

Semester-Wise Programme structure for B.Sc. + M.Sc. HGMM (Integrated) (5 Years)

Sr No.	Year 1		Year 2		Year 3		Year 4		Year 5	
	Semester 1	Semester 2	Semester 3	Semester 4	Semester 5	Semester 6	Semester 7	Semester 8	Semester 9	Semester 10
1	Biochemistry-I [CU:6,L-4, P-2] {CC}	Biochemistry-II [CU:6,L-4, P-2] {CC}	Biotechniques [CU:6,L-4, P-2] {CC}	Immunology[CU:6,L-4, P-2] {CC}	Molecular Biology [CU:6,L-4, P-2] {CC}	Gene Regulation [CU:6,L-4, P-2] {CC}	Clinical Genetics [CU:4,L-3, P-1] {CC}	Population and evolutionary genetics [CU:2,L-2] {CC}	Principles of Pathology [CU:4,L-4] {CC}	Omics Technology and its Applications [CU:4,L-4] {CC}
2	Basic Cell Biology [CU:6,L-4, P-2] {CC}	Fundamentals of Genetics [CU:6,L-4, P-2] {CC}	Enzymology [CU:6,L-4, P-2] {CC}	Human Anatomy and Physiology [CU:6,L-4, P-2] {CC}	Developmental Biology [CU:6,L-4, P-2] {CC}	Molecular Biology of Human Diseases[CU:6,L-4, P-2] {CC}	Cell Culture Technology [CU:4,L-3, P-1] {CC}	Microbial diseases and vaccine technology [CU:2,L-2] {CC}	Advanced Enzymology [CU:4,L-4] {CC}	Cell Signalling and Cell Trafficking [CU:4,L-4] {AC}
3	General Chemistry [CU:4,L-3, P-1] {AC}	General Microbiology [CU:4,L-3, P-1] {AC}	Genetics & Inheritance Biology [CU:6,L-4, P-2] {CC}	Microbial Physiology and Metabolism [CU:6,L-4, P-2] {CC}	SE -1 [CU:4,L-4] {SE}	SE -3 [CU:4,L-4] {SE}	Research Paper Presentation [CU:2,P-2] {NTCC}	SE5 [CU:4,L-4] {SE}	Advanced Bioinformatics [CU:4,L-4] {CC}	SE6- [CU:4,L-4] {SE}
4	SEC1-Mathematics for Life Sciences [CU:2,L-2] {SEC}	SEC2-Statistics for Life Sciences [CU:2,L-2] {SEC}	Protein Science [CU:4,L-4] {AC}	Recombinant DNA Technology [CU:4,L-3, P-1] {AC}	SE -2 [CU:4,L-4] {SE}	SE -4 [CU:4,L-4] {SE}	OE1 [CU:4,L-4] {OE}	OE2 [CU:4,L-4] {OE}	Professional Ethics-I [CU:1,L-1] {VAC}	Professional Ethics-II [CU:1,L-1] {VAC}

5	EVS-I [CU:2,L-2] {AEC}	EVS-II [CU:2,L-2] {AEC}	SEC3-Prgram mng with C [CU:2,L-1,P-1] {SEC}	SEC4-Fundamentals of Physics [CU:2,L-2] {SEC}	SEC -5 [CU:2,L-2] {SEC}	SEC -7 [CU:2,L-2] {SEC}	Research Project [CU:10,P-10] {NTCC}	Research Project [CU:12,P-12] {NTCC}	Research Project [CU:12,P-12] {NTCC}	Research Project [CU:12,P-12] {NTCC}
6	Communication skills [CU:1,L-1] {VAC}	Communication skills [CU:1,L-1] {VAC}	-	-	SEC -6 [CU:2,L-2] {SEC}	SEC -8 [CU:2,L-2] {SEC}	-	-	-	-
7	Behavioural Sciences [CU:1,L-1] {VAC}	Behavioural Sciences [CU:1,L-1] {VAC}	-	-	-	-	-	-	-	-
8	FBL [CU:1,L-1] {VAC}	FBL [CU:1,L-1] {VAC}	-	-	-	-	-	-	-	-
9	PL/HCP [CU:1,L-1] {AEC}	PL/HCP [CU:1,L-1] {AEC}	-	-	-	-	-	-	-	-
Credits	24	24	24	24	24	24	24	24	25	25
Total Programme Credits										242

AC	Allied Course
AEC	Ability Enhancement Course
CC	Core Course
GE	General Elective
OE	Open Elective
SC	Skill component
SE	Specialization Elective Course
SEC	Skill Enhancement Course
VAC	Value Added Course

NTCC	Non Teaching Credit Course
CU	Credit Unit
L;T;P	Lecture ; Tutorial ; Practical
H	Honours

Integrated B.Sc. + M.Sc. (H) HGMM- 5 years(1st Semester)

Sr · N o	Course Code	Course Title	Course Type	Credits					Credi t Units
				L	T	PS	FW	SW	
1	BCH101	Basic Cell Biology	Core Courses	4	0	2	0	0	6
2	BCH102	Biochemistry-I	Core Courses	4	0	2	0	0	6
3		General Chemistry	Allied Courses	3	0	1	0	0	4
4		Mathematics for Biosciences	Skill component	2	0	0	0	0	2
5	ENV101	Environment Studies -I	Ability Enhancement Course	2	0	0	0	0	2
6	ENG101	Communication Skills -I	Value Added Course	1	0	0	0	0	1
7	FOL101/FOL102	Foreign Business Language	Value Added Course	1	0	0	0	0	1
8	PSY101	Behavioural Science -I	Value Added Course	1	0	0	0	0	1
9	INL101/INL102	Punjabi Language/Punjab History & Culture	Ability Enhancement course	1	0	0	0	0	1

Total Credits

24

BCH101: Basic Cell Biology

Course content and syllabus

L	T	P	Total Credits
4	0	2	6

Course Objectives: To develop basic understanding of cell biology

	Teaching Hrs
Unit I: Introduction to the Cell: theory and Broad Classification	18 hrs
Cell: The cell theory, Broad Classification of cells, Structure and function of cell organelles, Cytoskeletal structures (actin, microtubules etc.).	
Unit II: Cell wall and Cell Membrane	18 hrs
Cell wall and Cell Membrane: physical structure of model membranes in prokaryotes and eukaryotes, lipid bilayer, membrane proteins, other constituents; diffusion, osmosis, active transport, and regulation.	
Unit III: Cell division and cell cycle	18 hrs
Cell division and cell cycle: Mitosis and meiosis, Cell cycle, Apoptosis, Necrosis and Autophagy. Cell transformation and cancer: oncogenes and proto-oncogenes, Tumor suppressor genes, metastasis. Contribution of Nobel laureates in elucidation of the DNA structure, cell death and cell cycle.	
Unit IV: Cell Signalling	18 hrs
Cell signalling: General principles, signal transduction, Hormones and their receptors, second messengers, regulation of signalling pathways, bacterial chemotaxis and quorum sensing., Cell adhesion molecules, contribution in cell communication	

List of Experiments -with basic instructions

1. To study different parts of microscope
2. Cytochemical staining of proteins by Methylene blue
3. Cytochemical staining of polysaccharides by PAS
4. Study of stages of Mitosis using onion root tip
5. Study of stages of Meiosis in onion flower buds
6. Preparation of Buccal Smear for microscopic examination
7. To study the effect of isotonic, hypotonic and hypertonic solutions on cells
8. To demonstrate cell viability and cell death

Course Learning Outcomes:

- Understand types of cells and cellular organelles.
- Identify differences in the structure of different types of cell walls and membranes.
- Compare the cell division and cell cycle.
- Perceive knowledge of signalling cascades and communication networks in the cell.

Text/Reference Books

AUTHOR	TITLE	Publisher	Year of publication	ISBN	Pages
De-Robertis, F.D.P., and De-Robertis Jr. E.M.F.	Cell and Molecular Biology	Lippincott Williams & Wilkins	2011	9781260219718	233
Geoffrey, M	The Cell: A molecular approach	Oxford Sinauer Associates, Oxford University Press	2014	978-0070083660	322
Lodish, H.F	Molecular Cell Biology.	Macmillan International)	2021	9781260363821	456

BCH102 (Biochemistry -I)**Course content and syllabus**

L	T	P	Total Credits
4	0	2	6

	Teaching Hours
Unit I: Water and its Properties	18 hrs
Water and its Properties: Dissociation and association constants, pH and buffers. pI , pK_a , Henderson Hasselbalch equation and its implications. Basic Thermodynamics: Laws of thermodynamics. Concepts of ΔG , ΔH and	

ΔS .	
Unit II: Carbohydrates	18 hrs
Carbohydrates: Structure, properties and functions of: Monosaccharides (glucose, fructose, ribose and others, D-and L- sugars, reducing and non-reducing sugars), Disaccharides (maltose, sucrose and lactose) and polysaccharides (Starch and glycogen)	
Unit III: Lipids and Nucleic Acids	18 hrs
Lipids: Classification, Structure and function. Conformation of Nucleic acids: Structural characteristics of A, B and Z-DNA. Significance of DNA and RNA.	
Unit IV: Proteins	18 hrs
Proteins: Physico-chemical and structural properties of amino acids, non-protein and rare amino acids. Protein Structure: Primary, Secondary, Tertiary, Quaternary, structure of proteins, Forces stabilizing Primary, Secondary and Tertiary protein structures. Enzymes: structure & function. Forces that stabilize biomolecules: electrostatic and van der Waal's interaction, hydrogen bonding. Interactions with solvents, Hydrophobic effect.	

List of Practicals with basic instructions (Total = 60 hrs)

1. Preparation of solutions and buffers.
2. Preparation of 0.1M phosphate buffer, pH 7.4, 250ml without using the pH meter. (By using Henderson –Hasselbalch equation)
13. Verification of Beer Lamberts Law.
14. Estimation of carbohydrate in given solution by anthrone method.
15. Study the presence of reducing/non-reducing sugar in biological samples.
16. Protein estimation by Lowry's method and other methods.
17. Determination of acid value and saponification value of a fat.

Course Learning Outcomes:

- Understand the law of thermodynamics, water, and its properties.
- Determine the structure and properties of carbohydrates.
- Comparing the structure of various types of lipids, and their role on biological systems.
- Evaluate the structure and functional properties of proteins.

Text/Reference Books

Author	Title	Publisher	Ed/year	ISBN No	Pages
David L Nelson; and Michael M. Cox, W.H. Freeman	Lehninger's Principles of Biochemistry	WH Freeman	2012	0070492581, 9780070492585	957
Jeremy M. Berg, Lubert Stryer, John L Tymoczko, and Gregory J. Gatto,	Biochemistry	W.H. Freeman Company	2018	1319114652	1208

General Chemistry

Course content and syllabus

L	T	P	Total Credits
3	0	1	4

	Teaching Hours
Unit I: Atomic Theory	14 hrs
Bohr's theory, Wave mechanics: de' Broglie equation, Heisenberg's Uncertainty, Principle and its significance, Schrödinger's wave equation, Quantum numbers and their significance. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.	
Unit II: The Periodic Table: History and Periodic Trends	14 hrs

<p>Unit II: The Periodic Table: History and Periodic Trends 14 h</p> <p>Detailed discussion of the following properties of s, p, d, f block elements in long form of periodic table. with reference to s and p-block; Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table, Atomic radii (van'der Waals), Ionic and crystal radii (octahedral and tetrahedral), Covalent radius, Ionization enthalpy and factors affecting successive ionization energies. Applications of ionization enthalpy, trends in electron gain enthalpy, electronegativity- Pauling, Mullikan, Allred Rochow scales, electro-negativity and bond order, partial charge, hybridization, group electronegativity.</p>	
<p>Unit III: Fundamentals of Organic Chemistry</p>	<p>13 hrs</p>
<p>Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophilicity and basicity; Types, shape and relative stabilities of reaction intermediates (Carbocations, Carbanions, Free radicals and Carbenes). Organic reactions and their mechanism: Addition, Elimination and Substitution reactions</p>	
<p>Unit IV: States of matter : Gases and Liquids</p>	<p>13 hrs</p>
<p>Deviations from ideal gas behavior, compressibility factor, and its variation with pressure for different gases. Causes of deviation from ideal behavior. van de Waals equation of state, its derivation and application in explaining real gas behaviour; van der Waals equation expressed in virial form, Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, critical and van der Waals constants, law of corresponding states. Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.</p>	

List of Practicals with basic instructions (Total = 60 hrs)

Inorganic Chemistry Practicals

1. Titrimetric Analysis
 - a. Calibration and use of apparatus.
 - b. Preparation of solutions of different Molarity/Normality of titrants.
 - c. Use of primary and secondary standard solutions.
2. Acid-Base Titrations
 - a. Estimation of carbonate and hydroxide present together in mixture.
 - b. Estimation of carbonate and bicarbonate present together in a mixture.

Organic Chemistry Practicals

3. Chromatography
 - a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography
 - b. Separation of a mixture of two sugars by ascending paper chromatography
 - c. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC).

Physical Chemistry Practicals

4. Surface tension measurements
 - a. Determine the surface tension by (i) drop number (ii) drop weight method.
 - b. Study the variation of surface tension of detergent solutions with concentration.
5. Viscosity measurements using Ostwald's viscometer
Determine of viscosity of aqueous solutions of (i) ethanol (ii) sugar at room temperature.

Course Learning Outcomes:

- Knowledge of evolution of scientific theories to explain the atomic structure, molecular geometry and physico-chemical behaviour of atomic matter made from elements in periodic table.
- Focus on fundamentals of organic molecules, structure, stereochemistry, bonding, reactivity and reaction mechanisms.
- familiarization with solid and liquid states of matter and its physical laws related to describe them

Text/Reference Book

Author	Title	Publisher	Ed/year	ISBN No	Pages
J.D. Lee,	Concise Inorganic Chemistry	John Wiley and Sons Ltd	5th edition/2016	ISBN 978-8126518	547
Atkins P.W, Julio dePaula,	Physical Chemistry	Oxford University Press, ELBS	11 TH , 2018	ISBN 978-0198814740	250
Shoemaker, D.P Garland, C.W Nibler, J.W	., Experiments in Physical Chemistry,	McGraw Hill Inc,	8th edition (2008),	ISBN 978-0070570078	345

Mathematics for Biosciences

L	T	P	TOTAL CREDIT UNITS
2	0	0	2

Course Contents/syllabus:

	Teaching Hours
Unit I: Sets, Relations and Function	9 H
Sets and their properties, Cartesian product of Sets, relations, functions and their types and graphs	
Unit II: Matrix Algebra	9 H
Matrices, Types of Matrices, Addition of matrices, Subtraction of matrices and Product of matrices. Properties of Matrix Multiplication. Transpose of Matrix, Symmetric and Skew-symmetric Matrices, Inverse of Matrix and system of linear equations	
Unit III: Differential Calculus	9 H
Algebra of limits, Continuity, Derivative of a function, Fundamental rules for differentiation, increasing and decreasing functions, Introduction to Partial derivatives	
Unit IV: Integral Calculus	9 H
Indefinite and definite integrals, methods of Integration, Properties of definite integrals	

Course Learning Outcomes: On the successful completion of this course,

- Students will demonstrate the ability to distinguish corresponding sets as representations of relations or functions by the analysis of graphical, numeric, or symbolic data
- Students will demonstrate the ability to apply the concept of matrices in real-life situations
- Students will understand the concepts of Limits, Continuity and Differentiability and their applications
- Students will understand and analyze the concept of Integration with the help of Differentiation and study its various applications

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir	Thomas' Calculus(14th edition)	Pearson Education	2018	978-9353060411
H.K. Dass	Higher Engineering Mathematics	S. Chand	2014	978-8121938907

ENV101: Environmental Studies -I**Course content and syllabus**

L	T	P	Total Credits
2	0	0	2

	Teaching Hours
Unit-1- Multidisciplinary nature of environmental studies and Natural Resources-1	9 hrs
<i>Multidisciplinary nature of environmental studies:</i> Definition, scope and importance; components of environment –atmosphere, hydrosphere, lithosphere and biosphere. Concept of sustainability and sustainable development. <i>Natural resources:</i> Land resources and land use change, land degradation, soil erosion and desertification.	
Unit-2- Natural Resources-2	9 hrs

<p>Deforestation: causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal population.</p> <p>Water Resources-Use and over-exploitation of surface and groundwater, floods, drought, conflicts over water (international and inter-state).</p> <p>Heating of earth and circulation of air; air mass formation and precipitation.</p> <p>Energy resources- renewable and non-renewable energy sources, use of alternate energy sources, Growing energy needs, Case studies.</p>	
Unit-3-Ecosystems	9 hrs
<p><i>Ecosystem</i>: What is an ecosystem; Structure and function of an ecosystem; Energy flow in the ecosystem; Food chains, food webs and ecological succession. Case studies of the following ecosystems:</p> <p>Forest ecosystem; Grassland ecosystem; Desert ecosystem; Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).</p>	
Unit-4- Biodiversity and its conservation	9 hrs
<p><i>Biodiversity</i>: Levels of biological diversity: genetic, species and ecosystem diversity; Biogeographic zones of India; biodiversity patterns and global biodiversity hot spots.</p> <p>India as a mega-biodiversity nation; endangered and endemic species of India.</p> <p>Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; conservation of biodiversity: <i>in-situ</i> and <i>ex-situ</i> conservation of biodiversity.</p> <p>Ecosystem and biodiversity services: ecological, economic, social, ethical, aesthetic and information value.</p>	

Course Learning Outcomes:

- Understand natural resources and evaluate limitations surrounding renewable and non-renewable resources
- Understand the nuances of ecosystem and learn about behaviour of various ecosystem
- Learn about the types, services and threats to our biodiversity and importance of conserving it.

Text/Reference Books

AUTHOR	TITLE	Publisher	Year of publication	ISBN	Pages
William P. Cunningham, Mary Ann Cunningham	Principles of Environmental Science	McGraw-Hill	2019	9781260219718	--
Dash and Dash	Fundamentals of ecology	Tata McGraw-Hill Education	2009	978-0070083660	--
William P. Cunningham, Mary Ann Cunningham, Barbara Woodworth Saigo	Environmental Science: A global concern,	McGraw-Hill	2021	9781260363821	--
Gaston K.J. and Spicer, J. I.	Biodiversity –An Introduction 2 nd edition	Blackwell Publishing	2004	978-1-405-11857-6	--

ENG101: Communication Skills-I

L	T	P	Total Credits
1	0	0	1

Course Contents/syllabus:

	Teaching hours
Unit I: Basic Concepts in Communication	3.5 hrs

Definition of communication, Nature and process of communication, role and purpose of communication, types and channels of communication, communication networks/flow of communication: vertical, diagonal, horizontal, barriers to communication: physical, language, and semantic, socio-psychological, organizational, gateway to effective communication, towards communicative competence, choosing the appropriate channel and medium of communication, social communication: small talk and building rapport, barriers in communication.	
Unit II: Communication Types	5.5 hrs
Verbal communication: Oral Communication: Forms, Advantages & Disadvantages, Written Communication: Forms, Advantages & Disadvantages, Introduction of Communication Skills (Listening, Speaking, Reading, Writing), Nonverbal communication: functions and effective use, KOPPACT(Kinesics, Oculesics, Proxemics, Para-language, Artifacts, Chronemics, Tactilics). The implication of appropriate communication; effective ways of using social media, importance of digital literacy.	
Unit III: Reading and Writing Skills	3 hrs
Significance of reading; Reading Comprehension, gathering ideas from a given text, identify the main purpose and context of the text, evaluating the ideas, interpretation of the text, Paragraph development; essay writing.	
Unit IV: Speaking and Presentation Skills	6 hrs
Speaking skills: fluency, vocabulary, grammar, and pronunciation; effective speaking: selection of words, your voice, and non-verbal communication, functions of speaking: interaction, transaction, and performance; structuring the message; effective speaking strategies. Planning, preparation, practice, and performance; audience analysis, audio- visual aids, analyzing the non-verbal communication, methods of delivery: impromptu, extemporaneous, memorization, manuscript, and outlining.	

Course Learning Outcomes:

- Students will be able to understand the basic processes of communication, both verbal as well as non-verbal—nature, scope, and power of communication processes.
- Students will be able to demonstrate cultural sensitivity in communication and appreciation of cultural variations of diverse socio-cultural contexts.
- Students will be able to develop an awareness of the role of mass media in shaping public psyche, beliefs, and perceptions about social realities and build an informed and critical perspective.
- Students will be able to analyze situations and audiences to make right choices about the most effective and efficient ways to communicate and deliver messages.
- Students will be able to assess various barriers in communication and develop communicative competence thereby for effective communication.

Books/literature

AUTHOR	TITLE	Publisher	Year of publication	ISBN

P. D. Chaturvedi and Mukesh Chaturvedi	Business Communication: Concepts, Cases and Applications	Pearson Education	2006	9788131701720
Meenakshi Raman and Prakash Singh	Business Communication	Oxford University Press	2012	9780198077053
Jeff Butterfield	Soft Skills for Everyone	Cengage Learning	2017	9789353501051

FOL101: Introduction to French Culture & Language

L	T	P	Total Credits
1	0	0	1

Course Contents/syllabus:

	Teaching hours
Unit-I Introduction to French language	3 hrs
<ul style="list-style-type: none"> • Brief introduction of French and Francophone countries • Presenting oneself • Getting information about someone else • Greeting and taking leave • Asking/giving personal information 	
Unit-II- A rendez-vous ; Visiting a place	6 hrs
<ul style="list-style-type: none"> • Pronouncing and writing numbers in French • Spell and count numbers • Telling the time • Temporal expressions • Communicating in class • Fixing an hour, place for a meeting. • Describing a person. • Identifying a person, object and place • Describing relation in a family • A specific person, object and place 	
Unit-III- An interview	4.5 hrs

<ul style="list-style-type: none"> • Description of objects, people and places • Nationalities • Speaking about one's professions • Expressing Actions using regular –er ending verbs; avoir, être; reflexive verbs –usage, conjugation • Interview of celebrity 	
Unit-IV- At the discotheque	4.5 hrs
<ul style="list-style-type: none"> • Portrait by a journalist • Giving a positive or negative reply • Asking questions • Discussion with a person • Activities in a day 	

Course Learning Outcomes: At the end of this course, the students will be able to express themselves in writing and orally in basic French. This course content focuses on the speech of the students in a lucid and a concurrent manner using appropriate vocabulary and pronunciation techniques. Extra stress will be given on their understanding of grammatical structures and the foreign accent of the language. At the end of the course, the student shall be able to :

- Understand information; Express in his own words; Paraphrase; Interpret and translate.
- Apply information in a new way in a practical context
- Analyse and break-down information to create new ideas
- Evaluate and express opinion in a given context

Text / Reference Books:

Author	Title	Publisher	Year	ISBN No
Christine Andant, Chaterine Metton, Annabelle Nachon, Fabienne Nugue	A Propos - A1 Livre De L'Eleve, Cahier D' Exercices	Langers International Private Limited	2010	978- 938080 9069
Manjiri Khandekar and Roopa Luktuke	Jumelage - 1 Methode De Fraincais - French	Langers International Private Limited	2020	978- 938080 9854
Michael Magne, Marie- Laure Lions-Olivieri	Version Originale 1: Cahier d'exercices	Maison Des Langues	2010	978848 443561 7

FOL102: Introduction to German Culture & Language

L	T	P	Total Credits
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1	0	0	1
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Course Contents/syllabus:

	Teaching hours
Unit-I Introduction to German Language (Einführung)	3 hrs
Introduction to German as a global language, Self-introduction and Greetings, Die Alphabeten, Phonetics: the sound of consonants and vowels, Wie buchstabieren Sie Ihren Name?	
Unit-II- Numbers and everyday conversation (die Zahl und Gespräche)	6 hrs
Counting in German from 1-100, Simple Calculation and verb 'kosten' - Wie viel kostet das? Plural Forms, Vocabulary: Wochentage, Monate, Jahreszeiten, Ordinal numbers and the question - Wann haben Sie Geburtstag?	
Unit-III- Regular verbs and nominative case: articles and pronouns (Regelmässige Verben und Nominativ Kasus: Artikel und Pronomen)	4.5 hrs
Introduction to all personal pronouns and conjugation of Regular verbs Detailed exercise on regular verbs. Reading a text on regular verbs. Introduction to definite. Vocabulary: Schulsachen und Getränke, Nominative case/ Articles (der, die, das) Nominative Pronouns: - Applicability of pronouns for both persons and things. Usage of nominative Personal Pronouns Introduction of nominative possessive pronouns usage of nominative possessive pronouns	
Unit-IV- The Family, Work-life and Professions (Familienmitglieder und Berufe) & Interrogative sentences (W-Fragen)	4.5 hrs
The Family, Work-life and Professions (Familienmitglieder und Berufe) Vocabulary: Professions and conjugation of the verb 'sein' Introduction to simple possessive pronouns with the help of the verb 'haben' Usage of possessive pronouns. Interrogative sentences (W-Fragen) W-Fragen: who, what, where, when, which, how, how many, how much, etc. Exercises on the question pronouns	

Course Learning Outcomes: At the end of this course, the students will be able to express themselves in writing and orally in basic German. This course content focuses on the speech of the students in a lucid and a concurrent manner using appropriate vocabulary and pronunciation techniques. Extra stress will be given on their understanding of grammatical structures and the foreign accent of the language. At the end of the course, the student shall be able to:

- Understand information; Express in his own words; Paraphrase; Interpret and translate.
- Apply information in a new way in a practical context
- Analyse and break-down information to create new ideas
- Evaluate and express opinion in a given context

Text / Reference Books:

Author	Title	Publisher	Year	ISBN

Rolf Bruseke	Starten Wir A 1	Langers International Pvt Ltd (Max Hueber Verlag)	2017	978-3190160006
Giorgio Motta	Wir Plus Grundkurs Deutsch für Junge Lerner Book	Ernst Kleit Verlag	2011	978-8183072120
Heimy Taylor, Werner Haas	Station en Deutsch Self Study Course German Guide	Wiley	2007	978-0470165518

PSY101: Understanding Self for Effectiveness

L	T	P	Total Credits
1	0	0	1

Course Contents/syllabus:

	Teaching time
Unit I: Self: Core Competency	4.5 hrs
Understanding of Self, Components of Self – Self identity, Self concept, Self confidence, Self image, BIG5 Factors	
Unit II: Techniques of Self Awareness	4.5 hrs
Exploration through Johari Window, Mapping the key characteristics of self, Framing a charter for self Stages – self awareness, self acceptance and self realization	
Unit III: Self Esteem & Effectiveness	4.5 hrs
Meaning, Importance, Components of self esteem, High and low self esteem, Measuring your self esteem	
Unit IV: Building Positive Attitude and Emotional Competence	4.5 hrs
Meaning and nature of attitude, Components and Types of attitude, Importance and relevance of attitude Emotional Intelligence – Meaning, components, Importance and Relevance Positive and negative emotions, Healthy and Unhealthy expression of emotions	

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

- The student will apply self-introspection as a tool for self-awareness.
- The student will understand self-concept for self-recognition, self-improvement and perception of others.

