromatography technique	Isolation and identification of plant secondary metabolites	
9	*Agrobacterium tumefaciens*-mediated plant transformation	To understand importance and process for *Agrobacterium* mediated plant transformation	
10	GUS staining of transformed plants	To learn the technique to identify the transformants.	

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	40
End semester examination:	60
Total:	**100**

COURSE: IMMUNOLOGY
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 the immune system and it's function and the advances in the immunology.

COURSE OUTCOME:
On successful completion of this course students will:

- Understand the basics of immunology, cellular and molecular basis of response and its regulation
- Demonstrate fundamental principles in the interpretation of immunological responses
- Demonstrate the significance of immunology in protection against autoimmune disorders and various diseases

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

COURSE DESCRIPTION

Sr. No.	Topic	Description	Hrs
1.	Introduction to Immune System (i) The Cells and soluble mediators of the Immune system (ii) Organs of the Immune system	1. Historical Perspective: Early vaccination studies, Early studies of Humoral and Cellular Immunity, Theoretical Challenges, Infection and Immunity (in brief) 2. The Cells and soluble mediators of the Immune system (i) Cells of the immune system : Phagocytes, B cells & T cells, Cytotoxic cells, and Auxillary cells (ii) Soluble mediators of immunity : Acute phase proteins, Complement proteins & Cytokines 3. Immune response to pathogens : Innate and Adaptive Immunity (i) Innate Immune response, Pathogen Associated Molecular Patterns (PAMPs), Phagocytes and Lymphocytes as a key mediators of Immunity (ii) Adaptive Immune Response : Features of the adaptive immune response: (Specificity and Memory), Humoral Immunity & Cell-mediated Immunity (Antigen recognition and Antigen eradication, B cell clonal selection, Concept of antigen processing & presentation on MHC molecules) 4. Principle of vaccination 5. Inflammation: Principle components, Chemotaxis 6. Consequences of Immune system failure : Autoimmunity, Immunodeficiency, & Hypersensitivity 1. Primary and Secondary lymphoid Organs 2. Primary lymphoid Organs (Thymus, Bone Marrow) 3. Secondary Lymphoid Organs (Lymph nodes, Spleen, and Mucosa associated Lymphoid tissue (MALT)	8
2.	Generation of B cell & T cell response	1. Immunogenicity Versus Antigenicty 2. Haptens as valuable research and diagnostic tools 3. Properties of Immunogen Contributing to Immunogenicity 4. Biological System contribution in Immunogenicity	4

		5. Adjuvants : Freund's incomplete and complete adjuvant 6. Epitopes : Characteristic Properties of B-cell epitope	
3.	Immunoglobulins Structure and Function	1. Basic structure of antibodies, Chemical and enzymatic methods for basic antibody structure 2. Fine structure of antibodies 3. Antibody Classes and Biological activities 4. Antigen determinants on Immunoglobulins : Isotype, Allotype & Idiotype 5. Immunoglobulin Superfamily 6. Monoclonal Antibodies	6
4.	Antibody-mediated effector functions	1. Opsonization 2. Activation of complement system : Classical and alternative pathway 3. Antibody-dependent cell mediated cytotoxicity (ADCC)	3
5.	Organization and Expression of Immunoglobulin genes	1. Immunoglobulin genes organization & Rearrangements 2. Generation of antibody diversity 3. Synthesis, assembly, and Secretion of Immunoglobulins 4. Antibody Engineering	4
6.	Antigen-Antibody Interactions	1. Strength of antigen and antibody interactions: Antibody affinity, antibody avidity, and Cross reactivity 2. Precipitation reactions (Immunodiffusion and Immunoelectrophoretic technique) 3. Agglutination reaction 4. Radioimmunoassay 5. Enzyme linked Immunosorbant Assay (ELISA) 6. Western blot 7. Immunoprecipitation 8. Flow Cytometry	6
7.	The Major Histocompatibility Complex (MHC) and Antigen presentation	1. General Organization and Inheritance of the MHC, MHC molecules 2. Peptide binding by class I and class II MHC molecules 3. Experimental demonstration to prove processing of antigen is required for recognition by T cells 4. Antigen Presenting cells (APCs) 5. Antigen-Processing and Presentation Pathways (i) Endogenous Antigens: The Cytosolic Pathway (ii) Exogenous Antigens: The Endocytic Pathway	4
8.	Immune system in Health and Disease	1. Tolerance and Autoimmunity: Central and Peripheral Tolerance Establishment and Maintenance of Tolerance, Autoimmunity, Organ-Specific Autoimmune disease, Systemic Autoimmune Disease 2. Transplantation Immunology: Immunological basis of graft rejection, HLA typing, Mixed Lymphocyte Reaction, General Immunosuppressive Therapy 3. Immune Response to Infectious Diseases (Viral infections (Influenza virus) and bacterial infections (*Mycobacterium tuberculosis*), and Parasitic disease (*Plasmodium species*) 4. Vaccines: Active and Passive Immunization, Live, Attenuated vaccines, Inactivated or Killed Vaccines, Subunit and Conjugate Vaccines, DNA vaccines, Recombinant Vector Vaccines 5. AIDS: HIV infection of target cells and Activation of Provirus, Stages in viral replication cycle for therapeutic anti-retroviral drugs, Therapeutic agents inhibiting retrovirus replication	6

		6. Cancer and the immune system: Origin and terminology, Malignant transformation of cells, Oncogenes and Cancer induction, Tumors of the immune system, Tumor antigens, Tumor evasion of the immune system, Cancer immunotherapy	
Total Number of Lectures			**41**

METHODOLOGY:

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

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	60 minutes	20
II Internal	30 minutes	15
Attendance		5
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1. Immunology by J, Kuby , 5th edition, W.H. Freeman and company, New York, 2002.
2. Essentials of Immunology by I. M. Roitt, 10th edition, MOSBY, Elsevier Ltd. (International Edition), 2002.
3. Cellular and Molecular Immunology by A. Abbas, 8th edition, Elsevier Ltd., 2014.
4. Molecular Biology of the Cell by B. Alberts, 5th edition, Garland Science, 2007.

PRACTICAL IN IMMUNOLOGY (2 Hrs. Per Week) MARKS 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	Immunology, The experimental Series – II by W. Luttmann, K. Bratke, M. Kupper, Myrtek, USA, Elsevier, Academic Press; 2006
2.	Detection of syphilis using RPR card test	Immunological detection of specific bacterial infections by indirect agglutination	Manual of clinical laboratory Immunology by N. R. Rose, R. G. Hamilton, B. Detrick, 6th edition, ASM Press, 2002. Practical immunology by F. C. Hay, M. R. Olwyn, 4th edition, Westwood. Blackwell Publishing Company; 2002. Immunology by J. A. Owen, J. Punt, S. A. Kuby, 7th edition, USA: Susan Winslow; 2013
3.	Detection of typhoid infection by WIDAL test	Immunological detection of specific bacterial infections by direct agglutination	Manual of clinical laboratory Immunology by N. R. Rose, R. G. Hamilton, B. Detrick, 6th edition, ASM Press, 2002. Immunology by J. A. Owen, J. Punt, S. A. Kuby, 7th edition, USA: Susan Winslow; 2013
4.	Density gradient separation of PBMCs using Histopaque-1077	Principle of density gradient separation of immune cells	Immunology by M. D, J. Brostoff, D. B. Roth, I. Roitt, 7th edition, Elsevier, 2007. Immunology, The experimental Series – II by W. Luttmann, K. Bratke, M. Kupper, Myrtek, 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	• A handbook of practical and clinical immunology by G. P. Talwar, S. K. Gupta,. 2nd ed. Vol. I & II; 2006 • Manual of clinical laboratory Immunology by N. R. Rose, R. G. Hamilton, B. Detrick, 6th edition, ASM Press, 2002. • Practical immunology by F. C. Hay, M. R. Olwyn, 4th edition, Westwood. Blackwell Publishing Company; 2002. • Immunology by M. D, J. Brostoff, D. B. Roth, I. Roitt, 7th edition, Elsevier, 2007.
6.	Determination of antibody titre by ELISA	To learn about different types of ELISA method and their applications	• A handbook of practical and clinical immunology by G. P. Talwar, S. K. Gupta,. 2nd ed. Vol. I & II; 2006 • Manual of clinical laboratory Immunology by N. R. Rose, R. G. Hamilton, B. Detrick, 6th edition, ASM Press, 2002. • Immunology by J. A. Owen, J. Punt, S. A. Kuby, 7th edition, USA: Susan Winslow; 2013.
7.	Production of polyclonal antibodies in mouse	Principle of immunization, collection and analysis of serum for antibody	A handbook of practical and clinical immunology by G. P. Talwar, S. K. Gupta,. 2nd ed. Vol. I & II; 2006
8.	Purification of IgG from serum	Single step purification of IgG by affinity chromatography	Physical Biochemistry, D. Freifelder, 2nd ed. W.H. Freeman and Company, New York; 1982 Affinity Chromatography, Vol. 1: Antibodies, 18103746, handbook GE Healthcare http://www.gelifesciences.com/handbooks/

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

COURSE: DEVELOPMENTAL BIOLOGY
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 develop a basic understanding of animal development, emphasizing on various stages in embryonic development. The course would also give an insight on the influences of environment in animal development and applications of basic research in developmental biology.

COURSE OUTCOME:
Upon completion of this course students will:

- Acquire knowledge about the fundamental aspects in animal development.\
- Demonstrate a clear understanding of different developmental aspects in major groups of organisms.
- Understand the concepts of differential gene expression, which leads to generation of complexity in organisms.
- Understand the importance of developmental biology in sex and reproduction including *in-vitro* fertilization and cloning of animal cells etc.
- Demonstrate the importance of environmental influences on development and the translational aspects of developmental biology

PREREQUISITES:
The course requires senior school (10+2 or equivalent) level knowledge of development in animals.

COURSE DESCRIPTION

Sr. No	Topic	Description	Hours
1.	Introduction to Developmental Biology	• Early beliefs in organismal development • Discovery of primary embryonic organizer	2
2.	Gametogenesis and Fertilization	• Spermatogenesis and Oogenesis in placental mammals (mouse/human) • Comparison of internal and external fertilization • Steps in the fertilization process in mouse/human: Capacitation of sperm, Acrosome Reaction, Sperm-egg fusion, Activation of the egg, Fusion of sperm and egg pro-nuclei, Prevention of polyspermy (with reference to placental mammals and sea urchin)	6
3.	Embryonic Cleavage	• Cytoskeletal mechanisms in cleavage • Maternal-zygotic transition • Types of cleavage based on potentiality of blastomeres, position and amount of yolk, and position of mitotic spindles • Emphasis on cleavage in embryos of echinoderms (sea urchin), molluscs (snail), amphibians (frog) and placental mammals (mouse/human)	5
4.	Stages after embryonic cleavage and Gastrulation	• Pre-implantation and implantation of mouse/human embryos • Primary germ layers and their derivatives in	5

		placental mammals • Various types of morphogenetic movements during gastrulation • Gastrulation in mouse/human embryos with emphasis on primitive streak, differentiation of lateral mesoderm and somitogenesis	
5.	Genes and Development	• Origin of gene theories in development • Genomic equivalence: Evidences with emphasis on metaplasia and animal cloning, and exceptions to the rule • Differential gene expression: Regulation at the level of genome, transcription, translation and post-translation • Gene silencing: Antisense RNA and Gene knockouts • Cell fate specification based on position and lineage in early embryogenesis • Lateral inhibition in *Drosophila* neurogenesis	7
6.	Axes formation and Organogenesis	• Axes formation and early embryonic patterning in *Drosophila* and vertebrates • Homeotic genes • Development of the germ layer derivatives with emphasis on the formation of central nervous system and epidermis, fore-limb and hind-limb in vertebrates	6
7.	Metamorphosis and Regeneration	• Complete and incomplete metamorphosis, metamorphosis in insects and Anurans • Epimorphosis, Morphallaxis and Compensatory regeneration	4
8.	Environmental influences in development	• Environmental disruption of normal development • Teratogens, with emphasis on alcohol, retinoic acid and pathogens • Endocrine disruptors	4
9.	Translational developmental biology	• Biology of stem cells • Applications of stem cells in regenerative medicine • Assisted reproductive technology on *in vitro* fertilization (IVF) and intra-cytoplasmic sperm injection (ICSI) • Genetically modified organisms (GMOs) and their applications in biomedical research	4
Total Number of lectures			**44**

METHODOLOGY:

The course would be covered through lectures and group discussions using teaching aids.

EVALUATION SCHEME (THEORY)

Examination	Duration	Marks
I Internal	60 minutes	20
II Internal	45 minutes	15
Attendance		5
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS/JOURNALS RECOMMENDED:

1. Developmental Biology, Eleventh Edition, S. F. Gilbert, M. J. F. Barresi, Sinauer Associates Inc.; 2016.
2. Principles of Development, Fifth Edition, L. Wolpert, C. Tickle and A. M. Arias, Oxford University, 2015.
3. Essential Developmental Biology, Third Edition, Jonathan M. W. Slack, Wiley- Blackwell; 2012.
4. Stem Cells Handbook, Edited by S. Sell, Second Edition, Humana Press, New York, USA; Year 2013.
5. Genes and Development, Cold Spring Harbor, New York, USA, Years: 1987–present.
6. Development, The Company of Biologists, United Kingdom, Years: 1953–present, **Journal ISSN**: 0950-1991 (print); 1477-9129 (web), (Former name: Journal of Embryology and Experimental Morphology).
7. Developmental Biology, Elsevier B.V., Amsterdam, Netherlands, Years: 1959–present, **Journal ISSN**: 0012-1606 (print); 1095-564X (web).

PRACTICAL IN DEVELOPMENTAL BIOLOGY (2 hours per week) MARKS: 50

Sr. No.	Name of the Experiment	Learning objective	Literature/ Weblinks for reference and videos
1.	Introduction to life cycle in animal development (eg: *Drosophila*).	Familiarization with various stages of life cycle in insects. Understanding the the phenomenon of metamorphosis, and differentiation of the sexes.	Fly Pushing: The theory and practice of *Drosophila* genetics, By R. J. Greenspan 2nd Edition The Neurosciences Institute, San Diego.
2.	Dissection and identification of imaginal discs in the third instar larval stages in *Drosophila*.	Familiarization with the location and types of the progenitors of various adult structures.	1) Dissection of imaginal discs from 3rd instar *Drosophila* Larvae, D. C. Purves and C. Brachmann. *J Vis Exp*; (2): 140. 2007. 2) The preparative isolation of imaginal discs from larvae of *Drosophila Melanogaster*, J. W. Fristrom and H. K. Mitchell, *J Cell Biol*; 27: 445–448, 1965. 3) Fly Pushing: The theory and practice of *Drosophila* genetics, By R. J. Greenspan 2nd Edition The Neurosciences Institute, San Diego.
3.	Preparation and mounting of *adult Drosophila structures* in Hoyer's medium or Canada balsam.	Familiarization with wings, legs and thorax in adult flies and understanding the patterning of these cuticular structures.	1) Preparation and mounting of adult *Drosophila* structures in Canada balsam, D. L. Stern and E. Sucena, *Cold Spring Harb Protoc*; 373-375, 2012. 2) Preparation and mounting of adult *Drosophila* structures in Hoyer's medium, D. L. Stern and E. Sucena, *Cold Spring Harb Protoc*, 107-109, 2012.
4.	Examination of external morphology of *Drosophila* eyes using nail polish imprint technique.	Understanding the patterning of compound eye in insects.	A simple nail polish imprint technique for examination of external morphology of *Drosophila* eyes, R. Arya and S. C. Lakhotia, *Curr Sci*; 90:1179-1180, 2006.
5.	Preparation and identification of 48 hours and 96 hours chick whole-embryos using filter paper ring technique.	Familiarize with prominent structures formed during organogenesis in early chick embryos.	Improved method for chick whole-embryo culture using a filter paper carrier, S. C. Chapman et al, *Dev Dyn*; 220:284-289, 2001.

Sr. No.	Name of the Experiment	Learning objective	Literature/ Weblinks for reference and videos
6.	Study of cell death during morphogenesis	Observation of cell death in chick embryos (5 days old) limd morphogenesis	
7.	Staining bone and cartilage in zebrafish (*Danio rerio*) embryos.	To study skeletogenesis using a unique model that is amenable to developmental analyses and genetic screening.	1) A two-color acid-free cartilage and bone stain for zebrafish larvae, M. B. Walker and C. B. Kimmel, *Biotechnic & Histochemistry*, 82: 23-28, 2006. 2) Zebrafish embryology and cartilage staining protocols for high school students, Emran F et al, *Zebrafish*; 6: 139-143, 2009.
8.	Study of regeneration in Hydra	Observation of regeneration process in Hydra	

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

SEMESTER V						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT 501	Environmental Biotechnology	2	0	2	4	3
BT 502	Recombinant DNA Technology	3	0	4	7	5
BT 503	Biochemical Engineering & Bioprocess Technology	3	1	4	8	6
BT 504	Enzymology & Enzyme Technology	2	0	2	4	3
HU 501	Personality & Skill Development	2	0	0	2	2
BI 501	R Programming	1	0	0	1	1
BT 505/506/507	Elective-I	3	0	2	5	4
		16	**1**	**14**	**31**	**24**
Total						
Elective I (Biopharmaceuticals/ Clinical Research/ Human Diseases and Pathobiology)						

COURSE: ENVIRONMENTAL BIOTECHNOLOGY
COURSE CODE: BT-501 **L T P Hr C**
MARKS: 100 **2 0 2 4 3**

OBJECTIVES OF THE COURSE:

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

COURSE OUTCOME:

Upon completion of this course students will be able to:

- Demonstrate the significance of unpolluted surrounding environment and also different sources and types of pollutants.
- Demonstrate the significance of bioremediation, waste management and biofuels
- Understand the use of modified organisms (microorganism or plant) for the removal of certain undesirable molecules from air, soil or water as an essential requirement of bioremediation

PREREQUISITES

Since the course is very important 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	Environmental Biotechnology	Role of Biotechnology in protection and conservation of Environment	02
2	Environmental Pollution	Types of Pollution and their sources (Water pollution, Soil Pollution, Air Pollution, Noise Pollution) Case studies and Innovative technologies for preventing pollution	04
3	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. Biofilms and its relevance in microbial survival	06
4	Microbiology of degradation of xenobiotics	Xenobiotics in environment Decay behavior of xenobiotics	03

5	Bioremediation	Bioremediation I & II Solid phase bioremediation - land farming, prepared beds, Phytoremediation, Composting, Vermicomposting technology	05
6	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. Bioplastic-biopol, microbial rubber & adhesive polymers	05
7	Hazardous Waste Management & safety guidelines for disposed	Biotechnology application to hazardous waste Management Detoxification of chemical waste	03
8	Advances in Environmental Biotechnology	GIS in Environmental Management Computer based Environmental modeling Design of ETPs	02
		Total number of Lectures	30

METHODOLOGY

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

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

BOOKS RECOMMENDED:

1. Stanier R. Y., Ingram J.L., Wheelis M.L., Painter R.R., General Microbiology, McMillan Publications, 1989.
2. Foster C.F., John Ware D.A., Environmental Biotechnology, Ellis Horwood Ltd.,1987.
3. Karrely D., Chakrabarty K., Omen G.S., Biotechnology and Biodegradation, Advances in Applied Biotechnology Series, Vol.4, Gulf Publications Co. London,1989.
4. Bioremediation engineering; design and application 1995 John. T. cookson, Jr. Mc Graw Hill, Inc.

