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

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DR. D. Y. PATIL BIOTECHNOLOGY & BIOINFORMATICS INSTITUTE

TATHAWADE, PUNE

SYLLABUS FOR

M. TECH. (INTEGRATED) BIOTECHNOLOGY

2018-19

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

COURSE STRUCTURE FOR M. TECH. (INTEGRATED) BIOTECHNOLOGY

SEMESTER I						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BS 101	Physics	3	0	2	5	4
BS 102	Chemistry	3	0	4	7	5
BT 101	Electronics & Instrumentation Engineering	2	0	2	4	3
BI 101	Computers & C Programming	2	0	4	6	4
HU 101	Communication Skills	1	2	0	3	3
BS 103	Maths I – Mathematics	3	0	0	3	3
BT 102	Engineering Graphics	1	0	2	3	2
Total		**15**	**2**	**14**	**31**	**24**
SEMESTER II						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT 201	Biochemistry	3	0	4	7	5
BT 202	Cell Biology	3	0	2	5	4
BS 201	Maths II -Statistics	2	0	2	4	3
BT 203	Engineering Mechanics	2	0	2	4	3
BS 202	Environmental Sciences	2	0	2	4	3
HU 201	Disaster Management*	0	1	0	1	-
Total		**12**	**1**	**12**	**25**	**18**
Audit course, attendance is must						
SEMESTER III						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT 301	Analytical Techniques	3	0	4	7	5
BT 302	Microbiology & Virology	3	0	4	7	5
BT 303	Genetics	3	0	2	5	4
BI 301	Concepts in Bioinformatics	2	0	4	6	4
BT 304	Biosafety, Bioethics & IPR	2	0	0	2	2
Total		**13**	**0**	**14**	**27**	**20**
SEMESTER IV						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT 401	Molecular Biology	3	0	4	7	5
BT 406	Animal Tissue culture	2	0	2	4	3

BT 403	Plant Biotechnology	3	0	4	7	5
BT 404	Immunology	3	0	2	5	4
BT 405	Developmental Biology	3	0	2	5	4
Total		**14**	**0**	**14**	**28**	**21**
SEMESTER V						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT 501	Environmental Biotechnology	2	0	2	4	3
BT 502	Recombinant DNA Technology	3	0	4	7	5
BT 503	Biochemical Engineering & Bioprocess Technology	3	1	4	8	6
BT 504	Enzymology & Enzyme Technology	2	0	2	4	3
HU 501	Personality & Skill Development	2	0	0	2	2
BT 505/506/507	Elective-I	3	0	2	5	4
		15	**1**	**14**	**30**	**23**
Total						
Elective I (Biopharmaceuticals/ Clinical Research/ Disease Biology)						
SEMESTER VI						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT 601	Food Biotechnology	3	0	2	5	4
BT 602	Marine Biotechnology	2	0	2	4	3
BT 603	Basic Pharmacology & Toxicology	2	1	0	3	3
BI 601	Molecular Modeling & Chemoinoformatics	3	0	2	5	4
BT 605/606	Elective II	3	0	2	5	4
Total		**13**	**1**	**8**	**22**	**18**
Elective II (Perl & Bioperl / Structural Biology)						
SEMESTER VII						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT 705	Molecular Cell Signaling	2	0	0	2	2
BT 701	Nanobiotechnology and Biosensors	2	0	2	4	3
HU 701	Principles of Management & Entrepreneurial Developments	2	0	0	2	2
HU 702	Quality Control Management in Biotechnology	2	0	0	2	2
BI 701	Design and analysis of Algorithms	2	0	2	4	3
BT 702	Seminars in Biotechnology	2	0	0	2	2
BT 703/704	Elective-III	3	0	2	5	4
Total		**15**	**0**	**8**	**22**	**19**
Elective III (Metabolic Engineering/ Agriculture Biotechnology/Cancer Biology)						
Semester VIII						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BI 801	Simulation and Modeling	2	0	2	4	3

BT 801	Omics Technology	3	0	4	7	5
BT 802	Biomedical Engineering	2	1	0	3	3
BT 803	Stem Cell Technology	3	0	0	3	3
BT 804/ 805	Elective – IV	3	0	2	5	4
Total		**13**	**1**	**8**	**22**	**18**
Elective III (Tissue Engineering/ Molecular Diagnostics)						
Semester IX & X						
	Research Project (10 months)	**40 Credits**				
	TOTAL CREDITS	**201**				

