Semester-Wise Programme structure for B.Sc. + M.Sc. Biotechnology (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}	Genome Engineering [CU:4, L-3, P-1] {CC}	Diagnostic Techniques [CU:2,L-2] {CC}	Downstream in Biologicals [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}	Bioprocess Technology [CU:6,L-4, P-2] {CC}	Developmental Biology [CU:6,L-4, P-2] {CC}	Synthetic Biology [CU:6,L-4, P-2] {CC}	Cell Culture Technology [CU:4, L-3, P-1] {CC}	Food and Dairy Biotechnology [CU:2,L-2] {CC}	Advanced Enzymology [CU:4,L-4] {CC}	Advanced Microbiology [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 -I [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 Biosciences [CU:2,L-2] {SEC}	SEC2 - Statistics for Biosciences [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 - Programming with C [CU:2,L	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-	Research Project [CU:12, P-12] {NTCC}	Research Project [CU:12, P-12] {NTCC}	Research Project [CU:12,P-

			-1,P-1] {SEC}				10] {NTCC}			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**

Programme structure for Integrated B.Sc. + M.Sc. (H) Biotechnology- 5 years (1st Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit 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	CHE103	General Chemistry	Allied Courses	3	0	1	0	0	4
4	STA101	Mathematics for Life 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/INL103	Punjabi Language/Punjab History & Culture	Ability Enhancement course	1	0	0	0	0	1
		Total Credits							**24**

BCH101: Basic Cell Biology

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

L	T	P	Total Credits
4	0	2	6

Course content and syllabus

	Teaching Hours
Unit I: Water and its Properties	**18 hrs**
Water and its Properties: Dissociation and association constants, pH and buffers. pI, pKa, 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)
3. Verification of Beer Lamberts Law.
4. Estimation of carbohydrate in given solution by anthrone method.
5. Study the presence of reducing/non-reducing sugar in biological samples.
6. Protein estimation by Lowry's method and other methods.
7. 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
Wilson K., Walker J.	Principle and Techniques of Biochemistry and Molecular Biology	Cambridge University Press	6th edition/2006	978-0521178747	744
Plummer, David	An Introduction to Practical Biochemistry	Tata Mc Graw Hills	3rd edition/2017	978-0070994874	250

CHE103-General Chemistry

L	T	P	Total Credits
3	0	1	4

Course content and syllabus

	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**
Unit II: The Periodic Table: History and Periodic Trends 14 h 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 orscreening 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 bondorder, partial charge, hybridization, group electronegativity.	
Unit III: Fundamentals of Organic Chemistry	**13 hrs**
Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence ofhybridization 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; Nucleophlicity 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	
Unit IV: States of matter : Gases and Liquids	**13 hrs**

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, criticalstate, 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.	

List of Practicals with basic instructions (Total = 30 hrs)

Inorganic Chemistry Practicals

1. Titrimetric Analysis
   (i) Calibration and use of apparatus.
   (ii) Preparation of solutions of different Molarity/Normality of titrants.
   (iii) Use of primary and secondary standard solutions.
2. Acid-Base Titrations
   (i) Estimation of carbonate and hydroxide present together in mixture.
   (ii) 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 layerchromatography (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 geometryand physico-chemical behaviour of atomic matter made from elements in periodic table.
- Focus on fundamentals of organic molecules, structure, stereochemistry, bonding, reactivity andreaction 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 de Paula,	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

STA101-Mathematics for Biosciences

L	T	P	Total Credits
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

L	T	P	Total Credits
2	0	0	2

Course content and syllabus

	Teaching Hours
Unit-1- Multidisciplinary nature of environmental studies and Natural Resources-1	**9 hrs**
Multidisciplinary nature of environmental studies: Definition, scope and importance; components of environment –atmosphere, hydrosphere, lithosphere and biosphere. Concept of sustainability and sustainable development. *Natural resources*: Land resources and land use change, land degradation, soil erosion and desertification.	
Unit-2- Natural Resources-2	**9 hrs**
Deforestation: causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal population. Water Resources-Use and over-exploitation of surface and groundwater, floods, drought, conflicts over water (international and inter-state). Heating of earth and circulation of air; air mass formation and precipitation. Energy resources- renewable and non-renewable energy sources, use of alternate energy sources, Growing energy needs, Case studies.	
Unit-3-Ecosystems	**9 hrs**
Ecosystem: 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: Forest ecosystem; Grassland ecosystem; Desert ecosystem; Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).	
Unit-4- Biodiversity and its conservation	**9 hrs**
Biodiversity: Levels of biological diversity: genetic, species and ecosystem diversity; Biogeographic zones of India; biodiversity patterns and global biodiversity hot spots. India as a mega–biodiversity nation; endangered and endemic species of India. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; conservation of biodiversity: *in-situ* and *ex-situ* conservation of biodiversity. Ecosystem and biodiversity services: ecological, economic, social, ethical, aesthetic and information value.	

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 2nd 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, Paralanguage, 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**
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**
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**
Description of objects, people and places, Nationalities, Speaking about one's professions Expressing Actions using regular –er ending verbs; avoir, être; reflexive verbs –usage, conjuagation, Interview of celebrity	
Unit-IV- At the discotheque	**4.5 hrs**
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 and Language

L	T	P	Total Credits
1	0	0	1

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 fur Junge Lerner Book	Ernst Klelt Verlog	2011	978-8183072120
Heimy Taylor, Werner Haas	Station en Deutsch Self Study Course German Guide	Wiley	2007	978-0470165518

PSY101-Behavioural Science: 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 acharter 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 attitudes, Importance, and relevance of attitude Emotional Intelligence – Meaning, components, Importance andRelevance 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 perceptionof others.
- The student will be able to analyze their physical self, social self, the competent self andpsychological 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	9788126580 27
Towers, Marc	Self Esteem	merican 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	BantamBooks	2007	9780553095036
Goleman, Daniel	ing with E.I	Bantam Books	1998	9780553104622

INL101-Punjabi

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: ਸ੍ਵਰ 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 ਸ੍ਰੋਤ ਅਤੇ ਸਰੂਪ**	, ਵਾਰਿਸ ਸ਼ਾਹ ਫ਼ਾਊਂਡੇਸ਼ਨ, ਅੰਮ੍ਰਿਤਸਰ	**2012**	-	-
ਦੁਨੀ ਚੰਦ੍	**ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਦਾ ਵਿਆਕਰਣ**	, ਪੰਜਾਬ ਯੂਨੀਵਰਸਿਟੀ ਪਬਲੀਕੇਸ਼ਨ ਬਿਊਰੋ, ਚੰਡੀਗੜ੍ਹ	**1995**	-	-
ਜੋਗਿੰਦਰ ਸਿੰਘ ਪੁਆਰ ਅਤੇ ਹੋਰ	**ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਦਾ ਵਿਆਕਰਨ (ਭਾਗ**	ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਅਕਾਦਮੀ ਜਲੰਧਰ	**2003**	-	-

	1,2,3),				
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**
Harappan Civilization: extent and town planning and socio-economic life. Life in Vedic Age: socio-economic and religious; Growth and impact of Jainism and Buddhism in Panjab.	
Unit II:	**4.5 hrs**
Society and Culture under Maurayas and Guptas. Bhakti movement: Main features; prominent saints and their contribution. Origin and development of Sufism	
Unit III:	**4.5 hrs**
Evolution of Sikhism: teaching of Guru Nanak; Institutional Development- Manji, Masand, Sangat and Pangat, Transformation of Sikhism: Martyrdom of Guru Arjan; New policy of Guru Hargobind, martyrdom of Guru Tegh Bahadur. Institution of Khalsa: New baptism; significance	
Unit IV:	**4.5 hrs**
Changes in Society in 18th century: social unrest; emergence of misls and other institutions - rakhi, gurmata, dal khalsa. Society and Culture under Maharaja Ranjit Singh. 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
L.M Joshi,	History and Culture of the Punjab, Part-I	Punjabi University, Patiala	1989,3rd	-
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	-

Programme structure for Integrated B.Sc. + M.Sc. (H) Biotechnology- 5 years (2nd Semester)

Sr. No	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	STA104	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 it's 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 de-amination, Decarboxylation- urea cycle and it's 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 howdisturbances 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	978-1319381493	1328
Jeremy M. Berg, Lubert Stryer, John L Tymoczko, and Gregory J. Gatto,	Biochemistry	W.H. Freeman Company	2015	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**
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. 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.	
Unit II Mendelian Genetics	**18 hrs**
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). **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.	
Unit III: Non- Mendelian Genetics	**18 hrs**
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 hetrozygotes, mosaics, chimeras, hermaphrodites, Kappa articles in Paramoecium, Sigma factor in *Drosophila*, Cytoplamic Male Sterility (CMS) in maize maternal inheritance	

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.	

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 Punnet 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 E J, Simmons MJ, Snustad DP	Principles of Genetics	Wiley-India	6th/2008	978-0471291312	480
Snustad DP, Simmons MJ	Principles of Genetics	John Wiley and Sons Inc.	6th/2011	978-0470388259 0470388250	784
Griffith AJF, Wessler SR, Lewontin RC, Carroll SB	Introduction to Genetic Analysis	W. H. Freeman and Co., New York	2007	978-0716768876 0716768879	802
Strickberger, M.W	Genetics	Prentice-Hall India Pvt. Ltd., New Delhi	1999	8120309499 978-8120309494	914

Tamarin R.H	Principles of Genetics	Tata McGrawHill, 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	**18 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	**9 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, Archaebacterial 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	**18 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, synchronous batch and continuous culture, 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	**9 hrs**
Sterilisation and disinfection- Definitions, Principles. Methods of sterilization- Physical methods (Heat, Filteration), 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 = 30 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)
6. Demonstration of simple staining of a purified bacterial culture.
7. Demonstration of gram staining and acid-fast staining of a purified bacterial culture.
8. Demonstration of preservation of a bacterial strain.

Course Learning Outcomes:

- Understand the microbial diversity and contributions made by prominent scientists in microbiology.
- 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.