PRACTICAL IN ENVIRONMENTAL BIOTECHNOLOGY

2 Hrs per week **Marks:50**

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.

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

COURSE: RECOMBINANT DNA TECHNOLOGY
COURSE CODE: BT-502 **L T P HR C**
MARKS: 200 **3 0 4 7 5**

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

COURSE OUTCOME:

At the end of the course students will:

- Be able to obtain the fundamental principle of genetic engineering procedure.
- Attain competency to undertake genetic engineering by cloning any DNA/gene using tools of rDNA technology in an appropriate expression vector for recombinant protein production.
- Be able to design molecular techniques for diagnosis of various diseases.
- To assess the risk versus benefits of rDNA technology and practice, safety and other regulations for rDNA work.

Prerequisites: Knowledge of molecular biology is sufficient.

COURSE DESCRIPTION

Sr. No.	Topics	Description	Hours
1	Introduction	Landmarks in Molecular biology and Biotechnology What is genetic engineering and recombinant DNA technology? Advantages of using microorganisms in Genetic Engineering Genetic engineering in *E. coli* and other prokaryotes, yeast, fungi and mammalian cells.	3
2	Tools in genetic engineering	Enzymes: DNA polymerases, ligases, reverse transcriptases, nucleases restriction endonucleases (Restriction modification system, Restriction mapping) and, terminal transferases, phosphatases, polynucleotide Kinase etc. Cloning vectors: plasmids, bacteriophage vectors, cosmids, phagemids BAC,YAC vectors, Shuttle vectors, expression vectors etc.	7
3	Recombinant DNA techniques	Polymerase chain reaction (PCR) and its types Molecular Probes and Nucleic acid labeling Blotting Techniques (Northern, Southern and Western) Autoradiography, Hybridization, DNA foot printing, Electrophoretic mobility gel shift assay (EMSA) DNA sequencing, site directed mutagenesis and its applications DNA fingerprinting, RAPD, RFLP, AFLP. Different methods for analysis of gene expression	8
4	Gene cloning	Isolation and purification of DNA (genomic, plasmid) and RNA. Isolation of gene of interest- restriction digestion, electrophoresis, Cutting and joining of DNA	10

		Methods of gene transfer in prokaryotic and eukaryotic cells. Methods for Recombinant selection and screening: genetic, immunochemical, South-western analysis, nucleic acid hybridization, HART, HRT Expression of cloned DNA molecules and maximization of gene expression Cloning strategies- genomic DNA libraries, cDNA libraries, subtractive hybridization, chromosome walking and jumping.	
5	Applications of Recombinant DNA technology	Gene therapy, medicine, crop improvement, disease resistance: In vivo approach, ex-vivo approach of gene therapy, Antisense therapy, Interference technology (siRNA, shRNA, miRNA) CRISPAR Cas 9 mediated gene therapy, Transgenics	8
6	Genetic disorders, Diagnosis and screening	Prenatal diagnosis, Single nucleotide polymorphisms, DNA microarrays, Future strategies.	4
7	Protein interaction technology	Two-hybrid and other two component systems Detection using GST fusion protein, co-immunoprecipitation, FRET, BRET, Phage display assays, Surface plasmon resonance (SPR) etc	3
8	The Human Genome Project	The Human Genome Project Objectives and its outcome.	2
Total			45

Methodology: The course will be covered through lectures supported by PowerPoint presentations, research articles and practical teaching.

EVALUATION SCHEME (THEORY)

Examination	Duration	Marks
Internal Exam I	60 min.	20
Internal Exam II	45 min.	15
Teachers assessment		05
End Semester Examination	2 Hrs 30 min.	60
Total		100

BOOKS RECOMMENDED:

1. Principles of Gene Manipulation and Genomics by Sandy B. Primrose and Richard Twyman, eighth edition, John Wiley and Sons Ltd, June 2016

2. Analysis of gene and Genome by Richard J Reece, Wiley, 2004

3. Gene Cloning and DNA Analysis: An Introduction by T. A. Brown, Sixth edition Wiley-Blackwell, 2013

4. Molecular Cloning A Laboratory Manual (Vol 1,2,3) Michael R. Green, Joseph Sambrook, Fourth edition, Cold Spring Harbor Laboratory Press, 2013

Practical in Recombinant DNA Technology (4 hours per week) MARKS: 100

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1	Requirement of a genetic engineering lab including physical containment facilities and other biosafety procedures	Stringency awareness of genetic engineering procedures safeguarding personnel biosafety and biocontainment	Guidelines for the use and safety of genetic engineering techniques or recombinant DNA technology IICA, 1988, ISSN 0534-5391
2	Culturing *Escherichia coli* K12 and making competent cells for transformation	Preparation of the host for genetic engineering experiments	Sambrook J. Molecular cloning: a laboratory manual. Vol.1 / J.Sambrook, D.W.Russell. – 4th edition - New York: Cold Spring Harbor Laboratory, 2012. III, P.159 -162
3	Preparation of the vector DNA and target DNA, ligation and transformation	Preparation for transformation of competent cells for gene cloning	Fanglian He, Bio-protocol, standard DNA cloning DOI: https://doi.org/10.21769/BioProtoc.52
4	Elution of DNA from Agarose gel	Isolation of desired DNA fragments	Sambrook J. Molecular cloning: a laboratory manual. Vol.1 / J.Sambrook, D.W.Russell. – 4th edition - New York: Cold Spring Harbor Laboratory, 2012. II, P 125 -127
5	Selection of transformants by a) Antibiotic resistance b) Blue-white screening c) Restriction analysis	Screening methods for trans formants to check presence of positive and negative clone	Sambrook J. Molecular cloning: a laboratory manual. Vol.1 / J.Sambrook, D.W.Russell. – 4th edition - New York: Cold Spring Harbor Laboratory, 2012. III, P.210
6	Preservation and storage of clones	Different methods of clone preservation: Glycerol stock preservation, Filter paper preservation	Owens CB, Szalanski AL, Filter paper for preservation, storage, and distribution of insect and pathogen DNA samples J Med Entomol. 2005 Jul;42 (4):709-11
7	Cloning in expression vectors for expression of specific genes	Difference between cloning and expression vector	Sambrook J. Molecular cloning: a laboratory manual. Vol.3 / J.Sambrook, D.W.Russell. – 4th edition - New York: Cold Spring Harbor Laboratory, 2012. XIX, P.1481-
8	Target DNA amplification by polymerase chain reaction	Set-up of PCR program in thermocycler	Sambrook J. Molecular cloning: a laboratory manual. Vol.1 / J.Sambrook, D.W.Russell. – 4th edition - New York: Cold Spring Harbor Laboratory, 2012. VII, P 470 -476
9	DNA finger printing technique RFLP/RAPD	Phylogenetic analysis or Differences between individuals at molecular level.	Williams JG, et al. DNA polymorphisms amplified by arbitrary primers are useful as genetic markers.

			Nucleic Acids Res. 1990 Nov 25;18(22):6531-5.
10	Bioinformatics tools in Genetic engineering	Restriction site identification on gene. Primer designing (Primer blast)	Ye J Coulouris G, Zaretskaya I, Cutcutache I, Rozen S, Madden TL, Primer-BLAST: a tool to design target-specific primers for polymerase chain reaction BMC Bioinformatics. 2012 Jun 18;13:134. doi: 10.1186/1471-2105-13-134. Vincze, T., Posfai, J. and Roberts, R.J. NEBcutter: a program to cleave DNA with restriction enzymes Nucleic Acids Res. 31: 3688-3691 (2003)

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	40
End semester examination:	60
Total:	**100**

COURSE NAME: Biochemical Engineering and Bioprocess Technology
COURSE CODE: BT503 **L T P Hr C**
MARKS: 200 **3 1 4 8 6**

OBJECTIVE OF THE COURSE

The objective of the course is to create general understanding amongst the students in the subject of Biochemical Engineering and fermentation technology through in-depth lectures. The objective of the course is creating an understanding of concepts of and basic principles in the subject with emphasis on how to apply the knowledge in industrial processes involving Biochemical Engineering. 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.
- Understand the basic principles of engineering knowledge to solve a critical industrial biotechnology problem.
- Apply the knowledge in production of useful metabolites.

PREREQUISITES

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.	Topic	Description	Hrs
1.	Introduction to Biochemical Engineering and Bioprocess Technology	Historical background of Biochemical engineering, Introduction of industrially important biotechnologically products	2
2.	Isolation of microbes and Strain improvement	Isolation and preservation of industrially important microbes and introduction of strain improvement	4
3.	Design of fermentation media and inoculum development	Nutritional media components essential for growth of microorganisms and product formation, Media optimization using conventional and statistical designs, Inoculum development for bacterial, fungal and yeast strains	4
4.	Design of Fermenter, types of Bioreactors, Instrumentation and control	Design of fermenter and its important parts, Bioreactor types for products of microbial, plant and animal origin, Sensors for measurement of different bioprocess parameters, process control, Data analysis during process	8
5.	Sterilization	Sterilization of Fermenter (batch and continuous processes), Feed sterilization, filter sterilization and sterilization of liquid waste	4

6.	Downstream Processing	Cell separation techniques, Concentration of metabolites, Purification of metabolites	6
7.	Bioprocess Kinetics	Introduction of Stoichiometric analysis and yield concept with examples, ideal and nonideal bioreactors, Kinetics of microbial growth, Batch, continuous, fed-batch culture, Plug flow bioreactor, Product formation kinetics, Substrate utilization kinetics and Cell death kinetics	10
8.	Fluid flow and Mass Transfer	Introduction to Newtonian and Non-Newtonian fluids and rheology, Mass transfer concepts in different phase systems, K_La and oxygen transfer rate	4
9.	Scale up, Bioprocess Economics	Concept of scale up and scale down and consideration of important parameters for scale up, Introduction to Bioprocess Economics	2
10.	Biosynthesis of Metabolites	Examples of Industrial Production of few metabolites starting from inoculum development to downstream procesing	4
Total Lectures			**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

- P. F. Stanbury, A. Whitaker and S. J. Hall. 'Principles of Fermentation Technology', Pergamon Press, Oxford and revised editions 1995.
- J. E. Bailey, D. F. Ollis Biochemical Engineering Fundamentals, 2nd edition, McGraw-Hill, New. York) and revised editions 1986.
- Pauline Doran, Bioprocess Engineering Principles, Academic Press (1995) and revised editions.
- Shuler, ML and F. Kargi. Bioprocess. Engineering: Basic Concepts (Second Ed.). Prentice Hall, Englewood Cliffs, NJ. 2002.
- A.H. Patel. Industrial Microbiology. MacMillan 2000.
- Casida, L E JR Industrial Microbiology, Wiley Eastern (revised editions) 1984.

Practicals in Biochemical Engineering And Bioprocess Technology
(4 Hrs. Per Week) MARKS : 100

LIST OF PRACTICALS

1. Isolation of industrially important microorganisms by screening methods such as enzyme producer, antibiotic producer etc.
2. Introduction of different Preservation techniques of industrially important microorganisms.
3. Demostration of various parts of lab scale fermenter and study of bioreactor design.
4. Study of microbial growth kinetics and growth curve. Determination of growth rate constant, generation time, specific growth rate and saturation constant.
5. Production of alpha amylase by solid state fermentation and downstream processing for recovery of enzyme and determination of enzyme activity.
6. Production of streptomycin/penicillin antibiotic by fed batch fermentation and determination of antibiotic activity.
7. Production of bioethanol from sugarcane juice and molasses. Downstream processing for recovery of bioethanol by simple distillation and chemical estimation of bioethanol.
8. Production of citric acid using *Aspergillus niger* by surface and submerged fermentation and study of rheological parameters. Recovery of citric acid by precipitation method and chemical estimation of citric acid.
9. Determination of K_La by sulphite oxidation method.
10. Determination of thermal death point and thermal death time of different microorganisms.
11. Immobilization of whole cells for demonstration of its biological activity.
12. Industrial visit to fermentation industry.

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**

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

COURSE: ENZYMOLOGY AND ENZYME TECHNOLOGY

COURSE CODE: BT-504 **L T P HR C**

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

OBJECTIVE

- To familiarize the student with enzyme classification, enzyme-substrate interactions as well as mechanism of enzyme action
- To create thorough understanding regarding kinetics of allosteric and non allosteric enzymes.
- To impart knowledge about modeling of enzyme systems and structure-function relations in enzymes.
- To familiarize the student with Immobilization techniques and applications.

COURSE OUTCOME:

At the end of the course, the students will have:

- Demonstrable understanding of structure, functions and the mechanism of various enzyme action
- Knowledge of different methods for purification and characterization of enzymes and also techniques involved in immobilization of enzymes and its significance
- Exposure to wide applications of enzymes in several industries and their future potentials as therapeutic targets

PREREQUISITES

This is an advanced course. The student should be aware of basics in enzymology as well as some fundamental aspects of biomolecules and chemistry.

COURSE DESCRIPTION

Sr. No.	Topics	Detail syllabus	No. of Lectures
1	Enzymes	Classification: Trivial and Enzyme Commisions System of nomencleature C system, Properties of enzymes. Enzyme substrate interactions, enzyme substrate complex, concept of active site, transition state theory. Factors affecting enzyme activity: Effect of pH, temperature and substrate concentration on reaction rate	06
2	Mechanism of enzymatic Reactions	Enzyme Catalysis: Factors affecting catalytic efficiency - proximity and orientation effects. Bisubstrate reactions: single and double displacement reactions. Enzyme catalysis: acid-base, covalent and metal ion. Chemical modification of enzymes. Isoenzymes and multiple forms of enzymes.	05
3	Enzyme Kinetics	Enzyme activity, international units, specific activity, turnover number. Michaelis Menten equation, Significance of Km and Vmax, Enzyme inhibition and kinetics: competitive, non competitive, uncompetitive and mixed. Structure-Function Relations: chymotrypsin, lysozyme, metalloenzyme .	8
4	Allosteric interactions and Enzyme	Allosteric enzymes :Types, positive and negative cooperativity, theory of concerted and sequential models, kinetics of Allosteric enzymes.	5

	Regulations	Enzyme Regulation: Feedback inhibition, covalent modification and Zymogen activation.	
5	Enzyme Immobilization and applications	Methods of immobilization: ionic binding, adsorption, covalent binding (based on R groups of amino acids), microencapsulation and gel entrapment. Applications of enzymes: Food processing, medicine, diagnostics, leather industry, textile industry.	4
6	Enzyme Technology	Recent advances in enzyme technology, enzyme engineering, artificial enzymes**.**	2
Total Lectures			30

METHODOLOGY

The course will be covered through lectures and supported by practical.

EVALUATION SCHEME (THEORY)

Examination	Duration	Marks
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

BOOKS RECOMMENDED

- Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic proteins by Nicholas C. Price and Lewis Stevens; 3rd edition, 2010
- Enzymes: Biochemistry, Biotechnology, Clinical Chemistry by Trevor Palmer; 2nd edition, 2008
- Enzyme Technology by Ashok Pandey, Colin Webb, Carlos Ricardo Soccol, Christian Larroche, 2005
- Principles of Biochemistry by Lehninger, Nelson Cox, 4th edition, 2017
- Biochemistry by Lubert Stryer, 4th edition,1995

PRACTICAL IN ENZYMOLOGY AND ENZYME TECHNOLOGY
(2 Hrs. Per Week) MARKS: 50

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.
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.

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	**20**
End semester examination:	**30**
Total:	**50**

COURSE: PERSONALITY AND SKILL DEVELOPMENT

COURSE CODE: HU 501	**L T P Hr C**
MARKS: 50	**2 0 0 2 2**

OBJECTIVE:

The objective of the course is about personality development with regard to the different behavioral dimensions that have far reaching significance in the direction of organizational effectiveness and their holistic development.

COURSE OUTCOME:

On completion of the course students will

- Have better presentation skills
- Attain Leadership skills
- Be able to better manage stress
- Have improved employability skills

PREREQUISITES:

Students should have completed the course on Communication skills HU101

COURSE DESCRIPTION

Sr. No	Topic	Description	Hrs
1	Introduction to personality development skills.	Meaning, definition and importance of holistic personality. Habit, behavior and their roles in Personality Development.	3
2	Self-management and analysis	Self-evaluation: SWOT analysis Importance of self-confidence and self esteem Time management. Attitude, etiquette and ego.	4
3	Stress Management	Causes and impact of stress, Management of stress. General Adaptation Syndrome	4
4	Leadership skills: assessment and styles	Role of leader: Categories of leaders: entrepreneurial, administrative and political Leadership styles: autocratic, democratic and laissez-faire. Group Discussions	5
5	Motivation	Relevance and types of motivation: self-talk, intrinsic motivation, extrinsic motivation Analysis of motivation	5
6	Goal setting	SMART goals: Specific, Measurable, Agreed upon, Realistic and Time-based. Planning & Goal setting Types of goals: short and long term.	4

7	Presentation Skills	Preparing presentation: Layout, Structure, contents and logical sequence of ideas Delivering of presentation: Language, Speed, Audibility, Voice modulation, Use of pauses, Body posture, Facial Expression, Eye contact with audience and Confidence	5
Total Number of lectures			**30**

METHODOLOGY:

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total 50		
Total		**50**

BOOKS RECOMMENDED:

1. Personal Development, Steven R. Coveys, Publisher: Franklin Covey on Brilliance Audio; Unabridged edition (2014).
2. Personality Development and soft skills, Author, Barun K. Mitra, Publisher: Oxford University Press, 2nd Edition (2013).
3. Communication Skills and Personality Development. Author: J. R. Kadam, V. G. Patil, S.A.Dhenge, Publisher**:** Scientific publishers (India) (2018).
4. Essentials of Management, Harold Koontz and Heinz Weihrich, Tata McGraw-Hill, 6th Edition (2006).
5. Management: Tasks, Responsibilities, Peter F. Drucker, Harper Collins Publishers (2009).

COURSE: R Programming
COURSE CODE: BI 501 L T P Hr C
MARKS: 50 1 0 0 1 1

Course Outcomes :

- Get to know how to do programs in R
- Get to know how to do data analysis in R
- Biological analysis using R

Prerequisite –

- In depth knowledge of C programming is required
- Basic understanding of Statistics & Data Structure
- Basic knowledge of Molecular Biology, Genetics, Biochemistry and Computer aided drug designing.