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
BT 102	Engineering Graphics	1	0	2	3	2
Total		**15**	**2**	**14**	**31**	**24**

TITLE OF THE COURSE: PHYSICS

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

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

OBJECTIVE

The objective of this course is:

- To create general understanding regarding basic physical principles involved in living systems.
- To familiarize the student with basic concepts in physics as: classical optics used in microscopes and telescopes, thermometry and heat, mechanical, fluid and solid state properties.
- To familiarize students with concepts in digital electronics, lasers, sound waves, electricity.
- To introduce them to concepts in modern physics such as: production of X-ray, X-ray crystallography, quantum mechanics etc.

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 it's measurements, Platinum resistance Thermometer, Thermocouple and Thermistors, Modes of Heat Transfer.	05
3	Properties of Fluid: Surface Tension & Viscosity	Surface Tension, Surface Energy, Angle of Contact, Capillarity action, Determination of Surface tension by capillary rise method, Jaeger's method, Temperature dependence of surface tension and its applications. Viscosity, Coefficient of viscosity, streamline and turbulent flow, Reynold's number, Stoke's law, Terminal velocity, 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 effect, wave particle duality of radiation, de Broglie's hypothesis, Heisenberg's Uncertainty principle.	07
Total Lectures			**45**

METHODOLOGY

The course will be covered through lectures supported by practicals.

EVALUATION SCHEME (THEORY)

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

BOOKS RECOMMENDED:

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

PRACTICAL IN PHYSICS (TWO HOURS PER WEEK) Marks 50

The practical training would be in the area of optics, electronics, thermometry, calorimeter, conductivity, measurement of physical properties as: viscosity and surface tension.

LIST OF EXPERIMENTS

1. Diffraction Grating: Use of diffraction grafting for determination of wavelength of spectral lining.
2. Resolving Power: To determine the resolving power of Microscope or telescope.
3. Diode Characteristics: Study of forward and reverse characteristics of Diode.
   Transistor Characteristics: Study of characteristics of Photocell.
4. Band gap of semiconductor: Study of input and output characteristics of a transistor and determination of band gap of a semiconductor.
5. Ultrasonic Interferometer: Determination of velocity of ultrasonic waves by ultrasonic
6. Study of logic gates (OR, AND, NOT).
7. Thermocouple: Study of variation of thermo emf (electromotive force) with temperature.
8. Surface Tension: Determination of the surface tension of a given solution.
11. Viscosity: Determination the coefficient of viscosity by Stoke's method and its practical application.
12. Joule's Law: Determine of Joule's constant.
13. Determination of wavelength of monochromatic light by Newton's rings experiments.
14. Thermal Conductivity: Determination of coefficient of thermal conductivity of given specimen.

PRACTICAL EVALUATION SCHEME

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

TITLE OF THE 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 bioenergeticsin 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	11

		system. Acid-bases- Three concepts of acids & 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**

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

PRACTICAL EVALUATION SCHEME

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

COURSE: COMPUTERS AND C PROGRAMMING

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

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

OBJECTIVE:

The objective of the course is

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

COURSE OUTCOME

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

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

PREREQUISITES

The course requires the basic knowledge about the Computer system.

COURSE DESCRIPTION

Sr No	Topic	Description	Hrs
1	Organization of Computer	History of computer and various parts and functions performed by them	1
2	Hardware & Software	Various hardware of computer, Application software and system software	1
3	Operating System	Various functions of operating system, MS-DOS, LINUX commands	1
4	Basics of programming	Machine language, High level language, Compilation process	1
5	Introduction to C	An overview of C, C expressions, Operators, Data types	1
6	The Decision controls in C	The 'if' statements within *if,* Multiple statements within *if* , The '*if-else'* statement, The ! operator Hierarchy of Logical Operators, The Conditional Operators	2
7	Loop control structures	Loops, The '*While'* Loop, The '*for'* loop , Nesting of Loops , Multiple Initializations in the for loop The '*Odd'* Loop, The '*break'* statement, The '*continue'* statement, The '*do-while'* statement	5
8	Case control structures	Decisions using switch The *goto* statement	1
9	Functions	What is a function? Why Use Functions	3

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

METHODOLOGY:

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

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**

TITLE OF THE 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.

