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

DR. D. Y. PATIL VIDYAPEETH

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DR. D. Y. PATIL BIOTECHNOLOGY & BIOINFORMATICS INSTITUTE

TATHAWADE, PUNE

SYLLABUS FOR

B. TECH. MEDICAL BIOTECHNOLOGY

2021- 22

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

COURSE STRUCTURE FOR B. TECH. MEDICAL BIOTECHNOLOGY

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**
MB 201	Medical 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						

SEMESTER III						
BT 301	Analytical Techniques	3	0	4	7	5
BT 302	Microbiology & Virology	3	0	2	5	4
MB 301	Human Genetics	2	0	2	4	3
BI 301	Concepts in Bioinformatics	2	0	2	4	3
BT 304	Biosafety, Bioethics & IPR	2	0	0	2	2
MB 302	Human Anatomy & Physiology	3	0	2	5	4
HU 301	Universal Human Values II	2	1	0	3	3
	Total	**17**	**1**	**12**	**30**	**24**
SEMESTER IV						
BT 401	Molecular Biology	3	0	4	7	5
BT 406	Animal tissue culture	2	0	2	4	3
MB 401	Bioprocess Engineering	3	0	4	7	5
BT 404	Immunology	3	0	2	5	4
BT 405	Developmental Biology	3	0	2	5	4
MB 402	Pharmacology & Toxicology	2	0	0	2	2

	Total	**15**	**0**	**14**	**31**	**23**
SEMESTER V						
MB 501	Biopharmaceuticals	2	0	2	4	3
MB 502	Genetic engineering	3	0	4	7	5
MB 503	Tissue Engineering and Transplantation	2	0	2	4	3
BI 502	Molecular modelling and drug designing	2	0	4	6	4
MB 504	Disease Biology	2	0	2	4	3
BI 501	R Programming	1	0	0	1	1
MB 505/506	Elective 1	2	0	2	4	3
	Total	**14**	**0**	**16**	**30**	**22**
Elective I: (Cancer Biology / Nanomedicine)						
SEMESTER VI						
MB 601	Biomedical Devices and Instruments	2	0	2	4	3
MB 602	Artificial Organs and Biomimetics	3	0	0	3	3
HU 601	Health Care Law Management	2	0	0	2	2
BT 604	Genomics, Transcriptomics & Proteomics	3	0	4	7	5
MB 603	Molecular Diagnostics	2	0	2	4	3
BI 601	Artificial Intelligence	1	0	0	1	1
MB 604/605	Elective 1I	3	0	0	3	3
	Total	**16**	**0**	**8**	**24**	**20**
Elective 1I : (Vaccine Technology/ Personalized Medicine)						
SEMESTER VII						
MB 701	Clinical Trials	2	0	0	2	2
MB 702	Forensic Biotechnology	2	0	2	4	3
HU 703	Entrepreneurship and skill development	2	0	0	2	2
MB 703	Metabolic Engineering and Systems Biology	3	0	2	5	4
MB 704	Seminars in Medical Biotechnology	3	0	0	3	3
MB 705/706	Elective III	3	1	0	4	4
	Total	**15**	**1**	**4**	**20**	**18**
Elective III : (Biomechatronics/ Epidemiology and Public Health)						
SEMESTER VIII						
	Research Project/ Industrial Training/ Review Writing					**20**
	TOTAL CREDITS: 170					

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 Semiconductor Devices	Classification of Solids (Conductor, Semiconductor and Insulators), intrinsic and extrinsic semiconductors, PN Junction Diode, Zener Diode, Junction Transistors (CE,CB mode)	05
6	Introduction to Digital Electronics	Introduction to Binary mathematics, BCD numbers, Basic logic gates, De-Morgan's Theorem	02
7	Lasers	Properties of Lasers, Production mechanism, Ruby Laser, Helium Neon Laser, applications of Lasers.	03
8	Sound waves	Types of sound waves (Longitudinal and Transverse), Audible, Ultrasonic and Infrasonic waves, Beats, Doppler effect, Applications of Ultrasonic waves.	03
9	Electricity	Heating effect of electric current, Joule's law, Transformers, Types of Transformers.	02
10	Modern Physics: X-rays, Crystallography, Introduction to Quantum Mechanics	Introduction to X-Rays : Introduction, Production of X-rays, X-Ray diffraction and its Applications. Introduction to crystal structure, Unit cell, seven crystal systems. Plank's Quantum Theory, Properties of Photon, Photoelectric	07

		effect, wave particle duality of radiation, de Broglie's hypothesis, Heisenberg's Uncertainty principle.	
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 electrode to measure conductivity of a	Theory and applications of conductivity

		solution.	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 Passing values between functions, Scope of functions	3
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 Standard function; Rules of Integration, Integration of	03

		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**
MB 201	Medical 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: MEDICAL BIOCHEMISTRY
COURSE CODE: MB 201 **L T P Hr C**
MARKS: 200 **3 0 4 7 5**

OBJECTIVE
To familiarize the student with basic biochemistry involved in human metabolism.

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
-

PREREQUISITES
Basic knowledge of organic chemistry is required.

COURSE DESCRIPTION

Sr No.	Topics	Detail syllabus	No. of Lec
1	Carbohydrates Properties and Metabolism	Classification and biochemical importance, chemistry and functions of Monosaccharides, disaccharides and polysaccharides including Glycosaminoglycans (Mucopolysaccharides). Synthesis and break down of glycogen, glycolysis, gluconeogensis HMP shunt pathway and its biological significance, pathway. Metabolism of Galactose and Galactosemia. Blood sugar level and its regulation, oral GTT and glycosuria, Biochemistry of diabetes mellitus.	**10**
2	Lipids	Classification and biological importance of Triacyl glycerol, phospholipids, glycolipids, fatty acids (PUFA), steroids and lipoproteins. Biochemical aspects of digestion and absorption of lipids. Beta oxidation, biosynthesis of saturated fatty acids. cholesterol biosynthesis, role of HDL & LDL. Role of ketone bodies. Errors in cholesterol metabolism.	**10**

3	Proteins	General nature and classification of amino acids. amino acids, biologically important peptides, classification, properties and biological importance of proteins. Structural organization of proteins, plasma proteins and their clinical significance. Biochemical aspects of digestions and absorption of proteins. Fate of amino acid in the body (Deamination, Transmination), Urea cycle. Metabolism of aromatic and their inborn errors.	**10**
4	Enzymes	General nature, classification, specificity and mode of action of enzymes, factors affecting enzyme activity. Clinical importance (Diagnostic, therapeutic) of enzymes.	**05**
5	Vitamins	General nature, classification and clinical importance.	**02**
6	Hormones	General characteristics and Mechanism of hormone action (Steroid Thyroid hormones), cAMP and Ca^{++}-the second messenger.	**05**
7	Nucleic acid	Structure of purines, pyrimidine, structure of DNA and RNA,	03
		Total	**45**

METHODOLOGY:

The course will be covered through lectures supported by tutorials, PowerPoint presentations, research articles and practical. In tutorials, apart from the discussion on the topics covered in lectures, assignments in the form of questions will be given.

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**

BOOKS RECOMMENDED:

1. The principles of Biochemistry by A. Lehninger, D. Nelson, and M. Cox, 5th edition, M. W.H. Freeman and Company, New York, 2008.
2. Metabolic Pathways by D. M. Greenberg, 3rd edition, Academic Press, Elsevier Science & Technology Books, 2014.
3. Biochemistry by L. Stryer, 4th edition, W.H. Freeman and Company, New York, NY, 1995.
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.

PRACTICALS IN MEDICAL BIOCHEMISTRY MARKS: 100

Sr. N	Name of the experimen	Learning objective	Literature/ Weblinks for reference an videos
1	Preparation of buffers.	To understand the concepts of Normality, Molarity, Molality a ppm.	An Introduction to Practical Biochemist David T. Plummer, 3 rd ed., Tata McGra Hill Education Private Limited, New De 2011.
2	Verification of Beer Lambert's law and determination of λmax b colorimetric method.	To understand the basic princip colorimetry	An Introduction to Practical Biochemist David T. Plummer, 3 rd ed., Tata McGra Hill Education Private Limited, New De 2011.
3	Quantitative estimation o proteins using using Biu Lowry method	To understand the biochemical properties of proteins. To understand the methods for quantification of proteins in mg	Lowry OH, Rosebrough NJ, Farr *A L,* Randall R J. Protein measurement with the Folin phenol reag J Biol Chem. 1951; 193: 265-275. Shakir, F. K., Audilet, D., Drake, A. J., Shakir, K. M. (1994) A rapid protein determination by modification of the Lo procedure. Analyt. Biochem. 216, 232–2
4	Determination of blood glucose by GOD/POD method	To understand the physiologica role of glucose and the method quantification of blood glucose	Lloyd JB, Whelan WJ. An improved me for the enzymic determination of glucos the presence of maltose. Anal Biochem.1969; 30: 467-70. Trinder, P. (1969). Determination of blo glucose using an oxidase-peroxidase sys with a non-carcinogenic chromogen. J. Pathol., 22, 2, 158-161.
5	Estimation of serum alk phosphatase.	To analyze the serum level of alkaline phosphatase and its physiological role	Drang F, Dith E, and Rougest C, Metho Enzymatic Analysis, 1986, Vol 9, pp. 34 362. Rathman and Saxena BB, Methods of Enzymatic Analysis, 1986, Vol 9, pp. 39 404.
6	Determination of serum u by DAM method.	To measure the serum level of u and understand its biological significance in diabetic patient.	Determination of Urea in Blood and Uri with Diacetyl Monoxime H. L. Rosenthal, *Anal.Chem.*, 1955, *27* (pp 1980–1982.
7	Estimation of serum cholesterol by enzymatic method.	To understand the quantitative method for estimation of serum cholesterol and its correlation w atherosclerosis.	The direct colorimetric determination of in blood and urine, S. B. Barker, J. Biol. Chem. 1944, 152:453-463.
8	Determination of serum I of Alanine aminotransfer (SGPT) by DNPH metho	To understand the clinical role Alanine aminotransferase by measuring its serum level in pat with liver disease	Bergmeyer HU, Methods of enzymatic analysis, 2nd Ed, Vol II (1974) Academi Press N.Y. Toro G. and Ackarmann P.G. and 1975 Practical Clinical Chemistry, (Boston: L

			Brown)
9	Estimation of Bilirubin – Total and Direct by DMS method	To measure the content of billir in serum for detection of jaundi	Balistreri WF, Shaw LM. Liver function Tietz NW, ed. Fundamentals of clinical chemistry.3 rd ed. Philadelphia:WB Saunders: 1987:729-761. Tietz NW, ed. Clinical guide to laborato tests. 3rd ed.Philadephia: WB saunders; 1995:268-273.
10	Estimation of serum alb by BCG method.	To measure the level of serum albumin by using colorimetric method.	Bonvicini, P., Ceriotti, G., Plebani, M. a Volpe, G. Clin. Chem. 25 : 1459 (1979) Tietz. N.W. Fundamentals of Clinical Chemistry, p. 940. W.B. Saunders Co. Philadelphia, PA. (1987).