Course Description

Sr. No.	Topic	Description	Hours
1	Introduction and basics of R	What is R? History of R Features of R Uses of R Applications of R Data types Escape Sequences Variables Keywords Operators Control statements and loops	2
2	Data Structures	Vectors Lists Arrays Matrix Data Frames Factors	2
3	R Graphics	R Plot, R Line, R Pie Chart, R Bars	2
4	Data and File Handling	Reading and writing data R CSV file R Excel file R XML file R Database	2
5	R Statistics	R Mean, Median & Mode R Linear Regression R Normal Distribution R Binomial Distribution	5

		R Time Series Analysis R Random Forest R Chi Square Test Support with the machine Neural network Nearest neighbour	
6	R applications in Biotechnology	Use various R functions to solve biological problems	2
Lectures		**Total**	**15**

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.

EXAMINATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal		**20**
End Semester Exam		**30**
Total		**50**

References-

1. The Book of R: A first Course in Programming and Statistics by Tilman M. Davies
2. R for Data Science by Hadley Wickham and Garrett Gorlemun
3. https://bioinformatics-training.github.io/intro-machine-learning-2019
4. www.tutorialspoint.com
5. www.javatpoint.com
6. www.guru99.com

COURSE: BIOPHARMACEUTICALS (Elective I)

COURSE CODE: BT 505 **L T P Hr C**
MARKS: 150 **3 0 2 5 4**

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.

COURSE OUTCOME:

At the end of the course, the students will have:

- Sufficient understanding of the current status of biopharmaceuticals in the pharma industry
- Knowledge on biopharmaceutical formulation techniques.
- Ability to demonstrate the significance of therapeutic agents like hormones, blood products and enzymes in pharmaceuticals
- Understanding of the biological effects and production of monoclonal antibodies, vaccines and biosimilars

PREREQUISITES
Students should know the basics of Microbiology, Biochemistry

Sr. No.	Topics	Detailed syllabus	No. of Lectures
1	Overview	Introduction and current status of Biopharmaceuticals in the pharmaceutical industry. How are Biopharmaceuticals different from Pharmaceutical products	03
2	The drug manufacturing process	Good Manufacturing Practices: Cleanroom, cleaning, documentation and sanitation (CDS), preparation of purified water and water for injection for the biopharmaceutical processing, Source of Biopharmaceuticals: *E.coli* as a source of recombinant, transgenic animals, and transgenic plants Analysis of final biopharmaceutical products: Detection of protein based product impurities, pyrogen detection, endotoxin assay, and immunological approaches	09
3	Hormones of therapeutically interest	Insulin, Insulin receptors, production of human insulin by rDNA technology, insulin formulation, and Glucagon	07
4	Blood products and therapeutic enzymes	Anticoagulants: Hirudin, Vitamin K, and Antimetabolites, Oxygen carrying blood substitutes: Albumin, Dextran, and Gelatin	06
5	Growth factors and wound healing	Insulin growth factor (IGF), Epidermal growth factor (EGF), and Platelet derived growth factor (PDGF), Wound healing process	07
6	Vaccines and Nucleic acids therapeutics	Vaccines: Types of vaccines, peptide vaccine, and vaccine vectors Basic approach to gene therapy: Types of gene	09

		therapy vectors Antisense technology: Uses, advantages, and limitations	
Total Lectures			**40**

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

PRACTICALS IN BIOPHARMACEUTICALS (2 Hrs. Per Week) MARKS: 50

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. 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
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	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	To know endotoxin of	

	the therapeutic formulation (WFI, gentamycin injection ampicillin injections) by using LAL test reagent	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	

PRACTICAL EVALUATION SCHEME

Examination	Marks
Practical Internal (Continuous) assessment:	20
End semester examination:	30
Total:	50

COURSE: CLINICAL RESEARCH (Elective I)

COURSE CODE: BT 506 **L T P Hr C**
MARKS: 150 **3 0 2 5 4**

OBJECTIVE

The objective of the course is to familiarize the students about higher educational areas after their graduation. At the end of the course students should be able to understand various disciplines in the field of clinical research which will also help them in selecting their dissertation topics in final year of their course.

COURSE OUTCOME:

On completion of the course students will:

- Understand the different steps that are required to be carried out for drug approval
- Understand the various phases of the clinical trial
- Be able to understand the various ethical requirements as well as ethical guidelines related to carrying out a clinical trial
- Observe the working of a trial in a CRO to get a better understanding of clinical trials
- Be updated to the current situation of the clinical research in India and future for clinical research on topics that are relevant from Indian perspective

PREREQUISITE:

Students should be familiar with biology and basic statistics to take up this course.

COURSE DESCRIPTION

Sr. No.	Topic	Detailed syllabus	No. of Lectures
1.	**Introduction to clinical trials**	History & background of origin of clinical research; Drug development process and phases of clinical trials (CT); Terminology in clinical research	3
2.	**Introduction to different clinical guidelines and ethics**	Ethics in clinical research; Introduction to different clinical guidelines (Schedule Y, DGCI,ICMR, ICH-GCP); Principles of ICH-GCP, US Food and Drug Administration (USFDA); Medicines and Healthcare Products Regulatory Agency (MHRA): Overview, European Agency for Evaluation of Medicinal Products (EMEA), Ethical guidelines for biomedical research on human participants (as given in ICMR); Indian Good Clinical Practices; Clinical trial application requirements (IND,NDA,ANDA, orphan drugs); Informed consent; Ethical committee (EC)-constitution; Roles & responsibilities; Communication with EC	5
3.	**Design of the study**	Planning a protocol: an overview; Selection of questions, Defining the study population; Types of study design; Response variables and measurement; Bias and elimination of bias - Types and mechanics of randomization; Types of blinding in trials and methods of protecting blind design	8
4.	**Initiation of**	Sample size calculation; Recruiting participants;	3

	recruitment	Baseline assessment	
5.	**Clinical data monitoring and analysis**	Case report form (CRF); CRF Tracking, Data entry processing; Data validation and discrepancy management; Quality monitoring of the data; Minimizing poor quality data; Data analysis; Competing events; Co-variance adjustment; Subgroup analysis; Cut-points; Meta-analysis	7
6.	**Impact analysis**	Adverse effect; Health related quality of life; adherence and survival analysis	5
7.	**Termination and reporting**	Closeout- Termination of the trial; Procedure of termination; Post study follow up; Evaluation of the trial; Reporting a trial; Interpretation and publication bias; Comparing results between studies, clinical implication of the findings, Multicenter trials, Globalization of trials, Drug approval- Indian scenario and US FDA, EU	9
8.	**Other components of clinical research**	Medical writing; Pharmacoepidemiology; Pharmacovigilance; B.A./B.E. Studies; Overview of the on-going clinical trials in India	5
		Total	**45**

METHODOLOGY

The course will be covered through lectures and demonstrations.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	1 hour	20
II Internal	45 mins	15
Attendance	----	5
End Semester Exam	2 hours 30 mins	60
Total		**100**

BOOKS RECOMMENDED:

1. Fundamentals of clinical trials, by Friedman, LM; Furberg, CD; Demets, DL; 2015. ISBN 978-1-4419-1585-6, Publisher Springer
2. Clinical Trials Handbook: Design and Conduct, Cutis L. Meinert, ISBN 978-1-1182-1846-4, Publisher Wiley

PRACTICAL IN CLINICAL RESEARCH (2 Hrs. Per Week) MARKS: 50

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos	Hrs
1.	Drafting of Informed Consent Form/Assent Form-	To know about the patient consent form and ways to exchange information with patients and medico-legal requirements	https://cdsco.gov.in/opencms/opencms/en/Home/ https://www.who.int/ethics/review-committee/informed_consent/en/	2
2.	Drafting of CRF	To understand the documentation for patient recruit	Bellary S, Krishnankutty B, Latha MS. Basics of case report form designing in clinical research. *Perspect Clin Res*. 2014;5(4):159-166. doi:10.4103/2229-3485.140555	2
3.	Visit to clinical research setting (Industrial/Hospital based)	To understand the set up of a clinical research unit and its working.	Fundamentals of clinical trials	4

BOOK RECOMMENDATION:

1. Fundamentals of clinical trials, by Friedman, LM; Furberg, CD; Demets, DL; 2015. ISBN 978-1-4419-1585-6, Publisher Springer
2. Bellary S, Krishnankutty B, Latha MS. Basics of case report form designing in clinical research. *Perspect Clin Res*. 2014;5(4):159-166. doi:10.4103/2229-3485.140555

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

COURSE: HUMAN DISEASES AND PATHOBIOLOGY

COURSE CODE: BT 507 **L T P Hr C**

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

OBJECTIVE

The objective of the course is to develop an understanding regarding various human diseases. The course covers details of various infectious and non-infectious diseases.

COURSE OUTCOME:

On completion of the course would enable the student to understand various human diseases.

PREREQUISITES

Since the course is advance in nature knowledge in microbiology, human anatomy and physiology is required.

Sr. No.	Topics	Detailed syllabus	No. of Lectures
1.	Introduction to nature and investigation of diseases	Introduction to health and disease Characteristics and features of diseases Classification of disease Epidemiology Investigating diseases: Types of pathology laboratories, role and evaluation of hospital laboratory tests.	7
2.	Pathogens and virulence	Introduction to pathogens, parasites and types of infection Types of pathogens : Bacteria, Fungi, Helminths, Prions, Protozoans and Viruses Types and effects of microbial virulence factors (offensive and defensive).	6
3.	Infectious disease and treatments	Bacterial infections of skin, eye, ear, central nervous system, respiratory system urogenital system and gastrointestinal system Viral infections of central nervous system, respiratory system, urogenital system and gastrointestinal system Fungal infections of skin and respiratory system Systemic infections, Sepsis, Prevention and treatment of infections (with antibiotics, antiviral combination therapy and surgery)	6
4.	Disorders of immune system	Introduction to the defense system and types of immunodeficiency diseases Signs, symptoms, diagnosis and treatments of i) Primary immunodeficiency diseases : SCID, CVID, Transient hypogammaglobulinemia, DiGeorge Anomaly and Wiskott-Aldrich Syndrome	6

		ii) Autoimmune Disorders: Rheumatoid Arthritis, Systemic Lupus Erythematosus and Myasthenia Gravis iii) Immunological Hypersentivities: Type I to IV	
5.	Disorders of the endocrine system	Introduction to endocrine system and its disorders Signs, symptoms, diagnosis and treatments of disorders linked to a) Growth hormones : Acromegaly, Gigantism b) Thyroid Glands: Hypothyroidism and Hyperthyroidism c) Adrenal Glands: Addison disorder and Cushing syndrome d) Pancreas: Diabetes Mellitus e) Reproductive hormones : i) Male: Hypogonadism, Gynecomastia ii) Female: Amenorrhea and PCOS Causes and treatment of infertility in men and women	6
6.	Disorders of digestive system	Introduction to GIT and common disorders eg: Gastritis, Ulcers Signs, symptoms, diagnosis and treatments of Cholelithiasis, Hepatitis , Hernia, and Crohn disease	5
7.	Disorders of the cardiovascular system	Introduction to the circulatory system and common disorders eg: hypertension, cardiac failure and angina Signs, symptoms, diagnosis and treatments of dilated congestive cardiomyopathies, endocarditis and atherosclerosis	5
8.	Disorders linked to aging	Introduction to causes of aging, age-related disorders eg: Parkinson disorder, Alzheimer disorder and Progeria	3
9.	Disease surveillance	History and importance of surveillance in disease management	2
		Total No. of Lectures	**46**

METHODOLOGY

The course would be covered through lectures, group discussions, teaching aids and would be supported by practical.

EVALUATION SCHEME (THEORY)

Examination	Duration	Marks
I Internal	1 hour	20
II Internal	45 mins	15
Attendance	----	5
End Semester Exam	2 hours 30 mins	60
Total		**100**

RECOMMENDED BOOKS

1. Biology of Disease, by Nessar Ahmed, Maureen Dawson, Chris Smith, Ed Wood, **Publisher:** Taylor & Francis; **ISBN-13:** 978-0748772100

2. Gordis, L. (2004). *Epidemiology*. Third edition. Philadelphia: Elsevier Saunders. (The second edition is also acceptable.)

PRACTICAL IN Human Diseases and Pathobiology (2 Hrs. Per Week) MARKS: 50

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1.	Introduction to pathogens/parasites (e.g., bacteria, protozoans, arthropods etc.) including disease causing stages in their life cycle using permanent slide preparations/images.	Familiarize with various pathogens/parasites and understanding the relationship between pathogen-disease relationships.	https://www.cdc.gov/
2.	Identification of microbes$ using indicator media (e.g., Blood Agar).	Understand how indicator media are used to broadly predict the presence of a specific microbe.	Microbiology–A Laboratory Manual. 7th ed Cappuccino. J, Sherman. N Pearson Education Publishing, Inc: 2005.
3.	Common and rare skin diseases/disorders in a population (based on the cases in the outpatient unit of Department of Dermatology, DPU Medical College and Hospital)#.	Understand the clinical presentation, pathogenesis, diagnosis and treatment of skin diseases/disorders in a population.	a) https://medlineplus.gov/magazine/issues/fall08/articles/fall08pg22-25.html b) http://www.healthline.com/health/skin-disorders c) Literature procured from the Department of Dermatology, DPU Medical College and Hospital.
4.	Metabolic and immune disorders in a population (based on the cases in the outpatient unit of Departments of Pathology and General Medicine, DPU Medical College and Hospital)#.	Understand the clinical presentation, pathogenesis, diagnosis and treatment of metabolic/immune disorders	a) https://medlineplus.gov/metabolicdisorders.html b) https://medlineplus.gov/immunesystemanddisorders.html **c)** Literature procured from the Departments of Pathology and General Medicine, DPU Medical College and Hospital.
5.	Sexually transmitted diseases in a population (based on the cases in the outpatient unit of Department of Venereology, DPU Medical College and Hospital)#.	Understand the clinical presentation, pathogenesis, diagnosis and treatment of sexually transmitted diseases.	a) https://medlineplus.gov/sexuallytransmitteddiseases.html b) Literature procured from the Department of Venereology, DPU Medical College and Hospital.
6.	Clinical methods (eg: X-ray, CT scan etc.) used in diagnosis of common diseases (at the Departments of Radio-diagnosis, Pathology and Microbiology, DPU Medical College and Hospital)#.	Familiarize with the common clinical diagnostic methods.	a) http://www.who.int/topics/diagnostic_techniques_procedures/en/ b) Literature procured from the Departments of Radio-diagnosis, Pathology and Microbiology, DPU Medical College and

			Hospital.
7.	Study the implications of viral infections in the context of biomedical research (by visiting a research organization) #.	Familiarize with the biology of viruses, diseases caused and current research landscape.	a) https://medlineplus.gov/viralinfections.html b) Literature procured from the organization.

$ Non-pathogenic strains would be used for the experiment.

Students are to take note on the practical carried out and the observations made during visit to the Medical College and Hospital or other research institutes/centres. Practical examination would involve questions based on what has been studied/demonstrated in these visits.

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

SEMESTER VI						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT 601	Food Biotechnology	3	0	2	5	4
BT 602	Marine Biotechnology	2	0	2	4	3
BT 603	Basic Pharmacology & Toxicology	2	1	0	3	3
BI 602	Molecular Modeling & Chemoinformatics	3	0	2	5	4
BI 601	Artificial Intelligence	1	0	0	1	1
BT 605/606	Elective II	3	0	2	5	4
Total		**14**	**1**	**8**	**23**	**19**
Elective II (Perl & Bioperl / Structural Biology)						

COURSE: FOOD BIOTECHNOLOGY

COURSE CODE: BT 601 **L T P Hr C**
MARKS: 150 **3 0 2 5 4**

OBJECTIVE:

The objective of the course is to familiarize the students with quality process used in food industry and basic concept in Food Biotechnology

COURSE OUTCOME:

On completion of the course, the students will be able to:

- Identify and calculate the nutritional value of food products.
- Distinguish the beneficial microorganisms from non-beneficial one in food products.
- Demonstrate the knowledge of food biotechnology in modifying the food products by improving the nutritional value
- Demonstrate different types of biotechnological methods to improve the value of different food and new techniques used in Food Biotechnology.

PREREQUISITES:

Since the course is application oriented, student must know about the basics of Biomolecules, Microbiology and Fermentation technology.

COURSE DESCRIPTION

Sr No	Topic	Description	No of Lectures
1	Introduction to Food Biotechnology	Activities of Food Biotechnologist, Career in Food Biotechnology.	2
2	Nutritive aspects of Food Constituents	Food and Energy, Role of Carbohydrate, Proteins, and Fats in Nutrition. Bioavailability of Nutrients, Role of Vitamins, Minerals, Fiber and Water. Stability of Nutrients	6
3	Biotechnology in Food Processing	Unit Operation in Food Processing Quality Factors in Food Food deterioration Food Preservation and its Principle Rheology of Food in general.	10
4	Role of Microbes in Food and Food Products	Fermentation and other uses of Microorganism, Single Cell Proteins. Production of Pickle, Kefir, Wine, Beer, Bread, Monosodium Glutamate (MSG). Production of Cheese and Types of Cheese. Use of enzymes in food industry - Proteases, Glucose oxidase, Amylase.	12
5	Molecular cloning in Food Industry and Other technique to develop new plant varieties	Antisense RNA technology (Flavr Savr Tomatoes), Enviro Pig, Daisy Cow, Golden Rice, BT Brinjal. Agrobacterium mediated gene transformation, Somaclonal Variation, Gametoclonal Variation. Ethical Issues related to use of Genetically modified foods.	10
6	Food Laws and Standards	Prevention of Food Adulteration Act, FSSAI and its function, International Food Standards- FAO,	5

		WHO and CODEX Alimentarius. Hazard Analysis Critical Control Point (HACCP). Food Labeling and Nutrition Labeling. Quality Control in Food.	
Total Number of Lectures			**45**

METHODOLOGY

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

Evaluation Scheme (Theory)

Examination	**Duration**	**Marks**
I Internal	60mins	20
II Internal	45Mins	15
Teachers assessment	-	05
End Semester Exam	2hrs 30mins	60
Total		**100**

BOOKS RECOMMENDED:

1. Food Science by Norman Potter, Joseph Hotchkiss, Fifth Edition, 2007
2. Food Microbiology by William Frazier and Dennis Westhoff, 4th Edition, 2010
3. Modern Food Microbiology by James M Jay, 4th Edition, 2005
4. Food Biotechnology, edited by Dietrich Knorr, 2007

PRACTICAL IN FOOD BIOTECHNOLOGY (2 Hrs. per Week) MARKS: 50

Sr No	Experiment	References
1	Determination of quality of milk by MBRT test.	
2	To Detect the number of bacteria in milk or any given sample by Breed Count or Direct Microscopic Count (DMC).	Food Microbiology by Soman J P First Edition, 2008 Practical in Microbiology by R C Dubey, D K Maheshwari, First Edition 2005
3	To check the efficiency of food preservatives.	Food Microbiology by Soman J P First Edition, 2008
4	Estimation of Percentage of lactic acid (Titrable acidity) in given milk and milk product sample using titration method.	Practical in Microbiology by R C Dubey, D K Maheshwari, First Edition 2005
5	Detection of pathogenic bacteria from food sample using selective media.	Food Microbiology by Soman J P First Edition, 2008
6	To Detect the number of bacteria in food sample by Standard Plate Count (SPC) Method.	Food Microbiology by Soman J P First Edition, 2008 Practical in Microbiology by R C Dubey, D K Maheshwari, First Edition 2005
7	To make/bake bread using *Saccharomyces cerevisiae* (Baker's yeast).	Practical in Microbiology by R C Dubey, D K Maheshwari, First Edition 2005
8	To make Cheese in Laboratory	Practical in Microbiology by R C Dubey, D K Maheshwari, First Edition 2005

PRACTICAL EVALUATION SCHEME:

Examination	**Duration**	**Marks**
Continuous Assessment		20
End semester Exam Viva & Spotting	2 hrs	30
Total		**50**

COURSE: MARINE BIOTECHNOLOGY **L T P Hr C**
COURSE CODE: BT 602 **2 0 2 4 3**
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.