TITLE OF THE 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 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.	03 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.

TITLE OF THE 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,	2

		unilateral auxiliary view, bilateral auxiliary view.	
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**

SEMESTER II						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT 201	Biochemistry	3	0	4	7	5
BT 202	Cell Biology	3	0	2	5	4
BS 201	Maths II -Statistics	2	0	2	4	3
BT 203	Engineering Mechanics	2	0	2	4	3
BS 202	Environmental Sciences	2	0	2	4	3
HU 201	Disaster Management*	0	1	0	1	-
Total		**12**	**1**	**12**	**25**	**18**
Audit course, attendance is must						

TITLE OF THE COURSE: BIOCHEMISTRY

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

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

OBJECTIVE OF THE COURSE:

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

COURSE OUTCOME:

On successful completion of the course, students will:

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

PREREQUISITES:

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

COURSE DESCRIPTION

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

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

METHODOLOGY:

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

EVALUATION SCHEME (THEORY)

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

BOOKS RECOMMENDED:

1. The principles of Biochemistry, Lehninger by D. Nelson, and M. Cox, 7th edition, M. W.H. Freeman and Company, New York, 2017.
2. Metabolic Pathways by D. M. Greenberg, 3rd edition, Academic Press, Elsevier Science & Technology Books, 2014.
3. Biochemistry by L. Stryer, 7th edition, W.H. Freeman and Company, New York, 2012.
4. Biochemistry by J. M. Berg, J. L. Tymoczko, L. Stryer, 6th edition, W.H. Freeman and Company, New York, NY, 2007.
5. Biochemistry by G. Zubay, Addison-Wesley Educational Publishers Inc, 1983.

6. Outlines of Biochemistry by E. Conn and P. Stumpf, 5th edition, John Wiley & Sons, 2009.
7. Principles of Biochemistry by D. J. Voet, J. G. Voet, C. W. Pratt, 3rd edition, (International Student Version), John Wiley and Sons, Inc., 2008.

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

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

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

PRACTICAL EVALUATION SCHEME

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

TITLE OF THE 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	10

	composition.	dynamics and treadmilling), Nucleus (Structure of nuclear 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**

TITLE OF THE 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)	01 03

		Measures of Dispersion: Rauge, Variance, Coefficient of Cariance, Standard Derivation	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	Urban problems related to energy. Water conservation, Rain	4

	Environment	water harvesting, and watershed management. Resettlement and rehabilitation of people. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, Wasteland reclamation: Case studies. Environment protection Acts: Air (Prevention and control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife protection 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**

TITLE OF THE 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,	06

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

METHODOLOGY

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

EVALUATION SCHEME (THEORY)

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

BOOKS RECOMMENDED:

1. Introduction in "Confronting Catastrophe' by A. David Oxford University Press, 2000.
2. Vulnerability in Disaster Discourse, by Andharia J. JTCDM, Tata Institute of Social Science working Paper no. 8, 2008
3. At Risk Natural Hazards, Peoples, Vulnerability and Disasters by Blaikie, P, Cannon T, Davis I, Wisner B, Rutledge. 1997
4. Introduction to International Disaster Management, C. P. Damon, 2007,
5. Disaster Management : A Disaster Manager's Handbook, Carter and Nick, Asian Development Bank, Manila Philippines, 1991.
6. Development and Disasters, Cuny, F., Oxford University Press, 1983.
7. Document on World Summit on Sustainable Development 2012
8. Govt. of India : Disasters Management Act 2005. Government of India, New Delhi
9. Government of India, National Disasters Management Policy, 2009.
10. Environmental Knowledge for Disasters Risk Management, A. K. Gupta, S. S. Nair, NIDM, New Delhi, 2011.