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., Harlow, Addition-Wesley.	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

STA104-Statistics for Biosciences

L	T	P	Total credits
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, BernoulBinomial, 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 ofcentral tendency
- Students will be able to apply the concept of dispersion, skewness, correlation, and regressionof 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 differentdistributions

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	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**
Environmental Pollution: types, Cause, effects and controls –Air, water, soil, chemical andnoise 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**
Environmental Policies and practices: 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 conventionon 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 environmentalconservation. Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).	
Unit IV: Field Work	**9 hrs**
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	9781260219715	664
William P. Cunningham, Mary Ann Cunningham, Barbara Woodworth Saigo	Environmental Science: A global concern	McGraw-Hill	2021	9781260363821	1280

ENG103-Communication Skills—II

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

Course Contents/syllabus:

	Teaching Hrs (H)
Unit I: Basic Concepts in Communication	4.5 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	4.5 H
Nonverbal communication: detailed analysis, KOPPACT (Kinesics, Oculesics, Proxemics, Paralanguage, Artefacts, Chronemics, Tactilics).	
Unit III: Communication and Technology	4.5 H
Importance of digital literacy and communication on digital platforms.	
Unit IV: Presentation Skills	4.5 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 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

PSY106-INDIVIDUAL, SOCIETY AND NATION

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

Course Contents/syllabus:

	No. of Session
Unit-1- Individual differences & Personality	**4.5 H**
Personality: Definition& Relevance Importance of nature & nurture in PersonalityDevelopment Importance and Recognition of Individual differences inPersonality Accepting and Managing Individual differences Intuition, Judgment, Perception & Sensation (MBTI)BIG5 Factors	
Unit-2- Managing Diversity	**4.5 H**
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	**4.5 H**
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	**4.5 H**
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 mange individual differences
- To develop patriotic feelings
- To recognized 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	2015	9781711493978	458
Daksh Tyagi	"A Nation of Idiots"	Every Protest	2019	978-8194275015	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	**4.5 hrs**
Descriptors/Topics, talk about your family members, Usage of possessive adjectives, Describe your house/apartment, Prepositions of location Negation	
Unit II: Lifestyle	**4.5 hrs**
Descriptors/Topics, 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	**4.5 hrs**
Descriptors/Topics, filling up a simple form, Ask for personal information, Usage of interrogative adjectives Give directions about a place, Ordinal numbers, Usage of demonstrative adjectives	
Unit IV: Weekend	**4.6 hrs**
Descriptors/Topics, 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 wayon 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/year	ISBN No	Pages
Christine Andant, Catherine Metton, Annabelle Nachon, Fabienne Nugue	A Propos - A1, Livre de l'élève et Cahier d'exercices.	Langers International Pvt. Ltd.	2010	978-9380809069	---
Collins Dictionaries	Easy Learning French Complete Grammar, Verbs and Vocabulary	Collins	2016	978-0008141721	---
Nikita Desai, Samapita Dey Sarkar	Apprenons La Grammaire Ensemble - French	Langers International Pvt. Ltd.	2017	978-8193002681	---

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	**1.5 hrs**
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)	**4.5 hrs**
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)	**1.5 hrs**
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) Family and Relationship	**4.5 hrs**
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

INL104: Punjabi Language and Literature

L	T	P	Total Credits
1	0	0	1

Course content and syllabus

	Weightage (%)	Teaching Hours
Unit I:	**25%**	**4 hrs**
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 hrs**
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 hrs**
ਵਿਆਕਰਨ ਸਿਧਾਂਤ ਅਤੇ ਵਿਹਾਰ **2. 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 **3. ਪੰਜਾਬੀ ਵਾਕ ਬੋਧ** ਵਾਕ ਪ੍ਰੀਭਾਸ਼ਾ,ਵਾਕ ਦੇ ਤੱਤ, ਪੰਜਾਬੀ ਵਾਕ ਤਰਤੀਬ ਵਾਕ ਵਰਗੀਕਰਨ:ਕਾਰਜ ਦੇ ਅਧਾਰ ਤੇ ਵਾਕਾਂ ਦੀਆਂ ਕਿਸਮਾਂ, ਬਣਤਰ ਦੇ ਅਧਾਰ ਤੇ ਵਾਕਾਂ ਦੀਆਂ ਕਿਸਮਾਂ		
Unit IV:	**25%**	**5 hrs**
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 / Reference Books:

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 ਸ੍ਰੋਤ ਅਤੇ ਸਰੂਪ**	, ਵਾਰਿਸ ਸ਼ਾਹ ਫ਼ਾਊਂਡੇਸ਼ਨ, ਅੰਮ੍ਰਿਤਸਰ	**2012**	-	-
ਦੁਨੀ ਚੰਦ੍	**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	**ਪੰਜਾਬੀ ਭਾਸ਼ਾ**	ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਅਕਾਦਮੀ	**2010**	--	-

ਸੰਘਾ	**ਵਿਗਿਆਨ**	ਜਲੰਧਰ			
ਅਗਨੀਹੋਤਰੀ,ਵੇਦ	ਪਰਿਚਾਇਕ ਭਾਸ਼ਾ ਵਿਗਿਆਨ	ਦੀਪਕ ਪਬਲਿਸ਼ਰਜ਼ ਜਲੰਧਰ	**1981**	-	-

INL106: History and Culture of Punjab

Course Contents/syllabus:

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

	Teaching hours
Unit I:	**4.5 hrs**
Introduction of Colonial Rule in Punjab: Annexation of Punjab; Board of Administration. Western Education: Growth of Education and rise of middle classes. Agrarian Development: Commercialization of agriculture; canalization and colonization.	
Unit II:	**4.5 hrs**
Early Socio Religious Reform: Christian Missionaries; Namdharis; Nirankaris. Socio Religious Reform Movements: activities of Arya Samaj; Singh sabhas; Ahmadiyas; Ad Dharam Movement Development of Press & literature: growth of print technology; development in literature	
Unit III:	**4.5 hrs**
Emergence of Political Consciousness: Gadar Movement; Jallianwala Bagh Massacre, Gurudwara Reform Movement; major Morchas; Activities of Babbar Akalis. Struggle for Freedom: Non-Cooperation Movement; HSRA and Bhagat Singh; Civil Disobedience Movement; Quit India Movement.	
Unit IV:	**4.5 hrs**
Partition and its Aftermath: resettlement; rehabilitation Post-Independence Punjab: Linguistic Reorganization; Green Revolution.	

Course Learning Outcomes:

- Understand the history of Punjab region in modern times.
- Interpret the importance early socio religious reform, movements, developments.
- Examine the contribution of major reform movements: Gadar, Babbar Akalis and Gurdwara reform morchas.
- Examine the impact of Partition of Punjab and major changes in Punjab after independence.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages

Singh, Kirpal	**History and Culture of the Punjab, Part II (Medieval Period**)	Publication Bureau, Punjabi University, Patiala	1990(3rd ed.).	---	---
Singh, Fauja(ed.)	**History of the Punjab, Vol.III**	Punjabi University, Patiala	1972	---	---
Grewal, J.S.	**The Sikhs of the Punjab**, the New Cambridge History of India	Orient Longman	1990	---	---
Singh, Khushwant	: **A History of the Sikhs, vol I: 1469-1839**	oxford University Press, Delhi	1991	---	---
Chopra, P.N., Puri, B.N**.**	**A Social, Cultural and Economic History of India**, Vol.II, And Das	M.N. Macmillan , Delhi	1974	---	---

Programme structure for Integrated B.Sc. + M.Sc. (H) Biotechnology- 5 years (3rd Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	PS	FW	SW	
1	BTY201	Biotechniques	Core Course	4	0	2	0	0	6
2	BCH201	Enzymology	Core Course	4	0	2	0	0	6
3	HGM201	Genetics and Inheritance Biology	Core Course	4	0	2	0	0	6
4	BTY202	Protein Science	Allied Course	4	0	0	0	0	4
5	CAS211	Programming with C	Skill Enhancement Course	1	0	1	0	0	2
		Total Credits							**24**

BTY201-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 $K_2Cr_2O_7$
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	6th edition/2010	1118886143	832
Wilson K., Walker J.	Principle and Techniques of Biochemistry and Molecular Biology	Cambridge University Press	6th edition/2006	0521178746	744
Rana, SVS	Biotechniques: Theory and Practice	Rastogi Publications	2018	8171338860	388
Plummer, David	An Introduction to Practical Biochemistry	Tata Mc Graw Hills	3rd edition/2017	0070941629	376

BCH201-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 transcarbomoylase), 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/year	ISBN No	Pages
David L Nelson; and Michael M. Cox, W.H. Freeman	Lehninger: Principles of Biochemistry	WH Freeman	2012	978-1319381493	1328
Nicholas C.P. and Lewis S.	Fundamentals of Enzymology	Oxford University Press	1999	019850229X	1032
Voet, D., Voet, J.G.	Biochemistry	Wiley	2018	119451663	1200

HGM201-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, genomicimprinting and uniparentaldisomy, spontaneous mutations, mosaicism and chimerism, male lethality, X-inactivation, Risk assessment; application of Bayes' theorem, Allelefrequency 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 andrecurrence 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 artificialchromosome. 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 Hours = 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	6th/2008	978-0471291312	480
Snustad DP, Simmons MJ	Principles of Genetics	John Wiley and Sons Inc.	6th/2011	978-0470388259 0470388250	
Griffith AJF, Wessler SR,	Introduction to Genetic Analysis	W. H. Freeman and Co., New York	2007	978-0716768876 0716768879	800
Lewontin RC, Carroll SB					
Strickberger, M.W	Genetics	Prentice-Hall India Pvt. Ltd., New Delhi	1999	8120309499 978-8120309494	864

Tamarin R.H	Principles of Genetics	Tata McGrawHill, New York	2012	0072325305	656
Freshney, R.I.	Animal Cell Culture: A Practical Approach	IRL Press, Oxford, 2nd ed.	2nd/1992	9781119513018	832
Rooney, D.E. and Czepulkowski, B.H.	Human Cytogenetics: A Practical Approach	IRL Press Ltd., Oxford.	1986	0947946713 978-0947946715	260
Sumner, A.T	Chromosomes: Organization and Function	Blackwell Publishing Co., Oxford.	2003	0632054077	287

BTY202-Protein Science

L	T	P	Total Credits
4	0	0	0

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 AccessoryProteins, 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	**18 hrs**
Protein primary sequence analysis, DNA sequence analysis, pair wise sequence alignment, FASTA algorithm, BLAST, multiple sequence alignment, DATA base searching using BLAST andFASTA. Phylogenetic tree analysis	
Unit IV: Analysis of protein-protein interactions-	**18 hrs**
Pull-down assay, Yeast two hybrid assay, Coimmunoprecipitation assay, Fluorescenceresonance energy transfer (FRET). DNA- protein interactions, footprinting assay, EMSA.	