COURSE OUTCOME:

On the completion of the course, students will be able to,

- Demonstrate the methods to study the microbial biodiversity and role of microbes in the marine ecosystem
- Explain the marine natural products, their sources and their applications
- Culture algae for the production of various algal compounds and production of enzymes and antibiotics from marine microbes
- Explain the acts and laws related to conservation of marine life

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	• Bathymetry: Ocean basins, tectonics and sediments • Marine biology and ecology: Biodiversity, benthos, food chain, non-cultivable life forms	4
2	Marine Microbiology	• 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	4
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	6
4	Marine culture	• Aquaculture: Methods, ponds, cultivation systems, examples- Gastropod, Bivalve and Crustacean production • Marine life poisoning: marine toxins • Aquatic animal health management:	8

		diseases of commercial fishes, spoilage, control methods • Broodstock development: Maintenance of important broodstock	
5	Advanced technologies and products	• Transgenic fish: development and applications • Probing technologies: biochemical, molecular, bioindicators • Biosensors: role in marine environment	5
6	Marine models of regenerative medicine	• Principles of organ regeneration: Xenopus and Zebrafish as models for regeneration • Examples of marine biomaterials in regeneration	3
7	Marine Conservation	• Pollution in the marine environment: Causes • Marine protection acts and laws: for conservation,	2
	Total	**32**	

Methodology:

The course will be covered through lectures and laboratory practical's. 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).
2. Marine Biotechnology II, Le Gal, Yves, Ulber, Roland (Eds.), Springer (2005).
3. Handbook of Marine Biotechnology, Kim, Se-Kwon (Ed.), Springer (2015).
4. Micro Algae: Biotechnology & Microbiology, E. W. Becker Cambridge University Press.
5. Aqua Culture – An Introduction, Lee & Newman, Interstate Publishers Biotechnology an Introduction, Susan R. Barnum, Vikas Publishing House

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total 50		
Total		**50**

PRACTICAL IN MARINE BIOTECHNOLOGY (2 Hrs.) MARKS: 50

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 techniques	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. *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	_

PRACTICAL EVALUATION SCHEME:

Examination	**Duration**	**Marks**
Continuous Assessment		20
End semester Exam Viva & Spotting	2 hrs	30
Total		**50**

COURSE: BASIC PHARMACOLOGY &TOXICOLOGY
COURSE CODE: BT 603 **L T P Hr C**
MARKS: 100 **2 1 0 3 3**

OBJECTIVE OF THE COURSE:
The objective of the course is to familiarize the students with basic aspects of Pharmacology and toxicology.

LEARNING OUTCOME:

- Know about the types of drugs and their effective and lethal dosage.
- Understand the mechanism of action of pharmaceutical drugs on organs and their effects.
- Demonstrate experiments for screening of potential drugs

PREREQUISITES:
Students should studied chemistry and cell biology

COURSE DESCRIPTION

Sr. No	Topic	Description	Hrs
1	Introduction to pharmacology and toxicology	History and scope Definitions and terms	3
2	Dose-effect relationships	Assumptions in deriving the Dose: Response relationship Individual, graded and quantal Dose: Response relationship Evaluating Dose: Response relationship: Therapeutic, Lethal effective dosage. Dose–Response Assessment: NOAEL	6
3	Pharmacokinetic	Route and site of exposure: oral, dermal, inhalation and injection Absorption Distribution Metabolism Excretion	4
4	Biotransformation of Xenobiotics	Biotransformation versus metabolism Phase I and Phase II enzymes and reactions	6
5	Interaction of chemicals	Potentiation Agonism and Antagonism, Synergistic	3
6	Toxicity testing	*In vitro* and *in vivo* tests Acute, sub-chronic, chronic, Mutagenicity and carcinogenicity Special Tests	7
7	Response to different chemicals	Receptor classification Drug receptor interaction, Ligand-gated ion channel, G-protein coupled receptors, Kinase and enzyme linked and nuclear receptors.	6

Total Number of lectures	32

METHODOLOGY:

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	1 Hour	20
II Internal		15
Attendance		5
End Semester Exam	2 hours 30 minutes	60
Total		100

BOOKS RECOMMENDED:

1) Toxicology: The Basic Science of Poisons, Casarett and Doull's:Amdur, Mary O. PhD; Doull, John PhD, MD; Klaassen, Curtis D. PhD MC Graw Hill Publisher 7th Edition.
2) A text book of toxicology Ernest Hodgson A JOHN WILEY & SONS, INC., PUBLICATION, 4th edition
3) Lippincott's Illustrated Reviews: Pharmacology, 5th edition, Richard A. Harvey. Publisher- Lippincott Williams & Wilkins, a Wolters Kluwer Business.

COURSE: MOLECULAR MODELING AND CHEMOINFORMATICS

COURSE CODE: BI 602	**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 molecular modeling concepts and molecular modeling softwares.

COURSE OUTCOME:

At the end of the course the students,

- Will have sufficient knowledge of how the molecules
- Know 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 modeling and chemoinformatics	History, importance and application	01
2	Molecular Graphics Representation	Representation of molecules using co-ordinates, Matrices and tables	08
3.	Building of molecules	Building of small molecules, Building of Biopolymers DNA & oligopeptides in different secondary structure	02
4	File Formats	SMILES, mol, mol2, sdf, pdb etc.	06
5	Optimization of geometries (Molecular Mechanics)	Energy minimization by systematic search Method, Plotting conformation energy contours, (Ramachandran plot), and finding out minimum energy conformation, Gradient based Energy minimization, Molecular Dynamics method, Monte Carlo method, Genetic algorithm and simulated annealing	10
6	Optimization of geometries (Quantum Mechanics)	Schrödinger equation, Derivation, equation for Hydrogen and Helium and for a molecule	07
7	Ligand based drug design techniques	2D and 3D QSAR, Pharmacophore	05
8	Structure based drug design techniques	Docking and Pharmacophore	02
Total Number of lectures			44

METHODOLOGY:

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	1 Hour	20
II Internal		15

Attendance		5
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1. Molecular modeling: Principles and Applications. Andrew Leach, second edition, Pearson Publication
2. Molecular Modeling: Basic Principles and Applications, edited by Hans-Dieter Höltje, Gerd Folkers,, volume 5, VCH Publishers, Inc. New York, 2008
3. . Introduction to Computational Chemistry, Frank Jensen, Second Edition,Wiley,2013
4. Structural Bioinformatics. Jenny Gu, Philip E. Bourne, Wiley-Blackwell second edition
5. Chemoinformatics: A Text book. Johann Gasteiger, Thomas Engel Wiley-VCH
6. Applied Chemoinformatics: Achievements and Future Opportunities. Thomas Engel, Johann Gasteiger John Wiley & Sons.2018
7. Practical Chemoinformatics, Karthikeyan Muthukumarasamy, Vyas Renu, Springer 2014.

PRACTICAL IN MOLECULAR MODELING AND CHEMOINFORMATICS

2 HOURS 50 MARKS

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1.	Molecular Visualization (Small molecules)	Basic functioning of the visualization tool and its importance.	http://www.vlifesciences.com/ https://www.youtube.com/watch?v=tFHBQJFic9Q http://www.mrc-lmb.cam.ac.uk/rlw/text/MacPyMOL_tutorial.html
2.	Molecular Visualization (Macro molecules like Proteins& DNA)	Basic functioning of the visualization tool and its importance.	http://www.vlifesciences.com/ https://www.youtube.com/watch?v=tFHBQJFic9Q http://www.mrc-lmb.cam.ac.uk/rlw/text/MacPyMOL_tutorial.html
3.	Molecular structures-1	Learn to download from databases and molecular structure drawing using fragment library	http://www.vlifesciences.com/ https://www.youtube.com/watch?v=tFHBQJFic9Q http://www.mrc-lmb.cam.ac.uk/rlw/text/MacPyMOL_tutorial.html Chemoffice tutorial (2004)
4	Molecular structures-2	Systematic molecular drawing and calculations of bond length, bond angle and torsional angles	http://www.vlifesciences.com/ https://www.youtube.com/watch?v=tFHBQJFic9Q http://www.mrc-lmb.cam.ac.uk/rlw/text/MacPyMOL_tutorial.html Chemoffice tutorial (2004)
5	Preparation and study of different file formats	To understand different file formats	http://www.vlifesciences.com/ https://www.youtube.com/watch?v=tFHBQJFic9Q http://www.mrc-lmb.cam.ac.uk/rlw/text/MacPyMOL_tutorial.html Chemoffice tutorial (2004)
6	Energy minimization	Understanding the concept of lowest energy conformation	http://www.vlifesciences.com/ Chemoffice tutorial (2004) Avagadro (https://dasher.wustl.edu/chem430/software/learning-avogadro.pdf)
7	Molecular dynamics	To know the behavior of molecules with respect to time and temperature within specific solvent system	Chem office tutorial (2004) Avagadro (https://dasher.wustl.edu/chem430/software/learning-avogadro.pdf)
8	QSAR	To know the generation of molecular descriptors and model building	http://www.vlifesciences.com/ Chem office tutorial (2004)

9	Protein-ligand docking	To understand the interactions of ligand with protein	http://www.vlifesciences.com/ https://sites.ualberta.ca/~pwinter/Molecular_Docking_Tutorial.pdf

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

COURSE: ARTIFICIAL INTELLIGENCE

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

MARKS: 50 **1 0 0 1 1**

COURSE OBJECTIVE:

- This course introduces the concepts and state-of-the-art research in bioinformatics, data mining and AI especially for medical application
- To understand the various characteristics of Intelligent agents
- To learn the different search strategies in AI
- To learn to represent knowledge in solving AI problems
- To understand the different ways of designing software agents
- To know about the various applications of AI

LEARNING OUTCOME

Upon completion of the course, the learners will be able to:

1. Understand AI concepts used to develop solutions that mimic human like thought process on deterministic machines for real-world problems.
2. Analyze and evaluate whether a problem can be solved using AI techniques and analyze the same using basic concepts of AI.
3. Understand the fundamental concepts of Neural Networks, different neural network architectures, algorithms, applications and their limitations
4. Analyze biological sequences and score matrices with respect to data processing.
5. Implement data mining algorithms on microarray, gene expression, feature selection for proteomic and genomic data.
6. Apply AI in medical field for development of contributive solutions.
7. Investigate state-of-the-art research and developments in bioinformation

COURSE DESCRIPTION:

Sr. No.	Topics	Detail syllabus	No. of Lectures
1	Introduction to AI	Introduction to AI, history and scope, Application areas, Heuristic search, Algorithms	2
2	Search Algorithms	Random search, Search with closed and open list, Depth and Breadth first search	2
3	Probabilistic Reasoning	Probability, conditional probability, Bayes Rule, Bayesian Networks	1
4	Introduction to Machine Learning	Supervised & Unsupervised Learning	4
5	Introduction to Deep Learning	Neural networks, Computer Vision, Natural Language Processing	3
6	Application of AI in Biological Sciences	Case Study	4
	Total		**16**

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.

EXAMINATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal		20
End Semester Exam		30
Total		**50**

BOOKS RECOMMENDED:

1. J. Chen and S. Lonardi, Biological Data Mining, Chapman and Hall/CRC.
2. David Poole and Alan Mackworth, "Artificial Intelligence: Foundations for Computational Agents", Cambridge University Press 2010.
3. H. Zengyou, Data Mining for Bioinformatics Applications, Woodhead Publishing.
4. Elaine Rich and Kevin Knight, "Artificial Intelligence", Tata McGraw Hill.
5. S. Rastogi, N. Mendiratta and P. Rastogi, Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery, PHI.
6. Z. Ghosh, B. Mallick, Bioinformatics: Principles and Applications, Oxford University Press.
7. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", 3rd Edition, Prentice Hall
8. V. Buffalo, Bioinformatics Data Skills, O′Reilly Publishing.
9. Trivedi, M.C., "A Classical Approach to Artificial Intelligence", Khanna Publishing House, Delhi.
10. Saroj Kaushik, "Artificial Intelligence", Cengage Learning India, 2011

Elective II

COURSE: PERL & BIOPERL

COURSE CODE: BT 605 **L T P Hr C**

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

OBJECTIVE

The objective of the course is to familiarize the Perl programming concepts

COURSE OUTCOME:

On completion of the course students will be able to:

- Understand the syntax and semantics of Perl programming
- Understand how to write programs and solve the real time problems
- Understand the similarities and difference between various programming languages
- Learn debugging techniques

PREREQUISITES

Students should be familiar with basic concepts of programming.

COURSE DESCRIPTION

Sr. No.	Topics	Detailed syllabus	No. of Lectures
1	**Introduction and Installation**	Introduction to Perl, Use of Perl in Bioinformatics , History, Availability, Support and Basic Concepts	03
2	**Scalar Data**	Data types, variables, scalars, Number, String, String functions, Comments, Escape sequences, Operators and operator types	04
3	**Arrays and List Data**	Introduction, Literal Representation, Variables Array Operators and Functions, Scalar and List context	04
4	**Control Structure**	If-else, switch, last, next, for loop, while loop and do-while loop	05
5	**Hashes**	Hash variables, Literal Representation of hashes, Hash function	05
6	**Basic I/O**	Opening & closing file, reading & writing file, different modes of file.	05
7	**Regular Expressions**	Use of regular expression, Patterns, Matching operators, Substitution, Split and join functions	05
8	**Subroutines**	System and user function, The local Operator, Variable length parameter list	03
9	**Advanced features in Perl**.	Object oriented programming in Perl, Perl DBI, Advanced features in Perl, Advanced functions, operators files and directories System Interaction, Using Perl‟s command line tool, References and	08

		Structures, Perl CGI, BioPerl Modules	
Total Lectures			**42**

METHODOLOGY

The course will be covered through lectures and supported by practical.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
First Internal	60 minutes	20
Second Internal	45 minutes	15
Attendance		5
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED

1. Bioinformatics – A Practical Guide to the Analysis of Genes and Proteins by Andreas Baxevanis, Francis Ouellette, Wiley-Interscience, 2005.
2. Introduction to Bioinformatics by T. K. Attawood & D.J. Parry-smith, 8th reprint, Pearson education, 2004
3. Bioinformatics: Sequence and genome analysis by D. W. Mount, 2nd edition, CBS Publication, 2005.
4. Fundamental Concepts of Bioinformatics by D. E. Krane and M. L. Raymer, Pearson Publication, 2006.
5. Bioinformatics: Tools & Applications by D. Edward, J. Stajich and D. Hansen, Springer, 2009.
6. Bioinformatics: Databases, Tools & Algorithms by O. Bosu and S. K. Thurkral, Oxford University Press, 2007.
7. Bioinformatics: Methods and Applications - Genomics, Proteomics and Drug Discovery by S.C. Rastogi, N. Mendiratta, P. Rastogi, PHI Learning Pvt. Ltd., 2015.

Practicals on Perl & Bioperl (2 HRS) 50 MARKS

Teaching hours per week and credits for practical's only: 02 Hrs 1 Cr

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, O'Reilly Media, 2001. 2. Tisdall James Matering Perl for Bioinformatics, O' Reilly Media, 2003. 3. Schwartz Randal Phoenix Tom and Foy Brian D. Learning Perl, 6th Edition, O'Reilly.
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	Use of arrays and lists.	
5.	Write scripts using hashes with biological example.	To know about data structure hash.	
6.	Write scripts for Basic I/O with biological	Handling user input	
7.	Writing regular expressions for motifs and	Learning to write	
8.	Write scripts using subroutines with biological example.	Organizing script using subroutines.	
9.	Scripting to create and delete directories and	Learning directory	

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

COURSE: STRUCTURAL BIOLOGY

COURSE CODE: BT 606 **L T P Hr C**

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

OBJECTIVE

The objective of the course is to familiarize the student with Structural Biology.

COURSE OUTCOME:

On completion of the course students will be able to:

- Demonstrate knowledge of the working concepts of different computational tools.
- Describe the information and application of different databases and effective data retrieval for solving research problem.
- Develop basic understanding of different techniques of Structure Prediction and their utilization in Data Analysis.
- Predict the secondary and tertiary structures of proteins and their active sites.
- Investigate specific contemporary biological questions *in-silico* and critically analyze & interpret the results.

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	Protein sequences, sequence alignment; Basic polypeptide stereochemistry	Overview and scope of Bioinformatics, Computers in biology, medicine & different problems in biology.	02
2	Hierarchy in protein folds:.	Secondary structure, tertiary structure; Protein structure determination by X-ray crystallography	05
3	Principles of protein purification, crystallization, structure determination; Structure validation and best practices on the use of protein structures from the protein data bank; Protein fold-function relationships; structure and annotation.	protein purification, crystallization, structure determination Methods, Structure function relationship.	03
4	Tools and methods for structure prediction	RNA secondary structure prediction and covariation analysis; RNA secondary structure determination methods, RNA structure determination and dynamics by X-ray and	02

		NMR, RNA dynamics studies by other biophysical methods	
5	Protein RNA interaction and functional Analysis	Dynamics of Protein-RNA complexes; Structure and organisation of genomes; genome sequencing, assembly, annotation and functional genomics	04
6	Gene to structure functional analysis	Gene expression and its regulation; chromosome topologies, their dependence on cellular states and their influence on gene expression	03
7	Protein Dynamics	Protein functional dynamics, Protein dynamics studies by MD simulations;	02
8	Protein dynamics by NMR;	Basic NMR techniques	03
9	Protein dynamics studies by other biophysical techniques.	Computational Methods and Algorithms	03
10	Introduction to structural Bioinformatics.	Structure database and tools	03
Total Lectures			**45**

METHODOLOGY

The course will be covered through lectures and supported by practical.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
First Internal	60 minutes	20
Second Internal	45 minutes	15
Attendance		5
End Semester Exam	2 hours 30 minutes	60
Total		**100**

REFERENCE BOOKS

1. Biophysics – An Introduction by Cotterill, Wiley Student Edition.
2. Foundations of Biophysics by A.L. Stanford, Academic Press.
3. Principles of protein structure by G Schulz and R H Schrimer, Springer Verlag.
4. Principles of nucleic acid structure by Sanger, Springer Verlag.
5. Introduction to Protein Science by Arthur M Lesk, Oxford University Press.
6. Biological Spectroscopy by J. D. Campbell and R. A.Dwek, Plenum Press.
7. A Textbook of Biochemistry and Biophysics by S.M Gopinath, Archers & Elevators International Publishing House, India. 1st Edition, 2014.