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**

NAME OF THE 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
MB 301	Human Genetics	2	0	2	4	3
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: 150 **3 0 2 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	4

		and DNA and ssDNA, RNA tumor viruses requiring DNA intermediate for synthesis.	
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

(2 hrs per week) **Marks 50**

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.
7)
8)

9) **EVALUATION SCHEME**

10) **Examination**	**Marks**
11)	
12) Practical Internal (Continuous) assessment:	20
13) End semester examination:	30
14) **Total:**	**50**

COURSE: HUMAN GENETICS
COURSE CODE: MB 301 **L T P Hr C**
MARKS: 100 **2 0 2 4 3**

OBJECTIVE OF THE COURSE:

- The objective of the course is to familiarize the students with the importance & universality of Human Genetics.
- The students would understand Mendelian Genetics & its extensions in relation to human races.
- Students will be acquainted with Non-Mendelian Genetics, Sex Determination, Genetic diseases, Syndromes, Chromosomal Aberrations, and Population Genetics.
- The students will be familiar with sub-disciplines in Genetics and their importance in applied medical sciences.

COURSE OUTCOME:

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

- Have knowledge on the fundamental principles of inheritance.
- Understand the extension and deviations in Mendelian inheritance patterns.
- Understand the chromosomal basis of inheritance, sex determination and the importance of cytogenetics
- Familiarize with the principles of inheritance at the population level and also the application of pedigrees in following up inheritance.
- Know the importance of genetic counselling, pre-natal and post-natal testing and the applications of the Human Genome Project.

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.

Sr. N	Topic	Description	Hrs
1	History of Genetics	Historical views of heredity with reference to human genetics	2
2	Mendelian Genetics	• Mendelian laws and its application • Punnett Square and forked line method. • Probability Chi Square method. • Forward and Reverse Genetics	3
3	Extension of Mendelia laws	• Incomplete dominance and co-dominance. • Multiple alleles. • Gene Interactions that modifies Mendelian ratios different type of epistasis, complementation anal • Environmental effect on the expression of genes • Penetrance and expressivity, Pleiotropy. • Position effect and genomic imprinting.	5
4	Non-Mendelian inheri	• Rules and examples of Non-Mendelian Inherita mitochondrial, chloroplast • Maternal and uniparental inheritance. • Infectious heredity • Maternal Effect	4

5	Chromosomal basis of inheritance	• Evidences for chromosome theory of inheritance chromosomes, Sex linkage and non-disjunction c chromosomes. • Analysis of sex-linked and autosomal traits in humans. Mendelian inheritance in Human ; Pedi analysis	4
6	Cytogenetics and linka mapping	• Cytogenetic techniques. • Variations in chromosome structure and number associated disorders. • Linkage and crossing over and gene mapping in eukaryotes.	4
7	Sex determination	• Genotypic (Mammals, *Drosophila*, *C. elegans*), and environmental mechanisms. • Mechanisms of dosage compensation in Mamma *Drosophila*, *C. elegans*	4
8	Population genetics	• Genetic structure of population: genotype and all frequencies • The Hardy-Weinberg Law. • Genetic variation: mutation, migration, natural selection and random genetic drift.	4
9	Genetics Counselling Human Genome Proj	• Introduction to genetic counselling and ethics, Prenatal and post natal diagnosis of genetic disorders • Online Mendelian Inheritance in Man (OMIM) • Introduction to Human Genome Project	3
Total Number of Lectures			33

METHODOLOGY

The course would be taught through lectures, demonstrations & tutorials with the help of logical questions and numerical etc**.**

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. 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.	Name of the experim	Learning objective	Literature/ Web links for reference videos
1.	Introduction to different model organisms used i genetic studies (*Escheri coli, Drosophila melanogaster, Caenorhabditis elegans musculus, Saccharomyc cerevisiae and Arabidop thaliana)*	To understand the importa of model organisms in ge studies	Genetics, A Conceptual Approach by Pierce, 5th edition, , W. H. Freeman & Company, 2013. Human Molecular Genetics by A. P. R and T. Strachan, 4th edition, Taylor & Francis, 2011.
2.	Study the life cycle of *Drosophila* (fruit-flies) examine *Drosophila* sto with viable mutations	To recognize different sta of development in flies an familiarize with some of t mutant phenotypes	Fly Pushing: The Theory and Practice *Drosophila* Genetics Ralph J. Greenspan CSHL Press, 2004
3.	Analysis of ABO blood groups in human beings	To understand Mendelian inheritance and the concep multiple alleles	http://nib.gov.in/guidance_document/ Guidance_manucal_QC_ ABO_Rh_blood_grouping_26_03_20 f
4.	Monohybrid crosses usi the eye-color traits in *Drosophila*	To comprehend sex-linked inheritance with reference extension of Mendelian principles	Fly Pushing: The Theory and Practice *Drosophila* Genetics Ralph J. Greenspan CSHL Press, 2004
5.	Estimation of gene frequencies in a populat	To familiarize with the distribution of dominant a recessive traits in a popula and understand the applications of Hardy-Weinberg law	Genetics, A Conceptual Approach by Pierce, 5th edition, , W. H. Freeman & Company, 2013. Human Molecular Genetics by A. P. R and T. Strachan, 4th edition, Taylor & Francis, 2011.
6.	Preparation and analysis human karyograms	To understand the process karyotyping and preparati karyograms in order to an structural and numerical aberrations	https://labtestsonline.org.au/learning/t index/chromosome-analysis-karyotypi Human Molecular Genetics by A. P. R and T. Strachan, 4th edition, Taylor & Francis, 2011.
7.	Analysis of the skin markings or patterns on fingers and palms (Dermatoglyphics)	To understand polygenic inheritance and correlating fingerprint and palm patte with some genetic disorde	E-MANUAL, Life Sciences Protocol Manual, Published by DBT, Min. of Science and Technology, Govt. of Ind

8.	Dihybrid or Balanced le crosses in *Drosophila* (a one)	To understand: the inheritance of two unli traits in flies. **or** the importance of balance lethal fly stocks in mainta deleterious mutations over several generations	Fly Pushing: The Theory and Practice *Drosophila* Genetics Ralph J. Greenspan CSHL Press, 2004

PRACTICAL EVALUATION SCHEME

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

NAME OF THE COURSE: CONCEPTS IN BIOINFORMATICS

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

MARKS: 100 **2 0 2 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:	20
End semester examination:	30
Total:	**50**

COURSE: BIOSAFETY, BIOETHICS & 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.

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						
BT 401	Molecular Biology	3	0	4	7	5
BT 406	Animal tissue culture	2	0	2	4	3
MB 401	Bioprocess Engineering	3	0	4	7	5
BT 404	Immunology	3	0	2	5	4
BT 405	Developmental Biology	3	0	2	5	4
MB 402	Pharmacology & Toxicology	2	0	0	2	2
	Total	**15**	**0**	**14**	**31**	**23**

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	10

		• Gene conversion.	
5	Replication of DNA	• Models of DNA replication • 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.	5
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 stocl solutions for molecular biolog	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 requiremer specific methods depending on sourc DNA	
3	Quantification of DNA by UV absorption and analysis by aga gel electrophoresis	To understand the quality, and quanti DNA present per cell	
4	To isolate plasmid DNA from bacteria, restriction analysis ar agarose gel electrophoresis	To distinguish between plasmid and genomic DNA in terms of size and migration properties in gel	
5	To isolate RNA from eukaryo cells and analyse by denaturin formaldehyde agarose gel electrophoresis	To understand various types of RNA/RNA profile and quality of RN preparation	
6	To find the Melting temperatu DNA	Measure temperature and estimate T_m from your data	
7	Isolation of nuclei, calcium activation of endonuclease resulting DNA ladder includin mononucleosome formation	Hands-on verification of the concept chromatin structure	
8	Extraction of histone from nuc and analysis by SDS-PAGE	Understanding the contribution of histones in the formation of chromati	

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.	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, specia techniques) Contamination in cell culture Cryopreservation The art of animal cell culture;	6
2	Growth, metabolism & biolog 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	3

		continuous cell cultures of mammalian cells Culture evolution Transformation and immortalization Cell cloning and selection	
5	Characterization of cell lines	Karyotyping & chromosome analyses Biochemical characterization Genetic characterization. Growth characteristics & tumorigenicity Protein markers	3
6	Large-scale animal cell cultur	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 *vitro*	Hybridoma technology :Monoclonal Abs Production of therapeutic proteins & vaccines using ce culture *In vitro* cytotoxicity assays and tissue-engineered *in vi* tissue models Cell migration assay, *In vitro* tumorigenicity, Cell invasion assay	4
8	Applications of cell culture *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	2 hours 30 min	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: BIOPROCESS ENGINEERING
COURSE CODE: MB 401 **L T P Hr C**
MARKS: 200 **3 0 4 7 5**

OBJECTIVES:
The objective of the course is to create an understanding about basic industrial processes for the production of industrially and medically important compounds.

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

- Understand the key biochemical and cellular components and biochemical processes.
- Explain how the stoichiometry balance is important parameter for the biochemical processes.
- Demonstrate the kinetics of cell growth & death, substrate consumption and product formation and use of different models for the kinetic analysis of a fermentation process.
- Demonstrate different mathematical formulas for different modes of bioreactor and use those to plan and analyze bioprocesses

PRE-REQUISITES:
Students are expected to have a basic understanding in Biology.

COURSE DESCRIPTION:

Sr. No	Topics	Detail syllabus	No. of lectures
1	Fermentation Basics	• Design of a bioprocess facility • Components of fermentation process • Types of bioreactors with special emphasis on reactors for animal cell culture including single use bioreactors • Kinetics of cell growth, productivity and yield	8
2	Measurement and control of bioprocess parameters	• PID systems • Measurement and control of process variables- pH, temperature, pressure, flow, dissolved oxygen and carbondioxide	6
3	Process Optimization	• Design of experiments for fermentation process optimization • Removal of adventitious agents in production of medically important products	4
4	Downstream processing	• Centrifugation, Filtration, Precipitation • Chromatography: basic and high-throughput bioseparations including affinity monolith chromatography	8
5	Large scale mammalian cell culture	• Case studies- production and downstream processing of a) Viral products (viral vaccines) b) Monoclonal antibodies c) Immunological regulators (interferons/ interleukins) d) Hormones (Follice stimulating hormone, erythropoietin) e) Enzymes (Hyaluronidase, tissue plasminogen activator) f) Other biosimilars/recombinant products (e.g., insulin)	8
6	Bioprocess engineering applications in medicine	• Tissue engineered skin replacements • Chondrocyte culture for cartilage replacement • Production of viral vectors for gene therapy • Stem cell expansion and controlled differentiation	8
7	Economics	• Scale up • Challenges and cost economics	2
	Total		44

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.

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

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

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

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

Practical in Bioprocessing Engineering 4 hours per week 100 Marks

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos *
1.	Study of design of lab scale Stirred Tank Bioreactor (Lab scale fermenter) and calibration of different probes	To know basic of bioreactors with their parts and various dimensions. To understand the importance of calibration.	3
2	Measurement of control parameters during a fermentation- pH, temperature, dissolved oxygen	To know the importance of process parameters in bioreactors operations.	1,3
3	Removal of adventitious agents during fermentation of medically important products		
4	Production of streptomycin/penicillin antibiotic by fed batch fermentation and determination of antibiotic activity.	To learn upstream and downstream processing in antibiotic fermentation.	2,4
5	Recovery of medical compound/antibiotic from fermentation broth- precipitation, dialysis, concentration, chromatography	To understand different methods of DSP and their role.	4
6	Production of therapeutic recombinant products using fermentation	To learn culturing of recombinant cell.	1
7	Immobilization of yeast cells using different substrates and determination of biological activity	To know the basics of immobilization and its methods and significance.	3,4
8	Study of rheology of fermentation broth. Determination of viscosity, cell counts/ml, dry cell wt/ml broth and packed cell volume.	To know basic of fermentation process parameters and their significance.	1,3
9	Visit to Industry	To learn different units in industry such as production. Quality control, Quality assurance, R & D, and Lab. To study unit operations in industry.	

