Semester-Wise Programme structure for B.Sc. Microbiology with Research (4 Years)								
Sr. No.	Year 1		Year 2		Year 3		Year 4	
	Semester 1	Semester 2	Semester 3	Semester 4	Semester 5	Semester 6	Semester 7	Semester 8
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}
2	Basic Cell Biology [CU:6,L-4, P-2] {CC}	General Bacteriology[CU:6,L-4, P-2] {CC}	Enzymology [CU:6,L-4, P-2] {CC}	Bioprocess Technology [CU:6,L-4, P-2] {CC}	Food and Dairy Technology[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}	Microbial diseases and vaccine technology [CU:2,L-2] {CC}
3	Introduction to Microbial World [CU:4,L-3, P-1] {AC}	General Chemistry[CU :4,L-3, P-1] {AC}	Mycology and Phycology [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 -II [CU:4 ,L-4] {SE}	SE -3 [CU:4 ,L-4] {SE} SE -II [CU:4 ,L-4] {SE}	Research Paper Presentation [CU:2,P-2] {NTCC}	SE-5 [CU:4 ,L-4] {SE}
4	Mathematics for Biosciences [CU:2,L-2] {SEC}	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 -II [CU:4 ,L-4] {SE}	SE -4 [CU:4 ,L-4] {SE} SE -II [CU:4 ,L-4] {SE}	OE-1 [CU:4 , L-4] {OE}	OE-2 [CU:4 , L-4] {OE}
5	EVS-I [CU:2,L-2] {AEC}	EVS-II [CU:2,L-2] {AEC}	SEC-3: Programming with C [CU:2,L-1,P-1] {SEC}	SEC-4: Fundamentals of Physics [CU:2,L-2] {SEC}	SEC -5 [CU:2 ,L-2] {SEC} SEC -II [CU:2 ,L-2] {SEC}	SEC -7 [CU:2 ,L-2] {SEC} SEC -II [CU:2	Research Project [CU:10, P-10] {NTCC}	Research Project [CU:12,P-12] {NTCC}

						,L-2] {SEC}		
6	Communication skills [CU:1,L-1] {VAC}	Communication skills [CU:1,L-1] {VAC}	-	-	SEC -6 [CU:2 ,L-2] {SEC} SEC -II [CU:2 ,L-2] {SEC}	SEC -8 [CU:2 ,L-2] {SEC} SEC -II [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
Total Programme Credits								192

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

CU	Credit Unit
L;T;P	Lecture ; Tutorial ; Practical
H	Honours

Programme structure for B.Sc. (H) Microbiology (wih Research)- 4 years (1st Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	P	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	MBO104	Introduction to Microbial World	Core Courses	3	0	1	0	0	4
4	MAT113	Mathematics for Biosciences	Skill component	2	0	0	0	0	2
5	ENV101	Environment Studies -I	Ability Enhancement Course	2	0	0	0	0	2
6	ENG101	Communication Skills	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	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

Course Content and Syllabus

	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	Ed/year	ISBN No	Pages
De-Robertis, F.D.P. and De-Robertis Jr. E.M.F.	Cell and Molecular Biology	Lippincott Williams & Wilkins	2012	978-1469810997	---
Geoffrey, M.	The Cell: A molecular approach	Oxford Sinauer Associates, Oxford University Press	6th	978-1605351551	832
Lodish , H.F.	Molecular Cell Biology.	W H Freeman & Co	5th	978-0716788751	----

BCH102: Biochemistry-I

L	T	P	Total Credits
4	0	2	6

Course Objectives: Examine biomolecules to elucidate their structural and functional properties, fostering a deeper understanding of their roles in biological systems

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 andrare 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 = 72 hrs)

1. Preparation of solutions and buffers.
2. Preparation of 0.1M phosphate buffer, pH 7.4, 250ml without using the pH meter. (By usingHenderson –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
Zubay, G.L., Parson, W.W., and Vance, D.E.	Principles of Biochemistry	Wm. C. Brown, Dubuque, Iowa	1995	978-0697142757	---
Nelson, D.L. and Cox, M. Lehninger	Principles of Biochemistry	W.H.Freeman & Co Ltd	8th/2021	978-1319381493	---

Plummer, D.T.	An Introduction to Practical Biochemistry	Tata McGraw Hill	3rd/ 2017	978-0070994874	332

MBO104: Introduction to Microbial World

L	T	P	Total Credits
3	0	1	4

Course Objectives: Explore the microbial world to comprehend its diversity, and foster a foundational understanding of microbiology's relevance to scientific inquiry and practical applications.

Course content and syllabus

	Teaching Hours
Unit I: Introduction to Microbiology	**14 hrs**
Evolution, microbial life and biosphere, Brief history of Microbiology, naming and classification of microbes, Binomial Nomenclature, Whitaker's five kingdom system, CarlWoese three kingdom of classification, Difference between prokaryotic and eukaryotic microorganisms. Introduction to bacterial taxonomy– Bergey's manual of Systematic Bacteriology (Eubacteria and Archaebacterium).	
Unit II: The Prokaryotes: Domain Bacteria and Archaea	**13 hrs**
The prokaryotic groups, Domain Bacteria: Gram negative and Gram positive bacteria.Domain Archaea, diversity in archaea. **Microbial Growth and Nutrition:** The common nutritional requirements, Nutritional typesof Microbes, Microbes and Human welfare, Microbes and Human disease.	
Unit III: The Eukaryotes- Fungi, Algae, Protozoa and Helminths	**14 hrs**
Algae: General characteristics of algae, Different types of life cycles in algae, Selectedphyla of algae, roles of algae in nature. **Lichens** **Fungi**: General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra-structure, Medically important fungi, Fungal diseases.**Protozoa**	

General characteristics with special reference to Amoeba, Paramecium, Plasmodium, Leishmania and Giardia, Medically important protozoa. General characteristics of slimemolds and helminths.	
Unit IV: Viruses, Viroids and Prions	**13 hrs**
General characteristics of Viruses, Viroids and Prions - Host range, virus size, viral structure-nucleic acid, capsid and envelope, general morphology, taxonomy of viruses, Latent and persistent viral infections, Diseases associated with viruses, viroid and prions.	

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

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

Course Learning Outcomes:

- Understand diversity of Microbial world
- Evaluate bacterial classification and diversity
- Perceive knowledge of cellular organization of bacteria and archaea
- To understand the nutritional requirements of bacteria and different bacteriological techniques.

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, 9780070492581 5	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
James T. Staley Robert P. Gunsalus, Stephen lory, Jerome J. Perry	MICROBIAL LIFE	Sinauer Associates; 2nd edition	2007	0878936858, 9780878936854	1066

MAT113: Mathematics for Biosciences

L	T	P	TOTAL CREDIT UNITS
2	0	0	2

Course Contents/syllabus:

	Teaching Hours
Unit I: Sets, Relations and Function	**9 hrs**
Sets and their properties, Cartesian product of Sets, relations, functions and their typesand graphs	
Unit II: Matrix Algebra	**9 hrs**
Matrices, Types of Matrices, Addition of matrices, Subtraction of matrices and Product ofmatrices. 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 hrs**
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 hrs**
Indefinite and definite integrals, methods of Integration, Properties of definite integrals	

Course Learning Outcomes:

On the successful completion of this course

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

Text / Reference Books:

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

ENV101: Environmental Studies -I

Course content and syllabus

L	T	P	Total Credits
2	**0**	**0**	**2**

	Teaching Hours
Unit-1- Multidisciplinary nature of environmental studies and Natural Resources-1	**9 hrs**
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 erosionand 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. Energyresources- 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:

1. Understand natural resources and evaluate limitations surrounding renewable and non-renewable resources
2. Understand the nuances of ecosystem and learn about behaviour of various ecosystem
3. 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	9781260219715	--
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 globalconcern,	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	4 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 hrs
Verbal communication: Oral Communication: Forms, Advantages & Disadvantages, Written Communication: Forms, Advantages & Disadvantages, Introduction of Communication Skills (Listening, Speaking, Reading, Writing), Nonverbal communication: functions and effective use, KOPPACT(Kinesics, Oculesics, Proxemics,	
Para-language, Artifacts, Chronemics, Tactilics). The implication of appropriate communication; effective ways of using social media, importance of digital literacy.	
Unit III: Reading and Writing Skills	4 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 ofthe text, Paragraph development; essay writing.	
Unit IV: Speaking and Presentation Skills	5 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:

1. Students will be able to understand the basic processes of communication, both verbal as well asnon-verbal—nature, scope, and power of communication processes.
2. Students will be able to demonstrate cultural sensitivity in communication and appreciation ofcultural variations of diverse socio-cultural contexts.
3. 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.
4. Students will be able to analyze situations and audiences to make right choices about the mosteffective and efficient ways to communicate and deliver messages.
5. Students will be able to assess various barriers in communication and develop communicativecompetence thereby for effective communication.