- The student will be able to analyze their physical self, social self, the competent self and psychological self.

The student will be able to analyze what motivates his/her actions and the actions of others

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
Singh A.	Achieving Behavioural Excellence for Success	Wiley Publication	2012	978812658027
Towers, Marc	Self Esteem	American Media	1995	9781884926297
Pedler Mike, Burgoyne John, Boydell Tom	A Manager's Guide to Self-Development	McGraw-Hill	2006	978-0077114701
Covey, R. Stephen	Seven habits of Highly Effective People	Simon & Schuster Ltd	2013	978-1451639612
Khera Shiv	You Can Win	Macmillan	2005	978-0333937402
Gegax Tom	Winning in the Game of Life	Harmony Books	1999	978-0609603925
Singh, Dalip	Emotional Intelligence at Work	Publications	2006	9780761935322
Goleman, Daniel	Emotional Intelligence	Bantam Books	2007	9780553095036
Goleman, Daniel	Living with E.I	Bantam Books	1998	9780553104622

INL101: Punjabi Language

L	T	P	Total Credits
1	0	0	1

Course content and syllabus

	Weightage (%)	Teaching Hours
Unit I:	25%	4 hours
ਆਧੁਨਿਕ ਪੰਜਾਬੀ ਕਵਿਤਾ ਦਾ ਅਧਿਐਨ (ਕਾਵਿ-ਸੁਮੇਲ ਪਾਠ-ਪੁਸਤਕ) ਕਵਿਤਾ ਦਾ ਸਾਰ/ਕੇਂਦਰੀ ਭਾਵ ਅਤੇ ਪ੍ਰਸੰਗ ਸਾਹਿਤ ਵਿਆਖਿਆ ਕਵੀ ਦੇ ਜੀਵਨ ਅਤੇ ਸਾਹਿਤਕ ਯੋਗਦਾਨ ਬਾਰੇ ਮੁੱਢਲੀ ਜਾਣਕਾਰੀ		
Unit II:	25%	4 hours
1.ਲੇਖ-ਰਚਨਾ ਲੇਖ-ਰਚਨਾ: ਮਹੱਤਵ, ਕਿਸਮਾਂ ਅਤੇ ਵੱਖ-ਵੱਖ ਵਿਸ਼ਿਆਂ ਅਨੁਸਾਰ ਵਿਹਾਰਕ ਅਭਿਆਸ 2.ਸੰਖੇਪ-ਰਚਨਾ ਸੰਖੇਪ-ਰਚਨਾ: ਮਹੱਤਵ ਅਤੇ ਤਕਨੀਕ		
Unit III:	25%	5 hours
ਵਿਆਕਰਨ ਸਿਧਾਂਤ ਅਤੇ ਵਿਹਾਰ: 1.ਵਿਆਕਰਨ: ਪਰਿਭਾਸ਼ਾ;ਮਹੱਤਤਾ;ਉਦੇਸ਼;ਵਿਆਕਰਨ ਦੇ ਅੰਗ 2. ਪੰਜਾਬੀ ਧੁਨੀਵਿਓਂਤ: ਸ਼੍ਰੀ ਅਤੇ ਵਿਅੰਜਨ ਧੁਨੀਆਂ ਦਾ ਵਰਗੀਕਰਨ, ਉਚਾਰਨ ਅੰਗ		
Unit IV:	25%	5 hours
ਵਿਆਕਰਨ ਸਿਧਾਂਤ ਅਤੇ ਵਿਹਾਰ: ਸ਼ਬਦ ਸ਼੍ਰੇਣੀਆਂ: ਪਰਿਭਾਸ਼ਾ ਅਤੇ ਪ੍ਰਕਾਰ ਨਾਂਵ, ਪੜਨਾਂਵ, ਵਿਸ਼ੇਸ਼ਣ, ਕਿਰਿਆ, ਕਿਰਿਆ ਵਿਸ਼ੇਸ਼ਣ, ਸਬੰਧਕ,ਯੋਜਕ ਅਤੇ ਪ੍ਰਸ਼ਨ-ਸੂਚਕ ਸ਼ਬਦ		

Course Learning Outcomes:

1. Understand modern Punjabi Poetry.
2. Interpret the importance of essay and precise writing
3. Analyze the Punjabi language structure and grammar.
4. Examine the impact and importance of grammar and language structure.

Pedagogy for Course Delivery

Lectures: 14 sessions

Presentation / Seminar/ Assignment: 2 sessions

Mid Term Test & End Term Exam: 2 sessions
 Quiz: 3
 Total: 18 sessions

Assessment/ Examination Scheme:

Theory L/T (%)	Lab/Practical/Studio (%)	End Term Examination
100	0	100

Text /

Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN	Pages
ਡਾ. ਕਰਮਜੀਤ ਸਿੰਘ (ਸੰਪਾ.),	ਕਾਵਿ ਸੁਮੇਲ	ਪਬਲੀਕੇਸ਼ਨ ਬਿਊਰੋ, ਪੰਜਾਬ ਯੂਨੀਵਰਸਿਟੀ ਚੰਡੀਗੜ੍ਹ	2020	-	-
ਸੁਰਿੰਦਰ ਸਿੰਘ ਖਹਿਰਾ (ਸੰਪਾ.),	ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਵਿਆਕਰਨ ਅਤੇ ਬਣਤਰ	ਪਬਲੀਕੇਸ਼ਨ ਬਿਊਰੋ, ਪੰਜਾਬੀ ਯੂਨੀਵਰਸਿਟੀ ਪਟਿਆਲਾ	2015	-	-
ਡਾ. ਹਰਕੀਰਤ ਸਿੰਘ,	ਕਾਲਜ ਪੰਜਾਬੀ ਵਿਆਕਰਨ ਅਤੇ ਲੇਖ ਰਚਨਾ	ਪੰਜਾਬ ਸਟੇਟ ਯੂਨੀਵਰਸਿਟੀ ਟੈਕਸਟ ਬੁੱਕ ਬੋਰਡ, ਚੰਡੀਗੜ੍ਹ	1999	-	-
ਡਾ. ਪ੍ਰੇਮ ਪ੍ਰਕਾਸ਼ ਸਿੰਘ	ਕਾਲਜ ਪੰਜਾਬੀ ਵਿਆਕਰਨ ਅਤੇ ਲੇਖ ਰਚਨਾ	ਮਦਾਨ ਪਬਲੀਕੇਸ਼ਨਜ਼, ਪਟਿਆਲਾ	2002	-	-
ਡਾ. ਬੂਟਾ ਸਿੰਘ ਬਰਾੜ	ਪੰਜਾਬੀ ਵਿਆਕਰਨ ਸਿਧਾਂਤ ਅਤੇ ਵਿਹਾਰ	ਚੇਤਨਾ ਪ੍ਰਕਾਸ਼ਨ, ਪੰਜਾਬੀ ਭਵਨ, ਲੁਧਿਆਣਾ	2012	-	-
ਡਾ. ਬੂਟਾ ਸਿੰਘ ਬਰਾੜ	ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਸ਼ੈਲੀ ਅਤੇ ਸਰੂਪ	, ਵਾਰਿਸ ਸ਼ਾਹ ਫਾਊਂਡੇਸ਼ਨ, ਅੰਮ੍ਰਿਤਸਰ	2012	-	-

ਦੁਨੀ ਚੰਦ੍ਰ	ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਦਾ ਵਿਆਕਰਣ	, ਪੰਜਾਬ ਯੂਨੀਵਰਸਿਟੀ ਪਬਲੀਕੇਸ਼ਨ ਬਿਊਰੋ, ਚੰਡੀਗੜ੍ਹ	1995	-	-
ਜੋਗਿੰਦਰ ਸਿੰਘ ਪੁਆਰ ਅਤੇ ਹੋਰ	ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਦਾ ਵਿਆਕਰਨ (ਭਾਗ 1,2,3),	ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਅਕਾਦਮੀ ਜਲੰਧਰ	2003	-	-
ਸੁਖਵਿੰਦਰ ਸਿੰਘ ਸੰਘਾ	ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਵਿਗਿਆਨ	ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਅਕਾਦਮੀ ਜਲੰਧਰ	2010	--	-
ਅਗਨੀਹੋਤਰੀ, ਵੇਦ	ਪਰਿਚਾਇਕ ਭਾਸ਼ਾ ਵਿਗਿਆਨ	ਦੀਪਕ ਪਬਲਿਸ਼ਰਜ਼ ਜਲੰਧਰ	1981		

INL102: History and Culture of Punjab

L	T	P	Total Credits
1	0	0	1

Course Contents/syllabus

	Teaching hours
Unit I:	4.5 hrs
1. Harappan Civilization: extent and town planning and socio-economic life. 2. Life in Vedic Age: socio-economic and religious; 3. Growth and impact of Jainism and Buddhism in Panjab.	
Unit II:	4.5 hrs
4. Society and Culture under Maurayas and Guptas. 5. Bhakti movement: Main features; prominent saints and their contribution. 6. Origin and development of Sufism	
Unit III:	4.5 hrs
7. Evolution of Sikhism: teaching of Guru Nanak; Institutional Development- Manji, Masand, Sangat and Pangat 8. Transformation of Sikhism: Martyrdom of Guru Arjan; New policy of Guru Hargobind, martyrdom of Guru Tegh Bahadur. 9. Institution of Khalsa: New baptism; significance	
Unit IV:	4.5 hrs
10. Changes in Society in 18th century: social unrest; emergence of misls and other institutions - rakhi, gurmata, dal khalsa. 11. Society and Culture under Maharaja Ranjit Singh. 12. MAP (of undivided physical geographical map of Punjab): Major Historical Places: Harappa, Mohenjodaro, Sanghol, Ropar, Lahore, Amritsar, Kiratpur, Anandpur Sahib, Tarn Taran, Machhiwara, Goindwal, Khadur Sahib.	

Course Learning Outcomes:

Understand the history of various cultures in Punjab.

Interpret the importance of Maurayan, Gupta and Bhakti influences on Punjab
Apply the teaching of Sikhism on the emergence of the Khalsa .

Examine the impact societal changes on socio-cultural and physical landscape of Punjab

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No
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L.M Joshi,	History and Culture of the Punjab, Part-I	Punjabi University, Patiala	1989,3 rd	-
Buddha Prakash	Glimpses of Ancient Punjab	Punjabi University, Patiala,	1983	-
Khushwant Singh	A History of the Sikhs, vol I:1469-1839, .	oxford University Press, Delhi	1991	-

Integrated B.Sc. + M.Sc. (H) HGMM- 5 years (2nd Semester)

Sr . N o	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	PS	FW	SW	
1	BCH104	Biochemistry – II	Core Course	4	0	2	0	0	6
2	HGM101	Fundamentals of Genetics	Core Course	4	0	2	0	0	6
3	MBO102	General Microbiology	Allied Course	3	0	1	0	0	4
4		Statistics for Biosciences	Skill Enhancement course	2	0	0	0	0	2
5	ENV106	Environmental Studies-II	Ability Enhancement Course	2	0	0	0	0	2
6	ENG103	Communication Skills -II	Value Added Course	1	0	0	0	0	1
7	PSY106	Behavioural Science - II	Value Added Course	1	0	0	0	0	1
8	FOL103/ FOL104	Foreign Business Language –II	Value Added Course	1	0	0	0	0	1
9	INL104/ INL106	Punjabi Language/ History and Culture of Punjab	Ability Enhancement Course	1	0	0	0	0	1

Total Credits

24

BCH104: Biochemistry-II

L	T	P	Total Credits
4	0	2	6

Course content and syllabus

	Teaching Hours
Unit I: Carbohydrate Metabolism	18 hrs
Glycolytic pathway - aerobic and anaerobic glycolysis, Gluconeogenesis, Regulation of glycogen metabolism, Citric acid cycle and its regulation, Pentose phosphate pathway, Glyoxylate cycle, fate of absorbed carbohydrates, fructose, galactose, and mannose.	
Unit II: Lipid metabolism	18 hrs
Oxidation of fatty acids - Beta oxidation, alpha-oxidation, and omega oxidation, Ketogenesis, Biosynthesis of saturated and unsaturated fatty acids, Biosynthesis and degradation of tri-acyl glycerol and cholesterol, fate of absorbed dietary lipids	
Module III Protein Metabolism	18 hrs
Catabolism of amino acids, trans-amination, Oxidative and non-oxidative deamination, Decarboxylation- urea cycle and its regulation, Biosynthesis of creatinine, fate of dietary proteins	
Module IV Nucleic Acid Metabolism & Integration of metabolic pathways	18 hrs
Catabolism and biosynthesis of nucleotides, de-novo synthesis and salvage pathways, Regulation of purine and pyrimidine biosynthesis, Interrelationship among carbohydrate, protein and fat metabolism	

List of Experiments -with basic instructions (Total Teaching = 60 hrs)

1. Ninhydrin Test for Qualitative identification of Amino acids
2. Xanthoproteic Test for Qualitative identification of Aromatic Amino acids
3. Saponification test for lipid

4. Determination of Iodine number of fatty acids
5. Estimation of cholesterol
6. Estimation of protein by Bradford/Lowry's method
7. Estimation of DNA by Di-phenyl amine (DPA) method
8. Estimation of RNA by Orcinol method

Course Learning Outcomes:

- Students will understand the metabolic pathways linked with a series of chemical reactions occurring within a cell.
- This course will describe the chemical changes catalyzed by cellular components and various intracellular controls.
- Have knowledge of cellular metabolism, including central catabolic and anabolic pathways
- Understand how different control mechanisms may be integrated to coordinate cell metabolism and function.
- Understand how metabolism is coordinated in body systems and have knowledge of how disturbances in metabolism contribute to diseases

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
David L Nelson; and Michael M. Cox, W.H. Freeman	Lehninger's Principles of Biochemistry	WH Freeman	2012	0070492581, 9780070492585	957
Jeremy M. Berg, Lubert Stryer, John L Tymoczko, and Gregory J. Gatto,	Biochemistry	W.H. Freeman Company	2018	1319114652	1208

HGM101: Fundamentals of Genetics

L	T	P	Total Credits
4	0	2	6

Course content and syllabus

	Teaching Hours
Unit I Science of Genetics	18 hrs
<p>Description of cell cycle, cell division: mitosis, meiosis, DNA and RNA as genetic material, Chromosome structure: nucleosome, solenoid, chromatin loops, chromosomal territories, Types of chromosomes, Variation in chromosome structure and number: Deficiency, duplication, translocation, inversions, monosomy, nullisomy, trisomy, tetrasomy, haploidy, polyploidy. Origin and transmission of chromosomal aberrations.</p> <p>Brief history of genetics, Mendel and his experiments; Principles of segregation and independent assortment and their chromosomal basis; Test cross; Application of laws of probability to Mendelian inheritance. Understanding Punnet square.</p>	
Unit II Mendelian Genetics	18 hrs
<p>Chromosome Theory of Heredity (Sutton-Boveri), Inheritance patterns, phenomenon of Dominance and Dominance relationships (complete dominance, incomplete dominance and co-dominance), Multiple allelism; Lethal alleles; Pleiotropy; Epistasis; Penetrance and expressivity; Phenocopy; Polygenic inheritance, Pleiotropism, Modifier/Modifying genes. Inheritance patterns in Human (Sex-linked, Autosomal, Unifactorial, Multifactorial).</p> <p>Linkage & Crossing over: Chromosome theory of Linkage, kinds of linkage, linkage groups, Sutton's view on linkage, Morgan's view on linkage, types of Crossing over, mechanism of Meiotic Crossing over, theories about the mechanism of Crossing over, cytological detection of Crossing over, significance of Crossing over.</p>	
Unit III: Non- Mendelian Genetics	18 hrs
<p>Introduction to Genomic imprinting, maternal effects, extra nuclear inheritance in mitochondria and chloroplast. Sex determination, Dosage compensation with reference to X-inactivation in man, sex-linked, sex limited, sex influenced traits. Manifesting heterozygotes, mosaics, chimeras, hermaphrodites, Kappa articles in Paramecium, Sigma factor in <i>Drosophila</i>, Cytoplasmic Male Sterility (CMS) in maize maternal inheritance</p>	
Unit IV: Gene Mapping	18 hrs

Use of sexual process in bacteria and bacteriophages in genetic mapping, genetic mapping in haploid and diploid eukaryotes. Multifactorial inheritance and quantitative traits, determination of linkage groups, determination of map distance, determination of gene order, cytological mapping. Hardy-Weinberg principle and effect of selection, mutation, migration and genetic drift on Hardy-Weinberg equilibrium.	
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List of Experiments -with basic instructions (Total Teaching = 60 hrs)

1. Preparation of Mitotic Chromosome from human Leucocytes.
2. Study of salivary gland chromosomes in *Drosophila*.
3. Using Punnett Square in predicting genotypes of offsprings.
4. To test PTC tasting ability in a random sample and calculate gene frequencies for the taster and non-taster alleles,
5. Barr body analysis in buccal smear
6. To test for colour blindness using Ishihara charts
7. To study finger ball and palmar dermatoglyphics and calculate indices.
8. Human morphogenetic traits.

Course Learning Outcomes:

- Understand basic genetics.
- Gain knowledge about Mendelian principles and various exceptions to it.
- Understanding how sex of an organism has an impact on various diseases.
- Perceive knowledge of gene and chromosome mapping.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Gardner J, Simmons MJ , Snustad DP	Principles of E Genetics	Wiley-India	6 th /2008	978-0471291312	480
Snustad DP , Simmons MJ	Principles of DP Genetics	John Wiley and Sons Inc.	6 th /2011	978-0470388259 0470388250	740

Griffith AJF, Wessler SR, Lewontin RC, Carroll SB	Introduction to Genetic Analysis	W. H. 2007 Freeman and Co., New York		978-0716768876 0716768879	800
Strickberger, M.W	Genetics	Prentice-Hall India Pvt. Ltd., New Delhi	1999	8120309499 978-8120309494	600
Tamarin R.H	Principles of Genetics	Tata McGrawH ill, New York	2012	0072325305	697

MBO102: General Microbiology

L	T	P	Total Credits
3	0	1	4

Course content and syllabus

	Teaching Hours
Unit I: History of Microbiology and Microbial Diversity	14 hrs
Discovery of microorganisms, contributions of prominent scientists in microbiology, spontaneous generation v/s Biogenesis, discovery of antibiotics. Physiological diversity, microbial classification (prokaryotes: Bacteria and Archaea, eukaryotes: Fungi, Algae, Protozoa, Helminthes) Binomial nomenclature, Whittaker's and Carl Woese's classification.	
Unit II: Cell organization	13 hrs

Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaeobacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall. Cell Membrane: Structure, function and chemical composition of bacterial, archaeal and eubacterial cell membranes. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids Endospore: Structure, formation, stages of sporulation.	
Unit III: Microbial Nutrition, Growth and control	13 hrs
Nutritional requirements (macro and micronutrients), Temperature, pH, osmotic pressure, Types of culture media, uptake of nutrients, Maintenance of pure cultures. Microbial growth: Growth curve, Generation time, measurement of growth and factors affecting growth of bacteria. Methods in Microbiology: Microbial culture media, enrichment culture techniques, Pure culture techniques: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures.	
Unit IV: Sterilization, disinfection and microscopy	14 hrs
Sterilisation and disinfection- Definitions, Principles. Methods of sterilization- Physical methods (Heat, Filtration), Radiation and Chemical methods. Control of sterilization and Testing of sterility. Microscopy – Principles, Light microscope, Phase Contrast, Dark field, Bright field, Fluorescent, Interference microscope (Stereo microscope), Confocal, Inverted microscope, and Electron microscope (TEM and SEM). Measurement of Microorganisms- Micrometry. Staining- Simple, Gram staining, Negative staining, Capsule staining, Spore staining, Flagellar staining, Nuclear staining and Acid fast staining.	

List of Experiments -with basic instructions (Total Teaching = 36 hrs)

1. Microbiology-Good Laboratory Practices and Bio-safety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
3. Preparation of culture media for bacterial cultivation.
4. Sterilization of medium and glassware using Autoclave and Hot air oven, respectively and assessment for sterility.
5. Demonstration of the presence of microflora in the environment (soil/water/air)

Course Learning Outcomes:

- Understand the cellular organization of microbes and different methods of staining.
- Compare different nutritional requirements of microbes and methods of culturing.
- Identify different method of sterilization and imaging.
- Understand the microbial diversity and contributions made by prominent scientists in microbiology.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Pelczar, M.J. Jr., Chan ECS and Krieg, N.R.	Microbiology: Concepts and Applications	New York ;Madrid: McGraw-Hill,	1993	0070492581, 9780070492585	957
Cappucino, J.G.	Microbiology- A laboratory manual, 4th ed.,	Hoboken, N.J.: Pearson	2020	0135188997, 9780135203996, 0135203996	541
Tortora GJ, Funke BR and Case CL	Microbiology :An Introduction. 9th edition	Pearson Education	2008	0805347917	912
Madigan MT, Martinko JM, Dunlap PV and Clark DP.	Brock Biology of Microorganisms	Pearson International Edition	2014	9781292018317	1030

Statistics for Biosciences

L	T	P	TOTAL CREDIT UNITS
2	0	0	2

Course Contents/syllabus:

	Teaching Hours
Unit I:	9 H
Data collection and graphical presentation, Descriptive Statistics: Measures of central tendency-Arithmetic, geometric and harmonic mean, median, and mode.	
Unit II:	9 H

Measures of dispersion, Skewness and Kurtosis, Correlation, and regression	
Unit III:	9 H
Definitions of Probability, Conditional Probability, Bayes' theorem, random variables: discrete and continuous, density and mass functions.	
Unit IV:	9 H
Expected values and moment generating functions, Discrete distributions: Uniform, Bernoulli Binomial, Poisson, Continuous distributions: Uniform and Normal distribution	

Course Learning Outcomes: On the successful completion of this course,

- Students will understand the concept of data collection, representation, and measures of central tendency
- Students will be able to apply the concept of dispersion, skewness, correlation, and regression of the given data
- Students will be having knowledge of probability and random variables.
- Students will be able to apply the concepts of probability and random variables to different distributions

Text / Reference Books:

AUTHOR	TITL E	Publish er	Year of publicatio n	ISBN
Ronald E. Walpole , Raymond H. Myers , Sharon L. Myers , Keying E. Ye	Probability and Statistics for Engineers and Scientists	Pearson; 9th edition	2010	978-0321629111
G Shanker Rao	Probability and Statistics for Science and Engineering	Universities Press	2011	9788173717444
SC Gupta, VK Kapoor	Fundamentals of Mathematical Statistics	Sultan Chand & Sons Private Limited	2000	9788180545283

ENV106: Environmental Studies-II

L	T	P	Total Credits
2	0	0	2

Course content and syllabus

	Teaching Hours
Unit I: Environmental Pollution	9 hrs
<i>Environmental Pollution:</i> types, Cause, effects and controls –Air, water, soil, chemical and noise pollution. Nuclear hazard and human health risk Solid waste Management-control measures of urban and industrial waste. Pollution case studies.	
Unit II: Environmental Policies and Practices	9 hrs
<i>Environmental Policies and practices:</i> Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture. Environment laws: Environment Protection Act; Air (Prevention and Control of Pollution) Act; Water (Prevention and Control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act, international agreements: Montreal and Kyoto protocols and convention on biological diversity(CBD), The Chemical Weapons Convention (CWC). Natural reserves, tribal population and rights and Human-wildlife conflict in Indian context.	
Unit III: Human communities and the environment	9 hrs

Impacts on environment, human health and welfare. Carbon foot-print. Resettlements and rehabilitation of project affected persons, case studies. Disaster management: floods, earthquake, cyclone and landslides. Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan. Environmental ethics: Role of Indian and other religions and cultures in environmental conservation. Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).	
Unit IV: Field Work	9 hrs
<ul style="list-style-type: none"> • Visit to an area to document environmental assets: river/forest/flora/fauna, etc. • Visit to local polluted Site-Urban/Rural/Industrial/Agricultural • Study of common plants, insects, birds and basic principles of identification. • Study of simple ecosystems-pond, river, Delhi Ridge, etc 	

Course Learning Outcomes:

- Understanding the types of pollution and their impact on environment and human health.
- Understand the environmental concerns and their impact on humans and agriculture.
- Able to analyse the impacts of natural and manmade disaster on human population and settlements.
- Sensitization about the environmental issues and concerns leading to proactive actions to improve the environmental conditions in our daily life.
- Able to imbibe practical approach and solution to solve environmental concerns.

Text / Reference Books:

Author	Title	Publisher	Ed/ year	ISBN No	Pages
William P. Cunningham, Mary Ann Cunningham	Principles of Environmental Science	McGraw-Hill	2019	9781260219 718	--
William P. Cunningham, Mary Ann Cunningham, Barbara Woodworth Saigo	Environmental Science: A global concern	McGraw-Hill	2021	9781260363 821	--

Communication Skills—II (ENG-103)

L	T	P/S	SW/ FW	TOTAL CRED ITUNITS
1	0	0	0	1

Course Contents/syllabus:

	Teachin gHrs (H)
Unit I: Basic Concepts in Communication	3 H
Towards communicative competence; choosing the appropriate channel and medium of communication; ways to develop communication skills in the areas of Listening, Speaking, Reading, and Writing.	
Unit II: Communication Types	4 H
Nonverbal communication: detailed analysis, KOPPACT (Kinesics, Oculesics, Proxemics, Paralanguage, Artefacts, Chronemics, Tactilics).	
Unit III: Communication and Technology	3 H
Importance of digital literacy and communication on digital platforms.	
Unit IV: Presentation Skills	5 H
Planning, preparation, practice, and performance; audience analysis, audio-visual aids, analyzing the non-verbal communication, methods of delivery: impromptu, extemporaneous, memorization, manuscript, and outlining.	