SEMESTER III						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT 301	Analytical Techniques	3	0	4	7	5
BT 302	Microbiology & Virology	3	0	4	7	5
BT 303	Genetics	3	0	2	5	4
BI 301	Concepts in Bioinformatics	2	0	4	6	4
BT 304	Biosafety, Bioethics & IPR	2	0	0	2	2
Total		**13**	**0**	**14**	**27**	**20**

TITLE OF THE 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	4
	(ii) Fluorescence Spectroscopy	• Structural studies of Proteins using absorption of Ultraviolet light • Structural studies of DNA using absorption of Ultraviolet light	2

	(iii) Infrared Spectroscopy (iv) Optical Rotatory Dispersion (ORD) & Circular Dichroism (CD) (v) Nuclear Magnetic Resonance (NMR) Spectroscopy (vi) Mass spectrometry	• 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 • 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):	10

		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	
4.	Electrophoresis	• Electrophoresis : General Principle, Agarose and Polyacrylamide gels • 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	4
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)	

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

TITLE OF THE COURSE: MICROBIOLOGY AND VIROLOGY

COURSE CODE: BT 302 **L T P Hr C**
MARKS: 200 **3 0 4 7 5**

OBJECTIVE OF THE COURSE:
The objective of the course is to familiarize the students with microorganisms and viruses, their structures, diseases caused by bacteria and viruses and their control.

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

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

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

COURSE DESCRIPTION

Sr. No	Topic	Description	Hrs
1	Introduction to Microbiology	Scope and history of Microbiology. Characterization, classification and identification of microorganism. Microscopic examination (Staining and microscopic techniques)	7
2	Microorganism-Bacteria	Morphology and fine structure of bacteria. Cell wall structure in details. Cultivation of bacteria. Reproduction and growth. Growth kinetics. Isolation and preservation.	7
3	Control of Microorganisms	Control of By physical and chemical agents. Role of antibiotics and chemotherapeutic agents	7
4	Micro –organisms and Human diseases	Multiple drug resistant bacteria and their biofilm lifestyle. Microbial diseases of skin and eye, nervous system, cardiovascular & lymphatic system, respiratory, and digestive system.	5
5	The Viruses	Discovery, virus structure, classification, viral replication cycle, detection and enumeration of viruses, virus cultivation in lab, viriods, prions.	5
6	Bacteriophages	Morphology, reproduction of ds DNA phages, ss DNA phages and RNA phages.	4
7	Plant Viruses	Nomenclature and classification, viruses infecting fruits and vegetables	4

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

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

EVALUATION SCHEME (THEORY)

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

BOOKS RECOMMENDED:

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

PRACTICAL IN MICROBIOLOGY AND VIROLOGY

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

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

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

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

References:

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

PRACTICAL EVALUATION SCHEME

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

TITLE OF THE COURSE: GENETICS

COURSE CODE: BT 303 **L T P Hr C**

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

OBJECTIVE OF THE COURSE:

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

COURSE OUTCOME:

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

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

PREREQUISITES:

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

COURSE DESCRIPTION

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

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

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

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

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

PRACTICAL EVALUATION SCHEME

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

NAME OF THE COURSE: CONCEPTS IN BIOINFORMATICS

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

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

OBJECTIVE:

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

COURSE OUTCOME:

On completion of the course students will be able to:

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

PREREQUISITES

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

COURSE DESCRIPTION

Sr. No.	Topics	Detailed syllabus	No. of Lectures
1	Overview of Bioinformatics.	Overview and scope of Bioinformatics, Computers in biology, medicine & different problems in biology.	02
2	Introduction to nucleic acid and protein databases.	NCBI, EMBL, DDBJ, UNIPROT, PDB, SCOP, CATH.	05
3	Data acquisition, Database content, structure and annotation.	File formats: GenBank, EMBL, PDB, PIR, ALN Types of database: flat file, relational, hierarchical, network, object-oriented. Annotated sequence databases, Genome and Organism specific databases.	03
4	Retrieval of Biological Data.	Data retrieval tools: Entrez, SRS etc.	02
5	Pairwise sequence alignment.	Sequence comparisons & alignment concepts, Global Alignments – Needleman-Wunsch Algorithm Local Alignments – Smith-Waterman Algorithm Introduction to Homology, Analogy, Orthology Paralogy, Xenology.	04
6	Multiple sequence alignment.	Methods of multiple sequence alignment, CLUSTALW & MUSCLE Algorithms, Applications of MSA.	03
7	Database similarity	FASTA, BLAST, PSI-BLAST algorithms.	02