Books/literature

AUTHOR	**TITLE**	**Publisher**	**Year of publication**	**ISBN**
P. D. Chaturvedi andMukesh Chaturvedi	Business Communication : Concepts, Cases and Applications	Pearson Education	2006	9788131 701720
Meenakshi Raman and Prakash Singh	Business Communication	Oxford University Press	2012	9780198 077053

Jeff Butterfield	Soft Skills for Everyone	Cengage Learning	2017	9789353 501051

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	**4 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	**5 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 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	**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 :

1. Understand information; Express in his own words; Paraphrase; Interpret and translate.
2. Apply information in a new way in a practical context
3. Analyse and break-down information to create new ideas
4. 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	978-9380809069
Manjiri Khandekar and Roopa Luktuke	Jumelage - 1 Methode De Fraincais - French	Langers International Private Limited	2020	978-938080 9854
Michael Magne, Marie-Laure Lions-Olivieri	Version Originale 1: Cahier d'exercices	Maison Des Langues	2010	978848 443561 7

FOL102: Introduction to German Culture & Language

L	T	P	Total Credits
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 begiven on their understanding of grammatical structures and the foreign accent of the language. At the endof the course, the student shall be able to:

1. Understand information; Express in his own words; Paraphrase; Interpret and translate.
2. Apply information in a new way in a practical context
3. Analyse and break-down information to create new ideas
4. 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 StudyCourse German Guide	Wiley	2007	978- 04701655 15

PSY101: Behavioural Science: Understanding Self for Effectiveness

L	T	P	Total Credits
1	0	0	1

Course Contents/syllabus:

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

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

1. The student will apply self-introspection as a tool for self-awareness.
2. The student will understand self-concept for self-recognition, self-improvement and perceptionof others.
3. The student will be able to analyze their physical self, social self, the competent self and psychological self.
4. 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	97881265 8027
Towers, Marc	Self Esteem	American Media	1995	9781884926297
Pedler Mike, Burgoyne John, Boydell Tom	A Manager's Guide to Self-Development	McGraw-Hill	2006	978-0077114701
Covey, R. Stephen	Seven habits of HighlyEffective People	Simon & Schuster Ltd	2013	978-1451639612
Khera Shiv	You Can Win	Macmillan	2005	978-03339374 02
Gegax Tom	Winning in the Game of Life	Harmony Books	1999	978-0609603925

Singh, Dalip	Emotional Intelligence at Work	Publications	2006	9780761935322
Goleman, Daniel	Emotional Intelligence	Bantam Books	2007	9780553095036
Goleman, Daniel	ing with E.I	Bantam Books	1998	9780553104622

INL101: Punjabi Language -I

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

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**	ਚੇਤਨਾ ਪ੍ਰਕਾਸ਼ਨ, ਪੰਜਾਬੀ ਭਵਨ,ਲੁਧਿਆਣਾ	**2012**	-	-

	ਸਿਧਾਂਤ ਅਤੇ ਵਿਹਾਰ				
ਡਾ. ਬੂਟਾ ਸਿੰਘ ਬਰਾੜ	**ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਸ੍ਰੋਤ ਅਤੇ ਸਰੂਪ**	, ਵਾਰਿਸ ਸ਼ਾਹ ਫ਼ਾਊਂਡੇਸ਼ਨ, ਅੰਮ੍ਰਿਤਸਰ	**2012**	**-**	**-**
ਦੁਨੀ ਚੰਦ੍ਰ	**ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਦਾ ਵਿਆਕਰਣ**	, ਪੰਜਾਬ ਯੂਨੀਵਰਸਿਟੀ ਪਬਲੀਕੇਸ਼ਨ ਬਿਊਰੋ, ਚੰਡੀਗੜ੍ਹ	**1995**	**-**	**-**
ਜੋਗਿੰਦਰ ਸਿੰਘ ਪੁਆਰ ਅਤੇ ਹੋਰ	**ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਦਾ ਵਿਆਕਰਨ (ਭਾਗ 1,2,3),**	ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਅਕਾਦਮੀ ਜਲੰਧਰ	**2003**	**-**	**-**
ਸੁਖਵਿੰਦਰ ਸਿੰਘ ਸੰਘਾ	**ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਵਿਗਿਆਨ**	ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਅਕਾਦਮੀ ਜਲੰਧਰ	**2010**	**--**	**-**
ਅਗਨੀਹੋਤਰੀ,ਵੇਦ	ਪਰਿਚਾਇਕ ਭਾਸ਼ਾ ਵਿਗਿਆਨ	ਦੀਪਕ ਪਬਲਿਸ਼ਰਜ਼ ਜਲੰਧਰ	**1981**		

INL102: History and Culture of Punjab

L	T	P	Total Credits
1	0	0	1

Course Contents/syllabus

	Teaching hours
Unit I:	**4.5 hrs**
1. Harappan Civilization: extent and town planning and socio-economic life. 2. Life in Vedic Age: socio-economic and religious; 3. Growth and impact of Jainism and Buddhism in Panjab.	
Unit II:	**4.5 hrs**
1. Society and Culture under Maurayas and Guptas. 2. Bhakti movement: Main features; prominent saints and their contribution. 3. Origin and development of Sufism	
Unit III:	**4.5 hrs**
1. Evolution of Sikhism: teaching of Guru Nanak; Institutional Development-Manji, Masand, Sangat and Pangat 2. Transformation of Sikhism: Martyrdom of Guru Arjan; New policy of Guru Hargobind, martyrdom of Guru Tegh Bahadur. 3. Institution of Khalsa: New baptism; significance	
Unit IV:	**4.5 hrs**

1. Changes in Society in 18th century: social unrest; emergence of misls and otherinstitutions - rakhi, gurmata, dal khalsa. 2. Society and Culture under Maharaja Ranjit Singh. 3. 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:

1. Understand the history of various cultures in Punjab.
2. Interpret the importance of Maurayan, Gupta, and Bhakti influences on Punjab
3. Apply the teaching of Sikhism on the emergence of the Khalsa .
4. 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 B.Sc. (H) Microbiology (wih Research)- 4 years (2nd Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	P	FW	SW	
1	BCH104	Biochemistry – II	Core Course	4	0	2	0	0	6
2	MBO103	General Bacteriology	Core Course	4	0	2	0	0	6
3	CHE113	General Chemistry	Allied Course	3	0	1	0	0	4
4	MAT114	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 Objective: Delve into the biochemistry of metabolism to analyze metabolic pathways, understand energy transformation processes, and explore the regulation of biochemical reactions, fostering insights into cellular physiology and disease mechanisms.

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 dietaryproteins	
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 = 72 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:

1. Students will understand the metabolic pathways linked with a series of chemical reactions occurringwithin a cell.
2. This course will describe the chemical changes catalyzed by cellular components and variousintracellular controls.
3. Have knowledge of cellular metabolism, including central catabolic and anabolic pathways
4. Understand how different control mechanisms may be integrated to coordinate cell metabolism andfunction.
5. Understand how metabolism is coordinated in body systems and have knowledge of how disturbances in metabolism contribute to diseases

Text / Reference Books:

Author	**Title**	**Publisher**	**Ed/year**	**ISBN No**	**Pages**
David L Nelson; and Michael M. Cox, W.H. Freeman	Lehninger's Principles of Biochemistry	WH Freeman	2012	0070492581, 9780070492585	957
Jeremy M. Berg, Lubert Stryer,John L Tymoczko, and Gregory J. Gatto,	Biochemistry	W.H. Freeman Company	2015	1319114652	1208

MBO103: General Bacteriology

L	T	P	Total Credits
4	0	2	6

Course Objectives: Study general bacteriology to comprehend bacterial morphology, physiology, and ecology, enabling the understanding of microbial roles in health, disease, and ecosystem dynamics, and the application of bacteriological knowledge in various scientific and industrial contexts.

Course content and syllabus

	Teaching Hours
Unit I: Anatomy of Prokaryotic cell	**18 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 and archaeal cell membranes.	
Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids Endospore: Structure, formation, stages of sporulation.	
Unit II: Bacterial Taxonomy	**18 hrs**
Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Differences between eubacteria and archaebacteria, Important archaeal and eubacterial groups.	

Unit III: Sterilization, disinfection and microscopy	18 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.	
Unit IV: Bacterial nutrition and bacteriological techniques	**18 hrs**
Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media. Pure culture isolation: Streaking, serial dilution and plating Selective and differential media. Growth curve and growth kinetics. Influence of environmental factors for microbial growth. Nutritional groups of bacteria: overview. Estimation of Microbes- Direct Microscopic count, Turbidometric assay, TVC- Indirect Method- CO_2 liberation- Protein estimation- Maintenance and Preservation of cultures.	

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

1. Preparation of different media: Complex media-Nutrient agar, McConkey agar, EMB agar.
2. Isolation and purification of micro-ogranisms from soil/water/air.
3. Estimation of CFU count by spread plate method/pour plate method.
4. Isolation of pure cultures of bacteria by streaking method.
5. Preservation of bacterial cultures by various techniques.
6. To perform the Simple staining and negative staining of a pure bacterial culture
7. To perform the Gram's staining and acid fast staining of a pure bacterial culture

Course Learning Outcomes:

1. Understand diversity of Microbial world
2. Evaluate bacterial classification and diversity
3. Perceive knowledge of cellular organization of bacteria and archaea
4. To understand the nutritional requirements of bacteria and different bacteriological techniques.