Course Learning Outcomes:

- Students will be able to understand the need and the methods required to develop communication skills in the areas of listening, speaking, reading, and writing.
- Students will be able to understand the significance of non-verbal communication in various contexts.
- Students will be able to develop an awareness of the role of digital platforms in shaping public psyche, beliefs, and perceptions about social realities and build an informed and critical perspective.
- Students will be able to develop and upgrade their presentation skills.

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
P. D. Chaturvedi and Mukes hChaturvedi	Business Communication: Concepts, Cases and Applications	Pearson Education	2006	9788131701720
Meenakshi Raman and dPrakash Singh	Business Communication	Oxford University Press	2012	9780198077053
Jeff Butterfield	Soft Skills for Everyone	Cengage Learning	2017	9789353501051

PSY106: INDIVIDUAL, SOCIETY AND NATION

Course Contents/syllabus:

L	T	P/S	SW/FW /PSDA	TOTAL CREDIT UNITS
1	0	0	0	1

	No. of Session
Unit-1- Individual differences & Personality	4 H
<ul style="list-style-type: none"> • Personality: Definition & Relevance • Importance of nature & nurture in Personality Development • Importance and Recognition of Individual differences in Personality • Accepting and Managing Individual differences Intuition, Judgment, Perception & Sensation (MBTI) BIG5 Factors 	
Unit-2- Managing Diversity	4 H

<ul style="list-style-type: none"> • Defining Diversity • Affirmation Action and Managing Diversity • Increasing Diversity in Work Force • Barriers and Challenges in Managing Diversity 	
Unit-3- Socialization, Patriotism and National Pride	4 H
<ul style="list-style-type: none"> • Nature of Socialization • Social Interaction • Interaction of Socialization Process • Contributions to Society and Nation • Sense of pride and patriotism • Importance of discipline and hard work • Integrity and accountability 	
Unit-4- Human Rights, Values and Ethics	3 H
<ul style="list-style-type: none"> • Meaning and Importance of human rights • Human rights awareness • Values and Ethics- Learning based on project work on Scriptures like- Ramayana, Mahabharata, Gita etc. 	

List of Professional Skill Development Activities (PSDA):

- Project on Understanding Diversity
- Term Paper on Patriotism among Youth

Course Learning Outcomes: On completion of the course:

- To recognize individual differences
- To manage individual differences
- To develop patriotic feelings
- To recognize their self in relation to society & nation

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN	Pages
Department of English, University of Delhi	The Individual & Society	Pearson Education	2010	978-8131704172	266

Umang Malhotra	Individual, Society, and the World	iUniverse	2004	978-0595662401	188
Tonja R. Conerly & Kathleen Holmes	Introduction to Sociology 3e	Openstax	2018	9781711493978	458
Daksh Tyagi	"A Nation of Idiots"	Every Protest	2019	978-8194275018	350

FOL103: French Grammar

L	T	P	Total Credits
1	0	0	1

Course content and syllabus

	Teaching Hours
Unit I: My family and my house	4 hrs
Descriptors/Topics <ul style="list-style-type: none"> • Talk about your family members • Usage of possessive adjectives • Describe your house/apartment • Prepositions of location • Negation 	
Unit II: Lifestyle	3 hrs
Descriptors/Topics <ul style="list-style-type: none"> • Talk about your hobbies and pastimes • Usage of appropriate articles : definite and contracted • Talk about your daily routine • Usage of pronominal verbs 	
Unit III: In the city	3 hrs

Descriptors/Topics <ul style="list-style-type: none"> • Filling up a simple form • Ask for personal information • Usage of interrogative adjectives • Give directions about a place • Ordinal numbers 	
<ul style="list-style-type: none"> • Usage of demonstrative adjectives 	
Unit IV: Week-end	3 hrs
Descriptors/Topics <ul style="list-style-type: none"> • Talk about your week-end plans • Usage of disjunctive pronouns • Usage of Near Future tense • Talk about weather • Write a simple post card 	

Course Learning Outcomes: At the end of this course, the students will be able to interact in a simple way on everyday topics. This course content focuses on the speech of the students in a lucid and a concurrent manner using appropriate vocabulary and pronunciation techniques. Extra stress will be given on their understanding of grammatical structures and the foreign accent of the language. At the end of the course, the student shall be able to:

- Understand information; Express in his own words; Paraphrase; Interpret and translate.
- Apply information in a new way in a practical context
- Analyze and break-down information to create new ideas
- Evaluate and express opinion in a given context

Text / Reference Books:

Author	Title	Publisher	Ed/ye ar	ISBN No	Pa ges
Christine Andant, Catherine Metton, Annabelle Nachon, Fabienne Nugue	A Propos - A1, Livre de l'élève et Cahier d'exercices.	Langers Internationala IPvt. Ltd.	2010	978-9380809069	---
Collins Dictionaries	Easy Learning French Complete Grammar, Verbs and Vocabulary	Collins	2016	978-0008141721	---

Nikita Desai, Samapita DeySarkar	Apprenons L a Grammaire Ensemble - French	Langers Internationa IPvt. Ltd.	2017	978- 8193002681	---
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FOL104: German Grammar

L	T	P	Total Credits
1	0	0	1

Course content and syllabus

	Teaching Hours
Unit I: Time (Uhrzeit); People and the World: Land, Nationalität und Sprache	4 hrs
<ul style="list-style-type: none"> • Introduction of time • Read text related to time and teach the students the time expressions • Exercises related to Time • Adverbs of time and time related prepositions • Vocabulary: Countries, Nationalities, and their languages • Negation: "nicht/ kein" • Ja/Nein Fragen. • All the colors and color related vocabulary, adjectives, and opposites • Exercises and comprehension for the same 	
Unit II: Irregular verbs (unregelmässige Verben)	3 hrs
<ul style="list-style-type: none"> • Introduction to irregular verbs and their conjugation e.g. fahren, essen, lesen etc • Read a text related to the eating habits of Germans • Vocabulary: Obst, Gemüse, Kleiderstück with usage of irregular verbs • Free time and hobbies • Food and drinks 	
Unit III: Accusative case: articles and pronouns (Akkusativ Kasus: Artikel und Pronomen)	3 hrs
<ul style="list-style-type: none"> • Introduction to the concept of object (Akkusativ) • Formation of sentences along with the translation and difference between nominative and accusative articles • Usage of accusative Definite articles • Usage of accusative Indefinite articles 	
Unit IV: Accusative case: possessive pronouns (Akkusativ Kasus: Possessivpronomen)	3 hrs

Family and Relationship	
<ul style="list-style-type: none"> • Accusative Personal Pronouns: - Revision of the nominative personal pronouns and introduction of accusative. Applicability of pronouns for both persons and things. • Usage of accusative Personal Pronouns • Introduction of accusative possessive pronouns • Difference between nominative and accusative possessive pronouns • usage of accusative possessive pronouns 	

Course Learning Outcomes: After completing these modules, the students will be capable of constructing sentences with possessive and demonstrative adjectives in German. In addition, they will be proficient in formulating meaningful sentences as they will be capable of applying their knowledge of all the irregular verbs they have learnt during the session. They will also have an idea of German culture by studying about various German festivals.

At the end of the course, the student shall be able to:

- Understand information; Express in his own words; Paraphrase; Interpret and translate.
- Apply information in a new way in a practical context
- Analyse and break-down information to create new ideas
- Evaluate and express opinion in a given context

Text / Reference Books: [mention the name of the books. Can add more rows]

Author	Title	Publisher	Ed/ year	ISBN No	Pages
Dora Schulz, Heinz Griesbach	Deutsche Sprachlehre Fur Auslander	Max Hueber Verlag	1984	978-3190010066	---
Hartmut Aufderstrasse, Jutta Muller, Helmut Muller	Themen Aktuell: Glossar Deutsch	Max Hueber Verlag	2003	978-3190816903	---
Giorgio Motta	Wir Plus Grundkurs Deutsch fur Junge Lerner Book German Guide	Goyal Publishers	2011		248

L	T	P	Total Credits
1	0	0	1

Course content and syllabus

	Weightage (%)	Teaching Hours
Unit I:	25%	4 hours
ਆਧੁਨਿਕ ਪੰਜਾਬੀ ਕਹਾਣੀ ਦਾ ਅਧਿਐਨ (ਕਥਾ ਕਹਾਣੀ) ਕਹਾਣੀ ਵਿਸ਼ਾ-ਵਸਤੂ/ਸਾਰ,ਪਾਤਰ-ਚਿਤਰਨ ਕਹਾਣੀਕਾਰ ਦੇ ਜੀਵਨ ਅਤੇ ਰਚਨਾ ਬਾਰੇ ਮੁੱਢਲੀ ਜਾਣਕਾਰੀ		
Unit II:	25%	4 hours
ਦਫ਼ਤਰੀ ਚਿੱਠੀ-ਪੱਤਰ ਰਚਨਾ ਚਿੱਠੀ-ਪੱਤਰ ਲੇਖਣ ਕਲਾ,ਮਹੱਤਤਾ ਅਤੇ ਕਿਸਮਾਂ ਦਫ਼ਤਰੀ ਚਿੱਠੀ-ਪੱਤਰ ਰਚਨਾ ਦੇ ਜ਼ਰੂਰੀ ਅੰਗ ਅਤੇ ਵੱਖ-ਵੱਖ ਵਿਸ਼ਿਆਂ ਅਨੁਸਾਰ ਵਿਹਾਰਕ ਅਭਿਆਸ		
Unit III:	25%	5 hours
ਵਿਆਕਰਨ ਸਿਧਾਂਤ ਅਤੇ ਵਿਹਾਰ 1. ਪੰਜਾਬੀ ਅਰਥ ਬੋਧ ਅਰਥਾਂ ਦੇ ਆਧਾਰ ਦੇ ਸ਼ਬਦਾਂ ਦੀਆਂ ਕਿਸਮਾਂ ਅਤੇ ਉਦਾਹਰਨਾਂ, ਸਮਾਨਰਥਕ ਸ਼ਬਦ, ਬਹੁਅਰਥਕ ਸ਼ਬਦ, ਵਿਰੋਧਾਰਥਕ ਸ਼ਬਦ, ਬਹੁਤੇ ਸ਼ਬਦਾਂ ਦੇ ਸਥਾਨ ਤੇ ਇੱਕ ਸ਼ਬਦ ਮੁਹਾਵਰੇ, ਅਖਾਣ : ਪਰਿਭਾਸ਼ਾ ਅਤੇ ਉਦਾਹਰਨਾਂ 2. ਪੰਜਾਬੀ ਵਾਕ ਬੋਧ ਵਾਕ ਪ੍ਰੀਭਾਸ਼ਾ,ਵਾਕ ਦੇ ਤੱਤ, ਪੰਜਾਬੀ ਵਾਕ ਤਰਤੀਬ ਵਾਕ ਵਰਗੀਕਰਨ:ਕਾਰਜ ਦੇ ਆਧਾਰ ਤੇ ਵਾਕਾਂ ਦੀਆਂ ਕਿਸਮਾਂ, ਬਣਤਰ ਦੇ ਆਧਾਰ ਤੇ ਵਾਕਾਂ ਦੀਆਂ ਕਿਸਮਾਂ		
Unit IV:	25%	5 hours
ਵਿਆਕਰਨ ਸਿਧਾਂਤ ਅਤੇ ਵਿਹਾਰ 1. ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਅਤੇ ਗੁਰਮੁਖੀ ਲਿੱਪੀ 2. ਭਾਸ਼ਾ, ਉਪਭਾਸ਼ਾ,ਟਕਸਾਲੀ ਭਾਸ਼ਾ ਅਤੇ ਪੰਜਾਬੀ ਦੀਆਂ ਉਪਭਾਸ਼ਾਵਾਂ		

Course Learning Outcomes:

1. Understand modern Punjabi Stories.
2. Interpret the importance of letter writing
3. Analyze the Punjabi language structure and grammar.
4. Examine the impact and importance of Punjabi dialects and Gurmukhi script on Punjabi language.

Pedagogy for Course Delivery

Lectures: 14 sessions

Presentation / Seminar/ Assignment: 2 sessions

Mid Term Test & End Term Exam: 2 sessions

Quiz: 3

Total:18 sessions

Assessment/ Examination Scheme:

Theory L/T (%)	Lab/Practical/Studio (%)	End Term Examination
100	0	100

Text /

Books:

Reference

AUTHOR	TITLE	Publisher	Year of publication	ISBN	Pages
ਡਾ. ਧਨਵੰਤ ਕੌਰ (ਸੰਪਾ.),	ਕਥਾ ਕਹਾਣੀ	ਪਬਲੀਕੇਸ਼ਨ ਬਿਊਰੋ, ਪੰਜਾਬ ਯੂਨੀਵਰਸਿਟੀ ਚੰਡੀਗੜ੍ਹ	2009	-	-
ਸੁਰਿੰਦਰ ਸਿੰਘ ਖਹਿਰਾ (ਸੰਪਾ.),	ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਵਿਆਕਰਨ ਅਤੇ ਬਣਤਰ	ਪਬਲੀਕੇਸ਼ਨ ਬਿਊਰੋ,ਪੰਜਾਬੀ ਯੂਨੀਵਰਸਿਟੀ ਪਟਿਆਲਾ	2015	-	-
ਡਾ.ਹਰਕੀਰਤ ਸਿੰਘ,	ਕਾਲਜ ਪੰਜਾਬੀ ਵਿਆਕਰਨ ਅਤੇ ਲੇਖ ਰਚਨਾ	ਪੰਜਾਬ ਸਟੇਟ ਯੂਨੀਵਰਸਿਟੀ ਟੈਕਸਟ ਬੁੱਕ ਬੋਰਡ,ਚੰਡੀਗੜ੍ਹ	1999	-	-
ਡਾ. ਪ੍ਰੇਮ ਪ੍ਰਕਾਸ਼ ਸਿੰਘ	ਕਾਲਜ ਪੰਜਾਬੀ ਵਿਆਕਰਨ ਅਤੇ ਲੇਖ ਰਚਨਾ	ਮਦਾਨ ਪਬਲੀਕੇਸ਼ਨਜ਼, ਪਟਿਆਲਾ	2002	-	-
ਡਾ. ਬੂਟਾ ਸਿੰਘ ਬਰਾੜ	ਪੰਜਾਬੀ ਵਿਆਕਰਨ ਸਿਧਾਂਤ ਅਤੇ ਵਿਹਾਰ	ਚੇਤਨਾ ਪ੍ਰਕਾਸ਼ਨ, ਪੰਜਾਬੀ ਭਵਨ,ਲੁਧਿਆਣਾ	2012	-	-
ਡਾ. ਬੂਟਾ ਸਿੰਘ ਬਰਾੜ	ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਸ਼੍ਰੋਤ ਅਤੇ ਸਰੂਪ	, ਵਾਰਿਸ ਸ਼ਾਹ ਫ਼ਾਊਂਡੇਸ਼ਨ, ਅੰਮ੍ਰਿਤਸਰ	2012	-	-
ਦੁਨੀ ਚੰਦ੍ਰ	ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਦਾ ਵਿਆਕਰਣ	, ਪੰਜਾਬ ਯੂਨੀਵਰਸਿਟੀ ਪਬਲੀਕੇਸ਼ਨ ਬਿਊਰੋ, ਚੰਡੀਗੜ੍ਹ	1995	-	-

ਜੋਗਿੰਦਰ ਸਿੰਘ ਪੁਆਰ ਅਤੇ ਹੋਰ	ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਦਾ ਵਿਆਕਰਨ (ਭਾਗ 1,2,3),	ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਅਕਾਦਮੀ ਜਲੰਧਰ	2003	-	-
ਸੁਖਵਿੰਦਰ ਸਿੰਘ ਸੰਘਾ	ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਵਿਗਿਆਨ	ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਅਕਾਦਮੀ ਜਲੰਧਰ	2010	--	-
ਅਗਨੀਹੋਤਰੀ, ਵੇਦ	ਪਰਿਚਾਇਕ ਭਾਸ਼ਾ ਵਿਗਿਆਨ	ਦੀਪਕ ਪਬਲਿਸ਼ਰਜ਼ ਜਲੰਧਰ	1981	-	-

INL106: History and Culture of Punjab

L	T	P/S	SW/FW	Total Credit Units
1	0	0	0	1

Course Contents/syllabus:

	Weightage (%)
Unit I:	4H
1. Introduction of Colonial Rule in Punjab: Annexation of Punjab; Board of Administration. 2. Western Education: Growth of Education and rise of middle classes. 3. Agrarian Development: Commercialization of agriculture; canalization and colonization.	
Unit II:	4H
4. Early Socio Religious Reform: Christian Missionaries; Namdharis; Nirankaris. 5. Socio Religious Reform Movements: activities of Arya Samaj; Singh sabhas; Ahmadiyahs; Ad Dharam Movement 6. Development of Press & literature: growth of print technology; development in literature	
Unit III:	4H
7. Emergence of Political Consciousness: Gadar Movement; Jallianwala Bagh Massacre 8. Gurudwara Reform Movement; major Morchas; Activities of Babbar Akalis. 9. Struggle for Freedom: Non-Cooperation Movement; HSRA and Bhagat Singh; Civil Disobedience Movement; Quit India Movement.	
Unit IV:	3H
10. Partition and its Aftermath: resettlement; rehabilitation 11. Post-Independence Punjab: Linguistic Reorganization; Green Revolution.	

1		Biotechniques	Core Course	4	0	2	0	0	6
2		Enzymology	Core Course	4	0	2	0	0	6
3		Genetics and Inheritance Biology	Core Course	4	0	2	0	0	6
4		Protein Science	Allied Course	4	0	0	0	0	4
5		Prgrammng with C	Skill Enhancement Course	1	0	1	0	0	2

Total Credits

24

Biotechniques

L	T	P	Total Credits
4	0	2	6

Objective: This course will provide students with the understanding of various analytical techniques used in biology/biotechnology-based research and industry. The course will acquaint the students with the various instruments, their configuration and principle of working, operating procedures, data generation and its analysis.

Course content and syllabus

	Teaching Hours
Unit I: Introduction to chromatographic techniques	18 hrs
Theoretical basis of chromatographic separations, Principles and applications of paper, thin layer, column, ion-exchange, affinity, gel permeation, normal phase and reverse phase chromatography, gas chromatography, High performance liquid chromatography (HPLC)	
Unit II: Spectroscopic and centrifugation techniques	18 hrs
Theory and application of UV-Visible, Infrared, Raman, Nuclear magnetic resonance, Fluorescence, Atomic absorption spectroscopy, X-ray diffraction, Introduction to mass spectroscopy, Introduction to centrifugation, basic principles of sedimentation, types of centrifuges and their uses, density gradient and analytical centrifugation, sub-cellular fractionation	
Unit III: Electrophoretic techniques	18 hrs
Theoretical basis of electrophoretic separations, electrophoretic mobility, moving boundary electrophoresis, paper, starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse-field gel electrophoresis, immune-electrophoresis, isoelectric focusing, western blotting	
Unit IV: Microscopy	18 hrs
Simple microscopy, phase contrast microscopy, fluorescence, and electron microscopy (Transmission and Scanning)	

List of Experiments:

1. To verify the validity of Beer's law and determine the molar extinction coefficient of KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$
2. Separation of amino acids by paper chromatography
3. To identify biomolecules in a given sample by paper/thin layer chromatography
4. Demonstration of HPLC instrument
5. Determination of concentration of metal ion using atomic absorption spectroscopy
6. Demonstration of working of centrifuge
7. Preparation of sub-cellular fractions of cells
8. Native and SDS-polyacrylamide gel electrophoresis of proteins.

Course Learning Outcomes:

Students will be able to

1. apply basic principles of different analytical techniques in analytical work.
2. use spectroscopy and chromatography in biotechnological applications.
3. use microscopy, centrifugation, and electrophoretic techniques.
4. demonstrate principle and working of various instruments.
5. use various techniques for solving industrial and research problems.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Karp, Gerald	Cell and Molecular Biology: Concepts and Experiments	John Wiley and Sons, Inc	6 th edition/2018	978-1118886144	832
Wilson K., Walker J.	Principle and Techniques of Biochemistry and Molecular Biology	Cambridge University Press	6 th edition/2006	978-0521178747	744
Rana, SVS	Biotechniques: Theory and Practice	Rastogi Publications	2018	-	376
Plummer, David	An Introduction to Practical Biochemistry	Tata Mc GrawHills	3 rd edition/2017	978-0070994874	250

Enzymology

L	T	P	Total Credits
4	0	2	6

Course content and syllabus

	Teaching Hours
Unit I: Enzymes and Coenzymes	18 hrs
Nature of enzymes - protein and non-protein (ribozyme). Cofactor and prosthetic group, apoenzyme, holoenzyme. IUBMB classification of enzymes. Features of enzyme catalysis Factors affecting the rate of chemical reactions, collision theory, activation energy and transition state theory, catalysis, reaction rates and thermodynamics of reaction. Catalytic power and specificity of enzymes (concept of active site), Koshland's induced fit hypothesis. Involvement of coenzymes in enzyme catalysed reactions: Mechanism of action of TPP, FAD, NAD, pyridoxal phosphate, biotin, coenzyme A, tetrahydrofolate, lipoic acid.	
Unit II: Enzyme Kinetics and Inhibition	18 hrs

Relationship between initial velocity and substrate concentration, steady state kinetics, equilibrium constant – mono-substrate reactions. Michaelis-Menten equation, Lineweaver-Burk plot, Eadie-Hofstee and Hanes plot. Km and Vmax, Kcat and turnover number. Effect of pH, temperature and metal ions on the activity of enzyme. Bi-substrate reactions: Types of bi bi reactions (sequential – ordered and random, ping pong reactions).	
Enzyme inhibition: Reversible inhibition and irreversible (competitive, uncompetitive, noncompetitive, mixed type). Mechanism based inhibitors - antibiotics as inhibitors.	
Unit III: Mechanisms of Enzyme catalysed reactions	18 hrs
General features - proximity and orientation, strain and distortion, acid base and covalent catalysis (chymotrypsin, lysozyme). Metal activated enzymes and metalloenzymes, transition state analogues. Regulation of enzyme activity : Control of activities of enzymes (end product inhibition) and metabolic pathways, feedback inhibition (aspartate transcarbamoylase), reversible covalent modification (phosphorylation). Proteolytic cleavage- zymogen. Multienzyme complexes (pyruvate dehydrogenase, fatty acid synthase) and Enzyme regulation	
Unit IV: Application of Enzymes	18 hrs
Application of enzymes in diagnostics (SGPT, SGOT, creatine kinase, alkaline and acid phosphatases), enzyme immunoassay (HRPO), enzyme therapy (Streptokinase). Immobilized enzymes. Isoenzymes Enzyme Inhibitors as drugs. Drug Design	

List of Experiments -with basic instructions (Total Teaching = 60 hrs)

1. Partial purification of acid phosphatase from germinating mung bean.
2. Assay of enzyme activity and specific activity, e.g. acid/alkaline phosphatase.
3. Effect of pH on enzyme activity
4. Effect of temperature on enzyme activity
4. Determination of Km and Vmax using Lineweaver-Burk plot
5. Enzyme inhibition - calculation of Ki for competitive inhibition.
6. Continuous assay of lactate dehydrogenase.
7. Coupled assay of glucose-6-phosphate dehydrogenase.

Course Learning Outcomes: at the end of the course, the students will learn

- Types of enzymes, classification and their importance
- Enzyme kinetics and enzyme inhibitors
- Mechanisms of enzyme action
- Application of enzymes in diagnostics and drug discovery

Text / Reference Books:

Author	Title	Publisher	Ed/yea r	ISBN No	Pag es
David Nelson	Lehninger: Principles of	WH Freeman	2017	9781319108243	1328

	Biochemistry				
Nicholas C.P. and Lewis S.	Fundamentals of Enzymology	Oxford University Press	3 rd Ed	978-0198064398	-
Voet, D., Voet, J.G.	Biochemistry	Wiley	4 th Ed	978-0071737074	-

Genetics and Inheritance Biology

L	T	P	Total Credits
4	0	2	6

	Teaching Hours
Unit I Human Genetics	18 hrs
History of Human Genetics and Human Genome, Pedigrees- gathering family history, pedigree symbols, construction of pedigrees, presentation of molecular genetic data in pedigrees. Monogenic traits Autosomal inheritance-dominant, recessive, Sex-linked inheritance, Sex-limited and sex-influenced traits, Mitochondrial inheritance, MIM number, Complications to the basic pedigree patterns- nonpenetrance, variable expressivity, pleiotropy, late onset, dominance problems, anticipation, genetic heterogeneity, genomic imprinting and uniparental disomy, spontaneous mutations, mosaicism and chimerism, male lethality, X- inactivation, Risk assessment; application of Bayes' theorem, Allele frequency in population, Consanguinity and its effects	
Unit II Complex Traits	18 hrs
Approaches to analysis of complex traits- 'Nature -nurture' concept, role of Family and shared environment, monozygotic and dizygotic twins and adoption studies, Polygenic inheritance of continuous (quantitative) traits, normal growth charts, Dysmorphology, Polygenic inheritance of discontinuous (dichotomous) traits- threshold model, liability and recurrence risk, Genetic susceptibility in multifactorial disorders (alcoholism, diabetes mellitus, obesity), Estimation of genetic components of multifactorial traits: empiric risk, heritability, coefficient of relationship.	
Unit III: Human Cytogenetics	18 hrs

Molecular organization of the human genome, Transposable elements, Human chromosome organization and structure, Centromeres, Neocentromeres, Kinetochores, Telomeres, chromosome nomenclature; sister chromatid exchanges (SCE); mosaicism; structure of human X and Y chromosome; ring chromosomes; human artificial chromosome. Heterochromatin and Euchromatin and its significance. Various types of mutations, Role of radiations and chemicals in inducing mutations, Effects of mutations, Mutation rates in humans, Pleiotropy.	
Unit IV: Techniques for inheritance Biology	18 hrs
Chromosome banding techniques — G,C,R,Q,T,NOR, High-resolution banding, Molecular correlates of chromosome bands, Fragile sites, Chromosome nomenclature and cytogenetic notation for G-banded chromosomes, VNTRs, Applications of amniocentesis, chorionic villus sampling (CVS) and fluorescence in situ hybridization (FISH). classification, use of Human Cyto-genetics in Medical science	

List of Experiments -with basic instructions (Total Teaching = 60 hrs)

- 1 Demonstration of short-term blood lymphocyte culture — Washing and sterilization of glassware and plasticware.
2. Preparation of chemical solutions and culture medium.
3. Setting up the culture; Harvesting the culture, Staining and Banding.
4. Scoring of prepared slides, Demonstration of photomicrography, Developing and printing of photographs,
5. Karyotyping of solid-stained and G-banded chromosome preparations.
6. Identification of structural and numerical chromosomal aberrations from photographs, Sister chromatid exchange analysis from peripheral blood lymphocyte culture.
7. Numericals on chromosome nomenclature.
8. Numericals on Pedigree Analysis.