References:

1. Manual of Industrial Microbiology and Biotechnology (2nd Edition by Arnold L. Demain and Julian E. Davies, Ronald M. Atlas, Gerald Cohen, Charles L. Hershberger, Wei-Shou Hu, David H. Sherman, Richard C. Willson and J. H. David Wu)

2.Industrial Microbiology-An introduction (By Michael J. Waites, Neil L. Morgan, John S. Rockey and Gary Higton)

3.Principles of Fermentation Technology. (2nd edition, by Peter F. Stanbury, Allan Whitaker and Stephen J. Hall, Butterworth-Heinemann, An imprint of Elsevier Science

4.Fermentation and Enzyme Technology By D.I.C. Wang, C.L. Cooney, A.L. Demain, P. Dunnill, A.E. Humphrey & M.D. Lilly John Wiley and sons, New York

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. N	Topic	Description	Hrs
1.	Introduction to Imn System (i) The Cells and so mediators of the Immune system (ii) Organs of the Immune system	1. Historical Perspective: Early vaccination studies, Early studies of Humo 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 and Auxillary cells (ii) Soluble mediators of immunity : Acute phase proteins, Complemen proteins & Cytokines 3. Immune response to pathogens : Innate and Adaptive Immunity (i) Innate Immune response, Pathogen Associated Molecular Patterns (PAM 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-mediate Immunity (Antigen recognition and Antigen eradication, B cell clonal selection, Concept of antigen processing & presentation on MHC molec 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 assoc Lymphoid tissue (MALT)	8
2.	Generation of B cel 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 5. Adjuvants : Freund's incomplete and complete adjuvant 6. Epitopes : Characteristic Properties of B-cell epitope	4

3.	Immunoglobulins Structure and Funct	1. Basic structure of antibodies, Chemical and enzymatic methods for basi antibody structure 2. Fine structure of antibodies 3. Antibody Classes and Biological activities 4. Antigen determinants on Immunoglobulins : Isotype, Allotype & Idioty 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 ge	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) ar Antigen presentatio	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 f 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, Systen 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 vi and bacterial infections (*Mycobacterium tuberculosis*), and Parasitic dis (*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 i viral replication cycle for therapeutic anti-retroviral drugs, Therapeutic agents inhibiting retrovirus replication 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	6

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: 100 **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.	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 placental mammals • Various types of morphogenetic movements during gastrulation • Gastrulation in mouse/human embryos with	5

		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.
6.	Study of cell death during morphogenesis	Observation of cell death in chick embryos (5 days old) limd morphogenesis	

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

COURSE: PHARMACOLOGY & TOXICOLOGY
COURSE CODE: MB 402 **L T P Hr C**
MARKS: 50 **2 0 0 2 2**

OBJECTIVE:

The objective of the course is to familiarize the students with aspects of Pharmacology, principles of Drug Action and toxicology.

COURSE OUTCOME:

On completion of the course students will be able to:

- 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

Since the course is very basic in scientific world, student must know about relationship between drugs with biological cell.

COURSE DESCRIPTION

Sr.	Topic	Description	Hrs
1	Pharmacology Introduction	History and scope Definitions and terms. Organized drug discovery and development.	2
2	Clinical Developments	Pre-clinical development: Clinical trials, patenting procedure	2
3	Mechanism of action	Molecular principles in agonist and antagonist action. Drug receptor interaction: Ligand-gated ion channel, G-protein coupled receptors, Kinase and enzyme linked and nuclear receptors.	4
4	Chemical Kinetics	Principles and practice of transition state mimicry Illustrative examples, collected substrate analogue inhibitors ,and design strategies	4
5	Aspects of Pharmacology	Combinatorial approach to compound libraries, current status and future Prospects.	2
6	Toxicology Introduction	Definition of toxins and toxicants, Sister sciences, Toxicokinetics: Absorption, Distribution, Biotransformation, Excretion. Endocrine Disruptors	3
7	Dose Response	Physiologic dose-response, Dose–Response Assessment: NOAEL The role of intercellular chemical communication.	4
8	Metabolism of Xenobiotics	Biochemistry of Xenobiotics metabolism, Phase I and Phase II enzymes and reactions,	3
9	Interaction of chemicals	Developmental status/age and toxicity Chemical Carcinogenesis	3

		Human Health Risk Assessment	
10	Experimental Toxicity Testing	*In vivo* and *in vitro* tests Acute, sub-chronic, chronic, Mutagenicity and carcinogenicity Special Tests	3
Total Number of lectures			**30**

METHODOLOGY

The course would be taught through lectures, demonstrations.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal	45 minutes	15
Attendance	----	5
End Semester Exam	2 hours 30 min	30
Total		**50**

BOOKS RECOMMENDED:

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

SEMESTER V						
MB 501	Biopharmaceuticals	2	0	2	4	3
MB 502	Genetic engineering	3	0	4	7	5
MB 503	Tissue Engineering and Transplantation	2	0	2	4	3
BI 502	Molecular modelling and drug designing	2	0	4	6	4
MB 504	Disease Biology	2	0	2	4	3
BI 501	R Programming	1	0	0	1	1
MB 505/506	Elective 1	2	0	2	4	3
	Total	**14**	**0**	**16**	**30**	**22**
Elective I: (Cancer Biology / Nanomedicine)						

COURSE: BIOPHARMACEUTICALS

COURSE CODE: MB 501 **L T P Hr C**

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

OBJECTIVE:

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

LEARNING OUTCOME:

- At the end of the course,
- The students will have sufficient understanding of the current status of Biopharmaceuticals.
- Students will get in depth knowledge on biopharmaceutical formulation techniques.

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	02
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	07
3	Hormones of therapeutically interest	Insulin, Insulin receptors, production of human insulin by rDNA technology, insulin formulation, and Glucagon	05
4	Blood products and therapeutic enzymes	Anticoagulants: Hirudin, Vitamin K, and Antimetabolites, Oxygen carrying blood substitutes: Albumin, Dextran, and Gelatin	04
5	Growth factors and wound healing	Insulin growth factor (IGF), Epidermal growth factor (EGF), and Platelet derived growth factor (PDGF), Wound healing process	05
6	Vaccines and Nucleic acids therapeutics	Vaccines: Types of vaccines, peptide vaccine, and vaccine vectors Basic approach to gene therapy: Types of gene therapy vectors Antisense technology: Uses, advantages, and limitations	07

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	2 hours 30 min	30
Total		**50**

BOOKS RECOMMENDED:

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

PRACTICALS IN BIOPHARMACEUTICALS (2Hrs. Per Week)

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
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	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
7	Determination of endotoxin in the therapeutic formulation (WFI, gentamycin injection ampicillin injections) by using LAL test reagent	To know endotoxin of bacterial origin, its structure and their role. To learn Significance of LAL test at commercial Level	
8	Determination of SGPT/SGOT activity in serum / plasma sample by chemical method	To estimate the concentration of SGOT and SGPT in samples. To learn importance of SGPT and SGOT activity with functional test The correlation of glucose concentration with different clinical conditions	
9	LIMIT test for chloride, sulphates, iron and heavy metals in pharmaceutical products.	To learn threshold level of ions in the pharmaceutical products. To understand the significance of LIMIT test at commercial level	
10	One day industrial visit to a pharmaceutical company	To understand the commercial production of biopharmaceutical Products	

PRACTICAL EVALUATION SCHEME

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

COURSE: GENETIC ENGINEERING

COURSE CODE: MB-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

Sr. No.	Topics	Detailed syllabus	Hours
1	Unit I 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	Unit II 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	Unit III 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 techniques, RAPD, RFLP, AFLP. Different methods for analysis of gene expression	8
4	Unit IV Gene cloning	Isolation and purification of DNA (genomic, plasmid) and RNA. Isolation of gene of interest- restriction digestion, electrophoresis, Cutting and joining of DNA 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	10

		Cloning strategies- genomic DNA libraries, cDNA libraries, subtractive hybridization,	
5	Unit V Applications of Recombinant DNA technology	In Medicine, in generation of disease resistant animals, Gene therapy: In vivo approach, ex-vivo approach of gene therapy, Antisense therapy, Interference technology (siRNA, shRNA, miRNA), CRISPAR Cas 9 mediated gene therapy, Transgenics animals	8
6	Unit VI Genetic disorders, Diagnosis and screen	Prenatal diagnosis, Single nucleotide polymorphisms, DNA microarrays, Future strategies.	4
7	Unit VII 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	Unit VIII The Human Genome Project	The Human Genome Project: Objectives and its outcome, Brief concept of personalized medicine.	2
Total			45

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

Evaluation Scheme (Theory)

Examination	Duration	Marks
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: **RECOMBINANT DNA TECHNOLOGY** (4 HOURS PER WEEK) **100 MARKS**

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for refere 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**

NAME OF THE COURSE: TISSUE ENGINEERING AND TRANSPLANTATION

COURSE CODE: MB 503 **L T P Hr C**

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

OBJECTIVE

The objective of the course is to impart training and competence in the modern science of Tissue Engineering and Regenerative Medicine, for alleviation of human degenerative diseases.

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
- Learn fundamentals of organ transplantation

PREREQUISITES

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

COURSE DESCRIPTION

Sr.	Topic	Detailed syllabus	No. of lectures
	Introduction and background tissue engineering	History of Tissue Engineering Elements of Tissue Engineering Degenerative Diseases Organ transplantation	03
	Concepts in tissues and cells	Types of tissues Cells and environment, Cell differentiation, Epigenetics Early embryonic development Mechanical properties of cells and tissues	03
	Cells for tissue engineering	Different types of cells for tissue engineering with advantages and disadvantages; adult stem cells, embryonic stem cells, perinatal stem cells, induced pluripotent stem cells, mesenchymal stem cells, differentiated cells. Cellular reprogramming Autologous/allogeneic cells, Cells and immunogenicity,	06
	Biomaterials in tissue enginee	Types of biomaterials (metals, ceramics, polymers,	06

		natural/synthetic), extracellular matrix as a biomaterial; Roles of biomaterials in tissue engineering Biocompatibility, biodegradability Types of biomaterial scaffolds; classical methods of scaffold fabrication; electrospinning Rapid prototyping, organ decellularization;	
	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 Vascularization of engineered tissues Bioreactors for tissue engineering	07
	Technologies relevant in engineering	Gene therapy, protein therapy Nanotechnology Controlled release, microfluidics, cell encapsulation, smart materials	03
	Tissue engineering in practice	Clinical translation of cell therapies and tissue-engineered products; Ethical issues in regenerative medicine	02
		Total lectures	**30**

METHODOLOGY

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

EVALUATION SCHEME (THEORY)

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

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. N	Name of the experiment	Learning objective	Literature/ Weblinks for referenc and videos
1	Preparation of ear-shaped hydrogel scaffolds.	Use of appropriate biomaterial a particular tissue shape.	http://cdn.intechweb.org/pdfs/18203
2	Preparation of porous scaff	A method for preparing porou scaffolds and their importance 3D culture of cells.	https://www.intechopen.com/books/ nces-in-biomaterials-science-and-biomedical-applications/biofabricati of-tissue-scaffolds
3	Culture of cells in porous scaffold and histological analysis	Performing 3D culture of cells study of the population of the scaffold with cells in 3D configuration.	Ratanavaraporn J (2006) Compariso Gelatin and Collagen Scaffolds for Fibroblast Cell Culture. *Journal* of Metals, *Materials* and Minerals. Vol No.1 pp31-36
4	Preparation of tubular cond 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 10.1016/j.actbio.2013.08.022.
5	Preparation of constructs w vascular-like channels	The importance of vascularizat in tissue engineered constructs a method to introduce channel construct	Lovett et. al. (2009) Vascularization Strategies for Tissue Engineering. T Eng Part B Rev. 15(3): 353–370.
6	Encapsulation of cells in alginate beads and MTT staining	Use and method for preparatio cell-laden alginate beads	Debnath T. et. al. (2015) Developme 3D Alginate Encapsulation for Bette Chondrogenic Differentiation Poten than the 2D Pellet System. J Stem C Res Ther 5:276.