PRACTICAL IN STRUCTURAL BIOLOGY (2 Hrs. Per Week) MARKS: 50

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1.	Understanding Protein structures and Visualization	Visualize and get familiarize with the protein Structure	Basic concepts
2.	Drawing helical wheel for alpha helix	Understanding the structure	Drawing Basic concepts
3.	Using Rasmol and PyMOL for 3-D visualization	Aquanted with rasmol and Pymol	https://pymol.org/
4	Analysis of protein-protein interaction and protein-DNA interaction	Study of Interactions	Interactome
5	Advanced PyMOL usage	Pymol	https://pymol.org/
6	Use of PDBsum for structural analysis	PDBSum Explore	https://prosite.expasy.org/prosite_link.html
7	Protein-Ligand interactions: LIGPLOT	LIGPLOT expore	
8	Secondary structure prediction methods	Prediction methods	Any standard Method
10	PROSITE - Protein signature patterns	Prosite explore	https://prosite.expasy.org/prosite_link.html
11	RNA secondary structure visualization	Any standard Tool	Any standard Tool

BOOK RECOMMENDED:

1) Introduction to Protein Structure, Carl Branden and John Tooze, Garland Publishing Inc., New York 29.
2) Bioinformatics: sequence and Genome Analysis, DW Mount, Cold Spring Harbor Laboratory Press, 200 30. Creighton T.E. ed.
3) Protein structure. A practical approach. (2004) Oxford University Press

PRACTICAL EVALUATION SCHEME:

Examination	**Marks**
Practical Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

SEMESTER VII						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT 706	Molecular Cell Signaling	2	0	0	2	2
BT 701	Nanobiotechnology and Biosensors	2	0	2	4	3
HU 701	Principles of Management & Entrepreneurial Development	2	0	0	2	2
HU 702	Quality Control Management in Biotechnology	2	0	0	2	2
BI 701	Design and analysis of Algorithms	2	0	2	4	3
BT 702	Seminars in Biotechnology	2	0	0	2	2
BT 703/704/705	Elective-III	3	0	2	5	4
Total		**15**	**0**	**6**	**21**	**18**
Elective III (Metabolic Engineering/ Agriculture Biotechnology/Cancer Biology)						

COURSE: MOLECULAR CELL SIGNALING

COURSE CODE: BT 706 **L T P Hr C**

MARKS: 50 **2 0 0 2 2**

OBJECTIVES:

The objective of the course is to:

- Develop basic understanding of molecular cell signaling.
- Build translational scope for students to pursue their research and in industrial applications.

COURSE OUTCOME:

At the end of the course the students will be,

- Familiarized with scientific understanding of interplay between cell to cell and cell-ECM interactions.
- Able to explain the role of molecular signaling in various human disease conditions and developmental defects.
- Understand the progress on key cellular signaling proteins being used as therapeutic targets.

PREREQUISITES:

Since the course is an advanced level course, the student should have sufficient knowledge of cell biology, protein biochemistry, genetics and molecular biology.

COURSE DESCRIPTION:

Sr. No.	Topic	Description	Hrs
1	Basic understanding of cell-cell and cell-ECM communications	Nature and structure of biomembrane, Extracellular signaling/transmission pathways; Endocrine transmissions, Paracrine transmissions, Autocrine transmissions, Juxtacrine transmission, Synaptic transmissions; Direct signaling and Indirect signaling pathways	03
2	Cell-Cell recognition	Cellular junctions such as Gap junction, tight junction, Adherene junction etc. Types of molecules involved in the cellular recognition, their functions and the mechanisms of recognition.	02
3	Cell-adhesion molecules	CAMs, their properties and types such as CAM, Cadherins, Integrins, Heparan sulfate proteoglycans including Syndecans, Glypicans, Perlecans	02
4	Concepts of receptors	Receptor ligand interactions (concepts of agonist and antagonist); Receptor characterizations; Receptor functions; Extracellular receptors	02
5	Types of receptors	Structure, functions and types of GPCR, Ion Channel receptors, catalytic receptors; Importance of these receptors in normal physiology and pathophysiological settings.	04
6	Calcium channels	Types of calcium channels, their structure, location	02

		and mechanism of transport, Consequence of low and high calcium concentrations in the cell and its effects.	
7	Intercellular receptors	Structure, functions and types of steroid receptors and their regulations	02
8	Mechanism(s) of signal transduction	Coupling of activation receptors to intracellular signal transducing machinery; protein kinase(s) cascade, convergence of multiple signaling pathways, Phosphoinositides, Inositol1,4,5, tris phosphate, diacyl glycerol, c-AMP, c-GMP, arachidonic acid, prostaglandins and Nitric oxide	04
9	Receptor modifications and adaptation of cells	Different structural and functional modifications in the receptors; Factors behind cellular adaptations due to changes in receptors	02
10	Developmental abnormalities due to defective signaling pathways	Abnormalities during growth and development; WNT, Notch and Toll-Like Receptor signaling pathways	03
11	Signal transduction pathways as targets therapeutics	Cancer drug discovery; Metabolic diseases drug discovery; Neurodegenerative diseases drug discovery; Use of knowledge as biomarkers study in genetic disease model	04
Total number of Lectures			**30**

METHODOLOGY:

The course would be taught through lectures and demonstrations.

EVALUATION SCHEME (THEORY):

Examination	**Duration**	**Marks**
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hour 15 minutes	30
Total		**50**

BOOKS RECOMMENDED:

1. Molecular cell biology by Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell. 8th Edition, 2016,New York: W. H. Freeman and Company
2. Molecular Biology of the cell by Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. 7th Edition. 2008. New York: Garland Science.
3. Cellular Signal Processing. An introduction to the molecular mechanisms of signal transduction. Second Edition. Frederich Marks, Ursula Klingmuller, and Karin Muller-Decker. 2017. Garland Science.
4. Molecular and Cellular Signaling by Beckerman, M. USA: Springer Science+Business Media, Inc, 2010. 592 p. ISBN 978-1-4419-1966-3.

COURSE: NANOBIOTECHNOLOGY & BIOSENSORS

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

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

OBJECTIVES:

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

COURSE OUTCOME:

1. Comprehend the basics of nanobiotechnology, nanomaterials and nanoparticles.
2. Demonstrate the application of nanobiotechnology in various fields such as medicine, drug encapsulation and drug delivery and other applications.
3. Understand the general concepts of biosensors and their construction and design.
4. Demonstrate the applications of biosensors in health care, agriculture and environment.

PREREQUISITES:

Since it is advance course, student should be familiar with basic knowledge of physics, chemistry, and biology.

COURSE DESCRIPTION:

Sr. No	Topic	Description	Hrs
1	Introduction to Nanobiotechnology	Nanotechnology and nanobitechnology, History, Broad perspective, and Today's World, Significance of Nanoscale materials.	3
2	Nanomaterials and nanoparticles	Different classes of nanomaterials Synthesis and characterization of nanomaterials One, two, and three dimensional structure of nanomaterials Bio-mimetics	5
3	Application of Nanomaterials in medicine	Drug delivery, Drug encapsulation Tissue repair and implantation Nanocoatings Miniaturized devices/ Lab on a chip Toxic effects of nanomaterials	6
4	Biosensors: General Concepts	Introduction to biosensors History of biosensors discovery	02
5	Construction and designing of biosensors	Components of a typical biosensor Types of biosensors (Calorimetric, Potentiomentric, amperometric, optical, Piezo-electric, Immuno based sensors)	06
6	Applications of biosensors	-Associated electronics with each category of biosensor - Applications related to healthcare, bio-defense, food and water safety, agriculture and environment	05
7	Case studies	Success and failure of Nanodevices and biosensors with suitable examples Multidisciplinary interactions for biosensor development	03
		Total Lectures	**30**

METHODOLOGY:

The course would be taught through lectures and practical.

EVALUATION SCHEME (THEORY):

Examination	Duration	Marks
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

BOOKS RECOMMENDED

1. Biosensors and Nanotechnology, (Editors; Zeynep Altintas) John Wiley & Sons Inc, 2017, ISBN: 9781119065159, 9781119065159
2. Biosensors and Bioelectronics: D. Dharaneeshwara Reddy, O.M Hussain, DVR. Sai Gopal, Muralidhara Rao, and K.S Sastry. I. K International Publishing House Pvt. Ltd, New Delhi. 2013. ISBN 978-93-82332-19-0
3. C. M. Niemeyer, "Nanobiotechnology: Concepts, Applications and Perspectives", Wiley – VCH, 2006
4. David S Goodsell, "Bionanotechnology", John Wiley & Sons, 2004
5. Understanding Nanomedicine: An Introductory Textbook, Rob Burgess, Publisher: Pan Stanford Publishing; 2012. ISBN-13: 978-9814316385
6. 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
7. Nanobiotechnology: Bioinspired Devices and Material of Future by Oded Shoseyov and Ilan levy, Human Press, First edition, 2007. The Nanobiotechnology Handbook (Editor; Yubing Xie) CRC press.

PRACTICAL IN NANOBIOTECHNOLOGY AND BIOSENSORS:

2 hrs per week Marks:50

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1	Preparation of silver nanoparticles using sodium borohydride	Method for preparing silver nanoparticles by chemical method	Preparation of colloidal silver nanoparticles by chemical reduction method. *Korean Journal of Chemical Engineering*. 2009, 26 (1);153–155
2	Green synthesis of silver nanoparticles using bacteria/plant/fungi	The importance of green synthesis of silver nanoparticles. Mechanism involved in synthesis of silver nanoparticles	Green synthesis of silver nanoparticles using *Azadirachta indica* aqueous leaf extract.*Journal of Radiation Research and Applied Sciences*. 2016 9 (1)**:1-7**
3	Characterization of nanomaterials using Scanning Electron Microscopy.	The effect of the (nano) size of matter on its properties.	Characterization of silver nanoparticles synthesized using *Urtica dioica* Linn. leaves and their synergistic effects with antibiotics *Journal of Radiation Research and Applied Sciences.2016,9(3):217-227*
4	Evaluation of antimicrobial activity of silver nanoparticles against Gram Positive and Gram negative microorganisms	The possible mechanism of antibacterial action of silver nanoparticles. The advantages of silver nanoparticles for medical uses	Characterization of silver nanoparticles synthesized using ***Urticadioica*** Linn. leaves and their synergistic effects with antibiotics *Journal of Radiation Research and Applied Sciences*. 2016, 9(3):217-27
5	Increasing bioavailability of drugs using nanostructured Beta-cyclodextrin	The importance of bioavailability of drugs during the treatment any disease. To increase the bioavailability of drug and its importance for antimicrobial study.	Transformation of Curcumin from Food Additive to ultifunctional Medicine: Nanotechnology Bridging the Gap. *Current Drug Discovery Technologies*, 2014, *11*, 197-213

6	Entrapment of silver nanoparticles in alginate beads for remediation of water.	The mechanism of gelation of alginate. Method for preparing alginate beads Applications of alginate beads loaded with AgNPs.	Preparation and Characterization of Silver Nanoparticles-Loaded Calcium Alginate Beads Embedded in Gelatin Scaffolds *AAPS PharmSciTech*. 2014; 15(5): 1105–1115.
7	Study of principle and working of glucose biosensor	The principle of working of a typical glucose biosensor. Construction of test strips using GOx. Method of using the glucose biosensor.	Glucose Biosensors: An Overview of Use in Clinical Practice (2010) *Sensors, 10,* 4558-4576; doi:10.3390/s100504558
8	Study of conductivity of DNA for use in biosensor	Important for developing DNA based amperometricsystems and biosensors	*Electrical conduction through DNA molecules. 1999 Nature 398, 407-410*
9	Internalization of drug conjugated nanoparticles in mammalian cells	Study mechanism of silver nanoparticles penetration through cells.	Simple and Easy Method to Evaluate Uptake Potential of Nanoparticles in Mammalian Cells Using a Flow Cytometric Light Scatter Analysis. *Sci. Technol.*, 2007, *41* (8), pp 3018–3024
10	Study of nano-structured materials used for tissue engineering	What nanostructures are formed in PVA and Pluronic gelation? What are the methods by which PVA and Pluronic form gels	Nanostructured materials for applications in drug delivery and tissue engineering. *J Biomater Sci Polym*. 2007; 18(3): 241–268.

EVALUATION SCHEME:

Examination	**Marks**
Practical Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

COURSE: PRINCIPLES OF MANAGEMENT AND ENTREPRENEURIAL DEVELOPMENTS

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

MARKS: 50 **2 0 0 2 2**

OBJECTIVE

- Make students understand the work culture in an organization
- Prepare them to be competent in the corporate world
- Motivate students to critically analyse the problem and solve it
- Apply the knowledge of management in their future endeavour

LEARNING OUTCOME

- Well aware of work culture in a corporate and research organization.
- Well equipped with all the things required to be a successful entrepreneur.
- Attain confidence to develop and implement the same policies in their professional endeavors.

PREREQUISITE

This is an application based and management learning course, so students must have an understanding of the entire application oriented subject such as Food Biotechnology, RDNA Technology, Plant Biotechnology, Cancer Biology, Pharmaceuticals and Drugs research.

COURSE DESCRIPTION:

Sr No	Topic	Description	Hrs
1	Principles of Management	Introduction to Management- Management and Manager Definition, Purpose of Management, Management function, Manager Role in Management, Levels of Management	4
		Planning - Nature of planning, Importance of Planning Planning Process, Barriers to effective planning Forecasting - Importance of Forecasting, Limitations of forecasting, Techniques of Forecasting	5
		Organising - Concept of Organising, Advantages of Organising, Need for organising structure Directing - Concept of Directing, Principles of Directing Leadership - Importance of Leaders, Leadership theories (Trait, Behavioural, Situational) Controlling - Importance of controlling, Controlling Process.	6

2	Entrepreneurial Development	Preparation of Business plan for Biotech Start-up Importance of Licensing Technology/Research Raising money from Venture Capitalists Government Grants	4
		Human Resources management - Definition, Functions and Objectives, Image and qualities of HR Manager Customers and Competitors Marketing - Introduction to Marketing Management, Role and Function of Marketing Manager.	6
		Current challenges in an Organization Diverse and Global work force Partnerships and Strategic Alliances	5
		Total Lectures	**30**

METHODOLOGY

The course would be covered through lectures, supported by quizzes and case history discussion.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45mins	15
Teachers assessment		05
End Semester Exam	1hrs 15mins	30
Total		**50**

References:

1) Principles and Practice of Management - by L M Prasad, 9th Edition, 2016
2) Principles of Management - by P C Tripathi and P N Reddy, 6th Edition, 2017.
3) A Handbook on Marketing Management - by Dr V O Varkey, 4th Edition, 2000.
4) Human Resource and Personnel Management- by K Aswathappa, 4th Edition, 2007

COURSE: QUALITY CONTROL MANAGEMENT IN BIOTECHNOLOGY

COURSE CODE: HU 702 **L T P Hr C**

MARKS: 50 **2 0 0 2 2**

OBJECTIVE:

- Make students realise the importance of Quality control in Pharma and biotech industry
- Prepare students competent in the field of quality control management of drugs and biopharmaceutical
- Create a general motivation amongst students to critically analyse the problem and to apply the knowledge of quality management in their future endeavour.

COURSE OUTCOME:

- Well aware with all the quality standards and policies of the pharma and biotech industry
- Able to practice quality control management in the industry and research labs
- Will be confident to develop and implement the same policies in their work without compromise

PREREQUISITE:

This is a unique course comprising the combination of research, industry and management, so students should have understanding of all the basic concepts in biotechnology and should be well aware with the working and functioning of the biotech and pharma based industries.

COURSE DESCRIPTION:

Sr No	Topic	Description	Hrs
1	Quality Management	Introduction, Definition of Quality, Evolution of Quality, Dimension of Quality, Factors affecting Quality, Definition of QA/QC.	2
2	TQM	Definition of TQM, History of TQM, Concept, Principles of TQM, TQM Framework, Barriers in TQM implementation, Benefits of TQM, Statistical tools to measure quality, Demings Cycle/PDCA cycle, Quality Movement in India.	4
3	Pharmacopoeias	Overview of the latest Indian Pharmacopoeias.	1
4	Standards Institutions	ISO 9000 Series, ISO 14000 Series, ISO 22000 Series, ISO 13485 Series, Bureau of Indian Standards (BIS).	6
5	Good Manufacturing Practice (GMP) for pharmaceutical Products (API)	Pharmaceutical Manufacturing Flow Chart study, GMP Implementation at - Personnel, Building and Facility, Process Equipment, Material management, Production and in-process control, Packaging and labelling, Storage and Distribution, Laboratory control, Validation of analytical procedure, Rejection and Reuse of material, Complaints and recalls, Agents, Brokers, Distributors and Re-labellers,	8

		Documentation and Records.	
6	Good Laboratory Practices(GLP) and SOP	GLP - History, GLP implementation and organization, GLP status in India. Standard Operating Procedure - Introduction, Need and Implementation.	3
7	ICH	Introduction and ICH Process for Harmonization.	3
8	Indian Regulatory Agencies and Accreditation	Central Drug Standard Control Organization (CDSCO) for Drugs. Food Safety and Standards Authority of India (FSSAI) for Food. National Accreditation Board for Testing and Calibration Laboratories (NABL).	3
		Total Lectures	**30**

METHODOLOGY:

The course would be covered through lectures, supported by quizzes and case history discussion.

EVALUATION SCHEME (THEORY) :

Examination	**Duration**	**Marks**
I Internal	45minutes	15
Teachers assessment		05
End Semester Exam	1hr 15minutes	30
Total		**50**

References:

1. Quality control assurance by T. Anjaneyulu, First Edition(Fifth Reprint) - 2017
2. Pharmaceutical management by Sachin Itkar, Second Edition - 2007
3. Pharmaceutical Master Validation Plan by Syed Imtiaz Haider, First Indian Edition - 2001
4. Biopharmaceuticals Second Edition by Gary Walsh, Second Edition -2011

COURSE: DESIGN AND ANALYSIS OF ALGORITHMS

COURSE CODE: BI 701	**L**	**T**	**P**	**Hr**	**C**
MARKS: 100	**2**	**0**	**2**	**4**	**3**

OBJECTIVES:

- To create general understanding of algorithms
- To understand how to analyze statistical data and draw relevant inferences
- To make students aware of machine learning using neural networks and its applications

COURSE OUTCOME:

On completion of the course the students will be able to:

- Understand the basic concepts in algorithm
- Know what are stochastic processes, importance of big statistical data and its analysis
- Understand what are artificial neural network and how they work
- Demonstrate basics of frequency domain analysis used in image processing

PREREQUISITES:

This is an introductory course. The students should have understanding of basics of algebra and programming in any one language.