Course Learning Outcomes:

- Understand Human Genome and various types of mutations.
- Gain knowledge about various complex traits of Humans.
- Acquaintance with various banding techniques
- Overall understanding about cytogenetics.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Gardner EJ, Simmons MJ, Snustad DP	Principles of Genetics	Wiley-India	6 th /2008	978-0471291312	480
Snustad DP, Simmons MJ	Principles of Genetics	John Wiley and Sons Inc.	6 th /2011	978-0470388259 0470388250	

Griffith AJF, Wessler SR, Lewontin RC, Carroll SB	Introduction to Genetic Analysis	W. H. Freeman and Co., New York	2007	978-0716768876 0716768879	800
Strickberger, M.W	Genetics	Prentice-Hall India Pvt. Ltd., New Delhi	1999	8120309499 978-8120309494	-
Tamarin R.H	Principles of Genetics	Tata McGrawH ill, New York	1998	978-0697354624	680
Freshney, R.I.	Animal Cell Culture: A	IRL Press, Oxford, 2 nd ed.	2 nd /1992	9781119513018	832
	Practical Approach				
Rooney, D.E. and Czepulkowski, B.H.	Human Cytogenetics: A Practical Approach	IRL Press Ltd., Oxford.	1986	0947946713 978-0947946718	260
Sumner, A.T	Chromosomes: Organization and Function	Blackwell Publishing Co., Oxford.	2003	0632054077	287

Protein Science

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I: Protein Structure	18 hrs
Peptide bond, protein secondary structure – fibrous and globular proteins, proteins stability, tertiary and quaternary structure, Protein Folding: Theory and Experiment, Folding Accessory Proteins, Protein Structure Prediction and Design, Protein Dynamics.	
Unit II: Protein misfolding, aggregation and denaturation	18 hrs

Protein misfolding and aggregation, amyloid formation. Conformational Diseases: Alzheimer's, Prion diseases, Huntington's disease, sickle cell anemia, Parkinsons. Structural Evolution Protein denaturation and folding, Chemical evolution, Chemical Synthesis of Polypeptides. IDP (Intrinsically disordered proteins).	
Unit III: Protein alignment and database research	12 hrs
Protein primary sequence analysis, DNA sequence analysis, pair wise sequence alignment, FASTA algorithm, BLAST, multiple sequence alignment, DATA base searching using BLAST and FASTA. Phylogenetic tree analysis	
Unit IV: Analysis of protein-protein interactions	12 hrs
Pull-down assay, Yeast two hybrid assay, Coimmunoprecipitation assay, Fluorescence resonance energy transfer (FRET). DNA- protein interactions, footprinting assay, EMSA.	

Course Learning Outcomes:

- Understand basic concepts of protein structure.
- Learn protein functions by ligand binding -enzymes and antibodies.
- To understand the role of proteins in cellular transport.
- To understand the role of proteins as signaling molecules.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Donald Voet, Judith G. Voet	Biochemistry, 4th Edition	John Wiley & Sons	2018	ISBN: 978-0-470-57095-1	18 20
David L. Nelson and Michael M. Cox	Lehninger Principles of biochemistry, 8 th Edition	Macmillan	2021	ISBN:9781319322328	1120

Programming with C

L	T	P	Total Credits
1	0	1	2

Course Objectives: The course is designed to provide basic knowledge of procedural programming and learn constructs of C language. Students will be able to develop logics which will help them to create programs in C.

Course Contents/syllabus:

	Teaching Hours
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Unit I: Unit I: Introduction of Programming Languages.	5 hrs
Introduction: Types of Languages, Evolution of 'C' Language, Structure of a 'C' Program, 'C' Program development life cycle, Executing and Debugging a 'C' Program. 'C' Tokens: Keywords and Identifiers, Operators, Constants, Variables, Data Types, Precedence of Operators, Scope and Lifetime of Variables	
Unit II: Control Statement and Looping	4 hrs
Control Statements: Decision Making using if statement, Types of if ...else block, Switch case Block, Arithmetic Expressions, Evaluation of Expressions, GOTO statement Looping: Concept of Loop, For loop, While loop, Do while loop, Jumping in Loop, break and continue statement.	
Unit III: Arrays and Strings	4 hrs
Arrays and Strings: Introduction to array, Processing Array Contents, 2D arrays, Array with three or more dimensions. String, string concatenation, Comparing strings, String handling Functions	
Unit IV: Functions, Structure and Unions	5 hrs
Function: Concept of Function, User defined Function, System Defined Function, Function Calling, Types of parameters passing in function, return type in Function. Structure & Union: Need of Structure, Implementing Structure Variable, Arrays of Structure, Structure within Structure, Introduction of Unions, Difference between Structure and Unions	

Course Learning Outcomes: After studying this course students will be able:

1. To understand the fundamentals and tokens of C programming.
2. To develop skills to implement decision making through control structures in C.
3. To Analyze the working and implementation of array in memory.
4. To Optimize the code with the help of functions and structures.

Lab/ Practical details, if applicable:

Objective: The aim of this section of Lab is to teach experiments of C programming pertaining to the units being taught in the theory paper specifically related to procedural programming, strings, structures and unions.

1. Write a Program to read radius value from the keyboard and calculate the area of circle and print the result in both floating and exponential notation.
2. Write a Program to convert temperature. (Fahrenheit –Centigrade and vice-versa)
3. Write a program for computing the volume of sphere, cone and cylinder assume that dimensions are integer's use type casting where ever necessary.
4. Write a Program to read marks of a student in six subjects and print whether pass or fail (using if-else).
5. Write a Program to calculate roots of quadratic equation (using if-else).
6. Write a Program to calculate electricity bill. Read starting and ending meter reading. The charges are as follows.

No. of Units Consumed Rate

in(Rs) 1-100 1.50 per unit

101-300 2.00 per unit for excess of 100 units

301-500 2.50 per unit for excess of 300

units 501-above 3.25 per unit for excess of 500 units

Do the Following Programs Using for, while, do-while loops.

7. Write a program to calculate sum of individual digits of a given number.
8. Write a program to check whether given number is palindrome or not.
9. Write a program to check whether a given number is a Fibonacci number or not.
10. Write a program to read 2 numbers x and n then compute the sum of the Geometric Progression. $1+x+x^2+x^3+\dots+x^n$