Course Learning Outcomes:

- Understand basic concepts of protein structure.
- Describe and understand the thermodynamic stability of proteins. Be able to apply this knowledge to interpret experimental data and calculate thermodynamic parameters for proteins with differentmechanisms of folding.
- Describe the energy landscape of protein folding and misfolding from a thermodynamic point of view.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Donald Voet, Judith G. Voet	Biochemistry, 4th Edition	John Wiley& Sons	2015	ISBN: 978-0-470-57095-1	1520

David L. Nelson and Michael M. Cox	Lehninger Principles of biochemistry, 8th Edition	Macmillan	2021	ISBN:9781319322328	1120

CAS211-Programming with C

L	T	P/S	SW/ FW	No. of PSDA	TOTAL CREDIT UNITS
1	0	1	0	0	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
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, breakand 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 beingtaught in the theory paper specifically related to procedural programming, strings, structures and

unions.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.

1. Write a Program to convert temperature. (Fahrenheit –Centigrade and vice-versa)
2. Write a program for computing the volume of sphere, cone and cylinder assume that dimensions areinteger's use type casting where ever necessary.
3. Write a Program to read marks of a student in six subjects and print whether pass or fail (using if-else).
4. Write a Program to calculate roots of quadratic equation (using if-else).
5. Write a Program to calculate electricity bill. Read starting and ending meter reading. The charges areas 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.

6. Write a program to calculate sum of individual digits of a given number.
7. Write a program to check whether given number is palindrome or not.
8. Write a program to check whether a given number is a Fibonacci number or not.
9. Write a program to read 2 numbers x and n then compute the sum of the Geometric Progression.1+x+ x2+x3+ +xn
10. Write a program to print the following formats.

```
1                    *
1 2                  * * *
1 2 3                * * * * *
1 2 3 4              * * * * * * *
```

11. Write a program to perform matrix addition, matrix subtraction and transpose pf a matrix.
12. Write a program to verify the given string is palindrome or not (without built-in functions, with usingbuilt-in functions).
13. Write a program to swap two numbers using a) Call By Value B) Call By Reference.
14. 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	Year of publication	ISBN
Jeri R. Hanly, Elliot B. Koffman	Problem Solving and Program Design in C	Pearson	2015	978-0134014890
Pradip Dey, Manas Ghosh	Programming In C	Oxford University Press	2018	978-0199491476

E Balagurusamy	Programming in ANSIC	McGraw Hill Education	2019	978-9351343202
Yashwant Kanetkar	Let Us C	BPB Publications	2020	978-9389845686

Programme structure for Integrated B.Sc. + M.Sc. (H) Biotechnology- 5 years (4th Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	PS	FW	SW	
1	IMM202	Immunology	Core Course	4	0	2	0	0	6
2	BTY206	Bioprocess Technology	Core Course	4	0	2	0	0	6
3	MBO203	Microbial Physiology and Metabolism	Core Course	4	0	2	0	0	6
4	BTY207	Recombinant DNA Technology	Allied Course	3	0	1	0	0	4
5	PHY213	Fundamentals of Physics	Skill Enhancement Course	2	0	0	0	0	2
		Total Credits							**24**

IMM202-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	**18 hrs**
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	**18 hrs**
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	**18 hrs**
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 (Live but attenuated, Killed, Subunit, Recombinant, DNA and Peptide)	
Unit IV: Immunological Techniques	**18 hrs**
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	

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, antibodyengineering, 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 (8th Edition)	WH Freeman and Company, USA	2012	1319114709	944
D. Male, J. Brostoff, D. Roth, I. Roitt	Immunology (8th Edition)	Saunders, Elsevier, USA	2012	9780702045486	482

BTY206-Bioprocess Technology

L	T	P	Total Credits
4	0	2	6

Course content and syllabus

	Teaching Hours
Unit I: Introduction to Bioprocess Technology and Media Design for Fermentation	**18 hrs**
Bioprocess vs chemical processing, advantages, disadvantages, Substrates for bioconversion process, Isolation, Preservation Techniques and Maintenance methods of Industrial Microorganisms, Cell culture technique, Media composition and design, Media type, Commercial media, Inoculum development and aseptic transfers, Criteria for inoculums transfer, (media formulation RSM, CCD,)	
Unit II: Process Technology for Production of Primary Metabolites	**18 hrs**
Ethanol: production by batch and continuous process by various technologies. Determination of fermentation efficiency, distillation efficiency and overall efficiency of ethanol production, recovery, uses, glucose effect etc. Power alcohol – definition, uses, merits and demerits of various technologies for its production. Amino Acid: Lysine: Indirect and direct fermentation Biomass: Bakers and distillers yeast production using various raw materials, “bios” factorsfor growth, Crabtree effect, harvesting, different forms and uses.	
Unit III: Process Technology for Production of Secondary Metabolites	**18 hrs**
Production of secondary metabolites – penicillin, streptomycin, Penicillin: Classification, various penicillin as precursor and ‘R’ – side chain, penicillinase,6-APA, penicillin production, harvest and recovery, uses of various forms etc. Streptomycin: chemical structure, production, harvest and recovery, use by-product of streptomycin fermentation etc.	
Unit IV: Microbial production of industrial enzymes	**18 hrs**
Glucose isomerase, Amylase, Lipase, Protease	

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

- Isolation of industrially important bacteria for microbial processes.
- Estimation of Reducing sugar by DNS method of unknown sample and establish calibration curve.
- Estimation of ethanol by potassium dichromate methods and establish calibration curve.
- Establish growth profile of bacteria with respect of optical density and maximum specific growthrate of bacteria
- Determination of Thermal Death Point and Thermal death time of bacteria for design of asterilizer.
- Cultivation of microorganism in batch process
- Ethanol production using grape juice
- Demonstration of bioreactor

Course Learning Outcomes:

- Design and formulation of production media for fermentation,
- Upstream and downstream techniques of primary and secondary product
- Production technology of biomass, primary and secondary metabolites

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
M.L. Shuler and Fikret. Kargi, 2nd edition,	Bioprocess Engineering Basi cConcepts,	Pearson Education Limited.	2013	9780136060659	957
W. Crueger and A. Crueger,	Biotechnology: A Textbook of Industrial Microbiology,	Sinauer Associates.	1990	0878931317	541

MBO203-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**
Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve **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. Passive and facilitated diffusion Primary and secondary active transport, concept of uniport,symport and antiport	
Unit II: Chemoheterotrophic Metabolism	**18 hrs**
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. **Anaerobic respiration and fermentation:** Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate /nitrite and nitrate/ammonia respiration; fermentative nitrate reduction) Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways.	
Unit III: Chemolithotrophic and Phototrophic Metabolism	**18 hrs**
Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (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. Demonstrationof 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.	14th Ed. /2014	9781292018317	1030
Moat AG and Foster JW	Microbial Physiology 4th Edition	John Wiley & Sons	2002	0471394831 978-0471394839	736
Willey JM, Sherwood LM, and Woolverton CJ	Prescott's Microbiology. 9th edition.	McGraw Hill Higher Education.	2013	9780073402406 0073402400	2272
Pelczar Jr MJ, Chan ECS, and Krieg NR.	Microbiology. 5th edition	Tata McGraw Hill.	1993	0070492581, 9780070492585	957

BTY207-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 8 bacteriophage, 8 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 online database 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	3rd Ed	978-0879695767	2344
T.A. Brown	Gene Cloning and DNA Analysis - An introduction	Wiley - Blackwell	2010	9781405181730	338

B

PHY213-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 acousticsrelating human body

Unit I: Interference, diffraction, and polarization	**Teaching hours**
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 MaluBrewster's Law, Circularly and Elliptically Polarized Light, Half and Quarter Wave Plates	**9 hrs**
Unit II: Lasers	**9 hrs**
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	
Unit III: Mechanics and dynamics of a human body	**9 hrs**
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	
Unit IV: Waves and human body	**9 hrs**
Speed and Properties of Sound Waves, Intensity of Sound Waves, Sound propagation from one Medium tAnother, Speech Production, Types of Sounds, Hearing, Other Vibrations of the Body, Cardiac and Other Sources of Sounds	

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 , ISSN 1618-721	2006	978-3540817062
W. HughesB	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

Programme structure for Integrated B.Sc. + M.Sc. (H) Biotechnology- 5 years (5th Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	PS	FW	SW	
1	HGM301	Molecular Biology	Core Course	4	0	2	0	0	6
2	HGM302	Developmental Biology	Core Course	4	0	2	0	0	6
3. 4.	 MBO302 MBO303	*Students will choose any two of the given choices** 1. Microbial Genetics 2. Nanomedicine 3. Virology 4. Archaea and Extremophiles 5. MOOC	Specialization Elective Course	 4 4	 0 0	 0 0	 0 0	 0 0	 4 4
5.	 CAS301	*Students will choose any two of the given choices*** 1. Cell Signalling 2.Research Methodology 3. Biowarfare and Bioterrorism 4. Programming in Python Lab 5. MOOC	Skill Enhancement Course	2 2	0 0	0 0	0 0	0 0	2 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 Skill Enhancement Course can also be taken through MOOC.
A maximum of 4 credits per semester can be taken though MOOC.

HGM301-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**
The History and Birth of Molecular Biology. Relationships between genotype and phenotype. Contributions of Nobel Laureates in the area of Molecular Biology, Genes and Genomes: Molecular definition of gene. Organization of genes on chromosomes. Repetitive DNA. Simple sequence DNA. Interspersed-Repeat DNA and mobile DNA elements. Chromosome structure: Bacterial chromatin and specific proteins to condense bacterial DNA. Nucleosomes. Chromatin organization in eukaryotes. Functional Rearrangements in chromosomal DNA. Extra-nuclear genomes, Specific notations, conventions and terminologies used in genetics	
Unit II: DNA Replication, Damage and Repair	**21 hrs**
DNA replication is semi-conservation and bi-directional. DNA replication in bacteria: Initiation, elongation and termination of bacterial DNA replication. Enzymes involved in DNA replication. Eukaryotic DNA replication machinery. Initiation, elongation and termination of replication. Telomeres and Telomerase. Leading strand problem in replication. DNA replication in Archaea DNA damage and repair mechanisms	
Unit III: Transcription	**18 hrs**

RNA Transcription in bacteria and eukaryotes, 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 complex. Inhibitors of RNA metabolism and their mechanism of action; RNA degradation.	
Unit IV: Protein Translation	**18 hrs**
Genetic code: Its deciphering, degeneracy and general features. 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, Translation in Prokaryotes: formation of initiation complex, initiation factors, elongation, elongation factors, and termination. Translation in Eukaryotes: formation of initiation complex, initiation factors, elongation, elongation factors and termination. Translation proof-reading, translation inhibitors. Post-translation modifications of proteins and their effect on their structure and function. Protein targeting: Signal sequence and targeting of proteins to specific cellular locations.	