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, 9780070492258 5	957
Cappucino,J.G.	Microbiology -A laboratory manual, 4th ed., Harlow, Addition- Wesley.	Hoboken, N.J.:Pearson	2020	0135188997, 9780135203996,	541
Tortora GJ, Funke BR andCase 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 InternationalEdition	2014	9781292018317	1030
James T. Staley Robert P. Gunsalus Stephen lory, Jerome J. Perry	Microbial Life	Sinauer Associates;2nd edition	2007	0878936858, 9780878936854 4	1066

CHE112: General Chemistry

L	T	P	SW/ FW	TOTAL CREDIT UNITS
3	0	1	0	4

Course Objectives: To develop basic understanding of atomic structure and related physico-chemical properties of elements of the periodic table. In addition, this course focuses on fundamentals of organic molecules, structure, bonding, reactivity and reaction mechanisms as well as familiarization with various states of matter and its physical laws related to describe them.

Course Content

	Teaching hours
Unit I: The Atomic Theory	**14 h**
Bohr's theory, Wave mechanics: de' Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, Quantum numbers and their significanc 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 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 or screening effect, Slater rules, variation of effective nuclear charge in periodic table, Atomic radii (van'der Waals), Ionic and crystal radii (octahedral and tetrahedral) Covalent radius, Ionization enthalpy and factors affecting successive ionizatior energies. Applicatio of ionization enthalpy, trends in electron gain enthalpy electronegativity- Pauling, Mullika Allred Rochow scales, electro-negativity and bonc order, partial charge, hybridization, group electronegativity.	
Unit III: Fundamentals of Organic Chemistry	**13 h**

Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fissiowith 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: Gaseous state of matter	**13 h**
Deviations from ideal gas behavior, compressibility factor, and its variation with pressure for different gases. Causes of deviation from ideal behavior. van der Waals equation of state, its derivation and application in explaining real gas behaviour; van der Waals equation expressed in virial form, Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, critical and v 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 pressuredependence, 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.	

Course Learning Outcomes

1. Knowledge of evolution of scientific theories to explain the atomic structure, molecular geometry and physico-chemical behaviour of atomic matter made from elements in periodic table.
2. Focus on fundamentals of organic molecules, structure, stereochemistry, bonding, reactivity and reaction mechanisms.
3. Familiarization with gaseous state of matter and its physical laws governing it

List of Experiments

Inorganic Chemistry Practicals

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

Organic Chemistry Practicals

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

Text Books

A. Theory

Author	**Title**	**Publisher**	**Ed/year**	**ISBN No**	**Pages**
J.D. Lee	Concise Inorganic Chemistry	John Wiley and Sons Ltd	5th edition (2016)	978-8126515547	---
Greenwood, Earnshaw	Chemistry of the Elements	Butterworth - Heinemann	2nd edition (1997)	978-0750633659	----
M. B. Smith, J. March, March's	Advanced Organic Chemistry: Reactions, Mechanisms, andStructure	Wiley-Interscience	8th Edition (2015)	978-8126556588	---
Atkins P.W, Julio de Paula	Physical Chemistry	Oxford University Press, ELBS	11th edition (2018)	978-0198814740	---

Practicals

Author	Title	Publisher	Ed/year	ISBN No	Pages
J. Mendham, R.C. Denney, J. D. Barnes, M.J.K. Thomas, Vogel's	Vogel's Quantitative Chemical Analysis	Longman	6th edition (1999)	978-0582226289	---
A.I. Vogel, A.R. Tatchell, B.S. Furnis	Vogel's Textbook of Practical Organic Chemistry	Prentice Hall	5th edition (2003)	978-0582462366	----
Shoemaker, D.P Garland, C.W Nibler, J.W.	Experiments in Physical Chemistry	McGraw Hill Inc	8th edition (2008)	978-0070570078	---

MAT114: Statistics for Biosciences

L	T	P	TOTAL CREDIT UNITS
2	0	0	2

Course Contents/syllabus:

	Teaching Hours
Unit I:	**9 hrs**
Data collection and graphical presentation, Descriptive Statistics: Measures of centraltendency-Arithmetic, geometric and harmonic mean, median, and mode.	
Unit II:	**9 hrs**
Measures of dispersion, Skewness and Kurtosis, Correlation, and regression	
Unit III:	**9 hrs**
Definitions of Probability, Conditional Probability, Bayes' theorem, random variables: discrete and continuous, density and mass functions.	
Unit IV:	**9 hrs**
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,

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

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN

Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying E. Ye	Probability and Statisticsfor 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 humancommunities and agriculture. Environment laws: Environment Protection Act; Air (Prevention and Control of Pollution)Act; Water (Prevention and Control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act, international agreements: Montreal and Kyoto protocols and convention on biological diversity(CBD), The Chemical Weapons Convention (CWC). Natural reserves, tribal population and rights and Human-wildlife conflict in Indiancontext.	
Unit III: Human communities and the environment	**9 hrs**

Impacts on environment, human health and welfare. Carbon foot-print. Resettlements and rehabilitation of project affected persons, case studies. Disaster management: floods, earthquake, cyclone and landslides. Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan. Environmental ethics: Role of Indian and other religions and cultures in environmental conservation. Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).	
Unit IV: Field Work	**9 hrs**
• 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:

1. Understanding the types of pollution and their impact on environment and human health.
2. Understand the environmental concerns and their impact on humans and agriculture.
3. Able to analyse the impacts of natural and manmade disaster on human population and settlements.
4. Sensitization about the environmental issues and concerns leading to proactive actions to improve the environmental conditions in our daily life.
5. 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	464
William P. Cunningham , Mary Ann Cunningham , Barbara	Environmental Science: A global concern	McGraw-Hill	2021	9781260363821	624

Woodworth Saigo					

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	5 hrs
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 hrs
Nonverbal communication: detailed analysis, KOPPACT (Kinesics, Oculesics, Proxemics, Paralanguage, Artefacts, Chronemics, Tactilics).	
Unit III: Communication and Technology	5 hrs
Importance of digital literacy and communication on digital platforms.	
Unit IV: Presentation Skills	5 hrs
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:

1. 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.
2. Students will be able to understand the significance of non-verbal communication in various contexts.
3. 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.
4. 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 NATIO

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

Course Contents/syllabus:

	Teaching Hrs
Unit-1- Individual differences & Personality	**4 hrs**
• Personality: Definition& Relevance • Importance of nature & nurture in Personality Development • Importance and Recognition of Individual differences in Personality • Accepting and Managing Individual differences Intuition, Judgment, Perception & Sensation (MBTI) BIG5 Factors	
Unit-2- Managing Diversity	**5 hrs**
• 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 hrs**
• 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	**5 hrs**

• 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):

1. Project on Understanding Diversity
2. Term Paper on Patriotism among Youth

Course Learning Outcomes: On completion of the course:

1. To recognize individual differences
2. To mange individual differences
3. To develop patriotic feelings
4. 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	978-81317041 72	266
Umang Malhotra	Individual, Society, and the World	iUniverse	2004	978-0595662401	188
Tonja R. Conerly & Kathleen Holmes	Introduction to Sociology 3e	Openstax	2015	97817114 93978	458
Daksh Tyagi	"A Nation of Idiots"	Every Protest	2019	978-81942750 15	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	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 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	**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: Week-end	**4 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 concurrentmanner 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:

1. Understand information; Express in his own words; Paraphrase; Interpret and translate.
2. Apply information in a new way in a practical context
3. Analyze and break-down information to create new ideas
4. 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	9789380809069	---
Collins Dictionaries	Easy Learning French Complete Grammar,	Collins	2016	978-0008141721	---

	Verbs and Vocabulary				
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	**4 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)	**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)	**5 hrs**

• Introduction to the concept of object (Akkusativ) • Formation of sentences along with the translation and difference betweennominative 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 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 constructingsentences with possessive and demonstrative adjectives in German. In addition, they will be proficient informulating meaningful sentences as they will be capable of applying their knowledge of all the irregularverbs they have learnt during the session. They will also have an idea of German culture by studying aboutvarious German festivals.

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

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

Text / Reference Books:

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 Literatu

L	T	P	Total Credits
1	0	0	1

Course content and syllabus

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

2. ਭਾਸ਼ਾ, ਉਪਭਾਸ਼ਾ,ਟਕਸਾਲੀ ਭਾਸ਼ਾ ਅਤੇ ਪੰਜਾਬੀ ਦੀਆਂ ਉਪਭਾਸ਼ਾਵਾਂ	

Course Learning Outcomes:

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

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 ਚੰਦ੍ਰ	**ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਦਾ ਵਿਆਕਰਣ**	, ਪੰਜਾਬ ਯੂਨੀਵਰਸਿਟੀ ਪਬਲੀਕੇਸ਼ਨ ਬਿਊਰੋ, ਚੰਡੀਗੜ੍ਹ	**1995**	-	-

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

INL106: History and Culture of Punjab

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

Course Contents/syllabus:

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

Course Learning Outcomes:

1. Understand the history of Punjab region in modern times.
2. Interpret the importance early socio religious reform, movements, developments.