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

METHODOLOGY

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

EVALUATION SCHEME (THEORY)

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

BOOKS RECOMMENDED

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

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

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

BOOK RECOMMENDATION:

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

PRACTICAL EVALUATION SCHEME

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

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

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

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

OBJECTIVES:

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

COURSE OUTCOME:

On completion of the course students will have:

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

PREREQUISITES:

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

COURSE DESCRIPTION

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

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

METHODOLOGY

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

EVALUATION SCHEME (THEORY)

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

BOOKS RECOMMENDED:

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

SEMESTER IV						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT 401	Molecular Biology	3	0	4	7	5
BT 406	Animal Tissue culture	2	0	2	4	3
BT 403	Plant Biotechnology	3	0	4	7	5
BT 404	Immunology	3	0	2	5	4
BT 405	Developmental Biology	3	0	2	5	4
Total		**14**	**0**	**14**	**28**	**21**

TITLE OF THE COURSE: MOLECULAR BIOLOGY

COURSE CODE: BT 401 **L T P Hr C**
MARKS: 200 **3 0 4 7 5**

OBJECTIVE OF THE COURSE:
The objective of the course is to familiarize the students with the basic concept in molecular biology.

COURSE OUTCOME:
Upon completion of this course students will be able to:

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

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

COURSE DESCRIPTION:

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

5	Replication of DNA	• Models of DNA replication • 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 stock solutions for molecular biology	Special preparations for carrying out molecular biology experiments	Molecular cloning by J. Sambrook, F. Edward and T. Maniatis, 2nd edition, New York: Cold spring harbor laboratory press, 2012.
2	To isolate DNA from a) bacteria b) animal tissues/cells c) plant material using appropriate methods	To understand the critical requirement of specific methods depending on source of DNA	
3	Quantification of DNA by UV absorption and analysis by agarose gel electrophoresis	To understand the quality, and quantity of DNA present per cell	
4	To isolate plasmid DNA from bacteria, restriction analysis and agarose gel electrophoresis	To distinguish between plasmid and genomic DNA in terms of size and migration properties in gel	
5	To isolate RNA from eukaryotic cells and analyse by denaturing formaldehyde agarose gel electrophoresis	To understand various types of RNA/RNA profile and quality of RNA preparation	
6	To find the Melting temperature of DNA	Measure temperature and estimate T_m from your data	
7	Isolation of nuclei, calcium activation of endonuclease resulting DNA ladder including the mononucleosome formation	Hands-on verification of the concept of chromatin structure	
8	Extraction of histone from nuclei and analysis by SDS-PAGE	Understanding the contribution of histones in the formation of chromatin	

PRACTICAL EVALUATION SCHEME

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

TITLE OF THE COURSE: ANIMAL TISSUE CULTURE

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

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

OBJECTIVE OF THE COURSE:

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

COURSE OUTCOME:

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

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

PREREQUISITES:

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

COURSE DESCRIPTION

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

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

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

EVALUATION SCHEME (THEORY)

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

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**

TITLE OF THE COURSE: PLANT BIOTECHNOLOGY

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

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

OBJECTIVE OF THE COURSE:

The objective of the course is to familiarize the students with basic concepts and advanced research areas in plant biotechnology.

COURSE OUTCOME:

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

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

PREREQUISITES

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

COURSE DESCRIPTION

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

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

METHODOLOGY:

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

EVALUATION SCHEME (THEORY)

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

BOOKS RECOMMENDED:

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

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

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

PRACTICAL EVALUATION SCHEME

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

TITLE OF THE COURSE: IMMUNOLOGY

COURSE CODE: BT 404 **L T P Hr C**

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

OBJECTIVE OF THE COURSE:

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

COURSE OUTCOME:

On successful completion of this course students will:

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

PREREQUISITES:

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

COURSE DESCRIPTION

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

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

		vaccines, Inactivated or Killed Vaccines, Subunit and Conjugate Vaccines, DNA vaccines, Recombinant Vector Vaccines 5. AIDS: HIV infection of target cells and Activation of Provirus, Stages in viral replication cycle for therapeutic anti-retroviral drugs, Therapeutic agents inhibiting retrovirus replication 6. Cancer and the immune system: Origin and terminology, Malignant transformation of cells, Oncogenes and Cancer induction, Tumors of the immune system, Tumor antigens, Tumor evasion of the immune system, Cancer immunotherapy	
Total Number of Lectures			**41**