PRACTICAL EVALUATION SCHEME

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

COURSE: MOLECULAR MODELING AND DRUG DESIGNING

COURSE CODE: BI 502	**L**	**T**	**P**	**Hr**	**C**
MARKS: 150	**2**	**0**	**4**	**6**	**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	02
2	Molecular Graphics Representation	Representation of molecules using co-ordinates, Matrices and tables	06
3.	Building of molecules	Building of small molecules, Building of Biopolymers DNA & oligopeptides in different secondary structure	03
4	Molecular File Formats	SMILES, mol, mol2, sdf, pdb etc.	04
5	Optimization of geometries (Molecular Mechanics)	Energy minimization by systematic search method and finding out minimum energy conformation, Gradient based Energy minimization, Molecular Dynamics method, Monte Carlo method, Genetic algorithm and simulated annealing	06
6	Optimization of geometries (Quantum Mechanics)	Schrödinger equation, Derivation, equation for Hydrogen and Helium and for a molecule	06
7	Drug design Methods	Ligand and structure based drug design	03
Total Number of lectures			**30**

METHODOLOGY

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

EVALUATION SCHEME (THEORY)

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

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

PRACTICALS IN MOLECULAR MODELING & DRUG DESIGNING

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

Sr. N	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1.	Molecular Visualization (Small molecu	Basic functioning of the visualiza 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 molecu like Proteins& DNA)	Basic functioning of the visualiza 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 databas 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 an 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 an study of differ file formats	To understand different file form	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 lov energy conformation	http://www.vlifesciences.com/ Chemoffice tutorial (2004) Avagadro (https://dasher.wustl.edu/chem430/software/learnir avogadro.pdf)
7	Molecular dynamics	To know the behavior of molecu with respect to time and tempera	Chem office tutorial (2004) Avagadro

		within specific solvent system	(https://dasher.wustl.edu/chem430/software/learnir avogadro.pdf)
8	QSAR	To know the generation of molec 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_Docki utorial.pdf

PRACTICAL EVALUATION SCHEME

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

COURSE: DISEASE BIOLOGY

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

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

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 Lect
1.	Introduction to nature and investigation of diseases	Introduction to health and disease Characteristi and features of diseases Classification of disea and introduction to epidemiology Investigating diseases: Types of pathology laboratories, role and evaluation of hospital laboratory tests.	5
2.	Pathogens and virulence	Introduction to pathogens, parasites and types infection Types of pathogens : Bacteria, Fungi, Helmintl Prions, Protozoans and Viruses Types and effects of microbial virulence factor (offensive and defensive).	5
3.	Infectious disease and treatments	Bacterial infections of skin, eye, ear, central nervous system and respiratory system Viral infections of central nervous system, respiratory system Sepsis, Prevention and treatment of infections antibiotics, antiviral combination therapy and surgery)	4
4.	Disorders of immune syst	Introduction to the defense system and types o immunodeficiency diseases Signs, symptoms, diagnosis and treatments of i) Primary immunodeficiency diseases: SCID, CVID ii) Autoimmune Disorders: Rheumatoid Arthri Systemic Lupus Erythematosus Basics of Immunological Hypersentivities: Typ to IV	5
5.	Disorders of the endocrin system	Introduction to endocrine system and its disord Signs, symptoms, diagnosis and treatments of disorders linked to	5

		a) Growth hormones –Acromegaly, Gigantism b) Thyroid Glands: Hypothyroidism and Hyperthyroidism c) Adrenal Glands: Addison disorder and Cush 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.	Disorders of digestive an cardiovascular system	a) Introduction to GIT and common disorders Gastritis, Ulcers, Hepatitis Signs, symptoms, diagnosis and treatments of Cholelithiasis and Crohn disease b) Introduction to the circulatory system and common disorders eg: hypertension, cardiac fa and angina Signs, symptoms, diagnosis and treatments of dilated congestive cardiomyopathies and atherosclerosis	4
7.	Disorders linked to aging	Introduction to causes of aging, Basics of age-related disorders eg: Parkinson disorder, Alzhe disorder and Progeria	1
8.	Disease surveillance	Brief history and importance of surveillance in disease management	1
		Total No. of Lectures	**30**

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	15
Attendance	----	5
End Semester Exam	1 hours 15 mins	30
Total		**50**

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 DISEASE BIOLOGY **(2 Hrs. Per Week)**

MARKS: 50

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for refer 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,	Familiarize with the common clinical diagnostic methods.	a) http://www.who.int/topics/diagnostic_techniques_procedures/en/

	Pathology and Microbiology, DPU Medical College and Hospital)#.		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**

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	5

		R Normal Distribution R Binomial Distribution 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
		Total Lectures	**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

Elective I

COURSE: Elective I CANCER BIOLOGY
COURSE CODE: MB 505 **L T P Hr C**
MARKS: 100 **2 2 4**

OBJECTIVE OF THE COURSE:

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:

The course would enable the student to:

- Understand the origin and development of cancer.
- Gain 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
	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.	3
	Cancer progression	Basis of tumour progression, Steps in tumor progression, Cancer stem cell theory for origin of cancer, Classifications, stages and grades of tumors.	3
	Causes of cancer	Chemical carcinogenesis Endogenous & exogenous mutagens, Identification of carcinogens, Tumour initiators & tumour promoters	2
	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, The role of viral genes in cancer progression (DNA tumour virus (SV 40) and human papilloma virus (E6 and E7).	4
	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	4

	Tumour suppressor genes	Molecular basis of tumor suppressor genes including Retinoblastoma (Rb), p53, Adenomatous polyposis coli (APC) in the development and progression of tumor.	4
	Metastasis	Molecular basis of metastasis, steps in cell invasion, intravasation, transport, colonization, angiogenesis.	2
	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
	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	4
		Total	**30**

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.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	1 hour	15
Attendance	----	5
End Semester Exam	1 hours 15 mins	30
Total		**50**

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 hours per week) Marks: 50

Sr. No.	Name of the experimen	Learning objective	Literature/ Weblinks for refere 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**
Practical Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

COURSE: NANOMEDICINE
COURSE CODE: MB 506 **L T P Hr C**
MARKS: 100 **2 0 2 4 3**

OBJECTIVE:

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

LEARNING OUTCOME:

- Comprehend the definitions, basic terms of nanobiotechnology, nanomaterials and nanotools
- Understand the application of nanomedicine in various fields such as cancer therapeutics, neuroscience and drug delivery
- Understand and describe use of different nanostructures to develop scaffolds, implants, and surgical instruments for application in tissue engineering, surgery and nanoparticles based drug delivery
- Define different *in vivo and in vitro* nanodignostics tools for drug and clinical development systems

PRE-REQUISITES:

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

COURSE DESCRIPTION

Sr. No	Topic	Description	Hrs
1	Introduction and Basics	Basics of nanotechnology, nanomaterials and nanoparticles	**3**
2.	Nanoparticles in drug delivery and cancer therapeutics	Types of nanoparticles based drug delivery, Nanoparticles for targeted drug and gene delivery, Nanoparticles and hyperthermal ablation, tumor ablation, in vivo anticancer delivery	**6**
3	Nanofiber based scaffolds and tissue engineering	Composition and types of nanofiber, methods of synthesis of nanofiber, application of nanofibers in tissue engineering	**4**
4	Nanotechnology in neuroscience	Nonmaterial scaffolds for neuroregenerative medicine, and neuroprotection scaffolds.	**4**
5	Nanotechnology and	Implants and surgical instrument design, nonplusses,	**4**
	surgery	Nanocoatings, laser assisted nanosutures, nanofiber based bandage, intracellular nanosurgery	4
6	Nanomaterials for cell	2D and 3D cell cultures, synthetic and natural	**5**

		nanofiber	
	culture	scaffolds, cellularisation of nanofiber and cellular trafficking	
8	Nanodiagnostics	*In vitro* and *In vivo* nanodiagnostics (using gold nanoparticles, nanotubes, and quantum dots) nanobiochips.	**4**
		Total Lecture	**30**

EXAMINATION SCHEME (THEORY)

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

Books recommended:

1) Understanding Nanomedicine: An Introductory Textbook, Rob Burgess, Publisher: Pan Stanford Publishing; ISBN-13: 978-9814316385
2) Bionanotechnolgy: Lesson from Nature, David S. Goodsell, Willey-Liss, First edition, 2004
3) Nanoscale technology in Biological Systems by Ralph Creco, Fritz Prinz and R. Lane Smith; CRC Press, First edition, 2005.
4) Nanobiotechnology: Concepts, applications and Perspectives, Christof M. Niemeyer (editor), Clad AMirkin (Editor), Wiley VCH, First edition, 2004.
5) Nanobiotechnology: Bioinspired Devices and Material of Future by OdedShoseyov and Ilan levy, Human Press, First edition, 2007.
6) Nanobiotechnology protocols (Methods in Molecular biology) by Sandra J Rosenthal David W. Wright, Human Press, First edition, 2005
7) The Nanobiotechnology Handbook, YubingXie, CRC press,
8) 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
9) Introduction to Nanotechnology, Charles Poole and Frank Owen, Wiley, First Edition, 2006
Nanocomposites Science and Technology Pulickel M. Ajayan, Linda Schadler, Paul Braun, Wiley- VCH Verlag, 2003.

PRACTICAL IN NANOMEDICINE (2 Hrs. Per week) MARKS: 50

LIST OF EXPERIMENTS:

1. Preparation of silver nanoparticles by chemical methods.
2. Biological synthesis of silver nanoparticles using plant extract.
3. Characterization of silver nanoparticles by SEM /TEM (Demonstration)
4. Study of antimicrobial activity of silver nanoparticles.
5. Preparation of biomolecule (drug, protein, and gene) conjugated nanocarriers
6. Internalization of nanoparticles in mammalian cells.