3. Examine the contribution of major reform movements: Gadar, Babbar Akalis and Gurdwarareform morchas.
4. 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 B.Sc. (H) Microbiology (wih Research)- 4 years (3rd Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	P	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	MBO201	Mycology and Phycology	Core Course	4	0	2	0	0	6
4	BTY202	Protein Science	Allied Course	4	0	0	0	0	0
5	CAS211	Programming in C	Skill Enhancement Course	1	0	1	0	0	2
		Total Credits							**24**

BTY201: Biotechniques

L	T	P	Total Credits
4	0	2	6

Course Objective: This course will provide students with the understanding of various analytical techniques usedin 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 generationand 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-cellularfractionation	
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	111830179X 978-1118301791	783
Wilson K., Walker J.	Principle and Techniques of Biochemistry and Molecular Biology	Cambridge University Press	6th edition/2006	0521178746 9780521178747	744
Plummer, David	An Introduction to Practical Biochemistry	Tata Mc GrawHills	3rd edition/2017	0070994870 9780070994874	332

BCH201: Enzymology

L	T	P	Total Credits
4	0	2	6

Course Objectives: Explore enzymology to understand enzyme structure, function, and kinetics, facilitating insights into biological processes, industrial applications, and the development of therapeutic interventions.

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 covalentcatalysis (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. Multienzymecomplexes (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 acidphosphatases), 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

1. Types of enzymes, classification and their importance
2. Enzyme kinetics and enzyme inhibitors
3. Mechanisms of enzyme action
4. Application of enzymes in diagnostics and drug discovery

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages

David L. Nelson	Lehninger: Principles of Biochemistry	**W. H. Freeman**	2013	978-1429234146 1429234148	1328
Nicholas C.P. and Lewis S.	Fundamentals of Enzymology	Oxford University Press	1989	019806439X	526
				978-0198064398	
Voet, D., Voet, J.G.	Biochemistry	Wiley	2010	0121822117 978-0470570951	1428

MBO201: Mycology and Phycology

L	T	P	Total Credits
4	0	2	6

Course Objectives: Investigate mycology and phycology to comprehend the diversity, ecology, and significance of fungi and algae in various ecosystems, industries, and human health, fostering a deeper understanding of their roles and applications in biotechnology, agriculture, and environmental management.

Course content and syllabus

	Teaching Hours
Unit I: MYCOLOGY - PHYLOGENY AND SYSTEMATICS	**18 hrs**
General characteristics; Ecology and distribution, Classification and General account of major classes of Fungi; Habit, Structure and Methods of Reproduction in Basiodiomycotina, Deuteromycotina and Mycoplasma. Occurrence, General structure, Nutrition, Reproduction, Fungi as infectious agents – plants, animals, and humans. Fear of fungi - extinction of species.	
Unit II: PHYCOLOGY - PHYLOGENY AND SYSTEMATICS	**18 hrs**
General characteristics; Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food, flagella; methods of reproduction; Classification; criteria, system of Fritsch, and evolutionary classification of Lee (only upto groups); Role of algae in the environment, agriculture, biotechnology and industry.	
Unit III: MOLECULAR MYCOLOGY AND PHYCOLOGY	**18 hrs**
Role of modern techniques like PCR, Chromatography and Spectroscopy in identification and characterization of species; Current advances in algal and fungal research; yeast and fungal genetics; yeast and fungi as genetic models to study human physiology, biochemistry, and disease.	
Unit IV: YEAST AND FUNGI AS INDUSTRIAL WORKHORSES	**18 hrs**
Role of yeast, fungi, and algae in food, pharmaceutical, and green chemistry industries.	

Secondary metabolites – production, biochemistry, and mechanisms of action.	

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

1. Identification and characterization of species by microscopy.
2. Isolation and purification of microorganisms from soil/water/air by streak plate method and serialdilution.
3. To perform the lactophenol blue staining of the purified fungal culture.
4. To test for the antibiotic sensitivity of the yeast and fungal sample.
5. To perform the MIC test for antibiotic sensitivity of a yeast and fungal strain against a specificantibiotic.
6. To perform standard growth curve of purified yeast and fungal strain.
7. To study the effect of temperature and pH on the growth of microorganisms.
8. Preservation of a microbial strain.

Course Learning Outcomes:

1. Understand Phycology and mycology – occurrence and ecology.
2. Evaluate bacterial classification and diversity
3. Role of mycology in bio-medical research
4. Perceive knowledge of applications of yeast, fungi and algae.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Bridge, P.D. CAB Intern. 1993..	Application of PCR in Mycology.	Ferry Lane, Kew, U.K.	1998		
Cook, R. C. and M. J. Whipps.	Ecophysiology of Fungi.	Blackwell Scientific, London, UK	1993	0632021683 9780632021680	337

Pelczar, M.J. Jr., Chan ECS and Krieg, N.R.	Microbiology: Concepts and Applications	New York; Madrid : McGraw-Hill,	1993	0070492581, 9780070492585	
Cappucino, J.G.	Microbiology-A laboratory manual, 4th ed., Harlow, Addition-Wesley.	Hoboken, N.J.: Pearson	2020	0135188997, 9780135203996, 0135203996	

BTY202: Protein Science

L	T	P	Total Credits
4	0	0	4

Course Objectives: Explore protein science to understand protein structure, function, and interactions, enabling the analysis of biological processes, drug discovery, and the development of biotechnological applications

Course content and syllabus

	Teaching Hours
Unit I: Protein Structure	**18 hrs**
Peptide bond, protein secondary structure – fibrous and globular proteins, proteins stability,tertiary and quaternary structure, Protein Folding: Theory and Experiment, Folding Accessory Proteins, Protein Structure Prediction and Design, Protein Dynamics.	
Unit II: Protein misfolding, aggregation and denaturation	**18 hrs**
Protein misfolding and aggregation, amyloid formation. Conformational Diseases: Alzheimer's, Prion diseases, Huntington's disease, sickle cell anemia, Parkinsons. Structural Evolution Protein denaturation and folding, Chemical evolution, Chemical Synthesis of Polypeptides. IDP (Intrinsically disordered proteins).	
Unit III: Protein alignment and database research	**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:

1. Understand basic concepts of protein structure.
2. 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.

3. 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	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 H**
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 H**
Control Statements: Decision Making using if statement, Types of if …else block, Switchcase Block, Arithmetic Expressions, Evaluation of Expressions, GOTO statement Looping: Concept of Loop, For loop, While loop, Do while loop, Jumping in Loop, break and continue statement.	
Unit III: Arrays and Strings	**4 H**
Arrays and Strings: Introduction to array, Processing Array Contents, 2D arrays, Arraywith three or more dimensions. String, string concatenation, Comparing strings, String handling Functions.	
Unit IV: Functions, Structure and Unions	**5 H**

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.

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

7. Write a program to calculate sum of individual digits of a given number.
8. Write a program to check whether given number is palindrome or not.