COURSE DETAILS:

Sr. No.	**Topics**	**Detail Syllabus**	**No of lectures**
1.	MATHEMATICS and ALGORITHMS	Fundamentals of Mathematics: Linear Algebra, Combinatorics, Boolean Functions, Number Theory, Fundamentals of Algorithms: Classification of Problems, Complexity, Asymptotic Notations. Recurrences: Master Theorem, Probabilistic Analysis: Sort, Search, Random Binary Search trees, Combinatorial Algorithms: Generating Permutations, Generating Partitions., Approximation Algorithms: Concept, Design, Applications. In approximability. Number -Theoretic Algorithms. Randomized Algorithms, Primality Testing, Constrained and Unconstrained Optimization, Evolutionary Algorithms.	5
2.	STOCHASTIC PROCESS	Probability space, Random variables, Random vectors, Conditional distributions, probability mass function, Binomial, Poisson, exponential, normal, uniform distributions, Expectation. Inequalities. Convergence of sequences of random variables. Types of convergences. Law of large numbers, Central limit theorem	5

4.	ARTIFICIAL NEURAL NETWORKS	Introduction to neural networks, Working of an artificial neuron, Perceptron, Back propagation algorithm, Optimization and Control, Supervised and unsupervised learning, Single layer and Multilayer Perception network for pattern classification; Multilayer feed forward neural networks for pattern mapping. Various types of optimization methods such as gradient descent, simulated annealing etc. Applications of neural networks, Deep Learning Concepts, Basics of Artificial Neural Network, Deep Neural Networks, Convolutional Neural Network (CNN), Recurrent Neural Network (RNN), Tensorflow, Keras, Introduction to Generative Adversarial Networks(GAN)	10
5.	DIGITAL IMAGE PROCESSING	Introduction to Image Processing Systems, Digital Image Fundamentals:- Image model, Relationship between Pixels, Sampling and quantization. Fast fourier transform, Image Enhancement in frequency domain: 1D& 2D Fourier transform, Low pass frequency domain filter, High pass frequency domain filters, Image Segmentation:- Detection of discontinuation by point detection, line detection, blurring of image, edge detection. Discrete image transform. Image Compression. Wavelet transformation	10
	Total Lectures		30

METHODOLOGY:

The course will be covered through lectures and supported by assignments and practicals.

EVALUATION SCHEME (THEORY):

Examination	Duration	Marks
Internal	45 minutes	15
Attendance		5
End Semester	1 hour 15 minutes	30
Total		50

BOOKS RECOMMENDED

1. Introduction to Algorithms, by Cormen, Leiserson, Rivest, and Stein, MIT Press, Third Edition, 2009
2. Algorithms, by Dasgupta, Papadimitrou and Vazirani, McGraw-Hill Education, 2006
3. Computer Algorithms, by Horowitz, Sahni, and Rajasekaran, Silicon Press, 2007.
4. Algorithm Design J. Kleinberg and Eva Tardos, Pearson Education (Indian edition)
5. J.A. Anderson, An Introduction to Neural Networks, MIT 1995.
6. Laurene V. Fausett, "Fundamentals of Neural Networks : Architectures, Algorithms and Applications", Pearson India 2017.
7. F.O. Karray and C De Silva, “Soft Computing and Intelligent Systems Design”. Pearson Education, 2004
8. Digital Image Processing Gonzalez & Wood, Pearson Education, 4th edition, 2018
9. Digital Image Processing A.K. Jain, Prentice-Hall of India Pvt.Ltd, 1990
10. Image Processing Dhananjay K. Techkedath, TechMax publications, 2018
11. R. Rajasekaran and G. A and Vijayalakshmi Pa, *Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications*, 2011. Prentice Hall of India

Practical in Design and analysis of Algorithms

1. Sorting algorithms
2. Random number generation
3. Validation of central limit theorem
4. Probability distributions and statistical interference
5. Construction of neural networks
6. Validation of network optimization using gradient descent
7. Difference in supervised and unsupervised learning and its applications
8. Understanding Deep Neural Networks
9. Use of High pass and Low pass filters for image modification

PRACTICAL EVALUATION SCHEME:

Examination Marks

Practical Internal (Continuous) assessment: 20
End semester examination: 30
Total: 50

COURSE: SEMINARS IN BIOTECHNOLOGY

COURSE CODE: BT 702	**L**	**T**	**P**	**Hr**	**C**
MARKS: 50	**2**	**0**	**0**	**2**	**2**

OBJECTIVES OF THE COURSE:

- To train the students for literature survey
- To understand and present a particular topic, published research work in front of an audience
- To develop capability and potential to discuss, delineate a topic precisely, professionally in an interactive manner

COURSE OUTCOME:

At the end of course, students will be able to:

- Prepare and present power points
- Understand, summarize and present a research article within a particular time frame.
- Handle discussions in a professional manner.
- Demonstrate public speaking skills

ELECTIVE III

COURSE: METABOLIC ENGINEERING

COURSE CODE: BT 703 **L T P Hr C**

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

OBJECTIVES:

- The course will provide an overview of the basic concepts and experimental techniques used in metabolic engineering and its applications in production of useful compounds of industrial importance.
- The students will also learn that how complex regulatory mechanisms at multiple levels control the dynamics of the cellular metabolism.
- The course will also cover examples of successful engineering strategies used for the production of commercially important primary and secondary metabolites or recombinant proteins.

COURSE OUTCOME:

- At the end of this course, the students will learn and systematically analyze the complexities defining the regulation of various metabolic pathways.
- They will be able to design and learn strain-engineering strategies to alter cellular behavior, metabolic flux, and product formation.
- They will also appreciate the vast industrial applications of metabolic engineering in the field of medicine, energy, and environment.

PREREQUISITES:

Students should be familiar with basic concepts of biochemistry, metabolism and bioinformatics.

COURSE DESCRIPTION:

Sr. No.	Topics	Detailed syllabus	No. of Lectures
1	Introduction to metabolic engineering and its importance	Introduction to metabolism, catabolism, anabolism. Basic concepts of metabolic engineering. Key differences between metabolic controls of prokaryotes and eukaryotes. Stoichiometry of cellular reactions, enzyme kinetics, reaction rates, dynamic mass balance, yield coefficients and linear rate equations, the black box model, elementary balance, heat balance different models for cellular Reactions-Induction-Jacob Monod Model and its regulation, differential regulation by isoenzymes, concerted or cumulative feedback regulation. Regulation in branched pathways, permeability and transport of metabolites.	12
2	Metabolic flux analysis.	Building stoichiometric matrix; Steady state and pseudo steady state assumptions; Using different optimizing functions to solve linear programming problem; understanding flux cone and constraints; Introducing additional constraints from thermodynamics.	08
3	Experimental	C13 labeling, NMR and GC-MS based methods for flux	04

	determination of metabolic fluxes.	determination.	
4	Computational study of metabolic engineering.	Role of Bioinformatics in the study of metabolic pathway such as for predicting and engineering metabolic pathways. Metabolic pathway databases and models (BioPath, BioSilico, KEGG, HUMANCyc, Model SEED, MouseCyc, Reactome). Metabolic pathway synthesis algorithms.	10
5	Industrial applications of metabolic engineering.	Pathway engineering strategies for overproduction of some commercially important primary and secondary metabolites (e.g. amino acids, organic acids, alcohols and therapeutic compounds) or industrially relevant enzymes and recombinant proteins, bioconversion-applications and factors affecting bioconversion, mixed or sequential bioconversions, regulation of enzyme production, strain selection and improvement, the modification of existing or the introduction of entirely new metabolic pathways.	08
Total Lectures			**42**

METHODOLOGY:

The course will be covered through lectures and supported by practical.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	1 hour	20
II Internal	45 minutes	15
Attendance	----	5
End Semester Exam	2 hours 30 mins	60
Total		**100**

BOOKS RECOMMENDED

1. Metabolic Engineering: Principles and Methodologies by Gregory N. Stephanopoulus, Aristos A. Aristidou, and Jens Nielsen, Academic Press, 1998.
2. Pathway Analysis and Optimization in Metabolic Engineering by Néstor V. Torres and Eberhard O. Voit, Cambridge University Press, 2002.
3. The Metabolic Pathway Engineering Handbook: Fundamentals by Christina D. Smolke, CRC Press, 2009.
4. The Metabolic Pathway Engineering Handbook: Tools and Applications by Christina D. Smolke, CRC Press, 2009.
5. Biochemical Engineering by Harvey W. Blanch and Douglas S. Clark, Marcel Dekker, 1995.
6. Synthetic Biology – Metabolic Engineering by Huimin Zhao, An-Ping Zeng, Springer 2018.
7. Metabolic Engineering for Bioactive Compounds: Strategies and Processes by Vipin Chandra Kalia, Adesh Kumar Saini, Springer 2017.
8. Metabolic Engineering by Sang Yup Lee and Eleftherios T. Papoutsakis, Marcel Decker 1999.

PRACTICAL IN METABOLIC ENGINEERING: 2 Hrs. Per Week MARKS:50

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1.	Develop engineering strategies to boost production of industrially relevant compound in E. coli	Production of industrially relevant compounds in E. coli.	The Metabolic Pathway Engineering Handbook: Tools and Applications by Christina D. Smolke, CRC Press, 2009.
2.	Strain engineering (deletion or overexpression of genes) to boost production of target compound followed by metabolite extraction and quantification.	To learn the production process of target compound by strain engineering (deletion or overexpression of genes) followed by metabolite extraction and quantification.	
3.	Demonstration of feed-back regulation and product inhibition.	To demonstrate feed-back regulation and product inhibition.	
4	Development of a flux model and correlation of the model with experimental data.	To develop flux model and correlation of the model with experimental data.	
5	Metabolic pathway databases I BioSilico, BioPath, KEGG	To search and analyze metabolic pathways. Explore database on biochemical pathways. Kyoto Encyclopedia of Genes and Genomes	http://biosilico.kaist.ac.kr/ https://www.mn-am.com/databases/biopath https://www.kegg.jp/
6	Metabolic pathway databases II MouseCyc, Reactome	Explore manually curated database of both known and predicted metabolic pathways for the laboratory mouse. Free, open-source, curated and peer-reviewed pathway database.	http://mousecyc.jax.org/ https://reactome.org/
7	Metabolic pathway databases III and metabolic pathway models. HUMANCyc, Model SEED,	Explore on human metabolic pathways. Optimization and analysis of genome-scale metabolic pathway models.	https://humancyc.org/ https://modelseed.org/

EVALUATION SCHEME :

Examination	**Marks**
Practical Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

ELECTIVE III
COURSE: AGRICULTURE BIOTECHNOLOGY

	L	T	P	Hr	C
COURSE CODE: BT 704	**3**	**0**	**2**	**5**	**4**

MARKS: 150

OBJECTIVES:

- To familiarize the students with basic concepts of Agriculture Biotechnology
- To clarify major scientific, ecological and sociological aspects of biotechnology in agriculture and food production.
- To familiarize advanced molecular biology applications in Agriculture Biotechnology

COURSE OUTCOME:

- The students will acquire knowledge about the range of approaches to manipulate and improve the plants, crop production and sustainable agriculture.
- They are able to demonstrate the ability to develop, interpret, and critically evaluate modern approaches to scientific investigation.
- Students will have sufficient scientific understanding of different biotechnological methods to improve the crop production and for sustainable agriculture.
- Students will understand the relationship between society and science and the justification for biotechnological manipulation in agriculture practices.

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.	Particulars	Hrs.
1.	Introduction: Agriculture and Agricultural Biotechnology	2
2	*In vitro* Germplasm Conservation Micro propagation *In vitro* production of pathogen and/or disease-free plants	2 2 2
3	Biotechnology- Methods of Crop Improvement Genetic Engineering for Crop Plants Improvement. Methods of gene transfer in plants, Transgenic Plants for biotic and abiotic stress resistance, *In vitro* induced mutagenesis Role of antisense and RNAi in crop improvement, Regulated and tissue specific expression of transgenes for crop improvement, Terminator gene technology	3 3 5
4	Recent advances – Non gel based techniques for plant genotyping – Homogenous assays – Qualitative/Real Time assays; DNA Chip and its technology. Molecular breeding (MAS) Transgenic Plants, Molecular Markers, QTL Mapping	3 3 3
5	*In vitro* Production of Secondary Metabolites Production of foreign compounds in transgenic plants Molecular Pharming, Production of Edible vaccines and other therapeutics, Biotransformation	5
6	Biofertilizers and Phyto-remediation Biopesticides, Agricultural antibiotics	5
7	Biotechnology in Agriculture, Hydroponics, Biosafety	3

	regulations, Ethical Aspects and Public Acceptance (Case studies)	
8	Animal farming, Animal farming with organic concept, Animal Breeding & Genetically modified animal products.	5
TOTAL		45

METHODOLOGY:

The entire course is covered through lectures, group discussions and with the help of ICT enabled teaching aids including PPTs, visits, E-learning resources etc.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	1 hour	20
II Internal	45 minutes	15
Attendance	----	5
End Semester Exam	2 hours 30 mins	60
Total		**100**

BOOKS RECOMMENDED:

1. Molecular Plant Breeding By B.D. Singh, N.S. Shekhawat, Scientific Publishers, 2017
2. Agricultural Biotechnology by H. D. Kumar, Daya Publishing House, 2005.
3. Agrobacterium Protocols, Volume 1- Editor- Kan wang, Humana Press, 2010.
4. Agrobacterium Biology- From Basic Science to Biotechnology. Ed. Stanton B. Gelvin, Springer International Publishing, 2018.
5. Plant Biotechnology and Agriculture Prospects for the 21st Century, Arie Altman, Paul Michael Hasegawa, Elsevier Science, 2012.
6. Biotechnology By B. D. Singh, Kalyani Publishers, 2010.
7. Omics Technologies and Crop Improvement by Noureddine Benkeblia, CRC Press,2014.
8. Agricultural Biotechnology by Geetha , Jebaraj S, Pandiyarajan P, Agro-Bios, 2008, Reprint 2012
9. The Role of Biotechnology in Improvement of Livestock: Animal Health and Biotechnology by Muhammad Abubakar, Ali Saeed, Oguz Kul, Springer, 2015.

PRACTICAL IN AGRICULTURE BIOTECHNOLOGY: 2 hrs. per week
Marks:50

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1	Use of bioreactors in plant secondary metabolite production	Mechanism and Principle involved in preparation of secondary metabolites using bioreactors	Secondary Metabolism of Hairy Root Cultures in Bioreactors In Vitro Cellular & Developmental Biology. Plant Vol. 38, No. 1 (Jan. - Feb., 2002), pp. 1-10 (10 pages)
2	Application of Polymerase Chain reaction – Marker based selection by using PCR	To understand the application of DNA technologies in agriculture, and achieve the goals to promote their utilities in modern agriculture science	Polymerase Chain Reaction Technology as Analytical Tool in Agricultural Biotechnology Journal of AOAC International vol. 88, no. 1, 2005
3	*Agro-bacterium*-mediated transformation protocol and selection of transformed regenerated plants (Laboratory visit)	To study the mechanism and effect of genetic transformation of clonally propagated crops	*Agrobacterium*- Mediated Plant Transformation: Biology and Applications *bioone.org/journals/the-arabidopsis-book/volume-2017/issue-15*
4	DNA finger printing methods, RAPD, SSR.	Different molecular biology based methods and their importance in recent advancements in Agricultural sciences	DNA finger printing in plants www.nbpgr.ernet.in Divisions_and_Units Downloadfile.aspx? EntryId=7432
5	Micropropagation, Visit to micro-propagation and Molecular Biology laboratory - a laboratory with automated Genotyping/sequencing facility.	The importance of micro propagation in plants and understanding the use of genetic engineering tools in it, to improve the quality and outputs of agricultural products	Micropropagation, Genetic Engineering and Molecular Biology of Populas . USDA Forest Service Gen. Tech. Rep. RM-GTR-297. 1997
6	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.	Principle of working of Greenhouse and its importance	Advances in greenhouse automation and controlled environment agriculture International Journal of Agricultural and Biological Engineering 11(1) January 2018.

PRACTICAL EVALUATION SCHEME:

Examination	Marks
Continuous Assessment:	20
End semester Examination:	30
Total:	50

ELECTIVE III

COURSE: CANCER BIOLOGY

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

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

OBJECTIVE S:

- The objective of the course is to develop understanding of the biology of cancer.
- The course will elaborate understanding of tumor hallmarks, carcinogens, diagnostic and therapeutic options to cancer patients.

COURSE OUTCOME:

At the end of course, students will be able:

- To understand the origin and development of cancer.
- To explain the molecular basis of tumor pathologies.
- To familiarize with knowledge on current diagnostic and therapeutic avenues for cancer patients.

PREREQUISITES:

Since the course is advance in nature, basic knowledge in biochemistry, cell biology, genetics, and molecular biology is essential.

COURSE DESCRIPTION:

Sr. No.	Topic	Description	Hrs
1.	Introduction to cancer	Cancer statistics and problems at National and International perspectives. Origin of cancer cell, Genetic, molecular and epigenetic changes in cancer cells, Tumor hallmarks, Tumor microenvironment.	5
2.	Cancer progression	Basis of tumour progression, Steps in tumor progression, Cancer stem cell theory for origin of cancer, Classifications, stages and grades of tumors.	6
3.	Causes of cancer	Chemical carcinogenesis Endogenous & exogenous mutagens, Identification of carcinogens, Tumour initiators & tumour promoters	6
4.	Molecular basis of cancer	Aberrant signaling in cancer, Cellular and viral oncogenes (Gain of Function), Deregulated apoptotic genes (Loss of functions), Genomic landscape of cancers, DNA repair response in cancer, Dysregulation of cell cycle and cell growth, mutation in apoptosis genes, The role of viral genes in cancer progression (DNA tumour virus (SV 40) and human papilloma virus (E6 and E7).	5
5.	Proto-Oncogenes and Oncogenes	Introduction to Oncogenes families Cell transforming ability of oncogene Retrovirus as a source of cancer Oncogenes: Ras, Myc, Src, Jun and Fos, Controlling factors of oncogene expressions	5
6.	Tumour suppressor genes	Molecular basis of tumor suppressor genes including Retinoblastoma (Rb), p53, Adenomatous polyposis coli	4

		(APC) in the development and progression of tumor.	
7.	Metastasis	Molecular basis of metastasis, steps in cell invasion, intravasation, transport, colonization, angiogenesis.	4
8.	Cancer biomarkers and diagnostic options	Expanded diagnostic technique, Tumour markers, Nucleic acid based markers and mitochondrial DNA mutation markers, Epigenetic markers including DNA methylation pattern and chromatin remodeling, mitochondrial DNA	4
9.	Cancer therapy	Contemporary chemotherapy, radiotherapy Emerging therapies (Targeted delivery & Synthetic lethal approaches) Inhibitors of oncogenic protein, tumour blood vessels as target for cancer therapy Tumor immunology and cancer immunotherapies	6
		Total	45

METHODOLOGY

The entire course is covered through lectures, group discussions and with the help of ICT enabled teaching aids including PPTs, Image, Videos, E-learning resources etc.