EVALUATION SCHEME (PRACTICAL)

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

SEMESTER VI							
MB 601	Biomedical Devices and Instruments	2	0	2	4	3	50, 50
MB 602	Artificial Organs and Biomimetics	3	0	0	3	3	100
HU 601	Health Care Law Management	2	0	0	2	2	50
BT 604	Genomics, Transcriptomics & Proteomics	3	0	4	7	5	100, 100
MB 603	Molecular Diagnostics	2	0	2	4	3	50, 50
BI 601	Artificial Intelligence	1	0	0	1	1	50
MB 604/605	Elective II	3	0	0	3	3	100
	Total	**16**	**0**	**8**	**24**	**20**	
Elective 1I : (Vaccine Technology/ Personalized Medicine)							

COURSE: BIOMEDICAL DEVICES AND INSTRUMENTS
COURSE CODE: MB 601 **L T P Hr C**
MARKS: 100 **2 0 2 4 3**

OBJECTIVE:
The objective of the course is to familiarize the students with various modern biomedical equipments.

COURSE OUTCOME:
At the end of the course, the students will understand basic principle and use of various equipments used in clinics.

PREREQUISITES:
Students must have basic knowledge of physics and electronics as well understanding of human anatomy and physiology.

COURSE DESCRIPTION:

Sr. No.	Topic	Description	Hrs
1	Bioelectric signals and Electrodes	Action potential and Resting potential - Electrodes for ECG, EEG, EMG – Electrode – Electrolyte interface – Half Cell Potential – Different types of amplifies like Bioelectric amplifiers – Isolation amplifiers etc.	**04**
2	Cardiac Activity Measurement Systems	ECG, sources of ECG, Normal and Abnormal waveform, Diagnosis interpretation – ECG Leads – ECG Recorder – Cardiac output measurements	**03**
3	Respiratory System Measurements	Mechanics of breathing – Parameters of Respiration – Respiratory Volume Measurement – Spirometers – Respiratory Gas Analyzers – Oxygen Therapy – Introduction about Ventilators	**03**
4	Instrumentation For Measuring Brain Function	Electroencephalography (EEG) Signal Amplitudes and Frequency Bands – EEG Machine	**04**
5	Biomedical Imaging	Radiography (X-Rray) – Magnetic Resonance Imaging (MRI) – Nuclear medicine – Ultrasound, Endoscope – CT scan	**08**
6	Patient Monitoring Systems	Patient Monitoring Systems – Bedside Monitors – Central Monitors – Measurement of heart rate, – respiration rate and temperature	**04**
		Electric Shock Hazards – Microshock –	

7	Patient safety	Macroshock – Leakage Currents – Types of Leakage currents – Precautions to minimize Electric Shock Hazards-Safety code for Electromedical Equipment	**04**
		Total number of Lectures	**30**

EXAMINATION SCHEME (THEORY)

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

REFERENCES:

1. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Prentice Hall of India, New Delhi, 1997
2. Joseph J Carr and John M Brown, "Introduction to Biomedical Equipment Technology", John Wiley & Sons, New York, 1997.
3. US Patents website, www.freepatentsonline.com.
4. Joseph J Carr and John M Brown, "Introduction to Biomedical Equipment Technology", John Wiley & Sons, New York, 1997.
5. John G Webster, "Medical Instrumentation Application and Design", John Wiley & Sons, New York, 1998.
6. Khandpur R S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 1997.

PRACTICAL IN BIOMEDICAL DEVICES (2 Hrs. Per Week) MARKS : 50

LIST OF EXPERIMENTS

1) Measurement of BP, heart sounds using Electronic Stethoscope and Analysis.
2) Determination of Pulmonary function using Spirometer.
3) Measurement of Respiration rate using Thermistors / other electrodes.
4) ECG Recording and Analysis.
5) EEG Recording and Analysis.
6) EMG Recording and Analysis.
7) X-Ray Image Acquisition and Analysis
8) MRI Image Acquisition and Analysis
9) CT Scan Image Acquisition and Analysis
10) Ultra sound Image Acquisition and Analysis

EVALUATION SCHEME (PRACTICAL)

Examination	**Duration**	**Marks**
Continuous Assessment (Internal)		20
Major test at the end of semester	2 hours	30
Total		**50**

REFERENCES:

1. Joseph J Carr and John M Brown, “Introduction to Biomedical Equipment Technology”, John Wiley & Sons, New York, 1997
2. Laboratory Manual prepared by Department of Biomedical Engineering.

COURSE: ARTIFICIAL ORGANS AND BIOMIMETICS

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

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

OBJECTIVE

The objective of the course is to familiarize the students with different types of technologies used for creation of artificial organs to overcome human disabilities, and the use of biomimetic science in Artificial Organs, Tissue Engineering and other medical applications.

COURSE OUTCOME:

On completion of the course students will:

- Acquire knowledge about design considerations of Artificial Organs
- Have sufficient scientific understanding of different types artificial organs from the more basic types such as prostheses, to more advanced technologies such as operative devices, biohybrid organs, bionics technology.
- Gain knowledge and principles of construction of specific tissue-engineered artificial organs.
- Learn about principles and incorporation of Biomimetics in medically relevant fields
- Have awareness of clinical considerations and ethical issues with respect to Artificial Organs

PREREQUISITES

Students should have studied basic Human Anatomy and Physiology, Tissue Engineering, Animal Tissue Culture.

COURSE DESCRIPTION

Sr. No	Topic	Detailed syllabus	No. of lectures
1	Introduction to artificial org	Introduction, Outlook for organ replacement, Clinical considerations, Substitutive medicine and ethics.	04
2	Engineering Considerations regarding Artificial Organs	Biomaterials and Biocompatibility, Mechanical Properties and Testing, Types of Materials Structure/Function Relationships in Biomaterials Failure Mechanisms in Biomaterials Surface Properties and Host Response (Biocompatibility) Design Principles for Tissue and Blood Contact Artificial exchange systems Power Systems for Implanted Systems Control of Artificial Organs Evaluation Processes	07
2	Organ-like substitutes	Prostheses (eg. Limbs, ocular, heart valves, stents, synthetic vascular grafts, total knee replacement) Non-living external devices (eg. Heart-lung machi ventricular assist devices, haemodialysis machine, peritoneal dialysis and automated artificial wearab kidney, hemofiltration device, artificial pancreas, artificial lung),	08

		Non-living intracorporeal devices (eg. Total artific heart, ventricular assist devices, heart pacemaker, intravascular artificial lung, implantable artificial pancreas)	
3	Specialized types of organ-l technologies	External biohybrid devices (eg. Bioartificial kidne extracorporeal liver assist device, biohybrid lung), Intracorporeal biohybrid devices (eg. Implantable bioartificial liver, kidney), Bionic technology (eg. Bionic ear, eye, arm), brain computer interface technology, Artificial blood, artificial cells, Organs-on-a-chip	08
4	Tissue-engineered artificial organs	Tissue engineered heart valves, blood vessels, myocardial patch, whole heart. Tissue-engineered skin substitutes (different types epidermal, dermal and composite skin replacement burns and non-healing wounds), melanocytes for vitiligo, *in vitro* melanoma model for drug testing. Tissue engineered bone (cells, materials, demineral bone matrix, bone morphogenetic proteins, examp bone substitutes) Tissue engineered cartilage, autologous chondrocy implantation, autologous matrix-induced chondrogenesis, cartilage substitutes Neural tissue engineering (different types of cells involved in nerve repair, peripheral nerve guidance conduits, stem cell therapy for Parkinson's and Alzheimer's disease) Commercialized tissue engineered products	10
5	Biomimetics	Introduction to biomimetics, Biological mechanisms, natural mechanisms and biomimetic structures, biomimicry at the cell-mate interface, Tissue structure and biomimetic applications, biomimetic composites, electroactive polymers, biological functional surfaces, Biomimetic products, biomimetic for medical impl biomimetic applications in medical device design, biomimetic and bioengineering applications, Biomimetics and challenges	08
		Total lectures	**45**

METHODOLOGY

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

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. Artificial Organ Engineering by Maria Cristina Annesini, Luigi Marrelli, Vincenzo Piemonte (Authors), Springer 2016.

2. Tissue Engineering and Artificial Organs: Volume 3 (The Biomedical Engineering Handbook, Fourth Edition) by Joseph D. Bronzino (Author, Editor), Donald R. Peterson (Author), Taylor and Francis 2006.

3. Artificial Organs (New Techniques in Surgery Series) by Nadey S. Hakim (Editor) Springer 2010.

4. Biomimetics: Biologically Inspired Technologies, By Yoseph Bar-Cohen (Editor), CRC Press 2005.

COURSE: HEALTHCARE LAW MANAGEMENT

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

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

OBJECTIVE

The objective of the course is to develop management skills among students focusing healthcare services.

COURSE OUTCOME:

The course would enable the student to understand the management aspect of healthcare services and clinical oriented research.

PREREQUISITES

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

COURSE DESCRIPTION

Sr. No.	Topic	Description	Hours
1	Overview	Need of management in healthcare, management definition, function and competencies.	2
2	Strategic planning	Purpose and importance of planning, SWOT analysis, planning & designing of healthcare facilities**,** role of health care manager	3
3	Healthcare marketing	Marketing basics, history of marketing healthcare, healthcare buyer behavior	2
4	Quality improvement basics	Defining quality in healthcare, key leaders in quality improvement, common elements and tools in quality improvement	3
5	Use of information technology	Use of information system by managers, the electronic medical record, challenges to clinical system adaptation	2
6	Financing health care and insurance	Introduction and history of health insurance, characteristic of health insurance, social insurance, coverage and costs, uninsured	3
7	Cost of healthcare management	Financial management definition and importance, reimbursement from third party, controlling cost and accounting, setting charges; managing working capital, account receivable, budget	5
8	Managing healthcare professionals	Physicians and nurses, home health aids, midlevel practitioners, allied health professionals	2
9	Fraud and abuse	Defining fraud and abuse, antitrust issue, corporate compliance program	3
10	Introduction to healthcare law	Laws related to healthcare, Human material transfer, organ and tissue procurement; sell of body parts, procurement and sell of sperm and ova; laws related to abortions, contraception.	5
		Total	**30**

METHODOLOGY

The entire course is covered through lectures, group discussions and with the help of teaching aids.

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. Introduction To Health Care Management, Sharon B. Buchbinder, Nancy H. Shanks, **Publisher:** Jones & Bartlett Learning; 2 edition, **ISBN-13:** 978-0763790868
2. Management Principles for Health Care Professionals, Fourth Edition, Joan Gratto Liebler, Charles McConnell, **Publisher:** Jones and Bartlett Publishers, Inc.; 4 edition, **ISBN-13:** 978-0763733209
3. Health Care Management and the Law: Principles and Applications: Principles and Applications, by Donna K. Hammaker, Cengage Learning, 2010.
4. Introduction to Health Services Stephen Joseph Williams, Paul Roger Torrens Cengage Learning, 2007

COURSE: GENOMICS, TRANSCRIPTOMICS & PROTEOMICS
COURSE CODE: BT 604 **L T P Hr C**
Total marks: 200 **3 0 4 7 5**

Course Objectives:

The recent proliferation of genomic data has transformed biology, making previously laborious and expensive experiments easier and cheaper, enabling new avenues of inquiry, and fundamentally altering our understanding of biology and medicine. This course will introduce to the questions that can be asked and answered with genomic data, and to the computational tools available to analyze that data.