11. Write a program to print the following formats. 1 *

```
1 2 ***
1 2 3 *****
1 2 3 4 *****
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12. Write a program to perform matrix addition, matrix subtraction and transpose of a matrix.
13. Write a program to verify the given string is palindrome or not (without built-in functions, with using built-in functions).
14. Write a program to swap two numbers using a) Call By Value B) Call By Reference.
18. Write a program to create structure for an account holder in a bank with following Fields: name, account number, address, balance and display the details of five account holders.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Jeri R. Hanly, Elliot B. Koffman	Problem Solving and Program Design in C	Pearson	2018	978-0134014890	345
Pradip Dey, Manas Ghosh	Programming In C	Oxford University Press	2018	978-0199491476	720
Yashwant Kanetkar	Let Us C	BPB Publications	2020	978-9389845686	556

Integrated B.Sc. + M.Sc. (H) HGMM- 5 years (4th Semester)

Sr No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	PS	FW	SW	
1		Immunology	Core Course	4	0	2	0	0	6
2		Human Anatomy and Physiology	Core Course	4	0	2	0	0	6
3		Microbial Physiology and Metabolism	Core Course	4	0	2	0	0	6
4		Recombinant DNA Technology	Allied Course	3	0	1	0	0	4
5		Fundamentals of Physics	Skill enhanceme ntcourse	2	0	0	0	0	2

Total Credits

24

Immunology

L	T	P	Total Credits
4	0	2	6

Objective: The objective of this course is to provide students with detail understanding of different cells of the immune system and their role in immune protection as well as application of immunological techniques

Course content and syllabus

	Teaching Hours
Unit I: Introduction and Immune Cell Types	1 hrs 8
Immune system, Concept of Innate and Adaptive immunity, Hematopoietic stem cells, Lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), Granulocytes and Monocytes, Cell participation in innate and adaptive Immunity	
Unit II: Antigens, Antibodies and Major Histocompatibility Complex	1 hrs 8
Characteristics of an antigen (Foreignness, Molecular size, and Heterogeneity), Haptens, Epitopes (T & B cell epitopes), T-dependent and T-independent antigens, Factors responsible for immunogenicity, Adjuvants, Super-antigens, Structure and function of antibody, Antibody classes, VDJ rearrangements, Monoclonal and chimeric antibodies, Major Histocompatibility: Structure and Functions of MHC I & II molecules, Antigen processing and presentation, Inflammatory response, Complement System	
Unit III: Generation of Immune Response and Vaccines	1 hrs 8
Primary and Secondary Immune Response, Generation of Humoral Immune Response (Plasma and Memory cells), Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co-stimulatory signals), Killing Mechanisms by CTL and NK cells, Types of autoimmunity and hypersensitivity with examples, Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak-Higashi syndrome, tumor antigens, Vaccines: Active and passive immunization, Vaccine types (Livebut attenuated, Killed, Subunit, Recombinant, DNA and Peptide)	
Unit IV: Immunological Techniques	1 hrs 8

Principles of Precipitation, Agglutination, Immunodiffusion, Immuno-electrophoresis, Immunoassays, ELISA, ELISPOT, Western blotting, Immunofluorescence, Flow cytometry, fluorescence activated cell sorting analysis, microarrays to assess gene expression	
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List of Experiments: (Total Teaching Hours = 60 hrs)

1. Identification of human blood groups.
2. Total Leukocyte Count of the given blood sample.
3. Differential Leukocyte Count of the given blood sample.
4. Separation of serum from the given blood sample.
5. Immunodiffusion by Ouchterlony method.
6. DOT ELISA.
7. Immuno-electrophoresis.

Course Learning Outcomes:

- Students will be able to explain the role of immune cells and their role in body defense mechanism
- Students will be able to devise strategies to combat infection or diseases produced by altered self.
- Students will develop ability to use this knowledge in the processes of immunization, antibody engineering, vaccine development, transplantation, and diseases.
- Students will be able to demonstrate immunological techniques

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
J. Owen, J. Punt, S. Stranford	Kuby Immunology (8 th Edition)	WH Freeman and Company, USA	2012	978-1319114701	944
D. Male, J. Brostoff, D. Roth, I. Roitt	Immunology (8 th Edition)	Saunders, Elsevier, USA	2012	978-0702045486	482
K. Murphy	Janeway's Immunobiology (8 th Edition)	Garland Science, USA	2011	978-0818342908	887
A. Abbas, A. Lichtman, S. Pillai	Cellular and Molecular Immunology (10 th Edition)	Saunders, Elsevier, USA	2014	978-8131264577	-

Human Anatomy and Physiology

L	T	P	Total Credits
4	0	2	6

Course content and syllabus

	Teaching Hours
Unit I Introduction to Developmental Biology	18 hrs
<p>Introduction: What is developmental biology? History and Basic Concepts</p> <p>From Sperm and Egg to Embryo: 1. Beginning the Developmental Program: Gametogenesis, Structure of eggs and sperm, Comparing oogenesis and spermatogenesis</p> <p>2. Fertilization: Beginning a New Organism- Gamete recognition, Gamete fusion and prevention of polyspermy, Activation of egg metabolism, Fusion of the genetic material.</p>	
Unit II Early Development	18 hrs
<p>Early Embryogenesis: Cleavage: Generating a Multicellular Embryo (a) Overview of Cleavage in Amphibians/Birds/Mammals, Gastrulation and cell movement and types of movement, Germ layers.</p> <p>Body Patterning: Animal-Vegetal Axis, Rotation of Fertilization and the Dorsal-Ventral Axis Organizer in Amphibia, Development of Body plan in <i>Drosophila</i>, Maternal genes, Zygotic genes, Segment Identity genes. Segment identity and Hox genes.</p>	
Unit III: Development of Various Organs	18 hrs
<p>Building with Ectoderm: The Vertebrate Nervous System and Epidermis: Neural Tube Formation and Patterning; Brain Growth; Neural Crest Cells and Axonal Specificity; Ectodermal Placodes and the Epidermis.</p> <p>Building with Mesoderm and Endoderm: Organogenesis; Paraxial Mesoderm: The Somites and Their Derivatives; Intermediate and Lateral Plate Mesoderm: Heart, Blood, and Kidneys; Development of the Tetrapod Limb; The Endoderm: Tubes and Organs for Digestion and Respiration.</p> <p>Postembryonic Development: Metamorphosis: The Hormonal Reactivation of Development; Regeneration; Aging and Senescence</p>	

Unit IV: Developmental Genetics	18 hrs
Principles of Developmental Biology - Genetic approaches, Genetic marking, Genetic malformations. Developmental Patterns – Developmental dynamics of cell specification (Autonomous, Syncytial & conditional), Morphogenetic fields. The Genetic Core of Development - The Embryological origins of Gene Theory, Early attempts at Developmental Genetics, Genomic equivalence, determining the function of genes during development, Gene targeting (Knockout) experiments, determining function of a message Antisense RNA.	

List of Experiments -with basic instructions (Total Teaching = 60 hrs)

1. Slide analysis and identification (Different developmental Stages).
2. Study of vertebrate development through models
3. Study of organogenesis in humans using educational videos.
4. *Drosophila* development: Setting up cross. Observing *Drosophila* embryo under microscope.
5. Studying *Drosophila* life cycle: Larvae, pupae and adult.
6. Studying Chick embryo in detail.
7. Cleavage patterns.

Course Learning Outcomes:

- Understand how a single cell develops to an organism.
- Perceive knowledge about early stages of development.
- Understand how three germ layers give rise to all the organs and organ systems.
- Acquire knowledge about genetics behind development.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Page s
S. F. Gilbert	Developmental Biology	Sinauer Associates Inc	8 th /2006	9781605356044	500
L. Wolpert, J. Smith, T. Jessell, P. Lawrence, E. Robertson and E. Meyerowitz	Principles of Development	Oxford Univ Press.	3 rd /2006	0199275378 978-0199275373	576

Microbial Physiology and Metabolism

L	T	P	Total Credits
4	0	2	6

Course content and syllabus

	Teaching Hours
Unit I: Microbial growth and effect of environmental factors on growth	18 hrs
<p>Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve</p> <p>Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe), barophilic. Microbial growth in response to nutrition and energy – Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph.</p> <p>Passive and facilitated diffusion Primary and secondary active transport, concept of uniport, symport and antiport</p>	
Unit II: Chemoheterotrophic Metabolism	18 hrs
<p>Aerobic Respiration: Concept of aerobic respiration, anaerobic respiration and fermentation. Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway TCA cycle, Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors.</p> <p>Anaerobic respiration and fermentation: Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate/nitrite and nitrate/ammonia respiration; fermentative nitrate reduction)</p> <p>Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways.</p>	
Unit III: Chemolithotrophic and Phototrophic Metabolism	18 hrs

Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogenoxidation (definition and reaction) and methanogenesis (definition and reaction) Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and cyanobacteria	
Unit IV: Nitrogen Metabolism	18 hrs
Introduction to biological nitrogen fixation Ammonia assimilation Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification	

List of Experiments -with basic instructions (Total Teaching = 60 hrs)

1. Study and plot the growth curve of *E. coli* by turbidometric and standard plate count methods.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data
3. Effect of temperature on growth of *E. coli*
4. Effect of pH on growth of *E. coli*
5. Effect of carbon and nitrogen sources on growth of *E. coli*
6. Effect of salt on growth of *E. coli*
7. Demonstration of alcoholic fermentation
8. Demonstration of the thermal death time and decimal reduction time of *E. coli*.

Course Learning Outcomes:

- Study the types of microbial growth and effect of environmental factors.
- Understand the mechanism of nutrients uptake and transport in micro-organisms.
- Study different types of growth in micro-organisms in response to nutrition and energy.
- Classify the microbes on the basis of metabolic processes and their energy requirements.
- Perceive knowledge of microbial nitrogen metabolism.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Madigan MT, and Martinko JM	Brock Biology of Microorganisms.	Prentice Hall International Inc.	14 th Ed./ 2014	9781292018317	1030

Moat AG and Foster JW	Microbial Physiology 4 th Edition	John Wiley & Sons	2002	0471394831 978-0471394839	736
Willey JM, Sherwood LM, and Woolverton CJ	Prescott's Microbiology. 9 th edition.	McGraw Hill Higher Education	2013	9780073402406 0073402400	2272
Pelczar Jr MJ, Chan ECS, and Krieg NR.	Microbiology. 5 th edition	Tata McGraw Hill.	1993	0070492581, 9780070492585	957

Recombinant DNA Technology

L	T	P	Total Credits
3	0	1	4

Course content and syllabus

Course Objective: To teach methods of DNA manipulations, cloning and gene editing

	Teaching Hours
Unit I: Gene Cloning and DNA Analysis	18 hrs
Polymerase chain reaction, DNA modifying enzymes: polymerases, kinases, ligases, phosphatases; Primers designing, Purification of DNA fragments, Restriction enzymes, DNA ligation, Vectors, DNA Transformation, GENOMIC DNA and Plasmid Isolation, Restriction digestion and DNA Analysis by gel electrophoresis.	
Unit II: Vectors for Gene Cloning and DNA Manipulation	9 hrs
Cloning vectors based on E. coli plasmids, Plasmid copy number control, Cloning vectors based on M13 bacteriophage, Cloning vectors based on λ bacteriophage, λ and other high-capacity vectors enable genomic libraries to be constructed, Vectors for other bacteria, Bacterial Artificial chromosomes (BACs); Vectors for yeast and other fungi, Yeast artificial chromosomes (YACs), Cloning vectors for higher plants, Tobacco Mosaic Virus (TMV); Cloning vectors for animals. Problem	

of Plasmid incompatibility, The problem of selection, Direct selection, Identification of a clone from a gene library, Methods for clone identification.	
Unit III: Cloning a Specific Gene	18 hrs
Transduction, conjugation and transfection, Types of plasmids, Recombinant Bacterial strains for bioremediation; online servers/software for DNA and protein analysis: Acquiring DNA sequence encoding the protein of interest (for example GFP) from onlinedatabase like PUBMED and PDB. Analysis of DNA sequence for presence of internal restriction digestion sites etc.	
Unit IV: Advanced Cloning Techniques	9 hrs
Homologous recombination, Molecular mechanism of RecBCD, RecA, RuvA-B, Holliday Model; Non-homologous End Joining (NHEJ) versus Homologous DNA recombination; Positive and negative selection, Zinc finger nucleases (ZFN), Transcription activator-like effector nucleases (TALENs), Discovery of adaptive immunity, The CRISPR-Cas9 (clustered regularly interspaced short palindromic repeats) system, Methods to create gene-knock out animal model systems. Cre-LoxP recombination system	

List of Experiments

1. Acquiring DNA sequence encoding the protein of interest (for example GFP) from online database like Genbank and Uniprot. Analysis of DNA sequence for presence of internal restriction digestion sites etc using softwares like gene runner.
2. Primer designing: Designing of 5' forward and 3' reverse complementary primers containing appropriate restriction digestion sites, affinity tags (penta-His etc.).
3. PCR amplification of the DNA segment of interest from a suitable source, purification of the PCR product.
4. Restriction digestion, and subsequent ligation into the suitable bacterial expression vector (also containing an antibiotic resistant marker) of interest.
5. Preparation of competent cells and transformation into suitable competent cells (BL21 etc.).
6. Selection of the antibiotic resistant single colony.
7. Plasmid isolation from the transformed cells and sequencing it to confirm the sequence of cloned DNA segment of interest.

Course Learning Outcomes:

Students will be able to:

1. Understand basic concepts of DNA manipulation.
2. Understand the procedure of gene cloning
3. Have a thorough understanding of vectors
4. Perceive knowledge of advanced gene editing methods

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
J. Sambrook, E. F. Fritsch, and T. Maniatis, 2nd Edn.,	Molecular cloning: a laboratory manual,	Cold Spring Harbor Laboratory Press	3 rd Ed	978-0879695767	2344
T.A. Brown	Gene Cloning and DNA Analysis - An introduction	Wiley - Blackwell	2010	9781405181730	338

Fundamentals of Physics

L	T	P	Total Credits
2	0	0	2

Course Objectives:

Aim of this course is to introduce the students about fundamentals of graduate level Physics, which forms the basis of all Applied Science specifically physical optics, mechanics, dynamics, and acoustics relating human body

Unit I: Interference, diffraction, and polarization (10)	HRS
Young's double slit experiment, Huygen's principle, Superposition principle, Analysis of interference (constructive and destructive) and conditions for sustained interference, Interference in thin parallel and wedge-shaped films, Newton's rings, introduction to diffraction: Fresnel and Fraunhofer diffraction, Rayleigh criterion and Resolving power and dispersive power of grating, Polarization of Light, Law of Malus, Brewster's Law, Circularly and Elliptically Polarized Light, Half and Quarter Wave Plates	9 hrs
Unit II: Lasers (8)	
Introduction of Lasers, Induced Absorption, Spontaneous and Stimulated Emission, Einstein Coefficients, Population inversion, Fundamental of Lasers, Types of Pumping, Concept of Three and Four Level Lasers, Construction and Working Lasers, Properties of Laser and its applications	9 hrs
Unit III: Mechanics and dynamics of a human body (12)	
Mechanics: Muscular Action, Friction, Energetics, Model of Walking, Material Components of the Body, Bone, Ligaments and Tendons, Cartilage, Elastic Properties, Basic Stress-Strain Relationships, Fluid mechanics: Characteristic Pressures in The Body, Physics of Pressure and Flow of Fluids, Law of Laplace, Fluids in Motion, Equation of Continuity, Bernoulli's Equation, Viscous Flow and Poiseuille's Law, Thermodynamics: First and second laws of thermodynamics, Concept of free energy, entropy, heat content of food, bomb calorimetry	9 hrs
Unit IV: Waves and human body (6)	
Speed and Properties of Sound Waves, Intensity of Sound Waves, Sound propagation from one Medium to Another, Speech Production, Types of Sounds, Hearing, Other Vibrations of the Body, Cardiac and Other Sources of Sounds	9 hrs

Course Learning Outcomes:

1. Understand the fundamental principles underlying phenomena of interference, diffraction, and polarization
2. Understanding on the properties, construction, and applications of laser
3. Understand and analyse the mechanical and dynamical aspects of the different components of a human body
4. Understand and analyzing basics of sound with its impact on the body

AUTHOR	TITLE	Publisher	Year of publication	ISBN
Irving P. Herman	Physics of the Human Body	Springer , ISSN1618-721	2006	978-3540817062
W. Hughes B	Aspects of Biophysics	John Willey and Sons	1979	978-0471019909
R.K. Hobbie	Intermediate Physics in Biology and Medicine	Springer	2001	978-3319126814
Halliday, Resnick and Walker	Fundamentals of Physics	Wiley India Pvt Ltd	2006	978-8126514427
Brijlal, Subramanyam & N Subrahmanyam	Principle of Optics	S. Chand publishing, 25th edition, 2012	2006	978-8121926119
Ghatak, Ajay	Optics	Tata McGraw-Hill	4th Edition	9789339220907
Jenkins F A, White H E	Fundamentals of optics	McGraw Hill	4th Edition	9780072561913

Integrated B.Sc. + M.Sc. (H) HGMM- 5 years (5th Semester)

Sr No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	PS	FW	SW	
1		Molecular Biology	Core Course	4	0	2	0	0	6
2		Developmental Biology	Core Course	4	0	2	0	0	6
3.		<u>Students will choose any two of the given choices*</u>	Specialization Elective Course	4	0	0	0	0	4
4.		1. Microbial Genetics 2. Nanomedicine 3. Virology 4. Endocrinology 5. MOOC		4	0	0	0	0	4
5.		<u>Students will choose any two of the given choices**</u>	Skill Enhanceme nt Course	2	0	0	0	0	2
		1. Cell Signalling 2. Research Methodology 3. Biowarfare and Bioterrorism 4. Programming in Python 5. MOOC		2	0	0	0	0	2

Total Credits

24

*The Specialization Elective Courses of 5th and 6th Semesters will be pooled together.

**The Skill Enhancement Courses of 5th and 6th Semesters will be pooled together.

The Specialization Elective Course and the Skill Enhancement Course can also be taken through MOOC. A maximum of 4 credits per semester can be taken through MOOC.

Molecular Biology

L	T	P	Total Credits
4	0	2	6

Course content and syllabus

Course Objectives: To teach the fundamentals of DNA replication, transcription and translation

	Teaching Hours
Unit I: Genes and Genomes	15 hrs
<p>The History and Birth of Molecular Biology. Relationships between genotype and phenotype. Contributions of Nobel Laureates in the area of Molecular Biology</p> <p>Genes and Genomes: Molecular definition of gene. Organization of genes on chromosomes. Repetitive DNA. Simple sequence DNA. Interspersed-Repeat DNA and mobile DNA elements.</p> <p>Chromosome structure: Bacterial chromatin and specific proteins to condense bacterial DNA.</p> <p>Nucleosomes. Chromatin organization in eukaryotes. Functional Rearrangements in chromosomal DNA. Extra-nuclear genomes, Specific notations, conventions and terminologies used in genetics</p>	
Unit II: DNA Replication, Damage and Repair	21 hrs
<p>DNA replication is semi-conservative and bi-directional.</p> <p>DNA replication in bacteria: Initiation, elongation and termination of bacterial DNA replication. Enzymes involved in DNA replication.</p> <p>Eukaryotic DNA replication machinery. Initiation, elongation and termination of replication. Telomeres and Telomerase. Leading strand problem in replication.</p> <p>DNA replication in Archaea</p> <p>DNA damage and repair mechanisms</p>	
Unit III: Transcription	18 hrs

<p>RNA Transcription in bacteria and eukaryotes</p> <p>RNA and Transcription: Types of RNA. Types of RNA polymerase and structure; Molecular apparatus and events during prokaryotic and eukaryotic RNA synthesis. Post— transcriptional modifications of transcripts. Processing of different types of RNA. RNA editing. Formation of spliceosome</p> <p>complex. Inhibitors of RNA metabolism and their mechanism of action; RNA degradation.</p>	
Unit IV: Protein Translation	18 hrs
<p>Genetic code: Its deciphering, degeneracy and general features.</p> <p>tRNA, aminoacylation of tRNA, tRNA identity and aminoacyl tRNA synthetases. Structure of ribosomes, and its assembly and disassembly. Codon: anti-codon base pairing, Wobble hypothesis</p> <p>Translation in Prokaryotes: formation of initiation complex, initiation factors, elongation, elongation factors, and termination.</p> <p>Translation in Eukaryotes: formation of initiation complex, initiation factors, elongation, elongation factors and termination.</p> <p>Translation proof-reading, translation inhibitors.</p> <p>Post-translation modifications of proteins and their effect on their structure and function.</p> <p>Protein targeting: Signal sequence and targeting of proteins to specific cellular locations.</p>	

List of Experiments -with basic instructions (Total Teaching = 72 hrs)

1. Verification of Chargaff's rule by paper chromatography.
2. Ultraviolet absorption spectrum of DNA and RNA.
3. Determination of DNA and RNA concentration by A₂₆₀nm.
4. Determination of the melting temperature and GC content of DNA.
5. To study the viscosity of DNA solutions.
6. Isolation of chromosomal DNA from E. coli/plant/yeast/animal cells.

7. Recombinant Protein Expression and Purification

Course Learning Outcomes: at the end of this course, students will learn about:

- History and development of molecular biology, structure of genome and terminologies used in molecular genetics
- DNA replication in bacteria, archaea and eukaryotes
- Mechanism of transcription in bacteria and eukaryotes.
- Mechanisms of translation in bacteria and eukaryotes.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Watson, JD., Baker, TA., Stephen, PB., Alexander, G., Levine, M., Losick R.	Molecular Biology of the Gene	Pearson Education	7 th Ed	978-9332585478	912
Tropp, B.E.	Molecular Biology Genes to Proteins	Jones and Bartlett	4 th Ed	978-93-80853-49-9	1096
Lewin, B.	Genes XI	Jones and Bartlett	2013	978-9380853710	-

Developmental Biology

L	T	P	Total Credits
4	0	2	6

Course content and syllabus

	Teaching Hours
Unit I Introduction to Developmental Biology	18 hrs

<p>Introduction: What is developmental biology? History and Basic Concepts From Sperm and Egg to Embryo: 1. Beginning the Developmental Program: Gametogenesis, Structure of eggs and sperm, Comparing oogenesis and spermatogenesis 2. Fertilization: Beginning a New Organism- Gamete recognition, Gamete fusion and prevention of polyspermy, Activation of egg metabolism, Fusion of the genetic material.</p>	
<p>Unit II Early Development</p>	<p>18 hrs</p>
<p>Early Embryogenesis: Cleavage: Generating a Multicellular Embryo (a) Overview of Cleavage in Amphibians/Birds/Mammals, Gastrulation and cell movement and types of movement, Germ layers. Body Patterning: Animal-Vegetal Axis, Rotation of Fertilization and the Dorso-Ventral Axis Organizer in Amphibia, Development of Body plan in <i>Drosophila</i>, Maternal genes, Zygotic genes, Segment Identity genes. Segment identity and Hox genes.</p>	
<p>Unit III: Development of Various Organs</p>	<p>18 hrs</p>
<p>Building with Ectoderm: The Vertebrate Nervous System and Epidermis: Neural Tube Formation and Patterning; Brain Growth; Neural Crest Cells and Axonal Specificity; Ectodermal Placodes and the Epidermis. Building with Mesoderm and Endoderm: Organogenesis; Paraxial Mesoderm: The Somites and Their Derivatives; Intermediate and Lateral Plate Mesoderm: Heart, Blood, and Kidneys; Development of the Tetrapod Limb; The Endoderm: Tubes and Organs for Digestion and Respiration. Postembryonic Development: Metamorphosis: The Hormonal Reactivation of Development; Regeneration; Aging and Senescence</p>	
<p>Unit IV: Developmental Genetics</p>	<p>18 hrs</p>
<p>Principles of Developmental Biology - Genetic approaches, Genetic marking, Genetic malformations. Developmental Patterns – Developmental dynamics of cell specification (Autonomous, Syncytial & conditional), Morphogenetic fields. The Genetic Core of Development - The Embryological origins of Gene Theory, Early attempts at Developmental Genetics, Genomic equivalence, determining the function of genes during development, Gene targeting (Knockout) experiments, determining function of a message Antisense RNA.</p>	

List of Experiments -with basic instructions (Total Teaching = 60 hrs)

1. Slide analysis and identification (Different developmental Stages).
2. Study of vertebrate development through models
3. Study of organogenesis in humans using educational videos.
4. *Drosophila* development: Setting up cross. Observing *Drosophila* embryo under microscope.
5. Studying *Drosophila* life cycle: Larvae, pupae and adult.
6. Studying Chick embryo in detail.
7. Cleavage patterns.

Course Learning Outcomes:

- Understand how a single cell develops to an organism.
- Perceive knowledge about early stages of development.
- Understand how three germ layers give rise to all the organs and organ systems.
- Acquire knowledge about genetics behind development.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
S. F. Gilbert	Developmental Biology	Sinauer Associates Inc	8 th /2006	9781605356044	500
L. Wolpert, J. Smith, T. Jessell, P. Lawrence, E. Robertson and E. Meyerowitz	Principles of Development	Oxford UnivPress.	3 rd /2006	0199275378 978-0199275373	576

Microbial Genetics

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I: Genome Organization and Mutations	18 hrs

Genome organization: <i>E. coli</i> , <i>Saccharomyces</i> , <i>Tetrahymena</i> . Organelle genome: Chloroplast and Mitochondria.	
Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations. Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes.	
Unit II: Plasmids	18 hrs
Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 μ plasmid, Plasmid replication and partitioning, Host range, plasmid- incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids Phage Genetics: Features of T4 genetics , Genetic basis of lytic versus lysogenic switch of phage lambda	
Unit III: Mechanisms of Genetics Exchange	18 hrs
Transformation - Discovery, mechanism of natural competence Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers	
Unit IV: Transposable Elements	18 hrs
Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon Eukaryotic transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds) Uses of transposons and transposition	

Course Learning Outcomes: at the end of the students will learn about

- Basics of microbial genetics including organization of genome of various microorganisms
- Mutations and their importance
- Roles and significance of transposable elements
- Mechanisms of genetic exchange

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Snyder, L., Peters, J.E., Henkin, T.M., and Champness, W.	Molecular Genetics of Bacteria	ASM Press	4 th Ed	978-1-55581-892-0	707
Klug WS, Cummings MR, Spencer, C, Palladino, M.	Concepts of Genetics	Pearsons	11 th Ed.	978-9353940409	-

Pierce BA	Genetics: A Conceptual Approach	WH Freeman	7th Ed.	978- 1319308318	976
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Nanomedicine

L	T	P	Total Credits
4	0	0	4

Objective: To make students acquainted with the fundamental concepts of nanotechnology and develop an understanding to employ its principles in biomedical applications.

Course content and syllabus

	Teaching Hours
Unit I: Introduction to nanomaterials	18 hrs
Importance of "Nano" dimension, size matters: bulk vs nanomaterials, nanotechnology exists in nature, brief history of nanotechnology, concept of dimensionality of nanomaterials, effect of 'nano' scale on material properties (electrical, thermal, mechanical, optical, chemical), quantum structures, quantum confinement, classification of nanostructured materials, surface effects of nanomaterials, nanocomposites	
Unit II: Synthesis and Characterization of Nanomaterials	18 hrs
Bottom-up and top-down approaches, physical and chemical methods: mechanical milling, laser ablation, arc discharge, chemical vapor deposition, physical vapor deposition, wet chemical synthesis of nanoparticles, self-assembly, biological synthesis of nanomaterials	
Unit III: Bionanotechnology	18 hrs
Surface functionalization of nanomaterials for biological applications, nano-antimicrobials, viral nanotechnology, Biological nanomachines: protein and DNA, peptide nanotechnology, DNA nanotechnology, cellular uptake mechanisms of nanomaterials	
Unit IV: Nanomaterials Applications in Biology and Nanotoxicity	18 hrs
Polymeric biomaterials, lipid nanoparticles for drug delivery applications, nanoparticles for bioimaging, cancer therapeutics, and tissue engineering applications, stimuli-responsive nanoparticles, nano-artificial cells, nanomaterials for organ printing, nanotoxicology	

Course Learning Outcomes:

Students will be able to

1. Comprehend the concept of "nanotechnology" and its interdisciplinary aspects.
2. Learn various approaches of synthesizing nanomaterials, their advantages, and limitations.
3. Gain knowledge about various techniques used for characterizing nanomaterials.

4. Comprehend the importance of engineered nanomaterials for biomedical, and therapeutic applications.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
G. Cao	Nanostructures and Nanomaterials: Synthesis, Properties and Applications	Imperial College Press	2004	978-9814324557	596
C. M. Niemeyer, C. A. Mirkin	Nanobiotechnology; Concepts, Applications and Perspectives	Wiley-VCH	2004	978-8126538409	-
G. J. Leggett, R. A. L. Jones	Bionanotechnology: In Nanoscale Science and Technology	John Wiley & Sons	2005	--	-
B. S. Murthy, P. Shankar, B. Raj, B. B. Rath and J. Murday	Textbook of Nanoscience and Nanotechnology	Universities Press-IIM	2012	978-3642280290	244
T. Pradeep	Nano: The Essentials	Tata McGraw-Hill Publishing Company Ltd.	2007	978-0070617889	461

Virology

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I: Nature and Properties of Viruses	18 hrs
Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Theories of viral origin. Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses. Isolation, purification and cultivation of viruses. Viral taxonomy: Classification and nomenclature of different groups of viruses.	
Unit II: Bacteriophages	18 hrs

Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda phage) concept of early and late proteins, regulation of transcription in lambda phage.	
Unit III: Viral Replication and Transmission	18 hrs
Modes of viral transmission: Persistent, non-persistent, vertical and horizontal. Salient features of viral Nucleic acid : Unusual bases (TMV, T4 phage), overlapping genes (ϕ X174, Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (Influenza virus), and non-segmented genomes (picornavirus), capping and tailing (TMV). Viral multiplication and replication strategies: Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses as per Baltimore classification (phi X 174, Retroviridae, Vaccinia, Picorna), Assembly with example of Polio virus and T4 phage, maturation and release of virions.	
Unit IV: Viral Diseases, prevention and application of viruses	18 hrs
Introduction to oncogenic viruses: Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes. Antiviral compounds and their mode of action. Interferon and their mode of action. General principles of viral vaccination.	
Application of virology: Use of viral vectors in cloning and expression, Gene therapy, Phage display and phage therapy.	

Course Learning Outcomes: at the end of the course the students will:

- Get an exhaustive account of viruses, their structure and classification