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

```
1                    *

1 2                  * * *

1 2 3                * * * * *

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

12. Write a program to perform matrix addition, matrix subtraction and transpose pf a matrix.
13. Write a program to verify the given string is palindrome or not (without built-in functions, with usingbuilt-in functions).
14. Write a program to swap two numbers using a) Call By Value B) Call By Reference.
15. 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, ManasGhosh	Programming In C	Oxford UniversityPress	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 B.Sc. (H) Microbiology (wih Research)- 4 years (4th Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	P	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**

*The Skill Enhancement Course can also be taken through MOOC

IMM206: Immunology

L	T	P	Total Credits
4	0	2	6

Course 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, Immunoelectrophoresis, Immunoassays, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, fluorescence activated cell sorting analysis, microarrays to assess gene expression	

List of Experiments:

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. Immunoelectrophoresis.

Course Learning Outcomes:

1. Students will be able to explain the role of immune cells and their role in body defense mechanism
2. Students will be able to devise strategies to combat infection or diseases produced by altered self.
3. Students will develop ability to use this knowledge in the processes of immunization, antibody engineering, vaccine development, transplantation, and diseases.
4. 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		
D. Male, J. Brostoff, D. Roth, I. Roitt	Immunology (8th Edition)	Saunders, Elsevier, USA	2012		
K. Murphy	Janeway's Immunobiology (8th Edition)	Garland Science, USA	2011		

A. Abbas, A. Lichtman, S. Pillai	Cellular and Molecular Immunology (8th Edition)	Saunders, Elsevier, USA	2014		

BTY206: Bioprocess Technology

L	T	P	Total Credits
4	0	2	6

Course Objectives: Study bioprocess technology to comprehend the principles and applications of biological systems in industrial processes, enabling the optimization of bioproduction methods for various products.

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 ofstreptomycin fermentation etc.	
Unit IV: Microbial production of industrial enzymes	**18 hrs**
Glucose isomerase, Amylase, Lipase, Protease	

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

1. Isolation of industrially important bacteria for microbial processes.
2. Estimation of Reducing sugar by DNS method of unknown sample and establish calibration curve.
3. Estimation of ethanol by potassium dichromate methods and establish calibration curve.
4. Establish growth profile of bacteria with respect of optical density and maximum specific growth rateof bacteria
5. Determination of Thermal Death Point and Thermal death time of bacteria for design of a sterilizer.
6. Cultivation of microorganism in batch process
7. Ethanol production using grape juice
8. Demonstration of bioreactor

Course Learning Outcomes:

1. Design and formulation of production media for fermentation,
2. Upstream and downstream techniques of primary and secondary product
3. 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	Pearson Education Limited.	2013	9780136060659	957

	Basic Concepts,				
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

Course Objectives: Teach students basics of microbial genetics and impart knowledge about the mechanism of genetic exchange and transposable elements

	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 growthcurve **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 ofuniport, 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 TCAcycle, 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 todissimilatory 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 branchedfermentation pathways.	
Unit III: Chemolithotrophic and Phototrophic Metabolism	**18 hrs**
Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogenoxidation (definition and reaction) and methanogenesis (definition and reaction) Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and cyanobacteria	
Unit IV: Nitrogen Metabolism	**18 hrs**
Introduction to biological nitrogen fixationAmmonia assimilation Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification	

List of Experiments -with basic instructions (Total Teaching = 72 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 thegiven data
3. Effect of temperature on growth of *E. coli*
4. Effect of pH on growth of *E. coli*
5. Effect of carbon and nitrogen sources on growth of *E.coli*
6. Effect of salt on growth of *E. coli*
7. Demonstration of alcoholic fermentation
8. Demonstration of the thermal death time and decimal reduction time of *E. coli*.

Course Learning Outcomes:

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

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Madigan MT, and Martinko JM (2014)	Brock Biology of Microorganisms. 14th edition	Prentice Hall International Inc.	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 onlinedatabase like PUBMED and PDB. Analysis of DNA sequence for presence of internal restriction digestion sites etc.	
Unit IV: Advanced Cloning Techniques	**9 hrs**
Homologous recombination, Molecular mechanism of RecBCD, RecA, RuvA-B, Holliday Model; Non-homologous End Joining (NHEJ) versus Homologous DNA recombination; Positive and negative selection, Zinc finger nucleases (ZFN), Transcription activator-like effector nucleases (TALENs), Discovery of adaptive immunity, The CRISPR-Cas9 (clustered regularly interspaced short palindromic	

repeats) system, Methods to create gene-knock out animal model systems. Cre-LoxP recombination system	

List of Experiments

1. Acquiring DNA sequence encoding the protein of interest (for example GFP) from online database likeGenbank 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 containingappropriate restriction digestion sites, affinity tags (penta-His etc.).
3. PCR amplification of the DNA segment of interest from a suitable source, purification of the PCRproduct.
4. Restriction digestion, and subsequent ligation into the suitable bacterial expression vector (alsocontaining 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	1989		
T.A. Brown	Gene Cloning and DNA Analysis - An	Wiley - Blackwell	2010	9781405181 730	338

	introduction				

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

Course content and syllabus

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

Speed and Properties of Sound Waves, Intensity of Sound Waves, Sound propagation from one Medium to Another, Speech Production, Types of Sounds, Hearing, Other Vibrations of the Body, Cardiac and Other Sources of Sounds	9 hrs

Course Learning Outcomes:

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

Text/Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
Irving P. Herman	Physics of the Human Body	Springer , ISSN 1618-721	2006	978-3540817062
W. Hughes B	Aspects of Biophysics	John willey and sons	1979	978-0471019909
R.K. Hobbie	Intermediate Physics in Biology and Medicine	Springer	2001	978-3319126814
Halliday, Resnick and Walker	Fundamentals of Physics	Wiley India Pvt Ltd	2006	978-8126514427
Brijlal, Subramanyam & N Subrahmanyam	Principle of Optics	S. Chand publishing, 25th edition, 2012	2006	978-8121926119

Ghatak, Ajay	Optics	Tata McGraw-Hill	4th Edition	9789339220907
Jenkins F A, White H E	Fundamentals of optics	Mcgraw hill	4th Edition	9780072561913

Programme structure for B.Sc. (H) Microbiology (wih Research)- 4 years (5th Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	P	FW	SW	
1	HGM301	Molecular Biology	Core Course	4	0	2	0	0	6
2	MBO301	Food and Dairy Technology	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.		*Students will choose any two of the given choices*** 1. Cell Signalling 2.Research Methodology 3. Biowarfare and Bioterrorism 4. Programing in Python 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 the Skill Enhancement Course can also be taken through MOOC. A maximum of 4 credits per semester can be taken through 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:

1. History and development of molecular biology, structure of genome and terminologies used in molecular genetics
2. DNA replication in bacteria, archaea and eukaryotes
3. Mechanism of transcription in bacteria and eukaryotes.
4. 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
Lewin, B.	Genes XI	Jones and Bartlett	10th ED/2014	9781449659059	940

MBO301: Food and Dairy Technology

L	T	P	Total Credits
4	0	2	6

Course Objectives: Teach basic principles and methods of food processing, preservation and process technology of milk and milk products and will also obtain knowledge about laws and standards for milk and milk products.

Course content and syllabus

	Teaching Hours
Unit I: Basic principles and methods of food processing and preservation.	**13 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.	**13 hrs**
Chemical and microbial spoilage of milk and milk products; Fluid milk Processing, packaging and distribution. Common dairy processes – cream separation (standardization),pasteurization, sterilization and Homogenization.	
Unit III: process technology for various milk products	**18 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.	**28 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.Venturecapital.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.	

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

1. Basic labs on sterilization, food pasteurization and homogenization
2. Preservation of a microbial strain.
3. Precipitation of protein (casein) from milk with an acid.
4. Determination of Milk Fat by Gerber Method.
5. Determination of Specific Gravity of Milk.
6. To perform Microbial Analysis of Foods.
7. Determination of Milk Fat (by Acid Digestion Method) in Cheese.
8. DETERMINATION OF LACTOSE BY COLORIMETRIC METHOD IN MILK BASED SWEETS.

Course Learning Outcomes: impart knowledge and technical proficiency in:

1. Clean milk production, handling and processing of milk
2. Manufacture of western and indigenous dairy products
3. Testing and quality control of milk and milk products
4. Marketing and economical aspects
5. Managing small and medium enterprises

Text / Reference Books:

Author	**Title**	**Publisher**	**Ed/year**	**ISBN No**	**Pages**
Pelczar, M.J. Jr., Chan ECSand Krieg, N.R.	Microbiology: Concepts and Applications	New York; Madrid : McGraw-Hill,	1993	0070492581, 9780070492585	957

Cappucino, J.G.	Microbiology-A laboratory manual	Hoboken, N.J.: Pearson	2020	0135188997, 9780135203996,	541

MBO302: Microbial Genetics

L	T	P	Total Credits
4	0	0	4

Course Objectives: Teach students basics of microbial genetics and impart knowledge about the mechanism of genetic exchange and transposable elements

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-compositetransposons, 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

1. Basics of microbial genetics including organization of genome of various microorganisms
2. Mutations and their importance
3. Roles and significance of transposable elements
4. Mechanisms of genetic exchange

Text / Reference Books:

Author	**Title**	**Publisher**	**Ed/year**	**ISBN No**	**Pages**