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 and 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 ofthe Gene	Pearson Education	7th Ed	978-9332585478	912
Tropp, B.E.	Molecular Biology Genes to Proteins	Jones and Bartlett	4th Ed	978-93-80853-49-9	1096

HGM302-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**
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.	
Unit II Early Development	**18 hrs**
Early Embryogenesis: Cleavage: Generating a Multicellular Embryo (a) Overview of Cleavage in Amphibians/Birds/Mammals, Gastrulation and cell movement and types ofmovement, Germ layers. **Body Patterning**: Animal-Vegetal Axis, Rotation of Fertilization and the Dorso-Ventral Axis Organizer in Amphibia, Development of Body plan in *Drosophila*, Maternal genes, Zygotic genes, Segment Identity genes. Segment identity and Hox genes.	
Unit III: Development of Various Organs	**18 hrs**
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 forDigestion and Respiration. **Postembryonic Development:** Metamorphosis: The Hormonal Reactivation of	

Development; Regeneration; Aging and Senescence	
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 ofa message Antisense RNA.	

List of Experiments -with basic instructions (Total Hours = 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	8th/2006	9781605356044	500
L. Wolpert, J. Smith, T. Jessell, P. Lawrence, E. Robertson and E. Meyerowitz	Principles of Development	Oxford Univ Press.	3rd/2006	0199275378 978-0199275373	576

MBO302-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: *E. coli, Saccharomyces, Tetrahymena*. Organelle genome: Chroloroplast 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.	ular Genetics of Bacteria	ASM Press	4th Ed	978-1-55581-892-0	707
Klug WS, Cummings MR, Spencer, C, Palladino, M.	Concepts of Genetics	Pearsons	11th Ed.	978-9353940409	897
Pierce BA	Genetics: A Conceptual Approach	WH Freeman	7th Ed.	978-1319308315	976

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	9814324558	596
C. M. Niemeyer, C. A. Mirkin	Nanobiotechnology; Concepts, Applications and Perspectives	Wiley-VCH	2004	8126538406	457
B. S. Murthy, P. Shankar, B. Raj, B. B. Rath and J. Murday	Textbook of Nanoscience and Nanotechnology	Universities Press-IIM	2012	3642280293	244
T. Pradeep	Nano:The Essentials	Tata McGraw-Hill Publishing Company Ltd.	2007	0070617880	461

MBO303-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 (ϕX174, 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 Poliovirus 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	6th Ed	978-1405171120	536
Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM	Principles of Virology, Molecular biology, Pathogenesis and Control	ASM Press	2nd Ed (2000)	978-1555811273	820
Carter J and Saunders V	Virology: Principles and Applications	Wiley	2nd (2013)	978-1119991427	394

Archaea and Extremophiles

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I: Basics on extremophiles	**18 hrs**
Concept of extremophiles v/s conventional microbial forms & archaea, habitats in universe, eco- niches, communities and community associations, biofilms, microbial community analysis of extreme environments using various molecular approaches (DGGE, cloning and next generation sequencing, functional genomics and transcriptomics).	
Unit II:	**18 hrs**
Occurrence, Physiological features, adaptation strategies of various extremophilic microbes: a) anearobes, barophiles/ peizophiles, cryophiles & thermophiles; b) oligotrophs, osmophiles, halophiles & xerophiles; radiophiles, metallophiles & xenobiotic utilizers; d) alkaliphiles/ basophiles, acidophiles. Potential applications of extremophilic microbes.	
Unit III: Microbes in toxic environments	**18 hrs**
Microbes in toxic environments: acid mine drainage, waste containing cyanides, xenobiotics, pesticides, heavy metals and radio isotopic materials,	
Unit IV: Applications and case studies	**18 hrs**
extremozymes and their applications, field and case studies.	

Course Learning Outcomes:

- Know the types of microbial diversity flourish in extreme environments.
- Understand how organisms cope under extreme living conditions with biochemical and molecular adaptation of extremophiles microorganisms.
- Understand modern techniques used for exploration of unculturable extremophiles
- Understand potential application of extremozymes in various industries and in functional genomics.

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

Author	Title	Publisher	Ed/year	ISBN No	Pages
Brock, T. D.	Thermophilic Microorganisms and Life at High Temperatures	Springer, New York.	1978	1461262860	465
Fred A Rainey and Aharon Oren	Extremophiles	Academic press	2006	0125215363	544

Cell Signalling

L	T	P	Total Credits
2	0	0	2

Course content and syllabus

	Teaching Hours
Unit I: Introduction to Cell Signaling	**9 hrs**
Modes of signaling, signaling molecules, Intracellular and cell surface receptors, Hormone signaling	
Unit II: GPCR & RTK	**9 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	**9 hrs**
Integrins, cadherins, Hedgehog, Notch, Heat shock and ER stress response, Serine/Threonine pathways	
Unit IV: Aberrant signaling	**9 hrs**
Cancer, Notch signaling dependent Diseases, Hedgehog signaling dependent Diseases, Diabetes	

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/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
Rakesh Srivastava	Apoptosis, cell signalling and human diseases	Humana Press	1st	9781588298829	395
Berg J.M., Tymoczko J.L., Stryer L.	Biochemistry	WH Freeman & Company	5th	978-1-4641-2610-9	1023

Research Methodology

L	T	P	Total Credits
2	0	0	2

Course content and syllabus

	Teaching Hours
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 andscaling 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 makeeffective power point presentation	
Unit IV: Literature Survey	**9 hrs**
The students will be required to review literature in their respective disciplines and submit anassignment 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: [mention the name of the books. Can add more rows]

Author	Title	Publisher	Ed/year	ISBN No	Pages
Kothari, C.R	Research Methodology: Methods and	New Age International Publishers	4th Ed.	978-9386649225	480

	Techniques				
Arya., P.P. and Pal, Y	Research Methodology in Management: Theory and Case Studies	Deep and Deep Publishers	2011	978- 8184503715	

Biowarfare and Bioterrorism

L	T	P	Total Credits
2	0	0	2

Course content and syllabus

	Teaching Hours
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/year	ISBN No	Pages
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

CAS301-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 ax2+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

Programme structure for Integrated B.Sc. + M.Sc. (H) Biotechnology- 5 years (6th Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	PS	FW	SW	
1	BCH302	Gene Regulation	Core Course	4	0	2	0	0	6
2		Synthetic Biology	Core Course	4	0	2	0	0	6
3.		*Students will choose any two of the given choices**	Specialization Elective Course						
4.	BTY303	1. Plant Biotechnology		4	0	0	0	0	4
	BIF301	2.Introductory Bioinformatics							
	MBO305	3. Industrial Microbiology		4	0	0	0	0	4
		4. Biopolymers and its Medical Applications							
		5. MOOC							
5.		*Students will choose any two of the given choices***	Skill Enhancement Course						
		1. Biomaterials		2	0	0	0	0	2
		2. Cancer Biology							
		3.BioEntrepreneurship							
		4. 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.

BCH302-Gene Regulation

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 (Galactosemetabolism, 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	**18 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:	**18 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 *hsp70* genes of *Drosophila melanogaster*; Genomic imprinting of *Igf-2* and *H-19* 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 prokaryotesand 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 Kilpatric, S.T.	Lewin's Genes XII	Jones and Bartlett Learning	12th Ed	1284104494	838
Watson JD, Baker TA, Bell SP, Gann A, Levine M, Losick R.	Molecular Biology of the Gene	Pearsons Publishers	7th Ed.	978-9332585478	912
Tropp, B.E.	Molecular Biology Genes to proteins	Jones and Bartlet	4th 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	6th Ed	978-0-8153-4464-3	1342

Synthetic Biology

L	T	P	Total Credits
4	0	2	6

Course content and syllabus

	Teaching Hours
Unit I: Fundamentals of Synthetic Biology	**18 hrs**
Modern techniques of DNA assembly – NEBuilder HiFi DNA Assembly, Gibson Assembly, BioBrick Assembly, Golden Gate Assembly. Synthetic bacterial chromosome, synthetic yeast chromosomes for modular metabolic engineering, Genomic engineering usingtransposable elements in vertebrates	
Unit II: Synthetic Networks	**18 hrs**
Biological parts – Sensor Proteins (switches), Regulatable promoters, Models of gene expression, artificial networks, production of simple networks capable of producing genetic oscillators and toggle switches, consequences of gene expression variability, examples of synthetic networks – Biofuels and green chemicals.	
Unit III: Fundamentals of System Biology	**18 hrs**
Stochastic gene expression in prokaryotes and eukaryotes- extrinsic and intrinsic noise, re-wiring of genetic networks to perform cellular functions, Identification of functional units ("network motifs") within large gene interaction networks, a classic study of variability in bacterial gene expression, a classic study of variability in cultured cells, and quantitative PCR-based methods to count mRNAs in individual cells	
Unit IV: synthetic Proteins	**18 hrs**
Expanding the chemistry of life by cell free protein synthesis and incorporation of nonnatural amino acids, Engineering of membrane proteins that responds to physical stimuli and their applications: Light-gated channels and pumps for optogenetics, Mechanoreceptors, Temperature- and magnetic field-gated channels. Geneticallyencoded nano-sensors, Ratiometric and intensimetric nano-sensors. *In vivo* use of nano-sensors	

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

1. Cloning of a complete gene expression system by HIFI DNA assembly.
2. Online data mining to identify genes which responds to physical and chemical stimuli.
3. Online data mining to identify promoters which responds to physical and chemical stimuli.
4. in-silico design of a protein with new features.

Course Learning Outcomes:

- Understand basic concepts of synthetic biology.
- Learn to construct artificial gene networks and proteins.
- Learn the techniques to re-wire genetic networks.
- To know the areas of applications of synthetic biology.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Edited By: Paul S Freemont (Imperial College, UK) and Richard I Kitney (Imperial College, UK)	Synthetic Biology — A Primer	World scientific	2012	ISBN: 978-1-84816-863-3	196
Uri Alon,	An Introduction to Systems Biology: Design Principles of Biological Circuits	Chapman & Hall/CRC	2006	ISBN-13978-1584886426	342

BTY303-Plant Biotechnology

L	T	P	Total Credits
4	0	0	4

Objective: The students will learn the fundamentals of culturing plant cells and tissues, culture environment, cell proliferation, differentiation, and media formulation. The students will acquire knowledge on various recombinant DNA techniques to produce genetically modified organisms with noveltraits.