Learning outcome:

At the end of the course students will have,

- Practical and theoretical skills concerning classical as well as new large-scale and technology-driven approaches in molecular biology
- Ability to discuss and evaluate when and how these methods are best put into use.
- Understanding to describe and differentiate between large-scale analyses at different levels, including genomics, transcriptomics, proteomics, metabolomics, metagenomics and systems biology.

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

S.No.	Units	Details	No of lectures
1.	Genomics	Structure and organization of prokaryotic and eukaryotic genomes- nuclear, mitochondrial and chloroplast genomes. Databases different types DNA databases, Tools for finding genes and regulatory regions.	4
2.	Transcriptomics	Concepts of transcriptomics and its scope.	2
			1
		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).	4
3.	Microarray technic Genomics Transcriptomics	• Basic principles and design of cDNA and oligonucleotide arrays, DNA microarray. Basic steps involved in designing a microarray experiment.	3
			3
			1
			2
		• 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.	3

		• Microarray databases – NCBI; GEO (Gene Expression Omnibus), Array Express (EBI); • Functional Analysis: Gene Ontology functional enrichment tools, Pathway analysis (KEGG Database)	
4.	Sequencing techn in Genomics transcriptomics	Next Generation sequencing (NGS): Introduction to NGS, overview and comparison of different Sequencing Platform (Illumina, 454 (Roche), SOLiD (Life technology), Specific Biosciences, Ion Torrent, Nanopore, PacBio. Types of NGS: DNA-sequencing (Whole genome sequencing), exome sequencing, Deep sequencing, ChIP sequencing, RNA-sequencing (Whole transcriptome sequencing, WTS).	4
			2
5.	Proteomics:	What is proteomics?; proteome complexity; Overview of protein structure-primary, secondary, tertiary and quaternary structure. , Clinical and biomedical applications of proteomics. Post translational Modifications (PTMs): Different type of PTMs, Quantitative proteomics, clinical proteomics and disease biomarkers, mass spectral tissue imaging and profiling Bioinformatics tools in Proteomics: Protein database, Relationship between protein structure and function.Track emrging diseases and design new drugs	2 3 4
6.	Metabolomics	An overview, basic sample preparation strategies-extraction, derivatization. Workflow for lipidomics; Targeted Vs Untargeted metabolomics; development of targeted assays for small molecules, Metabolomic Data Analysis:Peak detection, retention time alignment; identification of molecular features and metabolites; Structural confirmation of metabolites. Software- Multiquant, MZmine, XCMS, MarkerView,	4
7.	Techniques in Protein and Metabolite Identification	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	3
			45

Methodology:

The course will be covered through lectures supported by tutorials and practicals. In tutorials, apart from the discussion on the topics covered in lectures, assignments in the form of questions will be given.

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 text Books:

1.Principles of gene manipulation and Genomics Primrose S.B. and RM Twyman R.M.edi VII, 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.WMount Cold Spring Harbour Laboratories (CSHL) 2004
5. Discovering Genomics, Proteomics and Bioinformatic A. Malcolm Campbell , Laurie J. Heyer Benjamin Cummings; 2 edition (2006)

PRACTICAL IN GENEOMICS, TRANSCRIPTOMICS & PROTEOMICS(4 HRS) 100 MARKS

Sr. No	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1.	To determine genome size & genome complexity by Cot curve analysis	To study % GC content and repetitive DNA in the given sample	Molecular Cloning Sambrook J Green MR 2016 V edition.CSH
2.	To perform zoo blotting.	To investigate coding & non coding region s in the given zoo DNA samples.	
3.	Analyze microarray & RNA seq data	To learn expression profiling by microarray & RNA seq in the given genome/transcriptome data.	
4.	To carry out quantitative real time PCR (qRT-PCR)	To learn quantification of DNA	microRNA.gene.quantification.i
5.	To Isolate and analyse microRNA using polyacrylamide gel or PCR	To learn gene regulation using small RNA	microRNA.gene.quantification.i
6.	To predict possible microRNAs targeting the gene of interest.	Learn to locate target microRNAs by genome wide scanning	http://www.targetscan.org/vert_ http://mirdb.org & http://www.exiqon.com/micrrna target- prediction.
7.	To Perform DNA sequencing	To know the DNA/RNA sequence for finding gene of interest	www.nanopore technologies.co
8.	To Perform 2D gel electrophoresis & identification of the protein/peptide by MALDI	To resolve total set of proteins present ina mixture and identify proteins using mass spectrometry	Proteomics in Practice ; A guide successful experiment design Re Westermeier,Tom Naven Hans-Rudolf Hopkin Edition II Wiley VCH
9.	To carry out DNA sequence analysis from the available profile.	To identify DNA DNA elements in the given DNA sequence for structural /functional annotation	www.ncbi.nlm.nih.gov/genbank
10.	Genome Databases.	Ensemble, TIGR, Flymine	http://plantta.jcvi.org/ www.flymine.org/ www.ncbi.nlm.nih.gov/genbank https://www.ebi.ac.uk/embl/ www.ddbj.nig.ac.jp/

PRACTICAL EVALUATION SCHEME

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

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

COURSE: MOLECULAR DIAGNOSTICS

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

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

OBJECTIVES

The objective of the course is to make students understand how various molecular techniques/assays could be employed for improved diagnosis and prognosis of various human genetic disorders and infectious diseases. These studies could also shed light on the mechanisms of pathogenesis in various diseases.

COURSE OUTCOME:

On completion of the course students will be able to:

- Understand various medical diagnostic techniques.
- Understand the applicability of different diagnostic techniques for different medical conditions

PREREQUISITES

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

Sr. No	Topics	Detailed syllabus	No. of Lectures
1	Introduction to Molecular Diagnostics	History and evolution of diagnostics, Significance and scope of molecular diagnostics.	2
2	Chromosomes, Cytogenetic Analysis	Analyses of genome and chromosomal mutations; banding of chromosomes and karyogram analysis, Chromosome painting and spectral karyotyping for cancer, Fluorescence *in situ* hybridization (FISH) (with reference to diagnosis of Chronic myelogenous leukemia), Comparative genomic hybridization (CGH).	7
3	DNA Diagnostics	PCR-based detection of microbes and aneuploidy (with reference to diagnosis of Down syndrome), ARMS-PCR (with reference to diagnosis of Cystic fibrosis), Southern blotting based diagnostics (for Fragile X syndrome), and DNA sequencing (Sanger and NGS methods).	5
4	Clinical Diagnostics	Molecular detection of inherited diseases; Sickle cell disorders, Tay-Sachs disorder, Hemophilia A, Huntington chorea.	5
5	Emerging Diagnostic Techniques	Microarrays, FACS, Lab-on-a-Chip approach for molecular diagnosis, Introduction to SELDI-TOF and diagnostic proteomics	4
7	Biomarkers in Disease Prediction and Diagnosis	Introduction to disease markers, FDA definition of disease biomarkers, Difference between diagnostic and prognostic biomarkers, sources for disease markers, Role of predictive biomarkers in prognosis of diseases, Emerging disease biomarkers (eg. Metabolic markers), sepsis,	7

		diabetes and cancer (eg. Breast cancer) and molecular oncologic prediction.	
Total Lectures			**30**

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	15
Attendance	----	5
End Semester Exam	1 hours 15 mins	30
Total		**50**

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 chromosome number,	https://www.creative-biolabs.com/fluorescent-in-situ-hybridization-FISH.html

		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:

PRACTICAL EVALUATION SCHEME

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

COURSE: VACCINE TECHNOLOGY (ELECTIVE II)
COURSE CODE: MB 604 **L T P Hr C**
MARKS: 100 **3 0 0 3 3**

OBJECTIVE OF THE COURSE:

The objective of the course is to develop the concept behind vaccine production and development.

LEARNING OUTCOME:

The course would enable the student to understand the recent advances in vaccine technology that is involved in discovery and development of new vaccines.

PREREQUISITES:

Knowledge of immunology, cell and molecular biology is required**.**

COURSE DESCRIPTION

Sr. No	**Topic**	**Description**	**Hrs**
1	Introduction	Concept and scope of modern vaccine.	2
2	Principles of Vaccine Design	Stimulation of innate immunity, antigen processing and presentation, mucosal immune system, role of adjuvants, immunological memory, mouse and primate as models for vaccine design, e.g. vaccine for HIV.	8
3	Antigen Discovery	Computational approach for vaccine discovery and design, high throughput proteomic screening, phage library, biophysical characterization of vaccine formulations.	8
4	Antigen Engineering	Attenuated bacteria vaccine, antigen scaffold, recombinant MVA vaccine, adenovirus, avipoxvirus, cancer immunotherapy, nucleic acid vaccination, artificial antigen presenting cells.	10
5	Delivery Systems	Vaccine patch deliver system, needle free jet injection system, oral vaccine, ISCOMs, virus like particles, nanoparticles.	6
6	Evaluating Vaccine Efficacy	Formulation optimization and stability evaluation, immune monitoring design, clinical developmental strategy.	5
7	Implementing Immunizations	Mass immunization strategy, types of vaccination strategies, filing procedures of Investigational New Drug (IND), vaccine safety.	6
Total lectures			**45**

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

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. Vaccinlogy: Principles and Practice. By (Ed) W W. John W. Morrow (Editor), Nadeem A. Sheikh (Editor), Clint S. Schmidt (Editor), D. Huw Davies (Editor), Publisher**:** Wiley-Blackwell; ISBN-13: 978-1405185745.

2. Development of Vaccines: From Discovery to Clinical Testing, Manmohan Singh (Editor), Indresh K. Srivastava (Editor), Publisher**:** Wiley-Blackwell; ISBN-13: 978-0470256374.

COURSE: PERSONALIZED MEDICINE (ELECTIVE II)

COURSE CODE: MB 605 **L T P Hr C**
MARKS: 100 **3 0 0 3 3**

OBJECTIVE:
The objective of the course is to develop a thorough understanding of treatments that are tailor-made to counter diseases and suit individual health requirements for effective treatment, based mainly on the differences among the molecular background of individuals.

COURSE OUTCOME:
On completion of the course students will:

- Understand the complex human genomic structure, either at the static or the dynamic level
- Translate the human genomic context into specific diagnosis and treatment for a given disease by using specific methods of analysis
- Utilize specialized databases for the retrieval of genomic data and translate them into Pharmacogenomics and Pharmacogenetics applications
- Understand the basic principles governing the rational drug design, RNA-based therapeutics, gene editing systems and artificial intelligence platforms and their applications for tailored diagnosis and treatments
- Appreciate the importance and implications of personalized medicine in providing individualized treatment for various health conditions and understand its impact in futuristic healthcare.

PREREQUISITES
This course is advanced in nature, thus, a sound knowledge of molecular biology, genetics and genetic engineering is required.