METHODOLOGY:

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

EVALUATION SCHEME (THEORY)

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

BOOKS RECOMMENDED:

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

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

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1.	To determine Blood Group antigens by hemagglutination assay	To understand about the various blood group antigens present in a population; principle of agglutination	Immunology, The experimental Series – II by W. Luttmann, K. Bratke, M. Kupper, Myrtek, USA, Elsevier, Academic Press; 2006
2.	Detection of syphilis using RPR card test	Immunological detection of specific bacterial infections by indirect agglutination	Manual of clinical laboratory Immunology by N. R. Rose, R. G. Hamilton, B. Detrick, 6th edition, ASM Press, 2002. Practical immunology by F. C. Hay, M. R. Olwyn, 4th edition, Westwood. Blackwell Publishing Company; 2002. Immunology by J. A. Owen, J. Punt, S. A. Kuby, 7th edition, USA: Susan Winslow; 2013
3.	Detection of typhoid infection by WIDAL test	Immunological detection of specific bacterial infections by direct agglutination	Manual of clinical laboratory Immunology by N. R. Rose, R. G. Hamilton, B. Detrick, 6th edition, ASM Press, 2002. Immunology by J. A. Owen, J. Punt, S. A. Kuby, 7th edition, USA: Susan Winslow; 2013
4.	Density gradient separation of PBMCs using Histopaque-1077	Principle of density gradient separation of immune cells	Immunology by M. D, J. Brostoff, D. B. Roth, I. Roitt, 7th edition, Elsevier, 2007. Immunology, The experimental Series – II by W. Luttmann, K. Bratke, M. Kupper, Myrtek, USA, Elsevier, Academic Press; 2006 Cell Separation Media Methodology and Applications 18111569, handbook GE Healthcare Isolation of mononuclear cells Methodology and Applications 18-1152-69, handbook GE Healthcare http://www.gelifesciences.com/handbooks/

5.	To study interaction of antigen and antibody by Ouchterlony double diffusion assay	To learn about precipitin phenomena at equimolar concentrations of antigen and antibody	• A handbook of practical and clinical immunology by G. P. Talwar, S. K. Gupta,. 2nd ed. Vol. I & II; 2006 • Manual of clinical laboratory Immunology by N. R. Rose, R. G. Hamilton, B. Detrick, 6th edition, ASM Press, 2002. • Practical immunology by F. C. Hay, M. R. Olwyn, 4th edition, Westwood. Blackwell Publishing Company; 2002. • Immunology by M. D, J. Brostoff, D. B. Roth, I. Roitt, 7th edition, Elsevier, 2007.
6.	Determination of antibody titre by ELISA	To learn about different types of ELISA method and their applications	• A handbook of practical and clinical immunology by G. P. Talwar, S. K. Gupta,. 2nd ed. Vol. I & II; 2006 • Manual of clinical laboratory Immunology by N. R. Rose, R. G. Hamilton, B. Detrick, 6th edition, ASM Press, 2002. • Immunology by J. A. Owen, J. Punt, S. A. Kuby, 7th edition, USA: Susan Winslow; 2013.
7.	Production of polyclonal antibodies in mouse	Principle of immunization, collection and analysis of serum for antibody	A handbook of practical and clinical immunology by G. P. Talwar, S. K. Gupta,. 2nd ed. Vol. I & II; 2006
8.	Purification of IgG from serum	Single step purification of IgG by affinity chromatography	Physical Biochemistry, D. Freifelder, 2nd ed. W.H. Freeman and Company, New York; 1982 Affinity Chromatography, Vol. 1: Antibodies, 18103746, handbook GE Healthcare http://www.gelifesciences.com/handbooks/

PRACTICAL EVALUATION SCHEME

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

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

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

COURSE OUTCOME:
Upon completion of this course students will:

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

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

COURSE DESCRIPTION

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

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

METHODOLOGY:

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

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**

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

BOOKS/JOURNALS RECOMMENDED:

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

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

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

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

PRACTICAL EVALUATION SCHEME

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