Snyder, L., Peters, J.E., Henkin, T.M., and Champness, W.	Molecular Genetics of Bacteria	ASM Press	4th Ed	978-1-55581-892-0	707
Klug WS, Cummings MR, Spencer, C, Palladino, M.	Concepts of Genetics	Pearsons	11th Ed.	978-9353940409	896
Pierce BA	Genetics: A Conceptual Approach	WH Freeman	7th Ed.	978-1319308315	976

Nanomedicine

L	T	P	Total Credits
4	0	0	4

Course Objective: To make students acquainted with the fundamental concepts of nanotechnology and developan 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 and YngWang	Nanostructures and Nanomaterials: Synthesis, Properties and Applications	World Scientific, 2011	2004	9814322504, 9789814322508	581
C. M. Niemeyer, C. A. Mirkin	Nanobiotechnology; Concepts, Applications and Perspectives	Wiley-VCH	1st ED/2004	352730658, 978-352730658	491
B. S. Murthy, P. Shankar, B. Raj, B. B. Rath and J. Murday	Textbook of Nanoscience and Nanotechnology	Universities Press-IIM	2012	9788173717383, 978-8173717383	256
T. Pradeep	Nano:The Essentials	Tata McGraw-Hill Publishing Company Ltd.	2007	0070617880, 9780070617889	461

MBO303: Virology

L	T	P	Total Credits
4	0	0	0

Course Objectives: This course will give an overview of important viruses, their mode of replication and methods to control them.

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 Polio virus and T4 phage, maturation and release of virions.	
Unit IV: Viral Diseases, prevention and application of viruses	**18 hrs**

Introduction to oncogenic viruses: Types of oncogenic DNA and RNA viruses: Concepts ofoncogenes 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:

1. Get an exhaustive account of viruses, their structure and classification
2. Learn about replication of viruses
3. Viral diseases and methods to control them
4. 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,	ASM Press	2nd Ed (2000)	978- 1555811273	820
	Pathogenesis andControl				
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	0

Course Objectives: Investigate archaea and extremophiles to understand their unique biology, ecological roles, and potential applications in biotechnology.

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;[Text Wrapping Break]c) 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:

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

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Brock, T. D.	Thermophilic Microorganisms and Lifeat High Temperatures	Springer, NewYork.	1978	978-1-4612-6284-8	468
Fred A Rainey and AharonOren	Extremophiles	Academic press	2006	9780125215367	838

Cell Signalling

L	T	P	Total Credits
2	0	0	2

Course Objectives: Explore cell signaling to understand molecular mechanisms governing cellular communication, facilitating insights into physiological processes, disease pathways, and therapeutic targets.

Course content and syllabus

	Teaching Hours
Unit I: Introduction to Cell Signaling	**9 hrs**
Modes of signaling, signaling molecules, Intracellular and cell surface receptors, Hormonesignaling	
Unit II: GPCR & RTK	**9 hrs**
G-protein mediated signaling, second messengers, receptors tyrosine kinases, Ras-MAPKpathway, 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/Threoninepathways	
Unit IV: Aberrant signaling	**9 hrs**
Cancer, Notch signaling dependent Diseases, Hedgehog signaling dependent Diseases,Diabetes	

Course Learning Outcomes:

1. Differentiate structure, receptors, and mechanism of actions of hormones.
2. Describe pathways of cellular signaling, cross-talk and regulation.
3. 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	13: 978-1-4641- 2610-9	1023

Research Methodology

L	T	P	Total Credits
2	0	0	2

Course Objectives: Examine research methodology to develop critical skills in designing, executing, and analyzing research studies across various disciplines, fostering a comprehensive understanding of scientific inquiry and advancing proficiency in evidence-based research practices.

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:

1. Teach students importance of research conceptualization and planning

2. Teach student how to make effective written and spoken presentations
3. Teach students how to read a research paper

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Kothari, C.R	Research Methodology: Methods and Techniques	New Age International Publishers	4th Ed.	978-9386649225	480
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 Objectives: Analyze biowarfare and bioterrorism to understand the threats posed by biological agents, explore strategies for detection, prevention, and response, and preparedness against bioterrorist threats.

Course content and syllabus

	Teaching Hours
Unit I: Introduction	**9 hrs**
History of Biowarfare. Difference between biowarfare and bioterrorism. Laws preventingthe 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:

1. Will learn about the history of biological warfare
2. Understand the agents used as biological weapons
3. Delivery of Biological Agents
4. Methods to detect and identify biological agents.
5. 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

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 B.Sc. (H) Microbiology (wih Research)- 4 years (6th Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	P	FW	SW	
1	BCH302	Regulation of Gene Expression	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	0	0	0	0	4
4.	MBO304	1. Clinical Microbiology		4	0	0	0	0	4
	BIF301	2. Introductory Bioinformatics							
	MBO305	3. Industrial Microbiology							
		4. Microbial Quality Control in Food and Pharmaceutical Industries							
		5. MOOC							
5.		*Students will choose any two of the given choices***	Skill Enhancement Course						
		1. Biosensonrs		2	0	0	0	0	2
		2. Biomaterials		2	0	0	0	0	2
	CBA301	3. BioEntrepreneurship							
		4. MOOC							

Total Credits **24**

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

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

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

BCH302: Regulation of Gene Expression

L	T	P	Total Credits
4	0	2	6

Course Objectives: An understanding of different ways prokaryotes and eukaryotes regulate the expression of various gene and methods to study DNA-Protein interaction

Course content and syllabus

	Teaching Hours
Unit I: Regulation of Gene Expression in Prokaryotes	**18 hrs**
Regulation of Gene Expression in Prokaryotes: concept of operon, ORF. Control at initiation of transcription. Promoter strength and role of sigma factors. Lac Operon (Genetic and Biochemical aspects), araBAD operon. Catabolite repression. trp and his Operons. Regulation of genes for ribosomal RNA and proteins. Bacterial viruses(Lytic and Lysogenic modes). Role of small molecules and RNA in gene control. Riboswitches and bacterial two component system.	
Unit II: Regulation of Gene Expression in Eukaryotes	**18 hrs**
Regulation of Gene Expression in Eukaryotes: Gene regulation in Yeast (Galactose metabolism, Gal 4 protein, Mating Type), role of mediators, enhancer elements. Chromatin remodelling: histone modification, epigenetic changes Post-transcriptional regulation. RNA silencing: siRNA, miRNA, transitive RNAi, ncRNA. Regulation at translational level	
Unit III: DNA-Protein Interaction	**18 hrs**
Structures of DNA binding domain: HTH, wHTH, zinc fingers, leucine zippers, HL 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 cluste locus control region (LCR): structure and function LCR of mouse globin gene clust Insulators, structure and functions, the insulators of *hsp70* genes of *Drosoph melanogaster*; Genomic imprinting of *Igf-2* and *H-19* genes	

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

1. Will have the knowledge of structure and function of genes
2. Concept and knowledge of different strategies in regulation of gene expression in prokaryotes and eukaryotes
3. Understand structure of DNA-binding domains
4. 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		
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 Bartelet 4th Ed	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 Objectives: Explore synthetic biology to understand the principles of designing and engineering biological systems, enabling the development of novel biotechnological solutions and advancing knowledge in genetic engineering

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 using transposable 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 geneticoscillators 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 prokarytoes 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. Genetically encoded nanosensors, Ratiometric and intensimetric nanosensors. *In vivo* use of nanosensors	

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

1. Understand basic concepts of synthetic biology.
2. Learn to construct artificial gene networks and proteins.
3. Learn the techniques to re-wire genetic networks.
4. 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, and RichardI Kitney	Synthetic Biology — A Primer	World scientific	2012	978-1-84816-863-3	196
Uri Alon,	An Introduction to Systems Biology: Design Principles of Biological Circuits	Chapman & Hall/CRC	2006	139781588 86426	320

MBO304: Clinical Microbiology

L	T	P	Total Credits
4	0	0	0

Course content and syllabus

Course Objectives: This course is a basic introduction to principle of disease and epidemiology, etiology of infectious diseases caused due to microbial pathogens; and knowledge about the available diagnostic methods and their principles.

	Teaching Hours
Unit I: Introduction about disease Epidemiology and host pathogen interaction	**18 hrs**
Normal microflora of the human body: Basic concepts of normal microflora of skin, throat, gastrointestinal tract, urogenital tract **Host pathogen interaction**: Basic Concepts about Infection, Invasion, Virulence, Pathogen, Pathogenicity, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS. **Sample collection, transport and diagnosis**: Method of transportation of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests, Complement fixation, PCR, DNA probes).	
Unit II: Bacterial and Viral diseases	**18 hrs**
Bacterial diseases: Basic Introduction of the following diseases with Symptoms, causes and treatment. **Respiratory Diseases**: *Streptococcus pyogenes, Mycobacterium tuberculosis* ***Gastrointestinal Diseases****: Escherichia coli, Vibrio cholerae,Helicobacter pylori* **Others:** *Staphylococcus aureus, Bacillus anthracis, Clostridium tetani, Clostridium difficile* **Viral diseases**: Introduction about the following viral disease with Symptoms, mode of transmission and control: Polio, Hepatitis, Rabies, Dengue, AIDS, Influenza, Chikungunya,	
Unit III: Protozoan diseases and Fungal diseases	**18 hrs**
Protozoan diseases: Introduction about the following protozoan diseases with Symptoms, mode of transmission and control: Malaria, Kala-azar.	

Fungal diseases: Brief description of each of the following types of mycoses and one representative disease to be studied with respect to transmission, symptoms and prevention. **Cutaneous mycoses:** Tinea pedis (Athlete's foot). **Systemic mycoses:** Histoplasmosis. Opportunistic mycoses: Candidiasis	
Unit IV: Antimicrobial agents: General characteristics and mode of action	**18 hrs**
Antibacterial agents: Basic Introduction about modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism. **Antifungal agents**: Mechanism of action of Amphotericin B, **Antiviral agents**: Mechanism of action of Amantadine, Acyclovir, Azidothymidine Antibiotic resistance, MDR, XDR, MRSA, NDM-1.	