EXAMINATION 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. The Biology of Cancer, 2nd Edition; Author(s): Robert A. Weinberg; Garland Science; 2nd edition (14 May 2013). ISBN: 9780815342205.
2. Molecular biology of the cell, Garland Science; 5th edition (November 16, 2007), By Bruce Alberts (Author), Alexander Johnson (Author), Julian Lewis (Author), Martin Raff (Author), Keith Roberts. ISBN-10: 0815341059, ISBN-13: 978-0815341055.
3. Cancer Biology, 4 edition (10 May 2007) By Raymond W. Ruddon, Oxford University press, ISBN-10: 0195096908.

PRACTICAL IN CANCER BIOLOGY: 2 hrs. per week Marks:50

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1	To perform MTT assay for the assessment and understanding of anti-proliferative and cytotoxicity effects using suitable drugs.	To observe and learn concepts of cancer growth, proliferation, toxicity	Dai Y, Grant S. 2011. Methods to study cancer therapeutic drugs that target cell cycle checkpoints. Methods Mol Biol. 2011;782:257-304. doi: 10.1007/978-1-61779-273-1_19.
2	To study the effects serum starvation in cancer growth and its secreted microenvironment.	To observe and learn about the growth of growth factors and importance of intra-cellular and inter-cellular microenvironment	Pecorino L. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics. Third Edition. 2012. Oxford University Press.
3	To observe metastasis and angiogenesis (One of hallmarks of cancer) using Boyden chamber assay.	To understand and learn about metastasis and angiogenesis as hallmarks of cancer	Pecorino L. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics. Third Edition. 2012. Oxford University Press.
4	To perform clonogenic assay to understand clonal concept and growth characteristics of cancer cells.	To understand the concept of clonal theory of cancer growth and proliferation	Weinberg, R.A. The Biology of Cancer. Second Edition. 2013. Garland Science. Dai Y, Grant S. 2011. Methods to study cancer therapeutic drugs that target cell cycle checkpoints. Methods Mol Biol. 2011;782:257-304. doi: 10.1007/978-1-61779-273-1_19.
5	To study angiogenesis using chick embryo model.	To understand angiogenesis using chick embryo model	Pecorino L. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics. Third Edition. 2012. Oxford University Press.
6	To perform wound healing assay.	To develop concept on tissue repair and wound healing	Dai Y, Grant S. 2011. Methods to study cancer therapeutic drugs that target cell cycle checkpoints. Methods Mol Biol. 2011;782:257-304. doi: 10.1007/978-1-61779-273-1_19.
7	To study spheroid culture as a preferred model for angiogenesis study	To understand the concept of angiogenesis	Pecorino L. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics. Third Edition. 2012. Oxford University Press.

PRACTICAL EVALUATION SCHEME:

Examination	**Marks**
Continuous Assessment:	20
End semester Examination:	30
Total:	50

	Semester VIII					
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BI 801	Simulation and Modeling	2	0	2	4	3
BT 801	Omics Technology	3	0	4	7	5
BT 802	Biomedical Engineering	2	1	0	3	3
BT 803	Stem Cell Technology	3	0	0	3	3
BT 804/ 805	Elective – IV	3	0	2	5	4
Total		**13**	**1**	**8**	**22**	**18**
	Elective III (Tissue Engineering/ Molecular Diagnostics)					

COURSE: SIMULATION AND MODELING

COURSE CODE: BI 801 **L T P Hr C**
MARKS: 100 **2 0 2 4 3**

COURSE OBJECTIVE:

- The objective of the course is to introduce the students to modeling and simulation.
- Familiarize the students with the application of numerical methods to various physical process.
- Acquaint the students with verification and validation techniques of simulation models.
- Develop simulation models using heuristic methods.
- Equip the students with the knowledge of applying mathematical modeling to Biological systems.

COURSE OUTCOME:

- Understand the need of Modelling and simulation and its application in Biotechnology
- Able to write the basic modelling equations for a given Physical Process
- Will be able to understand Parameters, Process variables, Boundary conditions
- Apply knowledge of the subject to biological systems
- Use simple Numerical methods for finding the solutions of mathematical models

PREREQUISITES:

Since the subject is an advanced course, student should have good knowledge of Biotechnology concepts and basic mathematics.

COURSE DESCRIPTION:

Topics	Detailed syllabus	No. of Lectures
Introduction to Modeling:	Introduction, definition of Modelling and simulation, different types of models, application of mathematical modelling, scope of coverage	03
Fundamental laws:	Continuity equation, energy equation, equation of motion, transport equation, equation of state, Phase and chemical equilibrium, chemical kinetics	04
Examples of Mathematical Models:	Models based on Mass, component, energy and force balance: Batch reactors, PFR's, CSTR's, Reactors in series, Concept of Heated tanks	06
Classification of mathematical modeling:	Classification based on state of the processes, type of the processes, Comparison between rigid and stochastic processes	03
Modelling approaches for	Simulation approach to Batch Reactors, Fed batch systems, Chemostats, Chemostats with recycle	05

Biological systems:		
Models of Biological waste water treatment:	Modelling for activated sludge process, Model for anaerobic digestion, Model for lactic acid fermentation, antibiotic production	04
Numerical Methods:	Solution of equations by Bisection method, Newton Raphson, Eulers method, Numerical integration: Trapezoidal rule, Simpsons1/3rule, Simpsons 3/8 rule	05
Total Lectures		**30**

METHODOLOGY:

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

EVALUATION SCHEME (THEORY):

Examination	**Duration**	**Marks**
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

BOOKS RECOMMENDED:

Text Books:

1. Luyben W.L. " Process Modelling Simulation and Control for Chemical Engineers", McGraw Hill, 1988.
2. Davis M.E., " Numerical Methods and modelling for Chemical Engineers" , Wiley, New York, 1984.
3. Bailey, J. and Ollis, D., “Biochemical engineering Fundamentals”, McGraw Hill Kogakusha Ltd. Tokyo 2007.
4. Balu, K. and Padmanabhan, K., “Modeling and analysis of Chemical Engineering processes”, IK International private limited, 2007

Reference Books:

1. Zeigler B.P. Praehofer. H. and Kim I.G. "Theory of modeling and simulation", 2 nd Edition. Academic press 2000
2. Ogata K " Modern control Engineering" 3 rd edition. Prentice hall of India 2001 3 Jang J.S.R. sun C.T and Mizutani E,, "Neuro-Fuzzy and soft Computing ", 3 rd edition, Prentice hall of India 2002
3. Shannon, R. E., “System Simulation: the Art and Science”, Prentice Hall Inc. 1990 5 Pratab.R " Getting started with MATLAB" Oxford university Press 2009
4. Holland C. D., "Fundamentals and Modeling of Separation Processes", Prentice Hall., 1975
5. Dunn, I. J., et al., “Biological engineering Principles, Applications and Simulation”, VCH, Weinheim 2. Bioprocess Engineering Principles, Pauline M. Doran, Publisher: Elsevier Science & Technology Books, 2nd edition.

Practical in Modeling and Simulation: 2 Hrs per week 50 Marks

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1.	Evaluation of Matrix multiplication and inverse functions using Microsoft Excel Solver	Developing Matrix solving capability using Excel worksheets	https://www.youtube.com/watch?v=5bNooxRm960 https://engineerexcel.com/matrix-multiplication-in-excel/
2.	Solving Newton Raphson method using Microsoft Excel Solver	Numerical simulation using Excel sheets	https://www.youtube.com/watch?v=VuAqKL2hYeE https://www.instructables.com/id/Spreadsheet-Calculus-Newtons-method/
3.	Finding the root of Newton Raphson's Method using Microsoft Excel Solver	Numerical simulation using Excel sheets	https://www.youtube.com/watch?v=bxmUuH_gsYM http://www.real-statistics.com/matrices-and-iterative-procedures/newtons-method/
4	Implementing Euler's method in Excel	Numerical simulation using Excel sheets	https://www.youtube.com/watch?v=B6HhL90BevQ http://www.mathcs.richmond.edu/~caudill/localhome_links/m232/Excel/Euler_Lab1.pdf
5	Introduction to MATLAB operations	Introduction to MATLAB	https://www.math.utah.edu/~wright/misc/matlab/matlabintro.html
6	Evaluation of simple mathematical expressions using MATLAB	Simulation using MATLAB	https://www.youtube.com/watch?v=VkDEHz8_8cs http://www.hkn.umn.edu/resources/files/matlab/MatlabCommands.pdf

PRACTICAL EVALUATION SCHEME:

Examination	**Marks**
Practical Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

COURSE: OMICS TECHNOLOGY

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

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

OBJECTIVES:

- To familiarize the student with the concepts of different omics technologies.
- To provide knowledge about the different approaches and tools which can be applied for omics data acquisition and analysis.
- To learn about different microarray and sequencing platform and also the techniques involve in identification of proteins and metabolites.
- To learn about potential early biomarkers using non-invasive techniques.
- To learn the difference between the metabolomic profile of healthy vs diseased conditions.

COURSE OUTCOME:

- Demonstrate knowledge of several tools and database involved in genomic and transcriptomics studies.
- Describe the application and working principle of microarray and different sequencing platform.
- Develop basic understanding of different techniques used for studying and analyzing proteome and associated different posttranslational modifications.
- Demonstrate knowledge of several techniques involved in identification of protein and metabolites.
- The students would be able to understand and pick up the differences between metabolomic profiles of different conditions.
- The students would know how to use various software for Multivariate data Analysis, would know how to plot score plots etc and also would learn how to use software for metabolite identification and metabolite database (KEGG)

PREREQUISITES:

Basic knowledge of molecular biology, Recombinant DNA technology and Bioinformatics is required.

COURSE DESCRIPTION:

Sr. No.	Topics	Detailed syllabus	No. of Lectures
1	Genomics Genome organization and Databases	Structure and organization of prokaryotic and eukaryotic genomes- nuclear, mitochondrial and chloroplast genomes. Different types DNA databases, Tools for finding genes and regulatory regions.	04
2	Transcriptomics Concepts of transcriptomics and its scope	What is Transcriptome? Micro (mi) RNA biogenesis and its role in regulation of gene expression. Tools for analyzing gene expression: Serial Analysis of gene expression (SAGE), massively parallel signature sequencing (MPSS).	05
3	Microarray technique	Basic principles and design of cDNA and	05

	in Genomics and Transcriptomics Microarray its types and microarray databases	oligonucleotide arrays, DNA microarray. Basic steps involved in designing a microarray experiment. Types of microarray based on its applications:- Expression arrays, Comparative Genomic Hybridization (CGH) arrays, Re-sequencing arrays. Different microarray platforms (Affymetrix, Agilent etc.); Tools used to normalize microarray Data. Microarray databases – NCBI; GEO (Gene Expression Omnibus), Array Express (EBI); Functional Analysis: Gene Ontology functional enrichment tools, Pathway analysis (KEGG Database).	
4	Sequencing technology in Genomics and transcriptomics Next Generation sequencing (NGS) and Types of NGS	Introduction to NGS, overview and comparison of different Sequencing Platform (Illumina, 454 (Roche), SOLiD (Life technology), Specific Biosciences, Ion Torrent, Nanopore, PacBio. : DNA-sequencing (Whole genome sequencing), exome sequencing, Deep sequencing, ChIP sequencing, RNA-sequencing (Whole transcriptome sequencing, WTS).	05
5	Proteomics Concept of proteomics Post translational Modifications (PTMs) Bioinformatics tools in Proteomics	What is proteomics? proteome complexity; Overview of protein structure-primary, secondary, tertiary and quaternary structure. Different type of PTMs, Quantitative proteomics, clinical proteomics and disease biomarkers, mass spectral tissue imaging and profiling; Protein database, Relationship between protein structure and function.	05
6	Metabolomics Concept of metabolomics and analysis of metabolomics data	An overview, basic sample preparation strategies- extraction, derivatization. Workflow for lipidomics; Targeted Vs Untargeted metabolomics; development of targeted assays for small molecules, NMR metabolomics,	04

		Multivariate Data Analysis (MVDA), Metabolomic Data Analysis:Peak detection, retention time alignment; identification of molecular features and metabolites; Structural confirmation of metabolites. Software-Multiquant, MZmine, XCMS, MarkerView, SIMCA by Umetrics (MVDA software), Chenomx (metabolite identification software).	
7	Techniques in Protein and Metabolite Identification 2D PAGE and Mass spectrometry	Identification and analysis of proteins by 2D PAGE, Mass spectrometry: ion source (MALDI, spray sources), analyzer (ToF, quadrupole, quadruple ion trap) and detector for protein and metabolite analysis.	02
Total Lectures			30

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.

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 Gene Manipulation and Genomics by Sandy B. Primrose and Richard Twyman, eighth edition, John Wiley and Sons Ltd, June 2006

2. Introduction to Genomics, Arthur M Lesk IInd edition Oxford University Press.2012

3. Introduction to Proteomics: Tools for New Biology Daniel C Liebler 1st edition New York Humana Press, 2001

4. Bioinformatics Sequence and Genome Analysis D.W Mount Cold Spring Harbour Laboratories (CSHL) 2nd edition 2005

5. Discovering Genomics, Proteomics and Bioinformatic A. Malcolm Campbell , Laurie J. Heyer Benjamin Cummings; Pearson education, 2 edition, 2006

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

7. Molecular Cloning A Laboratory Manual (Vol 1,2,3) Michael R. Green, Joseph Sambrook, Fourth edition, Cold Spring Harbor Laboratory Press, 2013

8. Metabolomics, Metabonomics and Metabolite Profiling, edited by William J. Griffiths Royal Society of Chemistry, 2007.

9. Metabolomics: From Fundamentals to Clinical Applications by Alessandra Sussulini, 2017

PRACTICAL IN OMICS TECHNOLOGY : (4 Hrs. Per Week)
Marks: 100

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1.	To carry out quantitative real time PCR (qRT-PCR)	To learn quantification of DNA	https://www.bio-rad.com/en-id/category/real-time-pcr-detection-systems?ID=059db09c-88a4-44ad-99f8-78635d8d54db
2.	To Perform DNA sequencing	To know the DNA/RNA sequence for finding gene of interest	www.nanopore technologies.com
3.	To Isolate and analyse microRNA using polyacrylamide gel or PCR	To learn gene regulation using small RNA	http://www.protocol-online.org/prot/Protocols/Isolation-of-micro-RNA--miRNA--3342.html
4	To predict possible microRNAs targeting the gene of interest.	Learn to locate target microRNAs by genome wide scanning	http://www.targetscan.org/vert_71 http://mirdb.org & http://www.exiqon.com/micrrna-target- prediction.
5	Study of transcriptome analysis tools Transcriptome analysis using Hisat2 and StringTie	To learn how to analyze transcriptome data	https://bioinformaticshome.com/tools/rna-seq/descriptions/HISAT2.html Kovaka S, etal. Transcriptome assembly from long-read RNA-seq alignments with StringTie2, *Genome Biology* 20, 278 (2019),
6	Gel extraction of protein spots for identification by Mass spectrometry	Protein spot identification	Liebler Introduction to Proteomics: Tools for New Biology ;1st Edi. New York Humana Press 2001
7	2D gel electrophoresis	To resolve proteins from mixture of proteins	Liebler Introduction to Proteomics: Tools for New Biology ;1st Edi. New York Humana Press 2001
8	Bioinformatic analysis of BIND,DIP & GRID for protein protein interaction	To understand interacting proteins in a pathway or carrying out similar function	Bioinformatics by David Mount Sequence and Genome Analysis 2nd Edi Cold Spring Harbour Laboratory New York Publishing2004
9	Preparation of the	To know how to Prepare the	Metabolic Profiling: Methods and

	Sample for Metabolomics study and data acquisition	Sample for Metabolomics study and acquire the Data points.	Protocols Georgios A. Theodoridis, Helen G. Gika, Ian D. Wilson - 2019
10	Analyze the acquired and interpretation of metabolomics data for metabolite identification and Targeted Pathway/s	To learn how to analyse the acquired Data (PCA Score plots, PLS, PLS-DA etc) and how to Interpret the Data for metabolite Identification and targeted Pathway/s	Metabolic Profiling: Methods and Protocols Georgios A. Theodoridis, Helen G. Gika, Ian D. Wilson - 2019

EVALUATION SCHEME

Examination	Marks
Practical Internal (Continuous) assessment:	40
End semester examination:	60
Total:	100

COURSE: BIOMEDICAL ENGINEERING
COURSE CODE: BT- 802 **L T P Hr C**
Marks: 100 **2 1 0 3 3**

OBJECTIVES:

- The Objective of this course is to enable students to integrate the knowledge core of traditional engineering disciplines and modern biology to solve problems encountered in living systems.
- It will help students to understand 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.

COURSE OUTCOME:

- Apply knowledge of mathematics, science, and engineering to design a system, component, or process to meet desired biotechnology needs.
- Students will be able to develop and plan appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
- 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 -Bio mimicry and its role in biomedicine	02
2	Biomedical Instrumentation	-Regular optical methods and imaging systems, electro-mechanical probes -Patient monitoring systems -Impedance techniques in physiological measurements	05
3	Diagnostic equipments	- Blood Flow meters - Pulmonary function analyzers - Blood gas analyzers -Cell counters - Endoscopy - Robotics in diagnosis and therapy- case study	07
4	Biomaterials	-Molecular structural properties of biomaterials of	07

		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	
5	Regenerative medicine	-Principles of organ regeneration -Biological processes involved in wound healing and tissue remodeling following implantation in various organs -Challenges and ethical issues	05
6	Drug delivery systems	- Principles of Controlled Drug Delivery, controlled release devices, drug delivery system efficacy and challenges	03
7	Biosensors	-Components and properties of a typical biosensor -Types of biosensors -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	05
8	Personalized medicine	-Concept and applications -Case Study	02
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 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	1 hour	20
II Internal	45 mins	15
Attendance	----	5
End Semester Exam	2 hours 30 mins	60
Total		**100**

BOOKS RECOMMENDED:

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*
11. Joseph D.Bronzio ,Donald R. Peterson "Biomedical Engineering Fundamentals", The Biomedical Engineering Handbook, Fourth Edition,CRC Press,2014.
12. W.Mark Saltzman, "Biomedical Engineering: Bridging Medicine and Technology", Cambridge University Press, 2015.

COURSE: STEM CELL TECHNOLOGY

COURSE CODE: BT803 **L T P Hr C**

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

OBJECTIVES:

- The objective of the course is to familiarize the students with the basic concept in stem cell biology
- Students will also be introduced to the advanced research area of stem cell biology

COURSE OUTCOME:

- At the end of the course, the students will have sufficient scientific understanding of different types of stem cells
- Students would acquire knowledge about application of stem cells to the clinical aspect.
- Students would learn new techniques used in stem cell biology for their clinical implications.

PREREQUISITES:

Since the course is very advanced in nature, student must know about cell-cell interaction, cell signaling and developmental biology.