Course content and syllabus

	Teaching Hours
Unit I: Introduction to Plant biotechnology	**18 hrs**
Plant tissue culture—its history, development and applications, Plant tissue culture media,Types of cultures, Callus cultures, Cell and suspension cultures, Single cell clones, Protoplast culture and somatic hybridization. Micropropagation: Techniques and various steps involved in micropropagation, Production of disease-free plants, Commercial aspects, and limitations of micropropagation	
Unit II: Production of haploid plants and Embryo culture	**18 hrs**
Production of haploid plants: Androgenesis and Gynogenesis and production of homozygous lines, Significance and uses of haploids. Embryo culture and embryo rescue and its applications in plant improvement.	
Unit III: Secondary metabolite extraction and Germplasm conservation	**18 hrs**
Primary vs secondary metabolites, Production of secondary metabolites and other compounds using plant cell culture, Hairy root culture, Immobilized cell system, Elicitation and Biotransformation. Germplasm conservation: various approaches for Bio conservation, in vitro techniques especially cryopreservation in germ plasm conservation	
Unit IV: Recombinant DNA technology and Molecular farming	**18 hrs**
Recombinant DNA Technology and Manipulation of Phenotypic Traits: Strategies of molecular cloning of plant genes, Gene transfer methods—Vector mediated, Virus mediated and Vector less DNA transfer, rDNA approaches for introducing herbicide tolerance, pest resistance, plant disease resistance, Abiotic & biotic stress tolerance, Improvement of crop yield and quality, Molecular markers and marker assisted selection, Applications of plant transformations/ transgenics, Commercial transgenic crops. Molecular farming: of Alkaloids, Useful enzymes, Therapeutic proteins, custom- made Antibodies, Edible vaccines.	

Course Learning Outcomes:

Students will be able to:

1. Acquire the knowledge about the techniques of Plant Tissue Culture, Lab. organization and measures adopted for aseptic manipulation and nutritional requirements of cultured tissues.
2. Learn the techniques of culturing tissues, single cells, protoplasts & anther culture, germplasm conservation and cryobiology
3. Learn the large-scale clonal propagation of plants through various micropropagation techniques, Production of secondary metabolites under in vitro conditions
4. A good understanding of r-DNA technology, methods of gene transfer, molecular markers and markers assisted selection

5. Develop transgenics resistant to biotic & abiotic stresses & quality characteristics and their role in crop improvement

Text / Reference Books:

Author	**Title**	**Publisher**	**Ed/year**	**ISBN No**	**Pages**
Slater, A., Scott, N.W., and Fowler, M.R.	Plant Biotechnology	Oxford University Press	2nd/2008	0199560870	400
Razdan, M.K.	Introduction to Plant Tissue Culture	Science Publishers	2nd/2003	9788120417939	420
Primrose, S.B. and Twyman, R.M	Principles of Gene Manipulation and Genomics	Blackwell Publishing	7th/2006	8126548398	554
Satyanarayana, U	Yeast Biotechnology: Diversity and Applications	Springer	2009	1402082916	744

BIF301-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 spectrometery. Major features of completed genomes: *E.coli, S.cerevisiae, Arabidopsis,* 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/year	ISBN No	Pages

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

MBO305-Industrial Microbiology

L	T	P	Total Credits
4	**0**	0	**4**

Course content and syllabus

	Teaching Hours
Unit I: Introduction to industrial microbes	**18 hrs**
Microorganisms of industrial importance – yeasts *(Saccharomyces cerevisiae), moulds (Aspergillus niger) bacteria (E.coli), actinomycetes (Streptomyces griseus)*. Industrially important Primary and secondary microbial metabolites. Screening techniques. Techniques involved in selection of industrially important metabolites from microbes.	
Unit II: Industrial fermentation methods	**18 hrs**
Theory and principles of industrial fermentation, Batch, fed-batch and continuous cultures, Microbial growth and product formation kinetics, media formulation and sterilization, isolation, preservation and improvement of industrially important micro-organisms, inoculum development for industrial fermentations, fermenter design, various types of fermenters used in industrial fermentation. Surface, submerged and solid-state fermentation processes. Basic principal of microbial fuel cells and its application .	
Unit III: Industrial applications	**18 hrs**
Microorganisms involved in Pharma and therapeutic enzymes. Enzymes used in detergents, textiles and leather industries. Production of amylases and Proteases. Production of therapeutic enzymes. Role of microorganisms in bioleaching and textile industry.	
Unit IV: case studies	**18 hrs**
Industrial microorganisms: cell growth, microbial growth kinetics, factors affecting growth, basic nutrition, principles of production media, components of media, chemical composition of media. Microbial production of Industrial products: Citric acid, Ethanol, Penicillin, Glutamic acid, and vitamin B12.	

Course Learning Outcomes:

- Learning of different fermentation techniques, bioreactor design, inoculum development for industrial fermentations, Microbial growth and product formation kinetics, media formulation and sterilization, isolation, preservation and improvement of industrially important micro-organisms.
- Understanding of industrial production and purification of organic acids, alcohols, wine and vinegar with help of different microbes.
- Understanding of industrial production and purification of antibiotics, enzymes, amino acids and steroids.
- Understanding of different pathways followed in or by the microbes involved in production of these bio-chemicals. Method of manipulating these pathways to get desired yield.
- Understanding of application of these bio-molecules in benefit of mankind

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Pelczar, M.J. Jr., Chan ECSand Krieg, N.R.	Microbiology: Conceptsand Applications	New Y ork; Madrid : McGraw-Hill,	1993	0070492581 , 9780070492 585	957
Cappucino, J.G.	Microbiology-A laboratory manual, 4th ed., Harlow, Addition-Wesley.	Hoboken, N.J.: Pearson	2020	0135188997 , 9780135203 996, 01352039	541

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, Nano-polymers 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 Bio composites, Biopolymers as wound healing materials, Biopolymers as biofilters and bio-barriers. 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	3rd	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
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.	

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 biological response.
- 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	0125824610	484
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, 3rd edition	Springer press	2007	0123746264	1573

Cancer Biology

L	T	P	Total Credits
2	0	0	2

Course content and syllabus

	Teaching Hours
Unit I: Introduction to Cancer	**9 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 ofcancer, cancer stem cells	
Unit II: Molecular basis of Carcinogenesis	**9 hrs**
Mutagens, carcinogens, Tumor viruses, Proto-oncogenes, cellular and viral Oncogenes and tumor suppressor genes and their mechanism of action, Genetic abnormalities incancer, Angiogenesis, invasion and metastasis.	
Unit III: Role of cell cycle and apoptosis and autophagy	**9 hrs**
Cell cycle regulation and cell death, Cellular senescence, telomeres and immortalization,Autophagy in Cancer.	
Unit IV: Cancer Epigenetics & Metabolism	**9 hrs**
Role of DNA methylation, histone modifications and non-coding RNAs in cancer development, Cancer metabolism.	

Course Learning Outcomes:

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

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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 thecell	Garland Science;	6th	978-0815344322	1342
Rakesh Srivastava	Apoptosis,cell signalling and human diseases	Humana Press	1st	9781588298829	395
Berg J.M., Tymoczko J.L., Stryer L.	Biochemistry	WH Freeman & Company	5th	13: 978-1-4641-2610-9	1023

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 (20th 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 (11th Edition)	McGraw Hill	2020	978-9390113309	696
Donald F. Kuratko and Jeffrey S. Hornsby	New Venture Management: The Entrepreneur's Roadmap for Development, Management,	Routledge	2020	978-0367466725	356

	and Growth (3rd Edition)				
Bruce R. Barringer and R. Duane Ireland	Entrepreneurship: Successfully Launching New Ventures (6th Edition)	Pearson	2019	978-1-292-25533-0	617
Norman M. Scarborough and Jeffrey R. Cornwall	Essentials of Entrepreneurship and Small Business Management (9th Edition)	Pearson	2019	978-1-292-26602-2	827
Mary Jane Byrd and Leon Megginson	Small Business Management: An Entrepreneur's Guidebook (8th 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 (10th Edition)	McGraw-Hill Education	2016	978-0-07-786248-8	484
David H. Holt	Entrepreneurship: New Venture Creation	Pearson	2016	978-9332568730	584
Peter F. Drucker	Innovation and Entrepreneurship	Harper Business	2006	978-0060851132	288
Robert J. Calvin	Entrepreneurial Management	McGraw-Hill	2005	9780071450928	295
Steve Mariotti	Entrepreneurship and Small Business	Pearson publishers	2014	978-0133767186	

	Management				

Programme structure for Integrated B.Sc. + M.Sc. (H) Biotechnology- 5 years (7th Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	PS	FW	SW	
1		Genome Engineering	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.	BTY302	*Students will choose any one of the given choices** 1. IPR, Biosafety & Bioethics 2. Antimicrobial Resistance 3. Animal Biotechnology 4. Principles of Pathology 5. 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.

Genome Engineering

L	T	P	Total Credits
3	0	1	4

Course content and syllabus

	Teaching Hours
Unit I: GENOME BIOLOGY	**9 hrs**
Genomes, Studying DNA Mapping in Genomes, Sequencing Genomes, Genome Annotation, Identifying Gene Functions, genome anatomies, Eukaryotic Nuclear Genomes, Genomes of Prokaryotes and Eukaryotic Organelles, Virus Genomes and Mobile Genetic Elements	
Unit II: GENOME EXPRESSION	**18 hrs**
Accessing the Genome, The Role of DNA-Protein Interactions in Genome Expression, Transcriptomes, Proteomes, Genome Expression in the Context of Cell and Organism. Genome Replication, Mutations and DNA Repair, Recombination and Transposition, How Genomes Evolve	
Unit III: GENOME ASSAYS AND FUNCTIONAL GENOMICS	**18 hrs**
Genome-Wide Association Studies (GWAS) – SNP genotyping, Next Generation sequencing, Genome-wide analysis of DNA methylation patterns, ChIP-sequencing, Epigenomics, High throughput Reporter Gene assays, cDNA libraries and RNA-seq, high throughput Yeast two hybrid assays, MS based proteomic studies, System biology – integrating all the information to solve the puzzles of life.	
Unit IV: ADVANCED TECHNIQUES	**9 hrs**
Chemical mutagenesis, The CRISPR-Cas9 (clustered regularly interspaced short palindromic repeats) system, Database resources of the National Center for Biotechnology Information, Building Synthetic Genomes – bacteria and yeast, International 1000 Human Genome Sequencing Consortium.	