COURSE DESCRIPTION

Sr.	Topic	Detailed syllabus	No. of lect
1	Introduction to personalized medicine	History and evolution of personalized medicine Structure and dynamics of human genome and epigenome Understanding genetic variations in the context of human diseases Concepts in pharmacogenomics and pharmacogenetics	4
2	Basis for the development of personalized medicine	Adverse drug reactions and distributions of genetic polymorphisms influencing drug efficacy. Basis of pathological and neutral genomic variations, ethnic and gender variations in drug metabolism for clinical applications. Personalized approach to environmental factors in disease. Molecular Diagnostics as basis for personalized medicine.	7

3	Omic Technologies and Molecular Biomarkers	Introduction to Omics Technologies, Pharmacoproteomics, Metabolomics in personalized medicine. Different types of molecular biomarkers as effective predictive tools for drug responses in clinical practice	6
4	Advanced therapeutic strategies	Designing a personalized protocol for diagnosis and treatment of human diseases. Personalized Biological therapies: i) RNA-based therapeutics and genome editing techniques, description of drug delivery systems, use of cell therapy and iPSCs. ii) Gene therapy approaches in personalized medicine. iii) Personalized vaccines. Artificial Intelligence, Computer Aided Drug Design (CADD), Genome Wide Association Studies (GWAS) in developing personalized medicine. Personalized Approaches to treating inherited diseases	7
5	Additional elements in development of personalized medicine	Involvement of Non-genomic and Epigenomic factors, Circadian rhythms, Gut microbiome and Molecular imaging in development of personalized medicine Roles of Genetic Banking systems and Bioinformatics, general databases (dbSNP, Clinvar and OMIM) and integration of technologies in development of personalized medicine.	7
6	Case studies in personalized medicine	Case studies of the application of personalized medicine in Cancer, Pain relief and Cardiology. Personalized Management of Neurodegenerative disorders (Parkinson and Huntington disease), HIV infection, Lactose intolerance.	7
7	Ethics, Economics and Future of Personalized Medicine	Ethical issues in: Pharmacogenetics and Whole genome analysis, Genotype-specific clinical trials. Social and privacy issues. Affordability of personalized medicine, Personalized medicine and Orphan Drugs. Personalized prognosis of disease, Personalized preventive medicine, Pharmacotyping, Challenges in delivery of personalized medicine.	7
Total lectures			**45**

METHODOLOGY:

The entire course will be covered through lectures, group discussions and with the help of teaching aids.

EVALUATION SCHEME (THEORY)

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

BOOKS RECOMMENDED

1. Kisor DF et al (2013) Pharmacogenetics, Kinetics, And Dynamics For Personalized Medicine 1st Edition, Jones & Bartlett Learning.

2. Jain KK (2009) Textbook of Personalized medicine, Springer-Verlag New York.

3. Trent RJ (2012) Molecular Medicine - Genomics to Personalized Healthcare, Academic Press, USA.
4. Handbook of Personalized Medicine: Advances in Nanotechnology, Drug Delivery, and Therapy 1st Edition. Vizirianakis, IS (Ed.), Jenny Stanford Publishing 2014.

SEMESTER VII							
MB 701	Clinical Trials	2	0	0	2	2	50
MB 702	Forensic Biotechnology	2	0	2	4	3	50, 50
HU 703	Entrepreneurship and skill development	2	0	0	2	2	50
MB 703	Metabolic Engineering and Systems Biology	3	0	2	5	4	100, 50
MB 704	Seminars in Medical Biotechnology	3	0	0	3	3	100
MB 705/706	Elective III	3	1	0	4	4	100
	Total	**15**	**1**	**4**	**20**	**18**	
Elective III : (Biomechatronics/ Epidemiology and Public Health)							

NAME OF THE COURSE: CLINICAL TRIALS

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

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

OBJECTIVES:

- To familiarize the student with the basic concepts of clinical trials
- To provide the knowledge for designing a clinical trial

COURSE OUTCOME:

- 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 anticipate the ethical requirements as well as ethical guidelines related to carrying out a clinical trial
- Would be able to design a clinical trial for a given intervention

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 and Ethical issues	History & background of origin of clinical research; Drug development process and phases of clinical trials (CT); Terminologies used in clinical research; Ethics in clinical research	4
2.	Design of the study	Selection of questions; Defining study population; Type of study designs- randomized and nonrandomized control trials, Databases, Cross-over, Factorial, Group allocation, Hybrid design etc.	5
3.	Randomization and blinding	Types and mechanics of randomization; Types of blinding in trials and methods of protecting blind design; Bias control procedures; Stratification; Variance control	3
4.	Initializing recruitment	Sample size calculation and the importance of sample size; Recruitment of participants; Baseline assessment	4
5.	Data management and analysis	Quality monitoring of the data; Minimizing poor quality data; Data analysis; competing events; co-variance adjustment; Subgroup analysis; Cut-points; Meta-analysis	4
6.	Impact analysis	Determination, analysis, and reporting adverse effect; Assessment of health-related quality of life; Adherence monitoring; Estimation and comparison of survival curves.	4
7.	Close-out, reporting and interpretation of results	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	6
		TOTAL	**30**

METHODOLOGY:
The course will be covered through lectures and discussion of case studies.

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. 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, 2012. ISBN 978-1-1182-1846-4, Publisher Wiley.Principles and Practice of Clinical Research 4th Edition ,
3. Gallin J, Ognibene F, Johnson L.L. 2017. ISBN 978-0-1284-9905-4, Academic Press
4. Design and Analysis of Clinical Trials: Concepts and Methodologies, 3rd Edition , Shein-Chung Chow, Jen-Pei Liu, 2013 ISBN: 978-0-470-88765-3, Publisher Wiley

NAME OF THE COURSE: FORENSIC BIOTECHNOLOGY

COURSE CODE: MB 702 **L T P Hr C**
MARKS: 100 **2 0 2 4 3**
OBJECTIVE:

- The objective of the course is to
- Introduce students to modern forensic science.
- Accredit students with various branches and wide reach of Forensics Science
- Equip students to perform basic forensic analysis.

COURSE OUTCOME:

- The course would enable the students to
- Understand various dimensions of Forensic science.
- Apply medical biotechnology knowledge in various fields of forensic science.
- Apply modern techniques in forensics such DNA finger printing and blood stain analysis

PREREQUISITES:

Since the course is advance in nature, knowledge in biochemistry, genetics & molecular biology is essential to take the course.

COURSE DESCRIPTION:

Sr No	Chapter	Description	Hour
1	Introduction	Scope of Forensics. History of Forensics - Locard's exchange principle. Services offered by Forensic Labs.	2
2	Nature of Evidence	Types of evidence. Collecting evidence	4
3	Forensic Anthropology, Forensic Entomology, Forensic Odontology	Names of Major Human Bones, Identifying, understanding and collecting information about the crime scene using the Skeletal remains Understanding the relation between Insects and dead body Basic principle of Forensic Odontology, History of FO, Identification and Bite marks in theory.	6
4	Forensics Pathology & Forensic Serology	Basics of Forensic Pathology - Algor Mortis, Rigor Mortis, Post mortem lividity, Decomposition. ABO blood types & their inheritance. Blood Spatter analysis.	5
5	Fingerprints	Introduction to Fingerprints, Fingerprint pattern, Collecting and matching fingerprint evidence.	3
6	DNA analysis and DNA	Analysis of DNA using RFLP, RAPD. STR based DNA	5

	fingerprinting	fingerprinting, Mitochondrial DNA analysis.	
7	Drugs, Toxins and Alcohol	Abuse and effects of - Barbiturates, Opiates, Stimulants, Hallucinogens. Alcohol & it relationship to human anatomy & metabolism.	5
		TOTAL LECTURES	**30**

METHODOLOGY:

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

EVALUATION SCHEME (THEORY):

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

BOOKS RECOMMENDED:

1. The essentials of Forensic Medicine and Toxicology, by K S Narayan Reddy, 34th Edition 2017.
2. An Introduction to Forensic DNA Analysis, 1st Edition by Norah Rudin and Keith Inman, Publisher: CRC Press; ISBN-13: 978-0849381171, 2011
3. Fundamentals of Forensic DNA Typing, by John M. Butler, 2nd Edition, Publisher: Academic Press; ISBN-13: 978-0123749994, 2015.
4. Forensic Odontology , Principles & Practice by Taylor & Keiser, 1st Edition, Reprint 2016

PRACTICAL IN FORENSIC BIOTECHNOLOGY: (2 Hrs. Per Week) MARKS: 50

Sr N	Name of experiment	Learning objectives
1	Isolation of genomic DNA from body fluid/blood of different individuals and comparing the band pattern after restriction digestion.	To study genetic dissimilarities between individuals.
2	To amplify the DNA from body sample using PCR	To learn to amplify genomic DNA from unknown sources
3	To identify Drug/Poison from individual body fluid by using TLC/ Immunological method	To identify the drug and poison specifically using chromatography.
4	To study and detect the fingerprint using ninhydrin and compare fingerprints of two different individuals.	To identify the variations and patterns in finger prints between different individuals.
5	To Study hair sample of different origin/species under microscope.	To study hair sample of different origin
6	(a)To study and analyze the Blood stain pattern created from increasing height on various surface. (b)To determine the angle of blood and its point of origin.	To understand the Blood stain patterns created at crime scene
7	To identify the blood using Kastle Meyer Test	To know if the unknown stain is blood.
8	Demirjian's age estimation technique	To determine age using Forensic Odontology Principle

METHODOLOGY :

The course will be covered through practical work supported by field study.
They would be taught basic techniques in forensic science laboratory.

PRACTICAL EVALUATION SCHEME:

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

COURSE: ENTREPRENEURSHIP AND SKILL DEVELOPMENT
COURSE CODE: HU 703 **L T P Hr C**
MARKS: 50 **2 0 0 2 2**

COURSE OBJECTIVES:

The objective of the course is:

- to develop the basic skills in students to kickstart their career.
- to get students accustomed with management skills.
- to developing entrepreneurial skills in the students.

COURSE OUTCOME:

At the end of the course students will be:

- well aware of work culture in a corporate and research organization.
- well equipped with all the things required to be a successful entrepreneur.
- will be more confident to develop and implement the same policies in their
- professional endeavours.

PREREQUISITE:

This is an application based and self-developing course, so students must have an understanding of all the application oriented subject such as Food Biotechnology, RDNA Technology, Plant Biotechnology, Cancer Biology, Pharmaceuticals and Drugs research. Apart from technical subjects students should be well aware of soft skill like communication.

COURSE DESCRIPTION:

Sr No	Topic	Description	Hrs
1	Skill Development	Soft Skills - Definition, Importance, Identifying and Improving your soft skills.	2
		Self-Discovery - Importance of knowing yourself, Process of knowing yourself, SWOT analysis.	2
		Etiquette Attitude Manners - Good and Bad manners at Workplace	3
		Preparing CV/Resume.	1
		Interview Skills Group Discussion	2
		Time Management Stress Management	2
2	Entrepreneurial Development	Preparation of Business plan for Biotech Start-up Importance of Licensing Technology/Research Raising money from Venture Capitalists Government Grants	6
		Introduction to Management- Management and Manager Definition, Role of Manager. Human Resources management -Definition, Functions and Objectives.	6

		Marketing - Introduction to Marketing Management, Role of Marketing Manager.	
		Customers and Competitors Current challenges in an Organization Diverse and Global work force Partnerships and Strategic Alliances	6
		Total Lectures	**30**

METHODOLOGY:

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

EVALUATION SCHEME (THEORY):

Examination	**Duration**	**Marks**
Internal	45mins	15
Attendance		05
End Semester Exam	1hr 14mins	30
	Total	**50**

BOOKS RECOMMENDED:

1) Principles and Practice of Management - by L M Prasad, 9th Edition, 2015
2) Principles of Management - by P C Tripathi and P N Reddy, 6th Edition, 2017.
3) Soft Skills - by K Alex, Second edition, 2011
4) Developing Communication skills - by Krishna Mohan& Meera Banerji, 2nd Edition, 2017

COURSE: METABOLIC ENGINEERING AND SYSTEMS BIOLOGY

COURSE CODE: MB 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 learn that how complex regulatory mechanisms at multiple levels control the dynamics of the cellular metabolism.
- The course will cover examples of successful engineering strategies used for the production of commercially important primary and secondary metabolites or recombinant proteins.
- The course will also enable students to gain insights into the field of systems biology.