COURSE DESCRIPTION:

Sr. No.	Topics	Detailed syllabus	No. of Lectures
1	Introduction to stem cells	History of stem cell biology and axis of research; Embryonic stem cells; Adult/ tissue stem cells; Induced pluripotent stem cells	2
2	Stem cell types and applications	Nature, properties and applications of: embryonic stem cells, mesenchymal stem cells (bone marrow, adipose tissue and umbilical cord derived MSCs), cancer stem cells, hematopoietic stem cells, neural stem cells and neural crest stem cells; Production of uniparental embryonic stem cell lines; Parthenogenetic embryonic stem cells in non-human primates.	9
3	Genetic reprogramming	Nuclear and somatic cell genetic reprogramming; Reprogramming somatic cells to pluripotent stem cells and its biomedical applications. Observing and manipulating pluripotency in normal and cloned mouse embryos.	5
4	Pluripotency and epigenetics of stem cells	Pluripotent stem cell epigenetics during development and cancer	4

5	Developmental regulation of stem cells	Spermatogonial stem cells; differentiating gametes from stem cells; regulated transcripts and coregulated micro-RNAs in male spermatogonial stem cells.	5
6	Current applications of stem cell technology and Stem cell therapies	Clinical and therapeutic applications for: • Bone tissue regeneration; • Heart disease; • Liver regeneration, • Injured olfactory neuroepithelium repair; • Beta-cell replacement; • Corneal epithelial stem cells • Neurodegenerative diseases • Life style disorders • Exosomes for Drug Delivery • Tissue regeneration using different scaffolds and regenerative medicine	15
7	Challenges in cultivation and large scale production of stem cells and their derivatives for therapy	2D and 3D culture systems for pluripotent stem cell cultivation, suspension culture for large scale production of stem cells, isolation of stem cell derivatives such as exosomes	3
8	Contemporary ethical issues in stem cell research	Ethical issues in stem cell procurement and usage; Stem cell line banking and wide distribution of cell lines.	2
Total			**45**

METHODOLOGY:

The course will be covered through lectures, group discussions and visit to laboratories working on stem cells.

EVALUATION SCHEME (THEORY):

Examination	**Duration**	**Marks**
I Internal	1 hour	20
II Internal	45 mins	15
Attendance	----	5
End Semester Exam	2 hours 30 mins	60
Total		**100**

BOOKS RECOMMENDED:

1. Stem cell handbook, edited by Stewart Sell. Publisher: Springer. 2nd edition 2013, ISBN 978-1-4614-7696-2.

2. Essentials of stem cell biology, Edited by Robert Lanza & Anthony Atala. Publisher: Academic Press, 3rd Edition 2013; ISBN: 9780124095038, eBook ISBN: 9780124104273.

3. Stem cells from basic research to therapy, edited by: Federico Calegari & Claudia Waskow; Publisher: CRC Press; 1st Edition, ISBN 9781482207750.

4. Animal Cell Technology: From biopharmaceuticals to gene therapy, edited by: L.R. Castilho, A.M. Moraes, E.F.P. Augusto and M. Butler. Publisher: Taylor and Francis Group, ISBN: 978-0-415-42304-5.

5. Global Perspectives on Stem Cell Technologies, edited by: Aditya Bharadwaj, Published by Springer Nature. ISBN 978-3-319-63786-0 ISBN 978-3-319-63787-7 (eBook).

6. Stem Cell Research And Therapeutics edited by Shi Yanhong, Clegg Dennis O. Springer Netherlands 2008; ISBN 978-1-4020-8502-4 (eBook)

7. Stem cell biology and gene therapy, Booth Catherine, Cell Biology International, Academic Press. Published 2013; https://doi.org/10.1006/cbir.1999.0349

8. Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine, edited by Alexander Battler, Jonathan Leor, Springer- Verlag London 2006. ISBN 978-1-84628-142-6 (eBook).

ELECTIVE IV:

COURSE: TISSUE ENGINEERING

COURSE CODE: BT 804	**L**	**T**	**P**	**Hr**	**C**
MARKS:150	**3**	**0**	**2**	**5**	**4**

OBJECTIVES:

- Familiarize the students with the principles and advancements in the field of Tissue Engineering.
- Develop knowledge and awareness towards clinical application of Tissue Engineering.
- Impart training and competence towards developing Tissue Engineered Medical Products (TEMPs).

COURSE OUTCOME:

On completion of the course students will be able to:

- Demonstrate knowledge of the need and principles of Tissue Engineering.
- Describe the information and application of different types of cells that can be used for Tissue Engineering.
- Develop understanding of different types of biomaterials and their uses in Tissue Engineering.
- Gain the knowledge of different basic and advanced methodologies and technologies for engineering of tissues.
- Develop insights into the clinical translation of tissue engineering, including regulatory considerations.

PREREQUISITES:

Students should have undertaken courses in Cell Biology and Animal Tissue Culture.

COURSE DESCRIPTION:

Sr. No	**Topic**	**Detailed syllabus**	**No. of lectures**
1	Introduction and background of tissue engineering	History of Tissue Engineering; Elements of Tissue Engineering; Degenerative Diseases.	04
2	Concepts in tissues and cells	Types of tissues; Cells and environment, Cell signaling, Cell differentiation, Epigenetics, Early embryonic development; Mechanical properties of cells and tissues.	06
3	Cells for tissue engineering	Different types of cells for tissue engineering with advantages and disadvantages; Specific body tissues as stem cell sources; Cellular reprogramming; Autologous/allogeneic cells, Cells and immunogenicity; Stem cell niche; Methodologies for controlling stem cell fate.	06

4	Biomaterials in tissue engineering	Types of biomaterials (metals, ceramics, polymers, natural/synthetic), Physico-chemical properties of biomaterials (viscoelasticity, tensile strength), Extracellular matrix as a biomaterial; Roles of biomaterials in tissue engineering; Biocompatibility, interaction of cells with the biomaterials, biodegradability, *In vitro* and *In vivo* biocompatibility assessment methods for scaffolds; Types of biomaterial scaffolds, Classical methods of scaffold fabrication, Electrospinning Rapid prototyping, Organ decellularization; Materiomics.	08
5	Methodologies for tissue engineering	Three-dimensional cell culture methods, Self-organization, Cell sheet engineering, Scaffold-based methods; Microfabrication, Cell and organ printing, Extrusion printing, Laser-assisted printing, Inkjet-type printing, 4D bioprinting, Volumetric Bioprinting, Bioinks; Vascularization of engineered tissues; Bioreactors for tissue engineering.	07
6	Tissue engineering of specific organs	Tissue engineering of Skin; Bone; Cartilage; Cardiovascular tissue engineering; Neural tissue engineering	04
7	Technologies relevant in tissue engineering	Gene therapy, Protein therapy, Nanotechnology; Controlled release, Microfluidics, cell encapsulation, smart materials; Biomimetics; Technologies for *in vitro* applications: Organs-on-chips; Organoids.	04
8	Tissue engineering in practice	Clinical translation of cell therapies and tissue-engineered products, Safety and Effectiveness Testing, Cell therapy manufacturing, Regulatory considerations; Current status of Tissue Engineering / Regenerative Medicine (TE/RM), commercialized TE products, Tissue engineering in space; Ethical issues in TE/RM.	06
		Total lectures	**45**

METHODOLOGY:

The course will be taught through lectures, exercises, participative learning, videos and and supported by Practicals.

EVALUATION SCHEME (THEORY):

Examination	Duration	Marks
I Internal	1 hour	20
II Internal	45 mins	15
Attendance	----	5
End Semester Exam	2 hours 30 mins	60
Total		**100**

BOOKS RECOMMENDED

1. Tissue Engineering 2nd Edition, Eds. Clemens Van Blitterswijk, Jan De Boer, Elsevier Inc. 2015.
2. Introduction to Tissue Engineering: Applications and Challenges 1st Edition, Ravi Birla, Wiley-IEEE Press 2014.
3. Biomaterials Science and Tissue Engineering: Principles and Methods, Bikramjit Basu, Cambridge IISc Series 2017.
4. Principles of Tissue Engineering 4th Edition, Eds. *Robert Lanza, Robert Langer and Joseph P. Vacanti*, Elsevier Inc. 2013.
5. Tissue Engineering 1st Edition, Bernhard Palsson, Sangeeta Bhatia, Pearson Education India 2016.
6. Tissue Engineering 1st edition, John P. Fisher, Antonios G. Mikos, Joseph D. Bronzino, CRC Press 2007.

PRACTICAL IN TISSUE ENGINEERING AND TRANSPLANTATION

(2 Hrs. Per Week) **Marks: 50**

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1	Preparation of ear-shaped hydrogel scaffolds.	Use of appropriate biomaterials for a particular tissue shape.	http://cdn.intechweb.org/pdfs/18203.pdf
2	Preparation of porous scaffolds	A method for preparing porous scaffolds and their importance for 3D culture of cells.	https://www.intechopen.com/books/advances-in-biomaterials-science-and-biomedical-applications/biofabrication-of-tissue-scaffolds
3	Culture of cells in porous scaffold and histological analysis	Performing 3D culture of cells and study of the population of the scaffold with cells in 3D configuration.	Ratanavaraporn J (2006) Comparison of Gelatin and Collagen Scaffolds for Fibroblast Cell Culture. *Journal* of Metals, *Materials* and Minerals. Vol.16 No.1 pp31-36
4	Preparation of tubular conduits used for blood vessel engineering	Devising method for preparing tubular biomaterial conduits	Hasan A et. al. (2014) Electrospun Scaffolds for Tissue Engineering of Vascular Grafts. Acta Biomater. 10(1): 10.1016/j.actbio.2013.08.022.
5	Preparation of constructs with vascular-like channels	The importance of vascularization in tissue engineered constructs and a method to introduce channels in a construct	Lovett et. al. (2009) Vascularization Strategies for Tissue Engineering. Tissue Eng Part B Rev. 15(3): 353–370.
6	Encapsulation of cells in alginate beads and MTT staining	Use and method for preparation of cell-laden alginate beads	Debnath T. et. al. (2015) Development of 3D Alginate Encapsulation for Better Chondrogenic Differentiation Potential than the 2D Pellet System. J Stem Cell Res Ther 5:276.

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

ELECTIVE IV:
COURSE: MOLECULAR DIAGNOSTICS

COURSE CODE: BT 805 **L T P Hr C**
MARKS: 150 **3 0 2 5 4**

OBJECTIVES:

- Various molecular techniques/assays could be employed for improved clinical diagnosis and prognosis of various human genetic disorders and infectious diseases.
- Understand the principles of various molecular techniques in the context of studying clinically relevant diagnostic strategies
- Mechanisms of pathogenesis in various diseases.
- Recent advances and evolution of molecular techniques aiding in clinical diagnosis

COURSE OUTCOME:

At the end of the course students will be able to:

- Understand the importance of various molecular techniques in clinical diagnosis.
- Demonstrate the applications and choice of different molecular diagnostic strategies of different medical conditions
- Evaluate the advantages and limitations associated with each molecular techniques in relation to clinical diagnosis
- Understand how molecular markers could be used in predictive and prognostic evaluation of diseases

PREREQUISITES:

Students need to have a good understanding of techniques used in cell and molecular biology and biology of various diseases/disorders.

COURSE DESCRIPTION:

Sr. No.	Topics	Detailed syllabus	No. of Lectures
1	Introduction to Molecular Diagnostics	(i)History and evolution of diagnostics, (ii)Significance and scope of molecular diagnostics, (iii)Introduction to types of disorders; (a)Inherited Metabolic Disorders: (i)Lysosomal Storage: Tay-Sachs and Hurler disorders (ii)Peroxisomal: Zellweger spectrum disorder (iii)Mitochondrial: Friedreich ataxia (iv)Metal metabolism disorder- Wilson disease (v)Other inherited metabolic disorders – Phenylketonuria (b)Immune Disorders: Multiple sclerosis (c) Infectious diseases: Dengue (d) Parasitic diseases: Examples of vector-based, food-borne, water-borne, blood-borne	8

		etc.	
2	Cytogenetic Analyses	(i) Analyses of structural and numerical chromosomal mutations: Deletion, Duplication, Inversions, Translocations, Ring Chromosomes, Isochromosomes. (ii) Preparation and analysis of human karyogram. (iii) Banding and staining (AgNOR) of chromosomes. (iv) Fluorescence in situ hybridization (FISH) (v) Comparative genomic hybridization (CGH) in tumor diagnosis. (v)Spectral Karyotyping.	8
3	DNA Diagnostics	(i)PCR-based diagnostics: PCR-based detection of microbes and aneuploidy, Real-time PCR (qRT-PCR) (ii)Southern analyses based diagnostics: (with reference to Hemophilia A, Charcot-Marie-Tooth disease and Fragile-X syndrome) (iii) Principles and Applications of Ligation Chain Reaction, Single Strand Conformation Polymorphism (SSCP), ARMS-PCR (with reference to detection of Single Nucleotide Polymorphism and point mutations) (iv) DNA sequencing (Sanger and NGS methods) (v) Array based CGH (vi) Genetic Profiling (vii) Multiplex PCR	8
4	Clinical Application of Molecular Diagnosis	(i) Hemoglobinopathies: Sickle cell disorders (Hemoglobin electrophoresis) (ii)Neurodegenerative disorders and Dynamic Mutations: Huntington disorder (PCR) (iii)Metabolic disorders: Tay-Sachs disorder, (Direct DNA testing methods), Hemochromatosis (PCR-RFLP) (iv) Marfan Syndrome (Ghent Nosology and DNA tests)	8
5	Emerging Technologies	Microarrays, Phage display, FACS, Lab-on-a-Chip approach for molecular diagnosis, SELDI-TOF.	5
	Biomarkers in Disease	Introduction to disease markers, FDA	8

6	Prediction and Diagnosis	definition of disease biomarkers, Differences between diagnostic and prognostic biomarkers, Sources for disease markers, Role of predictive biomarkers in prognosis of diseases. Emerging disease biomarkers (eg. Metabolic markers), sepsis, diabetes and cancer (eg. Breast cancer) and molecular oncologic prediction.	
Total Lectures			**45**

METHODOLOGY

The course would be covered through lectures, group discussions, teaching aids and would be supported by practical.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	1 hour	20
II Internal	45 mins	15
Attendance	----	5
End Semester Exam	2 hours 30 mins	60
Total		**100**

BOOKS RECOMMENDED

1. Brooker, R. J. (2009). Genetics: Analysis & Principles. New York, NY: McGraw-Hill.
2. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, DC: ASM Press.
3. Coleman, W. B., & Tsongalis, G. J. (2010). Molecular Diagnostics: for the Clinical Laboratorian. Totowa, NJ: Humana Press
4. Molecular Diagnostics: Techniques and Applications for the Clinical Laboratory Wayne W. Grody, Robert M. Nakamura, Frederick L. Kiechle, Charles Strom, Publisher: Academic Press; ASIN: B003FQM2OI, 1st Edition

PRACTICAL IN MOLECULAR DIAGNOSTICS: (2 Hrs. Per Week)
Marks: 50

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
8.	Southern blot-based diagnosis (e.g. trinucleotide expansions in fragile-X syndrome, SCA, etc.)	Using complementary nucleic acid probes that can hybridize to target DNA, one could learn to analyze specific DNA sequences that may have undergone mutations such as single base change or nucleotide expansions	Molecular Cloning: A Laboratory Manual, Fourth Edition, Michael R. Green, Joseph Sambrook, 2001, Cold Spring Harbor Laboratory Press, ISBN: 978-087969577-4
9.	Western-blot based diagnosis	Using antibodies generated against specific antigens, one could learn how to detect the presence or absence of proteins, which may be diagnostic of certain health conditions.	Molecular Cloning: A Laboratory Manual, Fourth Edition, Michael R. Green, Joseph Sambrook, 2001, Cold Spring Harbor Laboratory Press, ISBN: 978-087969577-4
10	Multiplex PCR to detect deletions in genes (eg: deletions of exons in Duchenne Muscular Dystrophy)	Using combinations of specific primers in a single reaction vessel, one could detect the absence or increased copy number of DNA sequences, which may be indicative of certain genetic disorders.	Beggs, A.H., Koenig, M., Boyce, F.M. *et al.* Detection of 98% of DMD/BMD gene deletions by polymerase chain reaction. *Hum Genet* **86,** 45–48 (1990). https://doi.org/10.1007/BF00205170
11	ARMS-PCR to detect SNPs/point mutations (eg: SNPs in Follicle Stimulating Hormone Receptor linked to primary amenorrhea or point mutations in beta-globin gene leading to beta-thalassemia)	Familiarization with ARMS-PCR as a diagnostic tool to identify single base changes in a population and also genotype individuals who may be suffering from certain genetic disorders.	Little, S. (2001). Amplification-Refractory Mutation System (ARMS) Analysis of Point Mutations. Current Protocols in Human Genetics.doi:10.1002/0471142905.hg0908s07
12	Preparation of lymphocyte culture, metaphase chromosomes and G-banded karyograms for detection of autosomal /sex chromosomal disorders in human (eg. translocation, deletion, and aneuploidies, etc.)**	Understanding how size of chromosomes, position of centromere, and G-bands could help in the diagnosis of numerical and structural chromosomal aberrations.	Benn P and Delach J (2008) Human lymphocyte culture and chromosome analysis. CSH Protoc. doi: 10.1101/pdb.prot5035.
13	FISH for the detection of translocations and aneuploidies using appropriate probes (e.g., chromosomes 9-22 translocation, trisomy 21 in human beings)**	Understanding how FISH could be used to confirm the presence of chromosomal translocations or increase/decrease in	https://www.creative-biolabs.com/fluorescent-in-situ-hybridization-FISH.html

		chromosome number, which have been implicated in certain genetic disorders.	
14	Sequencing of human DNA to detect the presence of genomic changes such as point mutations, deletions, and duplications. **	Understand how DNA sequencing could be used to confirm the genetic changes that lead to specific health conditions	Molecular Cloning: A Laboratory Manual, Fourth Edition, Michael R. Green, Joseph Sambrook, 2001, Cold Spring Harbor Laboratory Press, ISBN: 978-087969577-4

**These could be demonstrated to students

BOOK RECOMMENDATION:

Additional:

1) Ausubel F. M. et. al. (1988) Current Protocols in Molecular Biology. John Wiley & Sons, Inc. ISBN: 978-0-471-50338-5.

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

Semester IX & X	
BT 901: Research Project/ Industrial Training/ Review writing (10 months)	**40 Credits**

OBJECTIVES:

The objectives of this course are to:

- Train the students to understand the research environment in a laboratory/ Industrial training and culture
- Enable students to learn practical aspects of research
- Impart training to the students for Literature review, Review writing, data analysis and thesis writing.

COURSE OUTCOME:

At the end of the research project/ Industrial training/ Review writing process the students will be able to:

- Learn how to formulate research questions, and effectively design, execute, evaluate and discuss their study.
- Attain practical training in the applied aspects of Biotechnology/ Bioinformatics in the industry
- Attain in-depth knowledge of the chosen area of research.
- Conduct research independently.
- Carry out appropriate literature survey and formulate review article
- Demonstrate Presentation skills