- Learn about replication of viruses
- Viral diseases and methods to control them
- Various applications of virology

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Dimmock, NJ, Easton, AL, Leppard, KN	Introduction to Modern Virology	Blackwell Publishing Ltd	6 th Ed	978-1405171120	536
Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM	Principles of Virology, Molecular biology, Pathogenesis and Control	ASM Press	2 nd Ed (2000)	978-1855811273	820
Carter J and Saunders V	Virology: Principles and Applications	Wiley	2 nd (2013)	978-1119991427	394

Endocrinology

Course content and syllabus

L	T	P	Total Credits
4	0	0	4

	Teaching Hours
Unit I Basics of Endocrine System	18 hrs
Functional organization and general characteristics of endocrine system, target gland concept, Negative and positive feed-back control, Classification of hormones, Methods to assay quantity and quality of hormones.	
Unit II Hormone Action	18 hrs
Mechanism of hormone action: Signal transduction pathways for steroidal and non-steroidal hormones, role of receptors, receptor desensitization, steroid hormones, signalling involving cyclic AMP, cyclic GMP, phosphoinositides, calcium, diacylglycerol and nitric oxide, kinase-phosphatase system and its examples.	
Unit III: Physiology of hormonal system	18 hrs
Structure, biosynthesis and release of hormones, biochemical and physiological role, and pathophysiology of Hypothalamus; Pituitary, Thyroid; Parathyroid, Calcitonin, Vitamin D ₃ ; Adrenals; Pancreas; Gonads; G.I.T. tract; Heart (Endothelins and ANF). Various diseases associated with these glands. How lifestyle plays an important role to maintain hormonal balance.	
Unit IV: Growth Factors	18 hrs
Growth factors: Chemistry, Biological functions and mechanism of action of Epidermal growth factor; Hematopoietic cell growth factor; Fibroblast growth factor and Interleukins; Insulin like-growth factors, Nerve growth factors. Placental hormones	

Course Learning Outcomes:

- Understand in detail about human Endocrine System.

- Perceive knowledge about various glands and diseases associated.
- Understand in detail about how hormones act on human body.
- Acquire knowledge about various growth factors.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Murray, R.K., Granner, D.K. and Rodwell, V.W,	Harper's Illustrated Biochemistry	McGraw Hill	30 th /2018	978-0071825344 0071825347	817
B. Alberts, D. Bray, J. Lewis, Martin Raff, Keith Roberts, and J. D Watson	Molecular and Cellular Biology	Garland Science	6 th /2012	978-0818344322 0818344325	1464
David G. Gardner, Dolores M. Shoback	Greenspan's Basic and Clinical Endocrinology	McGraw Hill	10 th /2017	978-1259589287 1259589285	944
Shlomo Melmed, Kenneth Polonsky, P. Reed Larsen, Henry M. Kronenberg	Williams Textbook of Endocrinology	Elsevier	30 th /2016	978-0323555968 0323555969	1792
Kumar V, Abbas, A.K., and Aster, J.C.	Robbins Basic Pathology	Saunders Elsevier.	8 th /2007	978-1416029731	952

Cell Signalling

L	T	P	Total Credits
2	0	0	2

Course content and syllabus

	Teaching Hours
Unit I: Introduction to Cell Signaling	4 hrs
Modes of signaling, signaling molecules, Intracellular and cell surface receptors, Hormone signaling	
Unit II: GPCR & RTK	12 hrs
G-protein mediated signaling, second messengers, receptors tyrosine kinases, Ras-MAPK pathway, JAK-STAT pathway, PI3K-AKT pathway,	
Unit III: Signaling through other pathways	10 hrs
Integrins, cadherins, Hedgehog, Notch, Heat shock and ER stress response, Serine/Threonine pathways	
Unit IV: Aberrant signaling	4 hrs
Cancer, Notch signaling dependent Diseases, Hedgehog signaling dependent Diseases, Diabetes	

(Total Teaching = 30 hrs)

Course Learning Outcomes:

- Differentiate structure, receptors, and mechanism of actions of hormones.
- Describe pathways of cellular signaling, cross-talk and regulation.
- Discuss how disruptions in cellular signaling may lead to disease, and illustrate with selected examples.

Text / Reference Books:

Author	Title	Publisher	Ed/yea r	ISBN No	Pag es
Bruce, Alberts and Alexander Johnson and Julian Lewis, and Martin Raff	Molecular biology of the cell	Garland Science;	6th	978-0818344322	1342
Rakesh Srivastava	Apoptosis, cell signalling and human diseases	Humana Press	1st	9781888298829	395
Berg J.M., Tymoczko J.L., Stryer L.	Biochemistry	WH Freeman & Company	5th	13: 978-1-4641-2610-9	1023

Research Methodology

L	T	P	Total Credits
2	0	0	2

Course content and syllabus

	Teachin gHours
Unit I: Basic Concepts	9 hrs
Research process, problem identification, research designs, informal experimental designs. Completing randomized design, randomized block design, latin square design, factorial designs	
Unit II: Sample collection	9 hrs
Random sampling, complex random sampling, non-probability sampling, measurement and scaling techniques. Data collection.	

Unit III: Research Presentation	9 hrs
The students will be taught to present their work in written form and also how to make effective power point presentation	
Unit IV: Literature Survey	9 hrs
The students will be required to review literature in their respective disciplines and submit an assignment for evaluation.	

Course Learning Outcomes:

- Teach students importance of research conceptualization and planning
- Teach student how to make effective written and spoken presentations
- Teach students how to read a research paper

Text / Reference Books:

Author	Title	Publisher	Ed/Year	ISBN No	Pages
Kothari, C.R	Research Methodology :Methods and Techniques	New Age International Publishers	4 th Ed.	978-9386649225	480
Arya., P.P. and Pal, Y	Research Methodology in Management: Theory and Case Studies	Deep and Deep Publishers	2011	978-8184503718	---

Biowarfare and Bioterrorism

L	T	P	Total Credits
2	0	0	2

Course content and syllabus

	Teaching Hours
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Unit I: Introduction

9 hrs

History of Biowarfare. Difference between biowarfare and bioterrorism. Laws preventing the use of Bioweapons	
Unit II: Agents of Biowarfare and Bioterrorism	9 hrs
Various biological agents (bacteria and viruses) that can be used as bioweapons, their properties, mode of spread, infection, incubation period, symptoms, and current treatment strategies.	
Unit III: Dissemination and Detection of Biological Agents	9 hrs
Modes of dissemination or delivery of biological Agents: by air through aerosol spray; through explosives (missile, bombs, artillery, etc), contamination of food and water; injected or absorbed through the skin Methods to detect and identify biological agents.	
Unit IV: Mitigation Strategies	9 hrs
Public Health and emergency response preparedness. Role of antimicrobials, vaccines, antibodies, immune modulators, and other medications in mitigation. Uses of different biomaterials as a protective cover.	

Course Learning Outcomes:

- Will learn about the history of biological warfare
- Understand the agents used as biological weapons
- Delivery of Biological Agents
- Methods to detect and identify biological agents.
- Public Health strategies to mitigate effects of biological weapons

Text / Reference Books:

Author	Title	Publisher	Ed/ye ar	ISBN No	Pa g es
Dando, M.R.	Bioterror and Biowarfare - A Beginner's Guide	OneWorld Publications	2006	978-1851684472	256
Boyle, F.	Biowarfare and Terrorism	Clarity Press	2005	978-0932863461	139

Programming in Python Lab

L	T	P/S	SW/FW	TOTAL CREDIT UNITS
0	0	4	0	2

Course Contents/syllabus:

List of Experiments (Total: 72 Hours)

1. Compute sum, subtraction, multiplication, division and exponent of given variables input by the user.
2. Compute area of following shapes: circle, rectangle, triangle, square, trapezoid and parallelogram.
3. Compute volume of following 3D shapes: cube, cylinder, cone and sphere.
4. Compute and print roots of quadratic equation $ax^2+bx+c=0$, where the values of a, b, and c are input by the user.
5. Print numbers up to N which are not divisible by 3, 6, 9,, e.g., 1, 2, 4, 5, 7,....
6. Write a program to determine whether a triangle is isosceles or not?
7. Print multiplication table of a number input by the user.
8. Compute sum of natural numbers from one to n number.
9. Print Fibonacci series up to n numbers e.g. 0 1 1 2 3 5 8 13.....n
10. Compute factorial of a given number.
11. Count occurrence of a digit 5 in a given integer number input by the user.
12. Print Geometric and Harmonic means of a series input by the user.
13. Evaluate the Arithmetic expressions.
14. Print all possible combinations of 4, 5, and 6.
15. Determine prime numbers within a specific range.
16. Count number of persons of age above 60 and below 90.
17. Compute transpose of a matrix.
18. Perform following operations on two matrices.
 - 1) Addition 2) Subtraction 3) Multiplication
19. Count occurrence of vowels.
20. Count total number of vowels in a word.
21. Determine whether a string is palindrome or not.
22. Perform following operations on a list of numbers:
 - 1) Insert an element 2) delete an element 3) sort the list 4) delete entire list
23. Display word after Sorting in alphabetical order.
24. Perform sequential search on a list of given numbers.

25. Perform sequential search on ordered list of given numbers.
26. Maintain practical note book as per their serial numbers in library using Python dictionary.
27. Perform following operations on dictionary
 - 1) Insert 2) delete 3) change
28. Check whether a number is in a given range using functions.
29. Write a Python function that accepts a string and calculates number of upper case letters and lower case letters available in that string.
30. To find the Max of three numbers using functions.
31. Multiply all the numbers in a list using functions.
32. Solve the Fibonacci sequence using recursion.
33. Get the factorial of a non-negative integer using recursion.
34. Write a program to create a module of factorial in Python.

Course Learning Outcomes: After studying this course students will be able to:

1. Explain environment, data types, operators used in Python.
2. Compare Python with other programming languages.
3. Outline the use of control structures and numerous native data types with their methods.
4. Design user defined functions, modules, files, and packages and exception handling methods.
5. Learn to handle exceptions in Python.

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
Programming in Python	Programming in Python	BPB	2017	978-9386551276
R. Nageswara Rao	Core Python Programming	Dreamtech Press	2021	978-9390457151
Martin C. Brown	Python, The complete Reference	Tata Mc. Graw Hill	2018	978-9387572942
A. Martelli, A. Ravenscroft, S. Holden	Python in a Nutshell	Shroff/O'Reilly	2017	978-9352135400

Integrated B.Sc. + M.Sc. (H) HGMM- 5 years (6th Semester)

Sr No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	PS	FW	SW	
1		Regulation of Gene Expression	Core Course	4	0	2	0	0	6
2		Molecular Biology of Human Diseases	Core Course	4	0	2	0	0	6
3.		<u>Students will choose any two of the given choices*</u>	Specialization Elective Course						
4.		1. Computational Skills		4	0	0	0	0	4
		2. Introductory Bioinformatics		4	0	0	0	0	4
		3. Biopolymers and its Medical Applications							
		4. MOOC							
5.		<u>Students will choose any two of the given choices**</u>	Skill Enhancement Course	2	0	0	0	0	2
		1. Biomaterials		2	0	0	0	0	2
		2. Cancer Biology							
		3. BioEntrepreneurship							
		4. MOOC							
Total Credits									24

*The Specialization Elective Courses of 5th and 6th Semesters will be pooled together.

**The Skill Enhancement Courses of 5th and 6th Semesters will be pooled together.

The Specialization Elective Course and the Skill Enhancement Course can also be taken through MOOC. A maximum of 4 credits per semester can be taken through MOOC.

Regulation of Gene Expression

L	T	P	Total Credits
4	0	2	6

Course content and syllabus

	Teaching Hours
Unit I: Regulation of Gene Expression in Prokaryotes	18 hrs
Regulation of Gene Expression in Prokaryotes: concept of operon, ORF. Control at initiation of transcription. Promoter strength and role of sigma factors. Lac Operon (Genetic and Biochemical aspects), araBAD operon. Catabolite repression. trp and his Operons. Regulation of genes for ribosomal RNA and proteins. Bacterial viruses (Lytic and Lysogenic modes). Role of small molecules and RNA in gene control. Riboswitches and bacterial two component system.	
Unit II: Regulation of Gene Expression in Eukaryotes	18 hrs
Regulation of Gene Expression in Eukaryotes: Gene regulation in Yeast (Galactose metabolism, Gal 4 protein, Mating Type), role of mediators, enhancer elements. Chromatin remodelling: histone modification, epigenetic changes Post-transcriptional regulation. RNA silencing: siRNA, miRNA, transitive RNAi, ncRNA. Regulation at translational level	
Unit III: DNA-Protein Interaction	17 hrs
Structures of DNA binding domain: HTH, wHTH, zinc fingers, leucine zippers, HLH, Loop-sheet-helix. Specificity in DNA-protein interactions. Techniques to study DNA-protein interaction- DNA footprinting, DNA pull down, EMSA, Super-shift, CHIP, reporter assays, Co-crystal studies, yeast two hybrid system, FISH.	
Unit IV:	13 hrs
Genomic regulatory domains: Introduction to regulation of expression of gene clusters; locus control region (LCR): structure and function LCR of mouse globin gene cluster; Insulators, structure and functions, the insulators of <i>hsp70</i> genes of <i>Drosophila melanogaster</i> , Genomic imprinting of <i>Igf-2</i> and <i>H-19</i> genes	

List of Experiments -with basic instructions (Total Teaching = 60 hrs)

1. Extraction of total nucleic acids from plant tissue.
2. Diauxic growth curve effect.
3. Isolation of mRNA from yeast by affinity chromatography.
4. Effect of inhibitors on protein synthesis.
5. Accumulation of protein due to proteasome inhibitors.

Course Learning Outcomes:

- Will have the knowledge of structure and function of genes

- Concept and knowledge of different strategies in regulation of gene expression in prokaryotes and eukaryotes
- Understand structure of DNA-binding domains
- Learn various techniques to study DNA-protein interaction

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Krebs, J.E., Goldstein, E.S., and Kilpatrick, S.T.	Lewin's Genes XII	Jones and Bartlett Learning	12 th Ed	978-1284104493	838
Watson JD, Baker TA, Bell SP, Gann A, Levine M, Losick R.	Molecular Biology of the Gene	Pearson Publishers	7 th Ed.	978-9332585478	912
Tropp, B.E.	Molecular Biology Genes to proteins	Jones and Bartlett	4 th Ed.	978-93-80853-49-9	1096
Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., and Walter, P.	Molecular Biology of The Cell	Garland Science	6 th Ed	978-0-818 3-4464-3	1342

Molecular Biology of Human Diseases

L	T	P	Total Credits
4	0	2	6

Course content and syllabus

	Teaching Hours
Unit I Essential Concepts of Human Disease	18 hrs
Introduction to Mechanisms of Human Disease, Cell Death, Cell Death; Inflammation and Tissue Remodeling, Inflammation and Tissue Remodeling, Mutations, Human Genetics and Epigenetics Respiratory Diseases: Introduction to the Respiratory System, Cystic Fibrosis; Asthma and COPD.	
Unit II Neoplasia and Reproductive Diseases	18 hrs
Neoplasia: Introduction to Neoplasia, Pulmonary Neoplasia, Breast Neoplasia, Prostate Hyperplasia and Cancer, Lymphoid and Myeloid Malignancy, Colorectal Neoplasia. Reproductive Disorders: Introduction to the Reproductive System, Male Infertility, Female Infertility I (Uterine Disorders), Female Infertility II (Turner Syndrome and	

PCOS).	
Unit III: Metabolic Disorders	20 hrs
<p>Disorders of carbohydrate metabolism: An overview of carbohydrate metabolism; diabetes mellitus, hyperinsulism; glycogen storage diseases including von Gierke disease, Pompe disease.</p> <p>Disorders of amino acid metabolism: An overview of amino acid metabolism; including albinism, Homocystinuria, Maple syrup urine disease, Phenylketonuria, Tyrosinemia.</p> <p>Disorders of fatty acid oxidation: An overview of fatty acid metabolism and transportation; including Gaucher's disease, Tay-sachs disease, Niemann-pick disease, Fabry's disease</p>	
Unit IV: Circulatory Diseases	10 hrs
Introduction to the Circulatory System, Hemostasis, Hemostatic Diseases, Atherosclerosis and Coronary Artery Disease; Stroke; Cardiomyopathy; Marfan Syndrome.	

List of Experiments -with basic instructions (Total Teaching = 60 hrs)

1. Preparation of buffers and solutions for molecular biology experiments
2. DNA isolation from Human blood and Microbes.
3. Plasmid DNA isolation.
4. Agarose gel Electrophoresis of genomic DNA and plasmid DNA.
5. Preparation of restriction digestion of DNA samples.
6. Gel Documentation and photography.

Course Learning Outcomes:

- Understand about a wide variety of human diseases.
- Perceive knowledge about cancers and its pathology.
- Understand in detail about metabolic disorders.
- Acquire knowledge about reproductive disorders.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Coleman W. B. and Tsongalis G.J	Molecular Pathology: The Molecular Basis of Human Disease	Academic Press	2 nd /2017	978-0128027618	802
Cox, M. M, Doudna, J and Donnell, M.	Molecular Biology, Principles and	W. H. Freeman	1 st /2012	978-0716779988	944

	Practice				
Lodish, H, Berk, A, Kaiser, C A, Krieger, M. Scott,	Molecular Cell Biology	W. H. Freeman	6 th /2008	978- 0716768876 0716768879	973
P.M., Bretscher, A, Ploegh, H and Matsudaira, P.					
Strachan, T. and Read, A. P	Human Molecular Genetics	John Wiley and Sons	3 rd /2004	978-0818 341826	596
Kumar V, Abbas,A.K., and Aster, J.C.	Robbins Basic Pathology	Saund ers Elsevie r.	8 th /2007	978- 1416029731	952

Computational Skills

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I: Computer Fundamentals	18 hrs
Introduction to Computers: Characteristics of Computers, Uses of computers, Types and generations of Computers	
Unit II: Computer Organization	18 hrs
Basic Computer Organization Units of a computer, CPU, ALU, memory hierarchy, registers, I/O devices User Interface with the Operating System, System Tools, Data Representation	
Unit III: Networks	18 hrs
Binary representation of integers and real numbers, 1's Complement, 2's Complement, Addition and subtraction of binary numbers, BCD, ASCII, Unicode Networks terminology, Types of networks, router, switch, server client architecture	
Unit IV: Multimedia	18 hrs
Introduction, Characteristics, Elements, Application, Problem Solving, Notion of algorithms, stepwise methodology of developing an algorithm, developing macros in spreadsheet, General Awareness IT Act, System Security (virus/firewall etc.)	

Course Learning Outcomes:

Students will be able to:

1. Understanding computer and computer related skills as the interface between biology and computer is intertwined.
2. Gain knowledge of characteristics and organization of computer units.
3. Apply different aspects of computer knowledge for tackling biology related aspect.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
V Rajaraman	Fundamentals of Computers	Prentice Hall India Learning Private Limited	2014	9788120350670	448
Anita Goel	Computer Fundamentals	Pearson Education	2010	9788131733097	500

Introductory Bioinformatics

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I: Introduction to Bioinformatics and Biological Databases	18 hrs
Introduction to Bioinformatics. Historical background. Scope of bioinformatics in modern research Introduction to biological databases - primary, secondary and composite databases, NCBI, PubMed, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (UniProt-Swiss-Prot, PDB), Structure visualization softwares (RasMol, PDBviewer), file formats (FASTA, ASN Genbank).	
Unit II: Sequence alignment	18 hrs
Concepts of sequence similarity, identity and homology. Alignment – local and global alignment, pairwise and multiple sequence alignments, amino acid substitution matrices (PAM and BLOSUM). Programs for pairwise and multiple sequence alignment (CLUSTALW), Introduction to database search using BLAST.	
Unit III: Protein Structure Prediction	18 hrs

Hierarchy of protein structure - primary, secondary and tertiary structures Structural Classes, Motifs, Folds and Domains. Protein secondary structure prediction Protein tertiary structure prediction in presence and absence of structure template. Energy minimizations and evaluation by Ramachandran plot. Protein structure and rational drug design.	
Unit IV: Genome Organization and analysis	18 hrs
Diversity of Genomes: Viral, prokaryotic & eukaryotic genomes. Genome, transcriptome, proteome, 2-D gel electrophoresis, MALDI- TOF spectrometry. Major features of completed genomes: <i>E.coli</i> , <i>S.cerevisiae</i> , <i>Arabidopsis</i> , Human.	

Course Learning Outcomes:

- Introduces students to bioinformatics which is an integral part of biomedical research
- Understand role of biological databases and download appropriate literature, sequences and other relevant information from biological databases
- Understand importance of sequence alignment
- Predict structures of proteins
- Understand organization of genomes and techniques used to study.

Text / Reference Books:

Author	Title	Publisher	Ed/yea r	ISBN No	Pag es
Xiong, J.	Essential Bioinformatics	Cambridge University Press	2006	0521706106	352
Ghosh, Z. and Mallick, B.	Bioinformatics –Principles and Applications	Oxford University Press	2008	9780195692303	560

Biopolymers and its Medical Applications

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I:	18 hrs
Introduction and Basic Concepts: Definition of Terminology and Basic Concepts,	

Nomenclature of Polymers, Polymer Architectures	
Unit II:	18 hrs
Polymers in Solution, Molecular Weight, Physical State Nano Polymers and related Materials: Fracture Behavior, Tailor-Made Plastics, Cross-Linked Materials, Polymer Additives, Nanopolymers and their applications. Hydrogels and applications	
Unit III:	18 hrs
Polymeric nanoparticles: the future of nanomedicine, Biopolymers Introduction and classification, Biopolymers: Bioplastics, biofibers, biopolymeric composites, Bio-inorganic polymeric composites, Biopolymers for Specific Applications, Biomedical, Drug delivery, Environmental, Pharmaceutical Technology.	
Unit IV:	18 hrs
Bio-polymeric nanomaterials and its applications: Polysaccharides, Polysaccharide Graft Copolymers – Synthesis, Properties and Applications, Chitosan bio-polymers- Basic sources, characteristics, polymer isolation process, derivatives and their various bio medical applications. Future research trends of biopolymers. Biopolymer Blends and Biocomposites, Biopolymers as wound healing materials, Biopolymers as biofilters and biobarriers. Stimuli responsive polymers: Classifications, preparation and their various applications	

Course Learning Outcomes:

Students will be able to:

1. Understand the recent developments and trends of biopolymers
2. Gain knowledge of various characterization techniques used for characterizing biopolymers
3. Analyze and apply knowledge for applications of biopolymers in various fields, especially in the field related to nanoscience and nanotechnology for medical application.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Fred W. Billmeyer	Textbook of Polymer Science	Wiley India Pvt. Ltd	3 rd	9788126511105	600
Susheel Kalia and LucAvérous	Biopolymers: Biomedical and Environmental Applications	Wiley India Pvt.Ltd	2011	9780470639238	642

Biomaterials

L	T	P	Total Credits
2	0	0	2

Objective: To impart knowledge on structure-property relationship in biomaterials and their applications as implants.

Course content and syllabus

	Teaching Hours
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Unit I: Introduction	9 hrs
Materials-Bulk properties and surface properties	
Unit II: Material Classes	9 hrs
Class of materials used in biomedical applications	
Unit III: Cell-Material Interactions	9 hrs
Biological interactions with materials-Proteins, cells, and tissues, biological responses:Inflammation, immunity, toxicity, coagulation, tumorigenesis. Biofilms, Pathological calcification, Biocompatibility	
Unit IV: Applications	9 hrs
Applications of biomaterials: drug delivery, tissue engineering, cardiovascular, orthopedic, dental, functional tissues, etc.	

Total teaching hours: 30 hrs

Course Learning Outcomes:

- Students will be able to understand the fundamentals and classes of materials.
- Describe interactions between biomaterials, proteins and cells.
- Explain methods to modify surfaces of biomaterials and choose material for desired biologicalresponse.
- Analyse the interactions between biomaterial and tissue for short term and long-term implantations, distinguish between reactions in blood and in tissue.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons	Biomaterials Science: An Introduction to Materials in Medicine	Academic Press, USA	2004	978-0123746269	18 73
J.B. Park and J.D. Bronzino	Biomaterials : Principles and Applications	CRC Press	2002	0849314917	264
K.C. Dee, D.A. Puleo and R. Bizios	An Introduction to Tissue-Biomaterial Interactions	Wiley	2002	0471253944	248
Park J.B. and Lakes R.S	Biomaterials: An Introduction, 3 rd edition	Springer press	2010	978-1441922816	562

Cancer Biology

L	T	P	Total Credits
2	0	0	2

Course content and syllabus

	Teaching Hours
Unit I: Introduction to Cancer	8 hrs
Basics of cancer, Theories of cancer development, classification, types of cancer Differences between benign tumor and malignant forms of cancer, Multi-step and multi-stage processes – initiation, promotion and progression, Overview of the hallmarks of cancer, cancer stem cells	
Unit II: Molecular basis of Carcinogenesis	12 hrs
Mutagens, carcinogens, Tumor viruses, Proto-oncogenes, cellular and viral Oncogenes and tumor suppressor genes and their mechanism of action, Genetic abnormalities in cancer, Angiogenesis, invasion and metastasis.	
Unit III: Role of cell cycle and apoptosis and autophagy	4 hrs
Cell cycle regulation and cell death, Cellular senescence, telomeres and immortalization, Autophagy in Cancer.	
Unit IV: Cancer Epigenetics & Metabolism	6 hrs
Role of DNA methylation, histone modifications and non-coding RNAs in cancer development, Cancer metabolism.	

(Total Teaching = 30 hrs)

Course Learning Outcomes:

- Demonstrate basic understanding of cancer biology
- Acquire knowledge on molecular mechanisms involved in initiation as well as progression of cancer
- Understand the application of cancer diagnosis and therapy

Text / Reference Books:

Author	Title	Publisher	Ed/yea r	ISBN No	Pag es
Bruce, Alberts and Alexander Johnson and Julian Lewis, and Martin Raff	Molecular biology of the cell	Garland Science;	6th	978-0818344322	1342
Rakesh Srivastava	Apoptosis, cell signalling and human diseases	Humana Press	1st	9781888298829	395

Berg J.M., Tymoczko J.L., Stryer L.	Biochemistry	WH Freeman & Company	5 th	13: 978-1- 4641-2610-9	1023
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BioEntrepreneurship

L	T	P	Total Credits
2	0	0	2

Course Objectives: To help students gain understanding of the basic concepts of entrepreneurship, diagnose new business opportunities, formulate business plans, and identify different institutional support available to the entrepreneurs.

Course Content/ Syllabus

	Teaching Hours
Unit I: Basic Concepts of Entrepreneurship	9
Introduction to Entrepreneurship: Meaning, Background, Importance, The Benefits of Entrepreneurship, The Potential Drawbacks of Entrepreneurship, Factors that Influence Entrepreneurship, How to Avoid the Pitfalls, Factors Responsible for Entrepreneurship Growth; Entrepreneur Background and Characteristics; Entrepreneurial Potential in a Prospective Entrepreneur; Entrepreneurial Skills and Competencies; Types of entrepreneurs and entrepreneurship, Myths and Realities about Entrepreneurs; New Trends in Entrepreneurship Development; Economic Development through Entrepreneurship; Role of Entrepreneurship in the Economic Development of India	
Unit II: Environmental Monitoring and Importance of Business Idea	9
Creativity and innovation, Role of Creativity & Innovation in Entrepreneurship, Sources of New Ideas – Consumers, Existing Products and Services, Distribution Channels, Federal Government, Research and Development; Methods of Generating Ideas – Focus Groups, Brainstorming, Brainwriting, Problem Inventory Analysis; Creative Problem Solving – Brainstorming, Reverse Brainstorming, Brainwriting, Gordon Method, Checklist Method, Free Association, Forced Relationships, Collective Notebook Method, Attribute Listing Method, Big-dream Approach, Parameter Analysis, Mind Mapping, Force-Field Analysis, TRIZ, Rapid Prototyping; Innovation, Types of Innovation – Breakthrough, Technological, and Ordinary Innovation; Opportunity Recognition; Product Planning and Development Process – Idea Stage, Concept Stage, Product Development Stage, Test Marketing Stage,	

and Commercialization Stage; Technology Readiness Levels; Intellectual Property Rights	
Unit III: Scanning the Environment & Business Plan Development	9
Identifying the business opportunity: SWOT and PESTEL analysis, Viability Screening/Feasibility Analysis: Market Feasibility, Production Feasibility, Organisational Feasibility, Financial Feasibility; Business Plan Development: Introduction, Business Plan, Various Business Models – The Business Model Canvas, The Lean Canvas, Types of Business Plans, Structure of a Basic Business Plan, Creating a Business Plan – Executive Summary, General Company Description, The Opportunity or Competitive Analyses, Market Research and Industry Analysis, Strategy, The Team, Marketing Plan, Operational Plan, Financial Plan, and An Appendix	
Unit IV: Sources of Capital and Institutional Support for Entrepreneurs	9
Sources of Funding for Entrepreneurs: Bootstrapping, Friends and Family Members, Crowdfunding, Angel Investment, Venture Capital, Financial Institutions, Bank Loans, Trade Credit, Initial Public Offerings/Issue of Shares, Debentures; Role of Government in Promoting Entrepreneurship: Atal Innovation Mission, Biotechnology Industry Research Assistance Council, Department of Science and Technology, Digital India, Jan Dhan-Aadhaar-Mobile, Make in India, National Skill Development Mission, Pradhan Mantri Kaushal Vikas Yojana, Science for Equity Empowerment and Development, Stand-Up India, Start-Up India, Support to Training and Employment Programme for women, Trade-Related Entrepreneurship Assistance and Development, USAID	

Course Learning Outcomes: On completion of the course, the student shall be able to:

- Understand the concept of entrepreneurship, its emergence and its need for society.
- Formulate a business idea and diagnose for a new business opportunity.
- Identify various business gaps and develop a business plan
- Evaluate and identify different institutional support available to the entrepreneur.

List of Professional Skill Development Activities (PSDA):

- Research on growth profile of an entrepreneur
- Identify opportunity, generate idea and conduct feasibility Analysis
- Design a Business Plan
- Develop an Entrepreneur Journal where reflection and personal experiences will be recorded
- Write personal insights, lessons learned, other readings, and the video clips you watch in this semester
- Interview one entrepreneur mentor and come up with five good business questions you would like to ask him or her

- Comparative study of startups in the field of Biopharmaceuticals, Bioagriculture, Bioindustry, and Bioservices.

Pedagogy for Course Delivery: The course will be taught using theory and case-based method. Blended mode of teaching-learning will be adopted. The students would be provided with content in form of study material, articles and videos. Instructor would lay emphasis on explaining basic concepts included in the course. PSDAs shall form part of internal assessment.

Lectures: 25 sessions

Presentation / Seminar: 2

Mid Term Test and End Term Test: 2 sessions

PSDA: 1 sessions

Quiz: - 6 sessions

Total: 36 sessions

Text / Reference Books:

Author	Title	Publisher	Year of publication	ISBN	Pages
Evan J. Douglas	Entrepreneurial Intention: Past, Present, and Future Research	Edward Elgar Publishing	2020	978-1-78897-522-3	216