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

1. Understand the principle of disease and epidemiology, etiology of infectious diseases.
2. Perceive basic knowledge about various bacterial and viral diseases
3. Perceive knowledge about various protozoan and fungal diseases
4. Understand the general characteristics and mechanism of action of different antimicrobial agents.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Ananthanarayan R. and Paniker C.K.J.	Textbook of Microbiology	University Press Publication	11th ED/2009	9389211433, 978- 9389211436	680
Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner,T.A.	Jawetz, Melnick and Adelberg's Medical Microbiology	McGraw Hill Publication	26th ED/ 2013	007181292X, 9780071812922 4	864

Willey JM, Sherwood LM, and Woolverton CJ.	Prescott, Harley and Klein's Microbiology. 9th Edition	McGraw Hill Higher Education	2013	0073402400, 9780073402406	1152
Madigan MT, Martinko JM, Dunlap PV and Clark DP.	Brock Biology of Microorganisms. 14th edition.	Pearson International Edition	14th ED/ 2014	0321897390, 978- 0321897398	1032

BIF301: Introductory Bioinformatics

L	T	P	Total Credits
4	0	0	0

Course content and syllabus

Course Ojbectives: Equipping students with foundational knowledge in bioinformatics, enabling them to analyze biological data, navigate bioinformatics tools and databases, and understand the interdisciplinary aspects of this field, thereby preparing them for further studies or careers in bioinformatics and related areas

	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 searchusing BLAST.	
Unit III: Protein Structure Prediction	**18 hrs**
Hierarchy of protein structure - primary, secondary and tertiary structuresStructural 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:

1. Understand role of biological databases and download appropriate literature, sequences and otherrelevant information from biological databases
2. Understand importance of sequence alignment
3. Predict structures of proteins
4. 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, 978- 0521600828	352
Ghosh, Z. and Mallick, B.	Bioinformatics –Principles and Applications	Oxford University Press	2008	0195692306, 9780195692303	560

MBO305: Industrial Microbiology

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

Course content and syllabus

Course Objectives: This course teaches students about utilization of various microbes in industries, principles of fermentation technology and application of microbes in various industries

	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:

1. Understanding fermentation techniques, bioreactor design and media optimization
2. Upstream process for organic acids, alcohols, wine and vinegar
3. Downstream process (Recovery and purification) of antibiotics, enzymes, amino acids and steroids
4. Significance of microbially derived bioproducts for 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 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, 01352039	541

Microbial Quality Control in Food and Pharmaceutical Industries

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

Course Objectives: Providing essential knowledge in maintaining microbial quality control within food and pharmaceutical sectors, ensuring adherence to industry standards and regulations, and equipping students for effective application in their professional roles.

	Teaching Hours
Unit I: Microbiological Laboratory and Safe Practices	**18 hrs**
Good laboratory practices - Good laboratory practices, Good microbiological practices Biosafety cabinets – Working of biosafety cabinets, using protective clothing, specification for BSL-1, BSL-2, BSL-3. Discarding biohazardous waste – Methodology of Disinfection, Autoclaving & Incineration	
Unit II: Determining Microbes in Food / Pharmaceutical Samples	**18 hrs**
Culture and microscopic methods - Standard plate count, Most probable numbers, Direct microscopic counts, Biochemical and immunological methods: Limulus lysate test for endotoxin, gel diffusion, sterility testing for pharmaceutical products. Molecular methods - Nucleic acid probes, PCR based detection, biosensors.	
Unit III: Pathogenic Microorganisms of Importance in Food & Water	**18 hrs**
Enrichment culture technique, Detection of specific microorganisms - on XLD agar, Salmonella Shigella Agar, Manitol salt agar, EMB agar, McConkey Agar, Saboraud Agar Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk at milk collection centres (COB, 10 min Resazurin assay)	
Unit IV: HACCP for Food Safety and Microbial Standards	**18 hrs**
Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water	

Course Learning Outcomes:

1. Develop skills on disinfection of instruments and equipments in laboratory and Hospitals.
2. Develop knowledge and skills on microbiological laboratory safety- General rules and regulations

3. To impart knowledge on different culture techniques.
4. To learn Microbial Standards for Different Foods and Water.

Text / Reference Books:

Author	**Title**	**Publisher**	**Ed/year**	**ISBN No**	**Pages**
Pelczar, M.J. Jr., Chan ECSand Krieg, N.R.	Microbiology: Conceptsand 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

Biosensors

L	T	P	Total Credits
2	0	0	2

Course content and syllabus

Course Objective: Offering fundamental understanding in the design, development, and application of biosensors, and preparing students to employ these advanced technologies across diverse fields such as healthcare, environmental monitoring, and biotechnology.

	Teaching Hours
Unit I: Introduction to Biosensors	**9 hrs**
Introduction to biosensors Biosensor classification Main elements in biosensors. Properties of Biosensors-sensitivity, selectivity and stability.	
Unit II: Biomolecules in biosensors:	**9 hrs**
Biomolecules in biosensors: DNA, enzyme, antibody, antigen, protein, peptide, aptamer, Protein/antibody-based sensors: protein immobilisation, specificity, binding constants, kinetics, diffusion.	
Unit-III: Basics of detection methods	**9 hrs**
Basics of detection methods: Fluorescence Spectroscopy, UV-Vis Absorption and Emission, Surface Plasmon Resonance, Magnetic labeling, Electrochemical Detection. Fundamentals of transducers.	
Unit IV: Applications of biosensing technology	**9 hrs**
Point-of-care diagnosis, molecular diagnostics, Fluorescence and colorimetric biosensors, microfluidics and paper-based diagnostics Detection of viruses and bacteria, Microbial biosensor. Applications of nanotechnology in biosensors.	

Course Learning Outcomes:

1. Perceive knowledge about the biosensor and its classification Understand the working principle of biosensor.
2. Perceive knowledge about different elements of biosensor and their applications in diagnostics.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Donald G. Buerk	Biosensors: Theory and Applications	CRC Press,	2009	ASIN : B07CSVY2HM	232
Brian R. Eggins	Chemical Sensors and Biosensors	John Wiley& Sons	2002	978-0-471-89914-3	300
Ashutosh Tiwari, Anthony P.F. Turner	Biosensors Nanotechnology	Scrivener Publishing LLC	2014	9781118773512	533

Biomaterials

L	T	P	Total Credits
2	0	0	2

Course Objective: To impart knowledge on structure-property relationship in biomaterials and their applicationsas 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, Pathologicalcalcification, Biocompatibility	
Unit IV: Applications	**9 hrs**
Applications of biomaterials: drug delivery, tissue engineering, cardiovascular, orthopedic,dental, functional tissues, etc.	

Course Learning Outcomes:

1. Students will be able to understand the fundamentals and classes of materials.
2. Describe interactions between biomaterials, proteins and cells.
3. Explain methods to modify surfaces of biomaterials and choose material for desired biological response.
4. Analyse the interactions between biomaterial and tissue for short term and long-termimplantations, 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	0123746264, 978-0123746269	1573
J.B. Park and J.D. Bronzino	Biomaterials: Principles and Applications	CRC Press	2002	0849314917, 9780849314919	250
K.C. Dee, D.A. Puleo and R. Bizios	An Introduction to Tissue-Biomaterial Interactions	Wiley	2002	0471253944, 9781280366642	228
T. M. Wright, and S. B. Goodman	Implant Wear in Total Joint Replacement: Clinical and Biologic Issues, Material and Design Considerations	American Academy of Orthopaedic Surgeons	1st ED/ 2001	0892032618, 9780892032617	224
Park J.B. and Lakes R.S	Biomaterials: An Introduction, 3rd edition	Springer press	3rd ED/ 2007	978-0387378794	574

CBA301: 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:

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

List of Professional Skill Development Activities (PSDA):

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

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

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, and Growth (3rd Edition)	Routledge	2020	978-0367466725	356

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 Management	Pearson publishers	2014	978-0133767186	

Programme structure for B.Sc. (H) Microbiology (wih Research)- 4 years (7th Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	P	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. 4.	BTY602	*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 Paper Presentation	NTCC	2	0	0	0	0	2
6.		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 Objective: Providing in-depth knowledge and practical skills in genome engineering techniques, enabling students to manipulate genetic material effectively for applications in biotechnology, medicine, and agriculture.

Course content and syllabus

	Teaching Hours
Unit I: GENOME BIOLOGY	**13 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	**14 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	**13 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	**14 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 = 36 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 assigning functions.

Course Learning Outcomes:

1. Understand basic concepts of Genome.
2. Learn the components of genome expression.
3. Learn the techniques to study whole genomes.
4. 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	Molecular cloning: a laboratory manual,	Cold Spring Harbor Laboratory Press	2nd ED/1989	0879693096 9780879693091	1626
T.A. Brown	Genomes 4	Wiley - Blackwell	2010	9781405181730	338

Cell Culture Technology

L	T	P	Total Credits
3	0	1	4

Course Objectives: To develop an understanding of basic principles underlying in vitro techniques for culture ofanimal 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 culturesand 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, Xeno-transplantatio ,GMP; Regulatory and ethical issues in Animal biotechnology	

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

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

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

1. Laboratory design and GMP practices in animal cell culture laboratory
2. Preparation and sterilization of cell culture media
3. Cryopreservation of cell lines
4. Thawing of frozen cells to initiate a new cell culture and sub-culture (passaging)
5. Cell counting and estimation of cell viability by trypan blue
6. Cell seeding
7. Subculture
8. Cytotoxicity assay by MTT