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

1. Whole genome isolation from prokaryotic and eukaryotic cells.
2. DNA amplification, purification for sequencing.
3. Analysis of DNA, RNA and protein sequences for coding regions, introns and restriction enzymes.
4. Identifying SNPs by gene sequencing
5. Bioinformatic analysis of genome sequence databases on PubMed.
6. Performing Blast to identify unknown genes and assign functions.

Course Learning Outcomes:

- Understand basic concepts of Genome.
- Learn the components of genome expression.
- Learn the techniques to study whole genomes.
- A thorough understanding of genome engineering procedures.

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	1989	0879695765	2344
T.A. Brown	Genomes 4	Wiley - Blackwell	2010	9781405181730	338

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	**9 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	**18 hrs**
Characterization of cultured cells: cell morphology, chromosome content, enzyme activity, immunostaining; Cell separation based on cell type and cell density, antibody-based techniques (immune-panning, magnetic sorting); Scaling up- techniques for cells in suspension and in monolayer	
Unit III: Animal Transgenesis	**18 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	**9 hrs**
Molecular pharming, Diagnostics, Drug screening, Gene therapy, Animal cloning, stem cell isolation and banking, Xenotransplantation, GMP; Regulatory and ethical issues in Animal biotechnology	

Course Learning Outcomes:

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

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

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

- Laboratory design and GMP practices in animal cell culture laboratory
- Preparation and sterilization of cell culture media
- 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 MTT
· Scratch assay

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
R. Ian Freshney.	Culture of Animal Cells: A Manual of Basic Technique & Specialized Applications	John Willey & Sons Inc, USA,	2016, 7th ED	9781118873656	736
Jeremy M. Berg, Lubert Stryer, John L Tymoczko, and Gregory J. Gatto,	Biochemistry	W.H. Freeman Company	2015	1319114652	1208
M Butler	Animal Cell Culture and Technology (THE BASICS)	Taylor & Francis	2003	9781859960493	256

Research Paper Presentation

L	T	P	Total Credits
2	0	0	2

Course content and syllabus:
The students will present a recent research paper published in an international peer-reviewed journal ofrepute.

IPR, Biosafety and Bioethics

L	T	P	Total Credits
4	0	0	4

	Teaching Hours
Unit I: Introduction to IPR and Patent Database	**18 hrs**
Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, TraditionalKnowledge, Geographical Indications. **Protection of New GMOs:** International framework for the protection of IP. IPs of relevanceto 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**

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; **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; **Risk Assessment:** Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol. **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 managementof crop genetic resources; Strategies on PVFR and Biodiversity Acts. **Biodiversity Legislation in India;** Indian Biodiversity Act and provisions on crop	
Unit IV: Bioethics, Ethics and the law issues	**18 hrs**
Bioethics: Concepts; Philosophical considerations; Epistemology of Science; Ethical Terms; Principles & Theories; Relevance to Biotechnology; **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; Improving public understanding of biotechnology products to correct misconceptions.	

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
4	0	0	0

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 ofthe 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 itsimpact 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 antibioticsin 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 topredict 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.	

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 treatinfections 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
Gillbert, D.N., Chambers, H.F., Saag, M.S., Pavia, A.T., and Boucher, H.W.	The Sanford Guide to Antimicrobial Therapy 2021	Antimicrobial Therapy	2021	978-1944272166	308

BTY302-Animal Biotechnology

L	T	P	Total Credits
4	**0**	0	4

Objective: The objective of this course is to enable students to develop basic skills for vertebrate cell culture, maintenance of cell lines and in vitro application of cell and molecular techniques and also to understand the principles of animal cloning and its applications.

Course content and syllabus

	Teaching Hours
Unit I: Introduction to Animal Tissue Culture	**18 hrs**
Background to animal tissue culture, Advantages, Limitations, Application, Culture environment, Cell adhesion, Cell proliferation, Differentiation. Layout of animal tissue culture laboratory. Media: Role of Physicochemical properties, Introduction to the balanced salt solutions and simple growth medium, Complete Media, Role of serum and supplements. Serum free media, Advantages, disadvantages, and their applications	
Unit II: Primary Culture and Culture of Specific Cell Types	**18 hrs**
Isolation of tissue, Steps involved in primary cell culture, Subculture and propagation, Cell lines, Nomenclature, Cell line designations, Routine maintenance, Immortalization of cell lines, Cell transformation. Cell cloning and Cell separation, Cell synchronization. Epithelial, Mesenchymal, Tumor cell culture. Measurement of viability and cytotoxicity	
Unit III: Characterization, Contamination and Cryopreservation of Cell Line	**18 hrs**
Morphology, Chromosome Analysis, DNA Content, RNA and Protein, Enzyme Activity, Antigenic Markers, Tumorigenicity, Cell counting, Plating Efficiency, Labeling Index, Generation Time, Source of contamination, Type of microbial contamination, Monitoring, Eradication of contamination, Cell banks, Transporting cells	
Unit IV: Gene Transfer Technology and Animal Cloning	**18 hrs**
Gene transfer techniques in mammalian cells, Viral and non-viral methods, Production of transgenic animals, ES and microinjection, retroviral method and molecular pharming, applications of transgenic animal technology. Animal cloning: Animal cloning basic concept, Techniques, relevance and ethical issues, embryo transfer, SCNT, embryo-spliting, embryo sexing, embryos, in situ and ex situ preservation of germplasm, in utero testing of foetus for genetic defects, pregnancy diagnostic kits, anti-fertility animal vaccines, gene knock out technology and animal models for human genetic disorders. Different methods for characterization of animal genomes, SNP, STR, QTL, RFLP, RAPD	

Course Learning Outcomes:

Students will be able to

1. explain the fundamental scientific principles that underlie cell culture
2. acquire knowledge for isolation, maintenance, and growth of cells.
3. develop proficiency in establishing and maintaining of cell lines.

4. acquire knowledge in animal cloning and its applications

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
R. Ian Freshney	Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications	Wiley-Blackwell	7th/2015	978-1118873656	736
Ranga, M.M	Animal Biotechnology	Agrobios	2nd/2007	8177543091	210
Masters, J.R.W	Animal Cell Culture	Oxford	3rd/2000	0199637962	344
Marshak L	Stem Cell Biology	Cold Spring Harbor Publication	2001	0879695757	550

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**
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. 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	
Unit II Inflammation and tissue repair	**18 hrs**
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, Granulomatus Inflammation. Role of Tissue repair, Healing and Fibrosis: Basic mechanism of tissue regeneration, and repair by healing, scar formation and fibrosis. Hemodynamic Disorders in diseases: An overview of Edema, hyperemia, congestion, hemorrhage, hemostasis and thrombosis, Embolism, Infarction and shock with suitable examples	
Unit III: Pathology of Cancer	**18 hrs**
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 genesand cancer stem cells.	

Unit IV: Molecular Pathology	18 hrs
Molecular Pathology: Rules for nomenclature of mutations & databases of mutations, Lossof function mutations, Gain of function mutations, Molecular pathology from gene to disease, Molecular pathology from disease to gene, Molecular pathology of chromosomaldisorders.	

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	6th/2009	978-8184484496	1694
Kumar V, Abbas, A.K., and Aster, J.C.	obbins Basic Pathology	Saunders Elsevier.	8th/2007	978-1437717815	928

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.

Programme structure for Integrated B.Sc. + M.Sc. (H) Biotechnology- 5 years (8th Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	PS	FW	SW	
1		Diagnostic Techniques	Core Course	2	0	0	0	0	2
2.		Food and Dairy Biotechnology	Core Course	2	0	0	0	0	2
3.		*Students will choose any one from the given choices* 1. Environmental and Marine Biology Fermentation Technology	Specialization Elective Course	4	0	0	0	0	4
4.	HGM601	*Students will choose any one of the given choices** 1. Stem Cell Biology and Regenerative Medicine 2. Biofertilizers and Biopesticides 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 Semsters 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.

Diagnostic Techniques

L	T	P	Total Credits
2	0	0	2

Course content and syllabus

	Teaching Hours
Unit I: Microscopic examination and culture methods.	**9 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	**9 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	**9 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 cytodiagnostic techniques	**9 hrs**
Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology, Cytodiagnostic techniques: - Flowcytometry and cell sorting, Immuno florescence, Electron Microscopy (Types of Electron Microscopy, concepts and operations with applications).	

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 Ed. 2006	1555818714	1240
Tille P.	Bailey's and Scott's Diagnostic Microbiology. 13th edition	Mosby.	2013	0323354823	1136
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)	1555813712	2476
Collee JG, Fraser, AG, Marmion, BP, Simmons A	Mackie and Mccartney Practical Medical Microbiology, 14th edition	Elsevier	(2007)	813120393X	992
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.	(2013)	0071790314	880

Food and Dairy Biotechnology

L	T	P	Total Credits
2	0	0	2

Course content and syllabus

	Teaching Hours
Unit I: Basic principles and methods of food processing and preservation.	**9 hrs**
Emerging Technologies in food processing. Food additives and preservatives. Food laws and standards. Effect of processing on acceptability and nutritive value of food.	
Unit II: Physico-chemical properties and structure of milk and milk constituents.	**9 hrs**
Chemical and microbial spoilage of milk and milk products; Fluid milk Processing, packaging,and distribution. Common dairy processes – cream separation (standardization), pasteurization, sterilizationand Homogenization.	
Unit III: process technology for various milk products	**9 hrs**
Process technology for manufacture of evaporated milk, condensed milk, dried milk, malted milk, infant and baby foods, ice-cream, cheese, butter, fermented milk and indigenous dairy products. Fermentation of foods	
Unit IV: Laws and standards for milk and milk products.	**9 hrs**
Laws and standards for milk and milk products. Technological processes for industrially manufactured foods of commercial importance, from plant and animal origin. Gas packaging and modified atmosphere Package design. Shelf-life prediction of foods in packages. Quality control in Food packaging. Product safety and packaging regulations. Government schemes and incentives for promotion of entrepreneurship. Government policy on Small and Medium Enterprises (SMEs) / SSIs. Export and Import Policies relevant to horticulture sector. Venture capital. Contract farming and joint ventures, public-private partnerships. Overview of Horti inputs industry. Characteristics of Indian horticultural processing and export industry. Social Responsibility of Business.	