Justin G. Longenecker, J. William Petty, Leslie E. Palich, and Frank Hoy	Small Business Management: Launching & Growing Entrepreneurial Ventures (20 th Edition)	Cengage	2023	978-0-3577-1880-3	712
Mike Kennard	Innovation and Entrepreneurship	Routledge	2021	978-0-367-51057-2	114
Debasish Biswas and Chanchal Dey	Entrepreneurship Development in India	Routledge	2021	978-0-367-76219-3	117
Robert D. Hisrich, Micheal P. Peters, Dean A. Shepherd, Sabyasachi Sinha	Entrepreneurship (11 th Edition)	McGraw Hill	2020	978-9390113309	696

Donald F. Kuratko and Jeffrey S. Hornsby	New Venture Management: The Entrepreneur's Roadmap for Development, Management, and Growth (3 rd Edition)	Routledge	2020	978-0367466725	356
Bruce R. Barringer and R. Duane Ireland	Entrepreneurship: Successfully Launching New Ventures (6 th Edition)	Pearson	2019	978-1-292-25533-0	617
Norman M. Scarborough and Jeffrey R. Cornwall	Essentials of Entrepreneurship and Small Business Management (9 th Edition)	Pearson	2019	978-1-292-26602-2	827
Mary Jane Byrd and Leon Megginson	Small Business Management: An Entrepreneur's Guidebook (8 th Edition)	McGraw Hill	2017	978-1259538988	496
Robert D. Hisrich and Veland Ramadani	Effective Entrepreneurial Management: Strategy, Planning, Risk Management, and Organization	Springer	2017	978-3-319-50465-0	230
Stephen Spinelli, Jr. and Robert J. Adams, Jr.	New Venture Creation: Entrepreneurship for the 21st Century (10 th Edition)	McGraw-Hill Education	2016	978-0-07-786248-8	484
David H. Holt	Entrepreneurship: New	Pearson	2016	978-9332568730	584

	Venture Creation				
Peter F. Drucker	Innovation and Entrepreneurs hip	Harper Business	2006	978- 0060851132	288
Robert J. Calvin	Entrepreneuri al Management	McGraw-Hill	2005	97800714509 28	295
Steve Mariotti	Entrepreneurs hip and Small Business Management	Pearson publishers	2014	978- 0133767186	

Integrated B.Sc. + M.Sc. (H) HGMM- 5 years (7th Semester)

Sr No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	PS	FW	SW	
1		Clinical Genetics	Core Course	3	0	1	0	0	4
2		Cell culture Technology	Core Course	3	0	1	0	0	4
3.		Research Paper Presentation	NTCC	0	0	2	0	0	2
3. 4.		<u><i>Students will choose any one of the given choices*</i></u> 1. IPR, Biosafety & Bioethics 2. Antimicrobial Resistance 3. Animal Biotechnology 4. MOOC	Open Elective	4	0	0	0	0	4
5.		Research Project	NTCC	0	0	10	0	0	10

Total Credits

24

*The Open Elective Courses of 7th and 8th Semesters will be pooled together.

The Open Elective Course can also be taken through MOOC. A maximum of 4 credits per semester can be taken through MOOC.

Clinical Genetics

L	T	P	Total Credits
3	0	1	4

Course content and syllabus

	Teaching Hours
Unit I History of Clinical Genetics	13 hrs
Historical development of Medical and Clinical Genetics. Impact of genetics in medicine. Indications for and types of invasive and non-invasive prenatal diagnostic techniques. Amniocentesis, Chorionic villus sampling, Ultrasonography, Fetoscopy, Maternal serum screening.	
Unit II Genetic Disorders during pregnancy	14 hrs
Pre-conceptional and Preimplantation genetic diagnosis: Teratogen exposure in early pregnancy. Importance of Gene and stem cell therapy for genetic conditions. Legal and ethical considerations.	
Unit III: Genetic Screening	13 hrs
Genetic screening and genetic testing, Newborn screening, population carrier screening, Presymptomatic and predispositional testing.	
Unit IV: Genetic Counselling	14 hrs
<p>Historical overview of genetic counselling: Models of Eugenic, Medical/Preventive, Decision making, Psychotherapeutic counselling; current definition and goals, Philosophy and ethos of genetic services and counselling</p> <p>Components of genetic counselling: Indications and purpose, Information gathering and construction of pedigrees, Medical Genetic evaluation, Basic components of Medical History, Past medical history: social & family history. Physical examination: General and dysmorphology examination, Documentation</p> <p>Patterns of inheritance, risk assessment and counselling in common Mendelian and multifactorial disorders.</p> <p>Biochemical and Molecular genetic tests: In Children, Presymptomatic testing for late onset diseases (predictive medicine)</p>	

List of Experiments -with basic instructions (Total Teaching =30 hrs)

1. Genetic databases (OMIM, London Dysmorphology, Possum)
2. Online Medical Genetic Support Groups for patients (Genetic Alliance, Family village).
3. Case studies and pedigree construction in clinical genetics.
4. Proforma designing for some genetic conditions, Importance of family history,
5. Practical aspects in the case management of some genetic diseases.
6. Types and importance of maintaining Genetic Registers.

Course Learning Outcomes:

- Understand how genetics is taken to bedside.
- Gain knowledge about prenatal and preimplantation disorders and genetics.
- Understand the legal restrictions about genetic screening.
- Acquire knowledge about Genetic Counselling.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Gardner, A. and Davies, T	Human Genetics	Viva Books, New Delhi	2 nd /2017	9789386105356.	328
Gibson, G	A Primer of Human Genetics. Sinauer.	Sinauer Associates is an imprint of Oxford University Press	2015	978-1605353135 1605353132	442
Korf, B.R. and Irons	Human Genetics and Genomics.	John Wiley and Sons, Hoboken	4 th / 2013	0470654473 978-0470654477	288
Read, A. and Donnai, D.	New Clinical Genetics.	Scion, UK	2015	9781911510703	468
Skirton, H. and Patch, C.	Genetics for the Health Sciences.	Viva Books, New Delhi, published by arrangements with Scion Publishing Limited.	2017	9781904842705	236
Strachan, T. Goodship, J. and Chinnery P.	Genetics and Genomics in Medicine.	Garland Publishers, New York.	2015	978-0815344803 0815344805	832

Turnpenny, P.D. and Ellard, S	Emery's Elements of Medical Genetics.	Elsevier	2015	9780702066856	416
Roderick R. McInnes and Huntington F. Willard	Thompson & Thompson Genetics in Medicine	Elsevier	8 th /2015	978-1437706963 1437706967	560

Cell culture Technology

L	T	P	Total Credits
3	0	1	4

Objectives: To develop an understanding of basic principles underlying in vitro techniques for culture of animal and human cells and their genetic manipulation for better understanding of human diseases.

Course content and syllabus

	Teaching Hours
Unit I : Principles of Cell Culture	13 hrs
Establishment, Maintenance and Cryopreservation of primary cell cultures and cell lines, Sub-culture; Growth phases of cells in a culture, Cell synchronization, Cell transformation and immortalization, Serum containing and serum-free media; Contamination, and sterilization in cell culture; Mechanisms of cell proliferation and cell death in animal cell culture in vitro	
Unit II : Characterization & Scale up techniques	14 hrs
Characterization of cultured cells : cell morphology, chromosome content, enzyme activity, immunostaining; Cell separation based on cell type and cell density, antibody- based techniques (immunepanning, magnetic sorting); Scaling up- techniques for cells in suspension and in monolayer	
Unit III: Animal Transgenesis	12 hrs
Transgenic animals – benefits, risks and challenges, Methods of creating transgenic animals; Production of Transgenic Mouse Model to Study Human Diseases. Strategies to create Knock-out, Knock-in and Conditional Knock-out Mice, Inducible knockouts..	

Unit IV: : Applications of Cell Culture technology	15 hrs
Molecular pharming, Diagnostics, Drug screening, Gene therapy, Animal cloning, stem cell isolation and banking, Xenotransplantation, GMP;Regulatory and ethical issues in Animal biotechnology	

List of Experiments -with basic instructions (Total Teaching = 30 hrs)

- Preparation and sterilization of cell culture media
- Laboratory design and GMP practices in animal cell culture laboratory
- Cryopreservation of cell lines
- Thawing of frozen cells to initiate a new cell culture and sub-culture (passaging)
- Cell counting and estimation of cell viability by trypan blue
- Cell seeding
- Subculture
- Cytotoxicity assay by Crystal violet
- Cytotoxicity assay by MTT
- Colony formation
- Scratch assay

Course Learning Outcomes:

1. Comprehend the fundamental concepts of animal cell culture, and its importance.
2. Identify the various types of cell culture protocols and their importance
3. Compare and Discuss the significance of transgenesis methods with reference to animal models.
4. Correlate the principles with applications of animal cloning and gene therapy alongwith ethical concerns.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
R. Ian Freshney .John	Culture of Animal Cells: A Manual of Basic Technique & Specialized Applications,	Willey & Sons Inc, USA,	2016,7 th ED	9781118873656	736
M Butler	Animal Cell Culture and Technology (THE BASICS)	Taylor & Francis	2003	9781859960493	256

Research Paper Presentation

L	T	P	Total Credits
0	0	2	2

Course content and syllabus:

The students will present a recent research paper published in an international peer-reviewed journal.

IPR, Biosafety and Bioethics

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I: Introduction to IPR and Patent Database	18 hrs
Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications. Protection of New GMOs: International framework for the protection of IP. IPs of relevance to Biotechnology and few Case Studies. Patent databases: Invention in context of "prior art"; Searching national/International Databases; Analysis and report formation	
Unit II: Types of patent and patent application	18 hrs
Types of patents: Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; PCT and Implications; Role of a Country Patent Office; Procedure for filing a PCT application	
Unit III: Biosafety, GMOs and Biodiversity Act	18 hrs

<p>Biosafety: Introduction; Historical Background: Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India;</p> <p>Definition of GMOs & LMOs: Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis;</p> <p>Risk Assessment: Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.</p> <p>Biodiversity Act 2002: Agricultural biodiversity; International Treaty on Plant Genetic Resources for Food and Agriculture (PGRFA); Conservation strategies for seed gene bank; Climate change and conservation of plant genetic resources; Global efforts for management of crop genetic resources; Strategies on PVFR and Biodiversity Acts.</p> <p>Biodiversity Legislation in India; Indian Biodiversity Act and provisions on crop</p>	
Unit IV: Bioethics, Ethics and the law issues	18 hrs
<p>Bioethics: Concepts; Philosophical considerations; Epistemology of Science; Ethical Terms; Principles & Theories; Relevance to Biotechnology;</p> <p>Ethics and the Law Issues: types and policies; Research concerns; Emerging issues: Biotechnology's Impact on Society; DNA on the Witness Stand - Use of genetic evidence in civil and criminal court cases; Challenges to Public Policy – To Regulate or Not to Regulate;</p> <p>Improving public understanding of biotechnology products to correct misconceptions.</p>	

Course Learning Outcomes:

- Understand IPR and its database.
- Evaluate different types of patents and policies
- Compare the biosafety methods and differences between GMOs and LMOs.
- Perceive knowledge of Bioethics and laws.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
D N Choudhary	Evolution of patent laws: "developing countries' perspective"	Delhi Capital Law House	2006	OCLC Number: 255182178	476

Antimicrobial Resistance

L	T	P	Total Credits
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4	0	0	0
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Course content and syllabus

	Teaching Hours
Unit I: Antimicrobials	18 hrs
Different generations of antibiotics (including antimicrobial peptide) and their mode of action. Combination therapy (e.g. amoxicillin and clavulanic acid; triple therapy - amoxicillin, clarithromycin, and a proton pump inhibitor such as omeprazole), Antifungals and Antivirals.	
Unit II: Antimicrobial Resistance	18 hrs
Antimicrobial resistance - natural and acquired problem; Antibiotic resistant microbes in relationship to humans, animals, and the environment. Multi drug resistant microbes (MDR, XDR), Superbugs. Suitable Case studies (CRE, MRSA, VRSA etc). Various antibiotic resistant genes and the antibiotic resistant microbes enlisted by Centre for Disease Control and Prevention (CDC) as urgent, serious and concern threats. Origin of the resistome. Various mechanisms of antimicrobial resistance. Analysis of diverse viewpoints on controversial issues related to sources of antibiotic resistance genes and microbes. Various modes of horizontal gene transfer, point mutation, efflux pumps and its impact on the evolution of antimicrobial resistant microbes. laboratory diagnosis of AMR, WHO priority pathogens.	
Unit III: Management of Antimicrobial Resistance	18 hrs
Antimicrobial stewardship of understanding drug exposure and optimizing use of antibiotics in human and animal health; reduce the incidence of infection through effective sanitation, hygiene and infection prevention measures, non-traditional methods to treat bacterial infection: Fecal transplants and viruses; Application of Next Generation Sequencing for detection of mutation leading to antibiotic resistance. Clinical management of antibiotic resistance. Case study of management multi-drug resistance tuberculosis. Antimicrobial resistance and its containment in India. Evolutionary epidemiology models to predict the dynamics of antibiotic resistance; quorum sensing inhibitors, interferons, plant based natural compounds, combinatorial approach. Need and importance of AMR surveillance	
Unit IV: Discovery of New Antimicrobials	18 hrs

Discovery of New antimicrobials: Strategies for searching new class of antibiotics from sources other than soil. Strategies to culture the unculturable microbes for discovering new antimicrobials. Identification of new antimicrobial targets. Use of combinatorial chemistry to develop novel drugs, developing drugs that inhibit resistance mechanisms, and developing drugs that target virulence factors and hold infections in check. Use of phages and Antimicrobial Peptides as antibacterials.	
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Course Learning Outcomes:

- Critically read and discuss on recent development of Antibiotic Resistance
- Describe the mode of action of different antimicrobials
- Explain the contribution of mutations to evolution to development of antimicrobial resistance
- Explain the mechanisms by which bacteria and viruses become resistant to drugs used to treat infections caused by them.
- Evaluate the use and misuse of antibiotics
- Describe methods to reduce antibiotic resistance

Text / Reference Books: [mention the name of the books. Can add more rows]

Author	Title	Publisher	Ed/year	ISBN No	Pages
Gilbert, D.N., Chambers, H.F., Saag, M.S., Pavia, A.T., and Boucher, H.W.	The Sanford Guide to Antimicrobia ITherapy 2021	Antimicrobia ITherapy	2021	978-1944272166	308

Research Project

L	T	P	Total Credits
0	0	10	10

Course content and syllabus:

The student will undertake a research project under the supervision of a faculty member.

Integrated B.Sc. + M.Sc. (H) HGMM- 5 years (8th Semester)

Sr No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	PS	FW	SW	
1		Population and Evolutionary Genetics	Core Course	2	0	0	0	0	2
2.		Infectious Diseases and Vaccine Technology	Core Course	2	0	0	0	0	2
3.		<u>Students will choose any one from the given choices</u> 1. Cancer Therapeutics and Personalized Medicine 2. Diagnostics Techniques 3. MOOC	Specialization Elective Course	4	0	0	0	0	4
4.		<u>Students will choose any one of the given choices*</u> 1. Stem Cell Biology and Regenerative Medicine 2. Clinical Trials 3. MOOC	Open Elective	4	0	0	0	0	4
5.		Research Project	NTCC	0	0	12	0	0	12

Total Credits

24

*The Open Elective Courses of 7th and 8th Semesters will be pooled together. The Specialization Elective Course and Open Elective Course can also be taken through MOOC. A maximum of 4 credits per semester can be taken through MOOC.

Population and Evolutionary Genetics

L	T	P	Total Credits
2	0	0	2

Course content and syllabus

	Teaching Hours
Unit I Human Evolution	7.5 hrs
Theories of evolution: Lamarckian evolution theory, Darwin's theory of evolution, Neo-Darwinism, modern synthesis theory of evolution, Macroevolution & Microevolution. Overview of human evolution, Primitive hominids and australopithecine stages, Evolutionary trends and relationship with family trees, Distributions, Physical characteristics, Brain size and cultural behaviour of pithecanthropine stage, neanderthal transition stage, neanderthal stage and modern human.	
Unit II Human Population Genetics	7.5 hrs
Introduction, Applications and subdivisions of human population genetics Allele frequencies - deriving genotypic & allelic frequencies, introduction to quantitative genetics, deriving allelic frequencies from molecular data, changes in allele frequencies. Genetics & Polymorphism - phenotypic & genotypic polymorphisms, transient polymorphism, balanced polymorphisms. Random & Non-random mating - positive & negative assortative mating, role in population size & change in gene frequency. Hardy-Weinberg method & its applications - calculating allelic frequencies, assumptions of Hardy-Weinberg equilibrium, proof of Hardy-Weinberg equilibrium, Generation time, testing for fit to Hardy-Weinberg equilibrium	
Unit III: Human Evolutionary Genetics	7.5 hrs
Random Genetic drift - definition, its effects in small & large populations, bottlenecking & founder effect, genetic drift simulation, genetic drift vs selection. Genetic equilibrium - definition, conditions for its stability, deviation of it (evolution). Selection - overview, types & subtypes, negative & positive selections, patterns and mechanism of selection (stabilizing, disruptive, directional, balancing, disassortative sexual selection, frequency dependent selection), overdominance, natural selection, artificial selection, ecological selection. Evolution of Genetic Diversity - natural variation, sources of genetic variation. Molecular Evolution - general approaches, principles, rates of molecular evolution. Evolution of eukaryotic genome structure, Gene family, evolution and phylogenetics, Gene genealogies, causes of change in allele frequency, molecular study of phylogeny, neutral theory of molecular evolution.	

Unit IV: Inbreeding and its effects	7.5 hrs
<p>Consanguinity and inbreeding, Inbreeding coefficient of a population and individuals through path analysis, Computation of Wright's 'F', Computation of 'F' for autosomal gene, Biological consequences of inbreeding, Concept of genetic load and its measurements,</p> <p>Genetics of Speciation- Patterns and processes of speciation: Reproductive isolating barriers, Species concepts, Genetics of reproductive isolation and species, Natural hybridization. Classification of races through UNESCO guidelines, Admixture of races, Ethnic elements in Indian population (Classification by A.C. Haddon, S.S. Sarkar and Guha), Objectives of racial classification.</p>	

Course Learning Outcomes:

- Understand Human Evolution and genetics associated.
- Gain knowledge about genetics at population level.
- Understand about polymorphisms.
- Acquire knowledge about various human races.

Text / Reference Books:

<u>Author</u>	<u>Title</u>	<u>Publisher</u>	<u>Ed/year</u>	<u>ISBN No</u>	<u>Pages</u>
Balding, D.J., Bishop, M. and Cannings, C.C	Handbook of Statistical Genetics	John Wiley and Sons, England	2007	978-047005830-5	1616
Brandon, R.N	Concepts and Methods in Evolutionary Biology	Cambridge University Press, USA.	1996	978-0521498883 0521498880	240
Cavalli-Sforza, L.L. and Bodmer, W.F.	The Genetics of Human Population	W.H. Freeman and Co., San Francisco, CA.	2013	978-0486406930	992
Falconer, F.S. and MacKay, T.F.C.	Introduction to Quantitative Genetics.	Benjamin-Cummings Pub Co; Subsequent edition	1996	0582243025 978-0582243026	464
Hamilton, M.B.	Population Genetics	Wiley-Blackwell, USA	2009	1405132779 978-1405132770	424

Hartl, D.L. and Clark, A.G.	Principles of Population Genetics.	Sinaur Associates, Inc., Massachusetts	4 th /2007	0878933085 978-0878933082	672
Hedrick, P.W.	Genetics of Population	Jones and Bartlett Publishers, Massachusetts	4 th /2011	0763757373 978-0763757373	675
Neale, B., Ferreira, M.A.R., Medland, S.E. and Posthuma, D.	Statistical Genetics: Gen eMapping through Linkage and Association.	Taylor and Francis Group, USA	2008	9780415410403	608

Infectious Diseases and Vaccine Technology

L	T	P	Total Credits
2	0	0	2

Course content and syllabus

	Teaching Hours
Unit I Microbes as pathogens	7.5 hrs
Entry of pathogens into the host, types of pathogens, Microbial toxins (exotoxins, enterotoxins, endotoxins, neurotoxins) and virulence factors. Role of horizontal gene transfer in pathogen evolution, Transformation, Conjugation and Transduction, Virulence factors for evasion of host defences, Toxins (cholera, diphtheria, tetanus, botulinum, anthrax), Superantigens, Resistance to antimicrobial peptides (AMPs), AMP efflux pumps; LanFEG and LanI proteins, Iron acquisition mechanisms, Pili and fimbriae as adherence factors, Biofilms.	
Unit II Microbial Diseases	7.5 hrs
Pathogenesis of microbial diseases caused by major human pathogens (E. coli, Salmonella, Helicobacter, Staphylococcus, Mycobacterium, Candida).	

Unit III: Viral Diseases	7.5 hrs
Brief introduction and pathogenesis of emerging viral diseases, HIV, HPV, Zika, Dengue, Chikungunya, Ebola and Marburg and Corona virus.	
Unit IV: Vaccine and Vaccine Technology	7.5 hrs
Vaccines & Vaccination – adjuvants, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, mRNA Vaccines. Principles of vaccination, passive & active immunization, immunization programs & role of WHO in immunization programs.	

Course Learning Outcomes:

- Understand microbial and viral diseases.
- Gain knowledge about various microbial toxins and host pathogen interaction.
- Understand importance of vaccination.
- Acquire knowledge about Covid-19 vaccination and its important role.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Alberts B, Johnson A, Lewis J	Molecular Biology of the Cell,	New York, Garland Science	4 th /2002	978-0815332183 0815332181	1616
Brenda A. Wilson, Abigail A. Salyers, Dixie D. Whitt, Malcolm E. Winkler	Bacterial Pathogenesis: A molecular approach	ASM Press, Washington, DC.	3 rd /2011	978-0632037759 063203775X	540
Tjeerd G. Kimman	Genetics of Infectious Disease Susceptibility	Springer Science & Business Media.	3 rd /2001	ASIN: B008ITIPYI	250
Apurba Sankar Sastry, Sandhya Bhat K	Essentials of Medical Microbiology	Jaypee Brothers Medical Publishers	2nd	9789351529873,	648

Cancer Therapeutics and Personalised Medicine

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I: Cancer and its Causes	15 hrs
Types of cancer, Common symptoms, Schemes of classification, WHO classification, staging and grading, degree of malignancy, Pathology of cancer – hyperplasia, dysplasia, metaplasia, carcinoma <i>in situ</i> , biological heterogeneity, Mechanism of physical and chemical carcinogenesis, biological agents as carcinogens, Cancer predisposing genes, Oxidative stress in cancer, Role of DNA damage and repair in cancer	
Unit II: Hallmarks of Cancer and its targeting	15 hrs
Emerging Hallmarks of cancer – Deregulating cellular energetics and avoiding immune surveillance, Tumor Microenvironment – Role of cancer stem cells, targeting of the Hallmarks of Cancer	
Unit III: Dysregulation of Signaling Pathways in Cancer and their targeting	15 hrs
Role of PI3K/AKT/mTOR, EGFR/RAS/MAPK, Wnt/ β -catenin, JAK/STAT, TGF- β , and Notch pathways in the development of human cancers. Therapeutics targeting these pathways.	
Unit IV: Molecular Tools for Personalized Medicine	15 hrs
Molecular markers and disease diagnosis, progression and therapy targets, Next generation sequencing (NGS) technologies, digital droplet PCR, System biology approaches, Genome editing & gene transfer technology.	

(Total Teaching = 60 hrs)

Course Learning Outcomes:

- Develop an advanced understanding of molecular mechanisms underlying cancer initiation and progression.
- Understand how genetic variants impact treatment outcomes.
- Discuss strategies to diagnose and treat various cancers

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Bruce, Alberts and Alexander Johnson and Julian Lewis, and Martin Raff	Molecular Biology of the Cell	Garland Science	6th	978-0815344322	1342

Robert A. Weinberg	The Biology of Cancer	Garland Science	2nd	978-0-81-534220-5	960
Lauren Pecorino	Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics	Oxford University Press	3rd	978-0-19-957717-0	360

Diagnostic Techniques

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I: Microscopic examination and culture methods.	18 hrs
Examination of sample by staining - Gram stain, Ziehl-Neelson staining for tuberculosis, Giemsa- stained thin blood film for malaria. Preparation and use of culture media - Blood agar, Chocolate agar, Lowenstein-Jensen medium. MacConkey agar, Distinct colony properties of various bacterial pathogens. Mechanised and automated methods in clinical Microbiology for microbial identification:- Manual biochemical system, Mechanised automated systems, Immunological methods, Substrate profile systems.	
Unit II: Enzyme linked diagnostic techniques	18 hrs
Comparison of enzymes available for enzyme immuno assays. Conjugation of enzymes, Solid phases used in enzyme immuno assays. Homogeneous and heterogeneous enzyme immuno assays. Enzyme immuno assays after immuno blotting. Enzyme immuno histochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays. Applications of enzyme immuno assays in diagnostic microbiology.	
Unit III: Serological and in-vitro diagnostics	18 hrs
Serological Methods - Agglutination, Counter Current Immuno Electrophoresis, Dot Blot Assay, Western Blot, Radioimmunoassay, Idiotypic Network (Classification, internal imaging and applications). Kits for rapid Detection of Pathogens: Typhoid, Dengue and HIV, Swine flu..	

Unit IV: Molecular diagnostics and cytodiagnostics techniques	18 hrs
<p>Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology</p> <p>Cytodiagnostic techniques:- Flowcytometry and cell sorting, Immuno fluorescence, Electron Microscopy (Types of Electron Microscopy, concepts and operations with applications).</p>	

Course Learning Outcomes:

- Perceive knowledge regarding importance of various microbial identification approaches Understand enzyme based diagnostic techniques available.
- Understand serological and in-vitro methods of diagnostics.
- Perceive knowledge about molecular methods and cyto-diagnostic techniques

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Detrick, B; Hamilton, R.G and Folds, J.D.	Manual of Molecular and Clinical Laboratory Immunology.	American Society for Microbiology press. 7th edition	2016	978- 155581871 5	1240
Tille P.	Bailey's and Scott's Diagnostic Microbiology.	Elsevier.	2021	978- 032368105 6	1184
Murray, P.R; Baron, E.J; Jorgensen, J.H; Landry. M.L and P. faller, M.A.	Manual of Clinical Microbiology.	American Society for Microbiology, Washington D.C. 9 th edition. Publication	2007	978- 155581371 0	2476
Collee JG, Fraser, AG, Marmion, BP, Simmons A	Mackie and Mccartney Practical Medical Microbiology, 14 th edition	Elsevier	2007	978- 813120393 4	-

Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A.	Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition.	McGraw Hill Publication .	2019	978- 126001202 6	880
Rose, N. R.	Manual of Clinical Laboratory Immunology..	American Society for Microbiology Press. Washington, D.C. 6th edition.	2002	978- 155581215 7	1348

Stem Cell Biology and Regenerative Medicine

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I: Introduction to Stem Cells	18 hrs
Definition; Historical Perspectives, Stem cell types, embryonic, extra-embryonic fetal, adult and induced pluripotent stem cells Origin and sources, Cancer stem cells, General characteristics of stem cells and major pathways controlling self renewal and pluripotency	
Unit II: Introduction to Cell-based Therapies	18 hrs
Fundamentals of Cell-Based Therapies, Stem Cell Research, Biology of Human Mesenchymal Stem Cells, endothelial progenitor cells and hematopoietic stem cells .	
Unit III: Regenerative Medicine for Diseases	18 hrs
Biology of regeneration, Strategies of Regenerative Medicine: Cell transplantation, Bio-artificial Tissue and Induction of Regeneration In Situ, Regenerative Medicine for Diseases of the Retina and limbal stem cell, Islet Cell Therapy and Pancreatic Stem Cells, Cell Therapies for Bone and Cartilage Regeneration, Regenerative Medicine Approaches to Skin Cell-Based Therapy , Use of stem cells for therapy of malignant diseases and non-malignant diseases like neurological, cardiac, autoimmune, and metabolic disorders	
Unit IV: Regulatory and Ethical Issues and future prospects	18 hrs
Overview of DCGI/FDA regulation in stem cell research and development Ethical and regulatory issues related to stem cell research and therapy, National and International Guidelines, Quality control issues in using stem cells for clinical applications, Clinical trials and future prospective	

(Total Teaching = 72 hrs)

Course Learning Outcomes:

- Develop basic understanding of stem cells
- Evaluate the clinical significance of stem cell research in regenerative medicine
- Assess strategies to overcome hurdles in stem cell biology

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Anthony Atala, Robert Lanza, James A.	Principles of Regenerative Medicine	Academic Press	3 rd	978-0-12- 369410-2	1454
Thomson and Robert M. Nerem					
Robert Lanza, John Gearhart, Brigid Hogan, Douglas Melton, Roger Pedersen, E. Donnall Thomas, James Thomson and Sir Ian Wilmut	Essentials of Stem Cell Biology	Elsevier	2 nd	978-0-12- 374729-7	712

Clinical Trials

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I: Introduction to Biomedical Study design	18 hrs
Definition, scope & types of clinical trials, Study population, randomization process, blinding, sample size, recruitment, Epidemiology and observational data	
Unit II: Clinical trial process	18 hrs
Key components of clinical trials including sample size, Phase 0,1,2,3,4, multi-centric trials, Documentation, Audit, Inspection, Pharmacovigilance and drug safety, Clinical trial Registries, IRB, Informed consent, reporting and evaluation of data.	
Unit III: QC in Biomedical research	18 hrs

Introduction to Quality Assurance & QC, GLP & Accreditation, adverse effect reporting(SAE), withdrawal of clinical trial, Data Safety Monitoring Boards, Harmonization and Good Clinical Practices, Ethics in biomedical research	
Unit IV: Current scenario of Clinical trials and its management	18 hrs
Globalization of clinical trials, scenario in India, limitation of clinical trials, IT in clinical trials, Examples of successful clinical trials	

(Total Teaching = 72 hrs)

Course Learning Outcomes:

- Examine the rationale for carrying out clinical trials
- Analyze major ethical issues one must consider when planning a human-subjects study
- Evaluate the process of Good Clinical Practice while conducting a clinical trial

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
David Machin Simon Day Sylvan Green	Textbook of Clinical Trials	Wiley India Pvt Ltd	3 rd	9788126524945	784
P. Brouwers	Handbook of Clinical Trials	Garland Science	2nd	1901346293	388

Research Project

L	T	P	Total Credits
0	0	12	12

Course content and syllabus

The student will undertake a research project under the supervision of a faculty member.

Integrated B.Sc. + M.Sc. (H) HGMM- 5 years (9th Semester)

Sr . No	Course Code	Course Title	Course Type	Credits					Credi t Units
				L	T	PS	FW	SW	
1		Principles of pathology	Core Course	4	0	0	0	0	4
2		Advanced Enzymology	Core Course	4	0	0	0	0	4
3		Advanced Bioinformatics	Core Course	4	0	0	0	0	4
6		Professional Ethics-I	Value Added Course	1	0	0	0	0	1
6		Research Project	NTCC	0	0	12	0	0	12

Total credits

25

Principles of Pathology

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I History of Pathology	18 hrs