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	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.	10
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.	07
3	Experimental determination of metabolic fluxes.	C13 labeling, NMR and GC-MS based methods for flux determination.	04
4	Industrial applications of	Pathway engineering strategies for overproduction of some commercially important primary and secondary metabolites	06

	metabolic engineering.	(e.g. amino acids, organic acids, alcohols and therapeutic compounds) or industrially relevant enzymes and recombinant proteins, bioconversion- applications and factors affecting bioconversion, regulation of enzyme production, strain selection and improvement, the modification of existing or the introduction of entirely new metabolic pathways.	
5	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
6	Introduction to Systems Biology.	Introduction of the systems approach to biology, Definition of system and elements of systems biology, Modeling in systems biology, key properties of biological systems/ models, Systems level understanding of biological systems, High throughput screens in cellular systems, Introduction to network biology.	08
Total Lectures			**45**

METHODOLOGY:

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

EVALUATION SCHEME (THEORY):

Examination	**Duration**	**Marks**
I Internal Exam	1 hour	20
II Internal Exam	45 minutes	15
Attendance		5
End Semester Exam	02 hours 30 minutes	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. Systems Biology, a Textbook by Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Wiley-BlackWell Publications, 2009.
9. Systems Biology in Practice: Concepts, Implementation and Application by EddaKlipp, Ralf Herwig, Axel Kowald, Christoph Wierling, Hans Lehrach, , Wiley VCH, 2005.

PRACTICAL IN METABOLIC ENGINEERING AND SYSTEMS BIOLOGY

(2 Hrs. Per Week) MARKS: 50

Sr. N	Name of the experiment	Learning objective	Literature/ Weblinks for referenc and videos
1.	Develop engineering strategies to boost production of industrially relevant compound in E. coli	To develop engineering strategies to boost production of industrially relevant compound in E. coli.	The Metabolic Pathway Engine Handbook: Tools and Applicatior Christina D. Smolke, CRC Press, 2
2.	Strain engineering (deletion or overexpression of genes) to boost production of target compound followed by metabolite extraction and quantification.	To boost production of target compound by strain engineering (deletion or over-expression 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/
8	BioModels	To learn repository of mathematical models of biological and biomedical systems	https://www.ebi.ac.uk/biomodels/

9	Cell Designer	To learn to model Biochemical Network.	http://celldesigner.org/
10	Complex Pathway Simulator (COPASI)	To learn powerful tool for the systemic analysis and simulation of mathematical models based on differential equations.	http://copasi.org/

PRACTICAL EVALUATION SCHEME :

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

NAME OF THE COURSE: SEMINARS IN MEDICAL BIOTECHNOLOGY

COURSE CODE: MB 704	**L**	**T**	**P**	**Hr**	**C**
MARKS: 100	**3**	**0**	**0**	**3**	**3**

OBJECTIVES:

- 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: BIOMECHATRONICS
COURSE CODE: MB 705 **L T P Hr C**
MARKS: 100 **3 1 0 4 4**

OBJECTIVES:

- Advance students' knowledge in the frontier and upcoming area of Biomechatronics.
- Familiarize students with the principles and applications of Biomechatronics in the medical field.
- Provide an understanding of Biosensor technology and its applications.

COURSE OUTCOME:

- Acquire knowledge about design elements and considerations in Biomechatronics.
- Understand the principles and working of Physical Intelligence and neural networks.
- Gain knowledge about use of Biomechatronics in Artificial support systems in different spheres of health and medicine.
- Learn about specialized Biomechatronics at molecular/cellular level, in surgery and Bio-inspired technologies.
- Learn the fundamentals of Biosensor technology and its applications.

PREREQUISITES:

Students should have studied basic Human Anatomy and Physiology, Artificial Organs and Biomimetics, Electronics, and Engineering Mechanics.

COURSE DESCRIPTION:

Sr. No	Topic	Detailed syllabus	No. of lectur
1	Introduction	Definition of Biomechatronic products, Applying mechatronic theory to Biotechnology; Kinematics and Dynamics, Introduction to Biomechatronic Design methods and tools.	05
2	Elements of Biomechatronics	Conventional actuators, Synthetic muscles, Electroactive polymers, Shape-memory alloys and Shape-memory polymers, Variable stiffness/Impedance actuators, Biological actuators (muscles), Natural sensors, Sensory receptors, Synthetic biological and non-biological sensors, Sensor fusion and integration, Systems for sensory feedback, Transducers and Signal processing.	08
3	Control, Physical Intelligence, Neural Interface	Physical intelligence, Control and artificial intelligence, Machine learning, Data mining, Biological Neural networks, Electrical Recording and stimulation, Optical recording and stimulation.	06
4	Artificial Support syst	Orthopaedic devices, neuromodulation, Advanced prosthetics, Powered orthotics, Exoskeletons, exomusculature, exosuits; Physical therapy and rehabilitation, Advanced wheelchairs, Assisted walking,	08

		Feeding and hygiene systems, Assistive robotic arms; Robotic Nurses, Robotic massage, Vocational aid; Biomechanics and Biomechatronics in sports & exercise.	
5	Highly specialized Biomechatronics	Molecular and cellular level, Micro- and nanorobots, Robotic surgery, Bioinspired Robotics (Bioinspiration; Bioinspired Locomotion, manipulation, Soft-robotics; Algorithmic bioinspiration).	06
6	Supplementary applications applying Biomechatronics appr	Blood glucose sensors, Surface Plasmon Resonance Biosensor Devices, Diagnostic Device for *Helicobacter pylori* Infection, Microarray devices, Cellular and Tissue Engineering Bioreactors, Stem Cell Manufacturing, Bioartificial Organ-Simulating Devices.	05
7	Biosensors	Principles in various biosensors, elements of biosensors; Types of biosensors based on biological recognition elements; Types of biosensors based on types of transducer; Applications of biosensors, characteristics of ideal biosensors; Introduction to biosensor instrument	07
		Total lectures	**45**

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

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. Biomechatronics 1st Edition by Marko Popovic (Author), Academic Press 2019.
2. Handbook of Biomechatronics 1st Edition by Jacob Segil (Editor), Academic Press 2018.
3. Biomechatronics in Medicine and Healthcare 1st Edition by Raymond Tong Kaiyu (Editor) Jenny Stanford Publishing 2011.
4. Biomechatronic Design in Biotechnology: A Methodology for Development of Biotechnological Products by Carl-Fredrik Mandenius, Mats Björkman (Authors), John Wiley & Sons Inc. 2011.
5. Biosensors: Essentials, by Gennady Evtugyn **(**Author) Springer 2014.

NAME OF THE COURSE: EPIDEMIOLOGY AND PUBLIC HEALTH

COURSE CODE: MB 706	**L**	**T**	**P**	**Hr**	**C**
MARKS: 100	**3**	**1**	**0**	**4**	**4**

OBJECTIVES:

The objective of this course is to familiarize students with

- The discipline of public health, the science of disease prevention in populations
- The science of epidemiology, a key discipline of public health studies
- Recent strategies and measures used in addressing current public health issues

COURSE OUTCOME:

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

1. Describe epidemiologic methods and approaches for investigating health and disease in populations
2. Explain the applications of epidemiologic methods in biomedical and public health research
3. Understand the multifactorial and interdisciplinary nature of the field of public health.

PREREQUISITES: Basic knowledge of communicable, non-communicable diseases, diagnostic procedures and biostatistics.

COURSE DESCRIPTION:

Sr. No	**Topics**	**Detailed syllabus**	**No. of Lectures**
1	The discipline of public health and its history	The science and practice of public health, Origin of the field of public health, Distinction between medicine and public health	3
2.	Health and disease	Concept of health, WHO definition, Disease causation models, Epidemiological triad, Natural history of disease, Risk factors, Risk groups	4
3.	Population-level disease measures	Measurement of morbidity and mortality: Incidence, Prevalence, Age adjustment	4
4.	Global and Indian health data	Sources of data, Global health databases, Sources of health data in India	3
5.	Global health and Health transition	Global Health status, Epidemiological transition, Demographic Transition, Health indicators of India	4
6.	The science of epidemiology	Aims, approaches and its applications.	3
7.	Epidemiological study designs	Descriptive studies [cross-sectional, case control, cohort] and Analytical studies [randomized controlled trials or RCT] Predictive value of diagnostics (Test validity: sensitivity, specificity, positive predictive value and	6

		negative predictive value of a screening and diagnostic test)	
8.	Ethical and regulatory issues in conducting human studies	Ethics: History, Nuremberg code, Helsinki declaration, ICMR guidelines, New Drug Regulation Rules 2019, IBSC, DBT-ICMR guidelines on Stem Cell Research	2
9.	Applications of epidemiology I :Prevention of diseases	Primary (specific protection eg. vaccines, health promotion eg. public health messaging), secondary (screening and early case detection) and tertiary prevention (disability limitation through appropriate medical and other services)	6
10.	Applications of epidemiology II : Investigation of disease outbreaks	Definitions, Epidemic curves, Steps in investigation, Endemic, Epidemic, Pandemic Herd Immunity and Ro, Case studies – the SARS-Cov-2 pandemic	8
11.	Public Health System	Organization of the Indian health system and its implications	2
			45

METHODOLOGY:
The course will be covered through lectures and case studies.

EVALUATION SCHEME (THEORY):

Examination	**Duration**	**Marks**
Internal	45 minutes	35
Attendance		5
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1. Oxford textbook of Public Health 6th Edition, 2015, Roger Detels, Martin Gulliford, Quarraisha Abdool Karim, and Chorh Chuan Tan ISBN-13: 9780199661756, Publisher: Oxford University Press
2. Gordis Epidemiology 6th Edition, 2019, Celentano David D. and Szklo M.M , ISBN: 978-0-323-55229-5, Publisher: Elsevier
3. Park's Textbook of Preventive and Social Medicine 25th Edition 2019, K. Park,, ISBN: 9780195647068, 9780195647068, Publisher : Bhanot publishing House
4. Public Health and Epidemiology at a Glance, 2nd Edition, 2016, Margaret Somerville, K. Kumaran, Rob Anderson, ISBN: 978-1-118-99932-5, Publisher: WileyBlackwell
5. US Dept of Health and Human Services, CDC Principles of Epidemiology in Public Health Practice 2012
6. The Bulletin of the World Health, Publisher :World Health Organization
7. The New England Journal of Medicine, Publisher: Massachusetts Medical Society (United States)

Semester VIII	
MB 801: Research Project/ Industrial Training/ Review writing (5 months)	**20 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