Course Learning Outcomes:

Impart knowledge and technical proficiency in:

Clean milk production and handling

Processing of milk

- Manufacture of western and indigenous dairy products
- Testing and quality control of milk and milk products

Marketing and economical aspects

- Managing small and medium enterprises

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., Harlow, Addition-Wesley.	Hoboken, N.J.: Pearson	2020	0135188997, 9780135203996, 0135203996	541

Environmental and Marine Biology

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I: Fundamentals of Environmental Sciences	**18 hrs**
A comprehensive introduction to the field of environmental and marine sciences, including an overview of evolution, habitation, and interactions within a diverse set of ecosystems. The diversity of marine organisms, their interactions, and their environments. A biological approach to the various environmental problems created by man's industrialization and expanding population, study of ecosystems, resources, environmental threats, alternatives, and recommendations. A study of the collection, interpretation, and presentation of ecological data. Emphasis on quantitative techniques for analyzing the structure and function of populations and communities.	
Unit II: Aquatic Ecology	**18 hrs**
Principles and processes of physical, chemical, geological, and biological oceanography. A study of the structure and function of freshwater, estuarine, and marine ecosystems including population and community dynamics of aquatic biota, trophic ecology, and physical and chemical characteristics in the aquatic environment.	
Unit III: Biology of Polluted Waters	**18 hrs**
An integrated study of microbial relationships to ecology, pollution, public health, and industry. Effects of anthropogenic and natural chemicals on aquatic organisms at various levels of organizations, from subcellular through individual organisms to communities and ecosystems.	
Unit IV: Marine Conservation and Management	**18 hrs**
Comprehension, evaluation, and synthesis of marine conservation and management plans. Socio-economic factors, by-catch, and habitat impacts. Case histories illustrating population assessment for conservation and management of marine species. A comprehensive study of the field of bioremediation and bio-restoration of contaminated environments. Application of bioremediation technologies in environmental restoration.	

Course Learning Outcomes:

- Understand basic concepts of environmental sciences.
- Learn marine ecology.
- Learn the biology of polluted waters.
- Learn the techniques to combat marine pollution.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages

Odum and Barrett.	Fundamentals of Ecology	Published by Brooks/Cole 2005	2005	978-0534420666	624

Fermentation Technology

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I: Introduction to fermentation process	**18 hrs**
History, Scope and Development of Fermentation technology; Isolation and screening of industrially important microorganisms − primary and secondary screening; Maintenance of Strains; Strain improvement: Mutant selection and Recombinant DNA technology.	
Unit II: media for industrial fermentations	**18 hrs**
Natural and Synthetic media; Basic components of a media (Carbon sources; Nitrogen sources; Vitamins; Minerals; Anti-foaming agents); Role of buffers in media; Process of aeration, and agitation.	
Unit III: design of fermenter	**18 hrs**
Basic designs of Fermenter; Type of fermenters: Waldorf, Tower, Deep jet, Cyclone column, Packed tower and airlift fermenter; Scale up study and Product development;Down-stream processing and Product recovery; Regulation and safety.	
Unit IV: Production of microbial products	**18 hrs**
Production of alcohol; Organic acid − Citric acid; Antibiotic − Penicillin, Amino acid − Glutamic acid; Vitamin − B1; Single Cell Protein (SCP).	

Course Learning Outcomes:

- Design of various reactors used in Industries.
- Criteria for selection of media for microbial growth and
- Methods for strain improvement and preservation of cultures.
- Upstream as well as downstream processing involved in fermentation industries

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Peter F Stanbury, Allan Whitaker, Stephen J Hall.	Principles of Fermentation Technology	Butterworth-Heinemann Press. UK.	2016	0070492581, 9780070492585	367
H. J. Peppler, D. Perlman.	Microbial Technology: Fermentation Technology.	Academic Press.	2014	0135188997, 9780135203996, 0135203996	438

HGM601-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	

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. Thomson and Robert M. Nerem	Principles of Regenerative Medicine	Academic Press	3rd	978-0-12-369410-2	1454
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	2nd	978-0-12-374729-7	712

Biofertilizers and Biopesticides

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I: Biofertilizers	**18 hrs**
General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers. Symbiotic N2 fixers: *Rhizobium* Isolation, characteristics, types, inoculum production and field application, legume/pulses plants, *Frankia*- Isolation, characteristics, Alder, Casurina plants, non-leguminous crop symbiosis. Cyanobacteria, *Azolla* - Isolation, characterization, mass multiplication, Role in rice cultivation, Crop response, field application.	
Unit II: symbiotic nitrogen fixers	**18 hrs**
Free living *Azospirillum, Azotobacter* - free isolation, characteristics, mass inoculums, production and field application.	
Unit III: phosphate solubilizers	**18 hrs**
Phosphate solubilizing microbes - Isolation, characterization, mass inoculum production, field application.	
Unit IV: Mycorrhizal Biofertilizers	**18 hrs**
Importance of *mycorrizal* inoculum, types of mycorrhizae and associated plants, Mass inoculum production of VAM, field applications of *Ectomycorrhizae* and VAM. Bioinsecticides- General account of microbes used as bioinsecticides and their advantages over synthetic pesticides, *Bacillus thuringiensis*, production, Field applications, Viruses –cultivation and field applications.	

Course Learning Outcomes:

- Understand the symbiotic relationship of biofertilizers and plants.
- Evaluate classification of biofertilizers and biopesticides
- Perceive knowledge of host-pathogen interaction.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Kannaiyan, S.	Bioetchnology of Biofertilizers,	CHIPS, Texas	2003	1842650998	612
Cappucino, J.G.	Microbiology-A laboratory manual, 4th ed., Harlow, Addition-Wesley.	Hoboken, N.J.: Pearson	2020	0135188997, 9780135203996, 0135203996	541

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.

Programme structure for Integrated B.Sc. + M.Sc. (H) Biotechnology- 5 years (9th Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	PS	FW	SW	
1		Downstream in Biologicals	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
4		Professional Ethics-I	Value Added Course	1	0	0	0	0	1
5		Research Project	NTCC/ Mandatory Course	0	0	12	0	0	12
		Total credits							25

Downstream in Biologicals

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I: Introduction to Downstream processing	**18 hrs**
Role and importance of Downstream processing in biotechnological processes. Characteristics of products, Economics, process design criteria for various classes of byproducts, physico-chemical basis of different bio-separation processes.	
Unit II: Primary separation, Recover process, Adsorption and Extraction	**18 hrs**
Cell disruption methods, Filtration, Centrifugation, Adsorption, Protein Precipitation, Liquid-liquid Extraction, ATPS	
Unit III: - Membrane Separations	**18 hrs**
Membrane Separation Processes: Basic principle, Classification of membrane separation processes, advantages and disadvantages. Retention or rejection coefficient. Concentration polarization and fouling. Membrane types, applications in various industries. Outline of RO, MF, UF and dialysis	
Unit IV: Product Resolution and Fractionation, Final Product Formulation and finishing operations	**18 hrs**
Gel filtration, Affinity, Chromatographic separation processes, Principles of electrophoresis-SDS- PAGE, 2D gel electrophoresis, capillary electrophoresis, Crystallization: Principle, crystallization equipment and its applications in Bioprocessing. Drying: Various types of drying methods, principles of drying, drying curves, various types of industrial dryers and their criteria for choice. Freeze drying technique and its advantages over other methods. Applications in bio-processing	

Course Learning Outcomes:

Students will be able to

1. Understand the strategy for economic process design criteria by using different combination of downstream processing techniques for a desired bio product.
2. Identify and understand the basic unit operations and primary separation techniques involved in downstream process
3. Learn how to apply various methods to purify biologically processed materials.
4. 4. Analyze the estimation of operating parameters for membrane separation processes.
5. Appraise the best techniques used for the purification of bioproducts.

Create and design the final and finishing separation approaches for different bioproducts.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
B Sivasankar	Bioseparations - Principlesand techniques	Prentice Hall of India, New Delhi	2010	178216 44 21	456
F. Stanbury, A. Whitaker, and S.J. Hall	Principles of Fermentation Technology	P Aditya Books	2004	978075 06 45010	786

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.

	Teaching Hours
Unit I: Enzyme Kinetics	**18 hrs**
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).	
Unit II: Chemical mechanisms of enzyme catalysed reactions	**18 hrs**
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 modelsfor action of allosteric enzymes and their significance, Hill and Scatchard plots.	
Unit III: Investigating the active site structure	**18 hrs**
Identification of active site of enzymes: By trapping of enzyme-substrate complex, useof 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.	
Unit IV: Enzyme turnover	**18 hrs**
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.	

Course Learning Outcomes:

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

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Ram Sarup Singh, Reeta Rani Singhania, Ashok Pandey, Christian Larroche	Advances in Enzyme Technology - A volume in Biomass, Biofuels, Biochemicals	Elsevier	2019	978-0-444-64114-4	-
N. S. Punekar	Enzymes: Catalysis, Kinetics and Mechanisms	Springer	2018	978-981-13-0784-3	562

Advanced Bioinformatics

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

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

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 Springer Harbor Lab Press	2nd Ed	978-9746520706	692
Lesk, A.M.	Introduction to Bioinformatics	Oxford UniversityPress	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	**4.5 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	**4.5 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	**4.5 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	**4.5 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 geneticallymodified 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

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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 University press	2017	978-0199475070	472

Research Project

L	T	P	Total Credits
0	0	12	12

Course content and syllabus

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

Programme structure for Integrated B.Sc. + M.Sc. (H) Biotechnology- 5 years (10th Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	PS	FW	SW	
1	HGM602	Omics and its applications	Core Course	4	0	0	0	0	4
2		Advanced Microbiology	Allied Course	4	0	0	0	0	4
3		*Students will choose any one from the given choices* Protein Engineering Clinical Biochemistry 3. Advanced Immunology and Immunotechniques 4. MOOC	Specialization Elective Course	4	0	0	0	0	4
4		Professional Ethics-II	Value Added Course	1	0	0	0	0	1
5		Dissertation Work	NTCC/Mandatory Course	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.