<p>Introduction: History of pathology, Basic definitions and common terms used in pathology, Survival Introduction mechanism and disease, microscopic and cellular pathology, scope and techniques used.</p> <p>Cell Injury and responses of cells: Cellular Adaptations, and Cell Death An overview of cellular adaptation: Hyperplasia, Hypertrophy, Atrophy, Metaplasia; Causes and mechanisms of cell injury, reversible and irreversible injury, Necrosis, Apoptosis, Types of apoptosis, Intracellular accumulations, Cellular ageing</p>	
Unit II Inflammation and tissue repair	18 hrs
<p>Role of Inflammation in disease Basic concepts with suitable examples of general features of acute and chronic inflammation: Vascular Changes, cellular events, important chemical mediators of inflammation, Morphological effects inflammation response, Granulomatous Inflammation.</p> <p>Role of Tissue repair, Healing and Fibrosis: Basic mechanism of tissue regeneration, and repair by healing, scar formation and fibrosis.</p> <p>Hemodynamic Disorders in diseases: An overview of Edema, hyperemia, congestion, hemorrhage, hemostasis and thrombosis, Embolism, Infarction and shock with suitable examples</p>	
Unit III: Pathology of Cancer	18 hrs
<p>Cancer: Definitions, Nomenclature, characteristics of benign and malignant neoplasms, grading and staging of cancer, biology of tumor growth, invasion and metastasis, carcinogens and cancer, concept of oncogenes, tumor suppressor genes, DNA repair genes and cancer stem cells.</p>	
Unit IV: Molecular Pathology	18 hrs

Molecular Pathology: Rules for nomenclature of mutations & databases of mutations, Loss of function mutations, Gain of function mutations, Molecular pathology from gene to disease, Molecular pathology from disease to gene, Molecular pathology of chromosomal disorders.	
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Course Learning Outcomes:

- Understand importance of pathology of diseases.
- Gain knowledge about various cell responses to cell injuries
- Perceive knowledge about cancer and its pathology.
- Relate pathology of a disease to genetics.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Ramnik. Sood	Medical Laboratory Technology Methods and Interpretations	Jaypee Brothers Medical Publishers	6 th /2009	978-8184484496	1694
Kumar V, Abbas, A.K., and Aster, J.C.	Robbins Basic Pathology	Saunders Elsevier	8 th /2007	978-1437717815	928

Advanced Enzymology

L	T	P	Total Credits
4	0	0	4

Objectives: The objective of the course is to provide a deeper insight into the fundamentals of enzyme structure and function and kinetics of soluble and immobilized enzymes. Also it deals with current applications and future potential of enzymes.

	Weightage (%)	Teaching Hours
Unit I: Enzyme Kinetics		

Concept of convergent and divergent evolution of enzymes; Purification of enzymes: strategy & criteria of enzyme purity, judging the success of purification procedure; Kinetics of multi substrate enzyme catalyzed reactions: classification, kinetics of multisubstrate reactions, Investigation of reaction mechanism by using initial velocity, inhibition and isotope exchange studies; Practical aspects of kinetic studies: Enzyme assays, coupled assays, Reaction conditions optimization (pH, temperature, substrate concentration).	25	18
Unit II: Chemical mechanisms of enzyme catalysed reactions		
Methods of pre-steady state analysis: Rapid mixing and sampling techniques, Relaxation methods, Absolute concentration of enzymes, Sigmoidal Kinetics: Cooperativity phenomenon for protein ligand binding, symmetric & sequential models for action of allosteric enzymes and their significance, Hill and Scatchard plots.	25	18
Unit III: Investigating the active site structure		
Identification of active site of enzymes: By trapping of enzyme-substrate complex, use of substrate analogues, enzyme modification by chemical procedures affecting amino acid side chains, treatment with class-specific inhibitors and site-directed mutagenesis, by studying the effect of changing pH. A brief account of investigation of three dimensional structure of active site, Structures & mechanisms of selected enzymes: Dehydrogenases, proteases, ribonuclease and lysozyme.	25	18
Unit IV: Enzyme turnover		
Enzyme turnover: Kinetics of turnover, methods for measuring rates of enzymes turnover, Correlation between rates of turnover and the structure and functions of enzymes, Mechanism of enzyme degradation, significance of enzyme turnover.	25	18

Course Learning Outcomes:

1. Comprehensive understanding of enzyme kinetics and thermodynamics with intention of concept application in enzyme research.
2. To enhance the knowledge in the application of enzymes in food, pharmaceutical, and green chemistry industry.
3. A thorough understanding of the techniques of enzyme engineering.

Advanced Bioinformatics

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I: Biological Databases	18 hrs

<p>Nucleotide and Protein databases: Primary, secondary and composite database: genbank, EMBL, DDBJ, Uniprot, Swissprot, PIR, PDB, Genpepts, SCOP, CATH, Pfam. NCBI, EBI, DDBJ. nucleotide sequence flat files. Sequence formats: Genbank, FASTA, ASN.</p> <p>Introduction to metabolic pathway databases on the web-KEGG, EcoCyc, Metacyc. Enzyme databases- BRENDA, LIGAND database. Molecule visualization softwares: RasMol, Pymol, Cn3D, VMD etc.</p> <p>Information retrieval from biological databases- NCBI resource, Entrez, Pubmed, MEDLINE.</p>	
Unit II: Sequence Alignment	18 hrs
<p>Introduction to sequence alignment: Pairwise Sequence Alignment, Global alignment and Local alignment, general, gap and affine penalty. DotPlot, Scoring functions, Substitution Matrices- PAM and BLOSUM matrices.</p> <p>Dynamic Programming- implementation of the Needleman and Wunsch algorithm and Smith Waterman Algorithm for pairwise alignment and testing alignment score</p> <p>Multiple Sequence Alignment- consensus sequence, motifs and profiles. SP (Sum of Pairs) measure. Progressive method of Sequence Alignment: Clustal W, Clustal X, T-COFFEE</p>	
Unit III: Sequence Database search and Protein Structure Prediction	18 hrs
<p>Sequence database search using BLAST and FASTA. Word method and k-tuple method of sequence alignment. Significance of alignment score: E-value and bit-score, p-value. Variants of BLAST- blastN, blastP, blastX, TblastN, TblastX. Hidden Markov Model, Position Specific Scoring Matrix</p> <p>Methods to predict secondary structure of proteins</p> <p>Methods to predict tertiary structure of proteins: Homology modelling, threading, ab-initio modelling</p>	
Unit IV: Gene Prediction and Phylogenetics	18 hrs
<p>Prediction of Genes in Prokaryotes and Eukaryotes Prediction of Promoter and regulatory Elements</p> <p>Introduction to Phylogenetics: Gene Phylogeny v/s Species Phylogeny.</p> <p>Phylogenetic tree construction: forms of tree representation, methods, and programs</p>	

Course Learning Outcomes: at the end of this course, students will learn to

- Search various biological database and extract biologically relevant information
- Perform pair-wise and multiple sequence alignment

- Search sequence database to identify homologous sequences in other organisms
- Predict secondary and tertiary structure of proteins
- Predict gene, promoter and regulatory elements
- Compare genomes and build phylogenetic tree

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Xiong, Jing	Essentials of Bioinformatics	Cambridge University	2007	978-0521706100	352
Mount, D.W.	Bioinformatics : Sequence and Genome Analysis	Cold Spring Harbor Lab Press	2 nd Ed	978-9746520706	692
Lesk, A.M.	Introduction to Bioinformatics	Oxford University Press	2014	978-0198724674	376

Professional Ethics -I

L	T	P	Total Credits
1	0	0	1

Course content and syllabus

	Teaching Hours
Unit I: [Origins of Morality and Ethics]	4 hrs
Moral Diversity, Moral Universals, Evolution of Morality, Reciprocal Altruism, Culture influence on our thought and action, Moral Differences, Kinds of Societies, Conservatives and Liberals, Disgust and Honor, Religion and Morality. Morality as Part of Our Nature, Skepticism About the Self, Free Will and the Situation. Utilitarian Ethics (outcome based), Deontological Ethics (duty based), Virtue Ethics (virtue based), and Communitarian Ethics (community based).	
Unit II: [Research Design: Inquiry and Discovery]	3 hrs

The Process of Inquiry, What is Curiosity, The components of enquiry design, What is a theory, Using inquiry as individuals, Elements of Critical Thinking, Inquiry Approaches: Quantitative, Qualitative, and Mixed Methods, Relationships Between Variables, Questions and Hypotheses, Conceptualization and Operationalization, What is Literature Review?	
Unit III: [Gender justice and workplace safety]	3 hrs
Introduction to Gender Justice- Notion and Significance, International and Constitutional Perspectives on Gender Equality, Protection of Women at Workplace, Gender Violence- Within and Beyond	
Unit IV: [Gene technology and Ethics]	4 hrs
History of genetics and genomics, Recent Developments in Cloning, Cloning and Conservation, DNA Fingerprinting, Individual Identification and Ancestry Next Generation Science Standards. Genomics in Medicine, Genetically Modified Organisms and food, Mapping Morality: The Rights and Wrongs of Genomics, Societal implications of genetically modified organisms and food	

Course Learning Outcomes:

1. Learn the concept of ethics and morality.
2. How to design experimental research – inquiry and discovery
3. Learn the problems of gender bias
4. Ethical issue related with gene technology

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Daniel McGuire	Synthetic Biology:	Syrawood Publishing House	2016	978-1682863374	278
R. Subramanian	Professional Ethics	Oxford Universitypress	2017	978-0199475070	472

Research Project

L	T	P	Total Credits
0	0	12	12

Course content and syllabus

The student will undertake a research project under the supervision of a faculty member.

Integrated B.Sc. + M.Sc. (H) HGMM- 5 years (10th Semester)

Sr No	Course Code	Course Title	Course Type	Credits					Credi t Units
				L	T	PS	FW	SW	
1		Omics and its applications	Core Course	4	0	0	0	0	4
2		Cell Signalling and celltrafficking	Allied Course	4	0	0	0	0	4
3		<u>Students will choose any one from the given choices</u> 1. Plant Genomics and Biotechnology 2. RNA interference and its Applications 3. Model Genetic System 4. Conservation Biology 5. Medical Genomics 6. MOOC	Specialization Elective Course	4	0	0	0	0	0
4		Professional Ethics-II	Value Added Course	1	0	0	0	0	1
5		Research Project	NTCC	0	0	12	0	0	12

Total Credits

25

The Specialization Elective Course can also be taken through MOOC. A maximum of 4 credits per semester can be taken through MOOC.

Omics and its applications

Course content and syllabus	L	T	P	Total Credits
		4	0	0

	Teaching Hours
Unit I: Genomics	18 hrs
DNA sequencing methods- Sanger and Maxam-Gillbert method. Next-generation sequencing platforms. Techniques for genome research (chromosome walking, RFLP, chromosome capture techniques). Application of microbial genome variability for human welfare. Human genome sequencing project. Genome sequencing strategies: Hierarchical and whole genome shotgun sequencing. 100000 genome project.	
Unit II: Genome Evolution and Annotation	18 hrs
Evolution by Genome Expansion and Reduction Metagenomics Methods to Compare Genomes Archaeal Genomics Microbial Genome Annotation Genomics for pathogenic microbes – Search for better vaccines	
Unit III: Transcriptomics and Proteomics	18 hrs
Introduction to Transcriptomics: Methods to estimate RNA – RT-PCR, SAGE, RNA sequencing, direct RNA sequencing. Introduction to Proteomics: Methods to estimate proteins: 2D-PAGE, 2D-DIGE, ICAT, ITRAQ, SILAC. Importance of transcriptomics and proteomics in infectious and non-infectious diseases	
Unit IV: Metabolomics, Interactomics	18 hrs
Introduction to metabolomics and Interactomics. Experimental approaches to estimate metabolite levels. Fluxomics. High-throughput approaches towards Protein-protein and DNA-protein interactions Integrated (multi-omic) approaches in infectious and non-infectious diseases	

Course Learning Outcomes:

- To expose students in the multiple areas of omic technologies
- Students will learn about different approaches used in the areas of Genomics, transcriptomics, proteomics, metabolomics, and interactomics
- Learn how different omic approaches is used to generate testable hypothesis
- Role of multi-omic approaches towards better understanding of infectious and non-infectious diseases

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Thomas J. Dougherty and Steven J. Projan	Microbial Genomics and Drug Discovery	CRC	2003	978-0824740412	264

A. Malcolm Campbell, Laurie J. Heyer	Discovering Genomics, Proteomics and Bioinformatics	Pearson Education	2007	978-8131715598	464
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Professional Ethics - II

L	T	P	Total Credits
1	0	0	1

Course content and syllabus

	Teaching Hours
Unit I: [Ethics and Empathy]	4 hrs
Religion and Morality. Morality as Part of Our Nature, Skepticism About the Self, Free Will and the Situation, Culture mixing and its consequences, Factors affecting Evaluative Responses to Culture Mixing, Culture as a Knowledge Structure, Multi-Culture Mindsets, Biculturalism & Frame Switching, Assimilation to a Cultural Frame, Globalization and the Forces Shaping the Behaviour.	
Unit II: [Importance of Sampling and Ethical Issues in Research]	5 hrs
Sampling and its Importance, Basic Statistics Concepts, Reliability and Validity, Creating a Representative Sample, Ethical Issues Overview, Voluntary Participation, No Harm to Participants, other Ethical Issues	
Unit III: [A bias neutral workplace]	5 hrs
Creating a Bias Neutral Work Environment, management strategies for workplace bias and personal bias, effective communication methods and how to measure outcomes, strengthening the position of women in society	
Unit IV: [Sustainability, Responsibility and Ethics]	4 hrs
Concepts of sustainability, such as social, environmental and economic dimensions, and the importance of time, Ecological Sustainability. responsible business and research practices, Different approaches to responsibility in research and corporate organizations, such social responsibility, social entrepreneurship, or corporate citizenship. Environmental Ethics, Land ethics, Deep ecology, Ecofeminism.	

Course Learning Outcomes:

- Understand basic concepts of morality in mixed cultures.
- Learn to resolve the issues in research.
- Learn to create a bias free work culture.
- To learn the concept of Sustainability and Responsibility

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
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Rita Gupta	Sexual Harassment at Workplace, 2013	Lexis Nexis	2013	978-9351430537	320
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Cell Signalling and Cell Trafficking

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I Cellular Communication	18 hrs
Introduction to cell signalling, fundamental commonalities and evolution of signalling pathways; Role of PTMs in signalling; Subcellular localisation and signalling molecules; Second messengers, Sensors and effectors; The modular architecture and evolution of signalling proteins; Methods for studying signalling networks. Signalling enzymes and their allosteric regulation, Localization of receptors and signal transducers, Receptor Tyrosine kinases, Insulin Signalling, Receptor Ser/Thr Kinase Receptor, Activation of Ras, Raf and MAPK signalling, kinase-phosphate relation in context to cell signalling, histidine kinases, Heterotrimeric and monomeric and G protein coupled receptors and downstream signalling.	
Unit II Cell signalling pathways	18 hrs
TGF receptors and activation of SMADs, Cytokine receptors and JAK-STAT signalling, phosphoinositide as a signal transducer, pathways that involve signal induced protein cleavage (NF-kb and NOTCH), Hedgehog and Wnt signalling (classical and non-classical), hippo signalling, downregulation of receptor signalling.	
Unit III: Signalling Processes	18 hrs

Gene Transcription and Regulation Cell Cycle and Proliferation Protein translation and non-coding RNAs Proteostasis and Protein Degradation Pathways, Cell Death Signalling ,Sensing and communication in Bacteria, DNA damage response and repair, Metabolism and Signalling, Nuclear Receptors Redox Signalling	
Unit IV: Co-translational protein trafficking	18 hrs
<p>Secretory pathway, concept of signal sequence, experimental demonstration for co- translational transport (protease protection assay), signal recognition particle (SRP), ER translocation of polypeptides (soluble and transmembrane), ER chaperons. N- glycosylation in the ER and Golgi (quality control, UPR, ERAD and proteosomal degradation)</p> <p>ER to Golgi transport, anterograde and retrograde transport, coat proteins their recruitment and removal, retrieval of ER resident proteins, vesicle fusion (factors involved), lysosomal biogenesis, endocytosis, protein trafficking in a polarized cell(apical & basolateral)</p> <p>Nucleocytoplasmic protein transport; Protein transport to Mitochondria, Chloroplast and Peroxisomes.</p> <p>Co translational vs Post Translational protein sorting; PTMs regulating protein transport.</p>	

Course Learning Outcomes:

- Gain in depth knowledge about cellular communication.
- Understand the language by which cell interacts.
- Acquaintance with cell death and various related signals.
- Overall understanding about protein trafficking.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Page s
John T Hancoc k	Cell Signalling	Wiley-India	4 th /2017	978-0199658480 019965848X	400

Lodish, H, Berk, A, Kaiser, C A, Krieger, M. Scott, P.M., Bretscher, A, Ploegh, H and Matsudaira, P.	Molecular Cell Biology	W. H. Freeman	6 th /2008	978-0716768876 0716768879	973
Murray, R.K., Granner, D.K. and Rodwell, V.W,	Harper's Illustrated Biochemistr y	McGraw Hill	30 th /2015	978-0071825344 0071825347	817
B. Alberts, D. Bray, J. Lewis, Martin Raff, Keith Roberts, and J. D Watson	Molecular and Cellular Biology	Garlan d Scienc e	6 th /2012	978-0815344322 0815344325	1464

Plant Genomics and Biotechnology

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teachin gHours
Unit I Plant Genomics	18 hrs

<p>Plant nuclear genome- genome organization in plant nucleus, Plant organellar genomes -plastid and mitochondrial genomes.</p> <p>Plant epigenome –epigenomic reprogramming in gametogenesis and seed development in plants, endosperm imprinting, histone modifications in response to light, natural epigenome variation in plants, heterosis.</p> <p>Plant genome sequencing strategies- high-throughput sequencing technologies, single molecule and real-time sequencing, assembly & alignment programs, genome browsers</p> <p>Plant proteomics- high throughput approaches–mass spectrometry based proteomics</p> <p>Plant metabolomics- analytical platforms–GC-MS, NMR, MALDI</p> <p>Plant genome editing and genome engineering applications- ZFN, TALENs, CRISPR- Cas9 and ODM</p>	
<p>Unit II Plant Secondary Metabolism & Metabolic Engineering</p>	<p>18 hrs</p>
<p>Secondary metabolites-transport storage and turnover, ecological functions & uses ofsecondary metabolites in biotechnology</p> <p>Terpenoids- synthesis of IPP, phenyltransferase and terpene synthase reactions,modification of terpenoid skeletons</p> <p>Alkaloid biosynthesis– nicotine and tropane alkaloids, benzyl isoquinoline alkaloids,moneterpene indole alklaoids</p> <p>Phenolic compounds – phenyl propanoid, phenyl propanoid-acetate pathways, Lignin&flavonoid biosynthesis</p> <p>Coumarins – classification, simple coumarins and Furanocoumarins, stilbenes, styrylpyrones and arylpyrones</p> <p>Plant metabolic engineering-Approaches to metabolic engineering-biotechnological application of alkaloid biosynthesis, phenolics metabolic engineering, terpenoids metabolic engineering.</p>	<p>18 hrs</p>
<p>Unit III: Plant Cell Biotechnology</p>	<p>18 hrs</p>

<p>Introduction to plant cell culture – different plant tissue culture media, role of plant growth regulators in tissue culture.</p> <p>Plant cell culture technique- callus and cell suspension cultures; applications of plant cellcultures.</p> <p>Somatic embryogenesis – induction of somatic embryos, production and applications ofsynthetic seeds</p> <p>Cryo-preservation- theoretical basis, methods and applications of cryo-preservation.</p> <p>Plant secondary metabolites produced by cell cultures, strategies to improve secondarymetabolite production in plant cell cultures -cell line selection, medium optimizations, permeabilization, elicitation, cell immobilization, biotransformation</p> <p>Mass cultivation of plant cell and organ culture- modes of bioreactor operations, different types of bioreactors, hybrid reactors and disposable bioreactors</p>	
<p>Unit IV: Transgenic Plants</p>	<p>18 hrs</p>

<p>Co-integrated vectors, binary vectors, novel and specialized vectors for transformation</p> <p>Selectable markers (positive & negative selection), novel selection methods and restriction enzymes to control T-DNA integration; marker free transgenic technology; analysis of transgenic plants</p> <p>Chloroplast transformation – advantages of chloroplast transformation; transplastomicplants -applications</p> <p>Molecular farming- advantages of transgenic plants as bioreactors, expression systems,sub-cellular targeting, plant expression hosts, downstream processing & purification</p> <p>Molecular farming for biopharmaceuticals – (plantibodies, plantigens, therapeutic proteins & edible vaccines)</p> <p>Molecular farming for industrial products (industrial enzymes, lysozyme, biopolymers,biofuel, paper manufacturing)</p>	
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Course Learning Outcomes:

- Understand the plant genome organization, structural and functional genomics.
- Acquires knowledge on basic characteristics of plant secondary metabolism and skills for manipulation through metabolic engineering.

- Able to generate transgenics for different applications
- Gain knowledge about different applications of plant cell cultures in medicine and industry

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Palmiro Poltronieri, Natalija Burbulis, Corrado Fogher	From Plant Genomics to Plant Biotechnology	Woodhead Publishing Limited, New Delhi	2013	978-1907568299 1907568298	274
Isabelle Nickel	Plant Genomics and Biotechnology	Syrawood Publishing House	2016	978-1682863275 682863271	279
		Elsevier	2012	978-0123814661 0123814669	624
Arie Altman, Paul M. Hasegawa,	Plant Biotechnology and Agriculture: Prospects for the 21st Century				
Rudolf Endress	Plant Cell Biotechnology	Springer-Verlag Berlin	1995	978-3-662-02996-1	353
Bob B. Buchanan, Wilhelm Gruissem, Russell L. Jones	Biochemistry and Molecular Biology of Plants	Wiley Blackwell	2015	978-0470714218	1280

RNA interference and its Applications

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I Introduction to RNAi biology	18 hrs
Discovery of RNA interference, Categories of small non-coding RNAs: dsRNAs, siRNAs, shRNAs, piRNAs and miRNAs, Different components of gene silencing (Dicer, Guide RNA and RNA-induced silencing complex, Translation initiation factor, RNA dependent RNA polymerase, Transmembrane protein), Mechanism of RNA interference (Processing of dsRNA into siRNAs, amplification of siRNAs, degradation of mRNA). Bacterial vectors for RNAi delivery.	
Unit II Small and Micro-RNA	18 hrs
Micro-RNA: Identification and biogenesis, Apoptosis-related micro-RNA, kinship of siRNA and Micro-RNA related pathways, functional classifications, Large-scale genetic analysis using RNAi: Genome-wide RNAi screens in <i>C. elegans</i> , and other systems, siRNA vectors, siRNA delivery in vitro and in vivo; RNAi in mammalian cells: Searching for right siRNA, getting siRNA into cells and verification for specificity.	
Unit III: RNAi and function of gene	18 hrs
RNAi to gene function: (Signal transduction, cell cycle regulation, development, cell motility, cell death, viral invasion/replication), RNAi interactomics and therapeutics informatics – RNAi libraries, discovering RNAi genes and role of bioinformatics, interactomics of RNAi, database and prediction tools of miRNA, siRNA.	

Unit IV: Applications of RNAi	18 hrs
<p>Expression of dsRNA in animals and plants and its applications: RNAi microarrays (Loss of function genetics in mammalian cells); Recent developments and applications in agriculture, Applications of, RNAi therapy: RNAi and therapeutics, (cancer, infectious diseases, cardiovascular and cerebrovascular diseases, neurodegenerative disorder, Future of RNAi in biology and medicine.</p> <p>Expression of dsRNA in animals and plants and its applications: RNAi microarrays (Loss of function genetics in mammalian cells); Recent developments and applications in agriculture, Applications of, RNAi therapy: RNAi</p>	

Course Learning Outcomes:

- Understand the plant genome organization, structural and functional genomics.
- Acquires knowledge on basic characteristics of plant secondary metabolism and skills for manipulation through metabolic engineering.
- Able to generate transgenics for different applications
- Gain knowledge about different applications of plant cell cultures in medicine and industry

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Gesteland, R., Cech, T and Atkins, J	The RNA World	CSHL Press	3 rd /2006	087969739 3 978- 087969739 6	768
Krishnarao Appasani	RNA Interference Technology- From Basic Science to Drug Development	Cambridge University Press	2005	978- 052183677 7 052183677 8	544
Gregory J. Hannon,	RNAi: A Guide to Gene Silencing	CSHL Press	2003	978- 087969641 2 978087969 6412	436

Lewin, B	Genes IX	Jones and Barlett Publishers	2009	978-0763740634 0763740632	892
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Model Genetic System

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I Introduction to various Model Genetic Systems	18 hrs
<p><i>Dictyostelium discoideum</i>: An overview: life cycle, Use of <i>Dictyostelium</i> as a model system.</p> <p>Yeast: Tetrad analysis, yeast mating type switch, Use as a model system to study cell cycle, genetic recombination</p> <p><i>Caenorhabditis elegans</i>: Isolation & identification of mutants, Study of cell lineage, apoptosis, RNA interference.</p> <p><i>Drosophila</i>: Advantages in genetic analysis, Nomenclature of gene mutation, Balancer chromosomes, Mutagenesis and isolation of new variants, Generation of somatic and germline mosaics, Targeted overexpression of genes, <i>Drosophila</i> genome, online databases and other resources.</p> <p>Zebrafish: Isolation and identification of mutants, use of Morpholinos, Zebrafish as a model system for the study of human diseases, Zebrafish genome and online resources.</p> <p>Mouse: Relationship between human and mouse chromosomes, Advantages to use as a model organism, Understanding gene function by transgenic and knockout studies, Mouse genome database, Humanized mice.</p>	

Unit II Exploiting <i>Drosophila</i> Genetics	18 hrs
Stem cells in <i>Drosophila</i> , Oogenesis in <i>Drosophila</i> , Ectopic expression, Generation of Transgenic <i>Drosophila</i> : (a) Germ-line transformation, (b) Application of P-element based vectors in transgenic generation; Advancement in <i>Drosophila</i> genetics: (a) Mitotic recombination, (b) Somatic clones, (c) Germ-line clones, (d) Conditional and /or targeted expression/ablation of genes/transcripts (e.g. UAS/GAL4 system), (e) RNAi based screening of gene functions in <i>Drosophila</i> .	
Unit III: <i>Drosophila</i> as a model for human diseases	18 hrs
<i>Drosophila</i> model for human genetic disorders like Parkinson's, Huntington's, Alzheimer's diseases etc.; Use of <i>Drosophila</i> as a model organism for drug screening. Online databases and other resources for <i>Drosophila</i> genetics.	
Unit IV: Model Organisms in Human Genome Project	18 hrs
Genome – about genomes of model organisms (<i>E. coli</i> , Yeast, <i>C. elegans</i> , <i>Drosophila melanogaster</i> , laboratory mouse, Zebra fish, Human), types of genomes, genomes & genetic variation, comparison of different genomes, genome evolution, Overview of their genome projects.	

Course Learning Outcomes:

- Understand basics of model systems.
- Gain knowledge about *Drosophila* and its genetics in greater detail.
- Acquaintance with various cloning techniques used in *Drosophila*.
- Understand use of model organisms in Human Genome Project.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Bate, Michael, and Martinez Arias, Alfonso	The Development of <i>Drosophila Melanogaster</i>	Cold Spring Harbor Press	1993	978-0879694234 0879694238	
Snustad DP, Simmons MJ	Principles of Genetics	John Wiley and Sons Inc.	6 th /2011	978-0470388259 0470388250	
L. Wolpert, J. Smith, T. Jessell, P. Lawrence, E. Robertson and E. Meyerowitz	Principles of Development	Oxford Univ Press.	3 rd /2006	0199275378 978-0199275373	576
Wood	The Nematode: <i>C.elegans</i>	CSHL Press	1988	978-0879694333 0879694335	667

Conservation Biology

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I: Structure and function of ecosystems	18 hrs
Energy flow and mineral cycling (C,N,P), primary production and decomposition; Structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine); Major terrestrial biomes, theory of island biogeography, biogeographical zones of India; Mega-centres of biodiversity; Biodiversity hot spots- Global and Indian; Measurement of biodiversity-species diversity; Concept of centre of origin and crop diversity	
Unit II: Environmental pollution	18 hrs
Environmental pollution: Soil, water, air; global climate/environmental change, Role of IPCC; Biodiversity: status, monitoring and documentation, major drivers of biodiversity change, biodiversity management approaches; Factors affecting biodiversity, Global climatic change; Invasive species eroding species diversity; Estimation of genetic diversity, population biology, concept of minimum viable population; Population viability and population genetics to facilitate conservation, Assessing the loss of biodiversity- Floristic surveys/inventory; IUCN Red data book	
Unit III: Strategies for conservation of biodiversity	18 hrs
Strategies for conservation of biodiversity; In situ conservation- Ecosystem approach, Habitat approach, Gene management zones; In situ-on farm conservation; Ex situ conservation- Whole plant conservation/maintenance, conservation through storage of orthodox seeds at low temperatures; Conservation using in vitro culture methods; Conservation using cryobiology; Conservation using storage of DNA molecule; Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).; International organisation supporting conservation (PETA); Indian organisation supporting conservation; International treaties/agreements for conservation; Indian laws for Conservation	
Unit IV: Behavioural Science	18 hrs
Animal Sexual behaviour: Monogamy, Polygamy with examples; Learning Behavior: Habituation, Classical Conditioning, Instrumental Conditioning, Latent Learning, Insight Learning; Communication: visual, acoustic, tactile and chemical communication; Social	

Behavior: Living In Groups, Agonistic Behavior, Aggressive behaviour Territories and Dominance Hierarchies, Altruism, Reciprocal Altruism, Kin Selection, Parental Care in humans, birds, animals (lion, elephant); Habitat Selection and Optimality in Foraging, Specialists and Generalists; Migration, Orientation And Navigation.	
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Course Learning Outcomes:

- Students will learn the structure, and functions of ecosystems
- Understand the concept and factors affecting biodiversity
- Gain knowledge of various strategies applied for the conservation of biodiversity
- Analyze the different aspects related to behavioral science

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
P D Sharma	Ecology and Environment	Rastogi Publications	2011	978-8171339655	-
Eugene Odum	Fundamentals of Ecology	Brooks/Cole	2004	978-0534420666	624

Research Project

L	T	P	Total Credits
0	0	12	12

Course content and syllabus

The students will undertake a research project under the supervision of a faculty member.