HGM602-Omics and its applications

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	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 omics technologies
- Students will learn about different approaches used in the areas of Genomics, transcriptomics, proteomics, metabolomics, and interactomes.
- Learn how different omics approaches is used to generate testable hypothesis.
- Role of multi-omics 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

Advanced Microbiology

L	T	P	Total Credits
4	0	0	4

	Teaching Hours
Unit I Microbial Physiology	**18 hrs**
Discovery of microbial world, controversy over spontaneous generation, concept ofpure culture. Theory and practice of sterilization. Isolation of microorganisms, staining methods, microscopy, preservationof microbial cultures Cell structure and function. Microbial growth: Growth curve, growth parameters, batchand continuous cultures, diauxic and synchronous growth, enumeration of cells by direct and indirect methods, phototrophy, chemolithotrophy,	
Unit II Virology and Microbial Ecology	**18 hrs**
Microbial evolution and systematics, prokaryotic diversity: bacteria and archaea, eukaryotic microorganisms (structure of algae, protozoa and fungi). Classical and molecular taxonomy. Viruses and virions, growth and quantification, viral replication, viroids and prions. Bacterial, plant and animal viruses. Analysis of microbial communities (overview, phylochips and environmental genomics), microbial habitats and nutrient cycling (carbon, sulphur and nitrogen cycles). Plant-microbes, animal- microbes interactions. Bioremediation and biodegradation (petroleum and xenobiotics).	
Unit III: Medical Microbiology	**18 hrs**
Normal microbiota, host pathogen interactions, epidemiology of microbial diseases, microbial toxins, microbial diseases (AIDS, influenza, tuberculosis, diphtheria, Botulism,tetanus, *E.coli* diarrhoea and hepatitis), Antibiotics, Antibiotic resistance and multi-drugresistance.	
Unit IV: Applied Microbiology	**18 hrs**
Microbial enzymes of industrial interest, microbial metabolites, wine production, single cell proteins, microbial transformation of steroids, food spoilage and preservation, production of dairy products (fermented milks and cheese), role of microbes in agriculture (biofertilizers, biopesticides), Waste water treatment.	

Course Learning Outcomes:

- Gain in depth knowledge about microbial diversity, taxonomy and dynamics of microbial interactionswith other populations
- Understand and define the basic principles of microbiology.

- Develop the knowledge of microbial cell structure, growth and metabolism
- Overall understanding about applied aspects of microbiology

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Tortora, Funke and Chase	icrobiology An Introduction	Benjamin Cummings	9th/2006	9780321733603	578
Stanier, Ingraham, Wheelis	General Microbiology	MacMillan	5th/1987	978-0333417683	647
rueger and Crueger	Biotechnology A textbook of Industrial Microbiology	Sinauer Associates Inc.,U.S.	2nd/1990	9780878931316	767

Protein Engineering

L	T	P	Total Credits
4	0	0	4

	Teaching Hours
Unit I: Protein Structure and Function Review	**18 hrs**
Amino acids in proteins; Protein structure: Chemistry, features and elucidation.	
Unit II Protein Architecture Analysis	**18 hrs**
Protein Structure assessment; Primary structure - Peptide mapping, peptide sequencing methods; Secondary structure - Motifs and functions; Tertiary structure - Domains, folding, kinetics; Protein structure modeling; Experimental and computational protein design	
Unit III: Structure Function relationships- Prediction, engineering and design	**18 hrs**
Protein motifs and role in engineering (DNA binding, Helix turn helix, Zn - finger, Leucine zippers); Mutagenesis and Protein engineering - Site directed and saturation mutagenesis, DNA shuffling; error prone PCR; Protein Evolution - Cell surface and cell free display, Library construction and screening; Protein engineering strategies - Directed evolution and Rational Design Combinatorial enzyme engineering; Therapeutic proteins in Antibody engineering; Multifunctional proteins	
Unit IV: High throughput Protein Engineering	**18 hrs**
Rational protein design - Computational design interventions; Engineered Biomimetic proteins; Protein Modular Design - re-engineering using non canonical amino acids, protein structural and mechanical property modification; Sequence and knowledge-based design; De novo protein design; Forward and reverse protein engineering, Case examples.	

Course Learning Outcomes:

- Recognize the fundamental concepts of protein structure and can apply this knowledge in designing proteins for bioengineering purposes.
- Explain the theory and practice of a variety of protein engineering methods.
- Infer and model specific examples of engineered proteins and their applications.
- Map the requisite strategies for devising bioreactors used in engineering tissues.
- Synthesize and design a basic protein engineering experiment.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages

oet D. and Voet G.,	Biochemistry	John Wiley and Sons,	3rd /2001	9780321733603	1178
Branden C. and Tooze J.	uction to Protein Structured	Garland Publishing, NY, USA	1999	13-4568799994	345

Clinical Biochemistry

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I: Disorders of carbohydrates	**18 hrs**
Carbohydrates- Diabetes mellitus, Glycogen Storage diseases, galactosemia, pentosuria. Amino Acids- Disorders of glycine, sulfur containing amino acids, aromatic amino acids, histidine, branched chain amino acids and proline, disorders of propionate and methylmalonate metabolism. Disorders in urea biosynthesis.	
Unit II: Disorders of lipid	**18 hrs**
Hyperlipoproteinemia, Abetalipoproteinemia, Hyperlipidemia, Tay-Sachs Disease (Gangliosidosis), Neimann Pick Disease, Gaucher's Disease, Krabb's Disease, Metachromatic leukodystrophy and Fabry's Disease, Wolman's Disease, Disorders of porphyrin and heme metabolism, Disorders in purine and pyrimidine metabolism.	
Unit III: Abnormalities in metabolism	**18 hrs**
Inborn Errors of Metabolism – Phenylketonuria, alkaptonuria, albinism, tyrosinosis, maple syrup urine disease, Lesch-Nyhan syndrome, sickle cell anemia, Histidinemia. Digestive diseases – Maldigestion, malabsorption, creatorrhoea, diarrhoea and steatorrhoea. Disorders of liver and kidney – Jaundice, fatty liver, normal and abnormal functions of liver and kidney. Inulin and urea clearance. Electrolytes and acid-base balance – Regulation of electrolyte content of body fluids and maintenance of pH, reabsorption of electrolytes. Abnormalities in Nitrogen Metabolism – Uremia, hyperuricemia, porphyria and factors affecting nitrogen balance.	
Unit IV: Biochemical and diagnostic tests in clinical practice.	**18 hrs**
Diagnostic Enzymes – Enzymes in health and diseases. Biochemical diagnosis of diseases by enzyme assays – SGOT, SGPT, CPK, cholinesterase, LDH Biochemical tests in clinical practice: uses of a chemical/biochemical analysis; Criteria for selecting a method for biochemical analysis; Enzymes as diagnostic tool; Advantages and disadvantages of enzyme assays; Isoenzymes and their diagnostic importance; Methods for the detection of isoenzymes; Organ function tests: clinical presentation and diagnosis of the diseases of the liver and kidney; Bilirubin metabolism and hyperbilirubinemia; Acid base disorders.	

Course Learning Outcomes:

- Understand the disorders of lipid and carbohydrate metabolism.
- Perceive the knowledge of genetic and chromosomal abnormalities.

- Understand the abnormalities due to defect in metabolic process.
- Understand biochemical test in the clinical practices and the mechanism.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No.	Pages
Marshell W.J. and Bangert, S.K.	Clinical Chemistry	International edition MOSBY, Elsevier	9th Ed	978-0702079368	432
Lieberman, M and Peet, A.	Medical Biochemistry, A Clinical Approach. 3rd Ed	Lippin Williman wilkins	2017	978-1496387721	1008

Advanced Immunology and Immunotechniques

L	T	P	Total Credits
4	0	0	4

Learning Objective: The objective of this course is to provide basics of immune system where students will learn the components and molecules of immunity and various immune responses at the cellular level that work together to protect the host, autoimmune disorders and Immunotechniques.

Course content and syllabus

	Teaching Hours
Unit I: Introduction and Overview of Immune System	**18 hrs**
Historical development of the branch "Immunology", Overview of the immune system, Molecules, cells and organs involved in immunity. Hematopoiesis, Innate immunity, adaptive immunity, Antigens, Immunogens, Haptens, Epitopes. Antigen-Antibody interactions, Discovery of immunoglobulins.	
Unit II: Adaptive Immune response	**18 hrs**
Humoral Immunity, Structure and function of various classes of immunoglobulins, Generation of antibody diversity, class switching among constant-region genes, B-cell activation and differentiation, B-cell receptor and the immunoglobulin superfamily, Generation of B cells, Responses, Immunological memory, Cell mediated immunity, MHC restriction and mechanism of antigen presentation, T-cell receptors, maturation, activation and differentiation, Generation of different types of T cells, Responses, Immunological memory.	
Unit III: Immune Effector Mechanisms and Immune system in Health/Disease	**18 hrs**
Properties of cytokines, receptors, The complement systems, mechanism of complement activation, pathology related to complement proteins, Allergy, hypersensitivity (I, II,III,IV), Tolerance, Mechanisms of induction of autoimmunity, treatment of autoimmune diseases. Immunodeficiencies, AIDS, Transplantation immunology, Tumor antigens and cancer immunotherapy, Concepts of vaccines, whole-organism vaccines, recombinant vaccines, DNA vaccine, synthetic peptide and multivalent sub-unit vaccines.	
Unit IV: Immunotechniques	**18 hrs**
Applications of antibodies in diagnostics and routine laboratory assay systems. Agglutination reaction, principles of western blots, radioimmunoassay, ELISA, immunohistochemistry, Development of monoclonal antibodies, Flow cytometry, immunocytes identification and purification.	

Course Learning Outcomes:

- Understanding of mechanisms used by the human body to fight foreign agents and disease-causing pathogens.
- 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 cancer therapy.
- Students will develop ability to use various techniques of immunology in research work.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages

J. Owen, J. Punt, S. Stranford	Kuby Immunology (8th Edition)	WH Freeman and Company, USA	2012	978-1319114701	944
D. Male, J. Brostoff, D. Roth, I. Roitt	Immunology (8th Edition)	Saunders, Elsevier, USA	2012	978-0702045486	482
K. Murphy	Janeway's Immunobiology (8th Edition)	Garland Science, USA	2011	978-0815342908	887
A. Abbas, A. Lichtman, S. Pillai	Cellular and Molecular Immunology (8th Edition)	Saunders, Elsevier, USA	2014	978-8131264577	-

Professional Ethics - II

L	T	P	Total Credits
1	0	0	1

Course content and syllabus

	Teaching Hours
Unit I: Ethics and Empathy	**4.5 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	**4.5 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	**4.5 hrs**
Creating a Bias Neutral Work Environment, management strategies for workplace bias andpersonal bias, effective communication methods and how to measure outcomes, strengthening the position of women in society	
Unit IV: Sustainability, Responsibility and Ethics	**4.5 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
Rita Gupta	Sexual Harassment atWorkplace, 2013	Lexis Nexis	2013	978-935143053 7	320

Research Project

L	T	P	Total Credits
0	0	12	12

Course content and syllabus

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