9. 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

BTY602: IPR, Biosafety and Bioethics

L	T	P	Total Credits
4	0	0	4

Course Objectives: Examine Intellectual Property Rights (IPR), Biosafety, and Bioethics to understand their implications in biotechnology and life sciences, fostering insights into ethical, legal, and safety considerations**.**

Course contents

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

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:

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

Text / Reference Books:

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

Antimicrobial Resistance

L	T	P	Total Credits
4	0	0	0

Course Objective: Providing comprehension knowledge in addressing antimicrobial resistance challenges, equipping students to tackle this global health threat through informed interventions and multidisciplinary approaches.

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 inrelationship 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. Originof the resistome. Various mechanisms of antimicrobial resistance. Analysis of diverse viewpoints on controversial issues related to sources of antibiotic resistance genes and microbes. Various modes of horizontal gene transfer, point mutation, efflux pumps anditsimpact on the evolution of antimicrobial resistant microbes. laboratory diagnosis of AMR, WHO priority pathogens.	
Unit III: Management of Antimicrobial Resistance	**18 hrs**

Antimicrobial stewardship of understanding drug exposure and optimizing use of antibiotics in human and animal health; reduce the incidence of infection through effective sanitation, hygiene and infection prevention measures, non-traditional methodsto 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 modelsto predict the dynamics of antibiotic resistance; quorum sensing inhibitors, interferons, plant based natural compounds, combinatorial approach. Need and importance of AMR surveillance	
Unit IV: Discovery of New Antimicrobials	**18 hrs**
Discovery of New antimicrobials: Strategies for searching new class of antibiotics from sources other than soil. Strategies to culture the unculturable microbes for discovering new antimicrobials. Identification of new antimicrobial targets. Use of combinatorial chemistry to develop novel drugs, developing drugs that inhibit resistance mechanisms, and developing drugs that target virulence factors and holdinfections in check. Use of phages and Antimicrobial Peptides as antibacterials.	

Course Learning Outcomes:

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

Text / Reference Books:

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 Therapy2021	Antimicrobial Therapy	2021	978- 1944272166	308

Animal Biotechnology

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

Course 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 outtechnology 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	2001	0879695757	550

Principles of Pathology

L	T	P	Total Credits
4	0	0	4

Course Objectives: Explore the fundamental principles underlying pathology to understand disease mechanisms and analyze pathological processes to comprehend their impact on human health.

Course Contents 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 featuresof 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, Loss of 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:

1. Understand importance of pathology of diseases.
2. Gain knowledge about various cell responses to cell injuries
3. Perceive knowledge about cancer and its pathology.
4. 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 Interpretatio ns,	Jaypee Brothers Medical Publishers	6th/2009	978-8184484496	1694
Kumar V, Abbas, A.K., and Aster, J.C.	Robbins Basic Pathology	Saunders Elsevier.	8th/2007	978-1437717815	928

Research Paper Presentation

L	T	P	Total Credits
2	0	0	2

Course Objectives: Learn effective techniques for presenting research papers to enhance communication skills and acquire strategies to deliver clear and engaging presentations of research findings for academic and professional audiences.

Course content and syllabus:

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

Research Project

L	T	P	Total Credits
0	0	10	10

Course objective: Undertake research work with an aim of conducting original research and gain proficiency in research methodologies and scholarly inquiries.

Course content and syllabus:

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

Programme structure for B.Sc. (H) Microbiology (wih Research)- 4 years (8th Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	P	FW	SW	
1		Diagnostic Techniques	Core Course	2	0	0	0	0	2
2.		Infectious Diseases and Vaccine Technology	Core Course	2	0	0	0	0	2
3.		*Students will choose any one from the given choices* 1. Environmental and Marine Biology 2. Fermentation Technology 3. MOOC	Specialization Elective Course	4	0	0	0	0	4
4.		*Students will choose any one of the given choices** 1. Biochemical Engineering 2. Biofertilizers and Biopesticides 3. MOOC	Open Elective	4	0	0	0	0	4
5.		Research Project	NTCC	0	0	12	0	0	8
		Total Credits							**24**

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

The Open Elective Course and the Specialization 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 Objective: Learn various diagnostic techniques to identify and assess medical conditions and apply the acquired skills in diagnostic procedures effectively to improve treatment planning

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 ofvarious 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 BlotAssay, 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 nucleotidepolymorphism and plasmid finger printing in clinical microbiology Cytodiagnostic techniques:- Flowcytometry and cell sorting, Immuno florescence, Electron Microscopy (Types of Electron Microscopy, concepts and operations withapplications).	

Course Learning Outcomes:

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

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Detrick, B; Hamilton, R.Gand Folds, J.D.	Manual of Molecular andClinical Laboratory Immunology.	American Society for Microbiolog ypress. 7th edition	8th ED/ 2006	1555818714 978- 1555818715	1240
Tille P.	Bailey's and Scott's Diagnostic Microbiology .13th edition	Mosby.	13th ED/2013	0323083307 978- 0323083300	1056
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.	9th ED/2007	1555813712 97815558131 0	1773

Collee JG, Fraser, AG, Marmion, BP, Simmons A	Mackie and Mccartney Practical Medical Microbiology ,14th edition	Elsevier	14th ed/2007	813120393X 978- 8131203934	992
Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A.	Jawetz, Melnick and Adelberg's Medical Microbiology .	McGraw Hill Publication .	26th ed/ 2004	97800717904 007181292X	864

Infectious Disease and Vaccine Technology

L	T	P	Total Credits
2	0	0	0

Course Objective Explore infectious disease mechanisms and vaccine technologies to understand prevention and treatment strategies.

Course content and syllabus

	Teaching Hours
Unit I Microbes as pathogens	**9 hrs**
Entry of pathogens into the host, types of pathogens, Microbial toxins (exotoxins, enterotoxins, endotoxins, neurotoxins) and virulence factors. Role of horizontal gene transfer in pathogen evolution, Transformation, Conjugation and Transduction, Virulence factors for evasion of host defences, Toxins (cholera, diphtheria, tetanus, botulinum, anthrax), Superantigens, Resistance to antimicrobial peptides (AMPs), AMP efflux pumps; LanFEG and LanI proteins, Iron acquisition mechanisms, Pili and fimbriae as adherence factors, Biofilms.	
Unit II Microbial Diseases	**9 hrs**
Pathogenesis of microbial diseases caused by major human pathogens (E. coli, Salmonella, Helicobacter, Staphylococcus, Mycobacterium, Candida).	
Unit III: Viral Diseases	**9 hrs**
Brief introduction and pathogenesis of emerging viral diseases, HIV, HPV, Zika, Dengue, Chikungunya, Ebola and Marburg and Corona virus.	
Unit IV: Vaccine and Vaccine Technology	**9 hrs**

Vaccines & Vaccination – adjuvants, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, mRNA Vaccines. Principles of vaccination, passive & active immunization, immunization programs & role of WHO in immunization programs.	

Course Learning Outcomes:

1. Understand microbial and viral diseases.
2. Gain knowledge about various microbial toxins and hos pathogen interaction.
3. Understand importance of vaccination.
4. Acquire knowledge about Covid-19 vaccination and its important role.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Alberts B, Johnson A, LewisJ	Molecular Biology of the Cell,	New York, Garland Science	4th/2002	978-0815332183 0815332181	1616
Brenda A. Wilson, Abigail A. Salyers, Dixie D. Whitt, Malcolm E. Winkler	Bacterial Pathogenesis: A molecular approach	ASM Press, Washington ,DC.	3rd/2011	978-0632037759 063203775X	540
Tjeerd G. Kimman	Genetics of Infectious Disease Susceptibility	Springer Science & Business Media.	3rd/2001	0792371550 978-0792371557	250
Apurba Sankar Sastry, SandhyaBhat K	Essentials of Medical Microbiology	Jaypee Brothers Medical Publishers	2nd/2018	9352704797 978-9352704798	714

Environmental and Marine Biology

L	T	P	Total Credits
4	0	0	4

Course Objective: Explore the principles and applications of environmental and marine biology to understand their role in sustainable resource management and conservation efforts.

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 analysing 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:

1. Understand basic concepts of environmental sciences.
2. Learn marine ecology.
3. Learn the biology of polluted waters.
4. 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/Cole2005	2005	978-0534420666	624

Fermentation Technology

L	T	P	Total Credits
4	0	0	4

Course Objective: Delve into fermentation technology to comprehend its applications in various industries and develop skills for optimizing fermentation processes for product enhancement and industrial efficiency.

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 an media (Carbon sources; Nitrogen sources; Vitamins; Minerals; Anti-foaming agents); Role of buffers in media; Process of aeration, and agitation.	
Unit III: design of fermentor	**18 hrs**
Basic designs of Fermentor; Type of fermentors: Waldhof, Tower, Deepjet, Cyclone column, Packed tower and airlift fermenter; Scale up study and Product development;[Text Wrapping Break]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:

1. Design of various reactors used in Industries.
2. Criteria for selection of media for microbial growth and
3. Methods for strain improvement and preservation of cultures.
4. 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

Biochemical Engineering

L	T	P	Total Credits
4	0	0	4

Course Objectives: Master the principles of biochemical engineering for designing bioprocesses and develop skills in bioreactor design, optimization, and bioproduct purification.

Course content and syllabus

	Teaching Hours
Unit I: Microbial growth kinetics	**18 hrs**
Kinetics of microbial growth, substrate utilization and product formation, mass and energy balance in microbial processes	
Unit II: Sterilization	**18 hrs**
Basics of Medium Sterilization, Thermal Death Kinetics, Continuous Sterilization of Media, Air Sterilization Mechanism and Filter Collection Efficiency **.**	
Unit III: Mass Transfer & Scale-Up	**18 hrs**
Mass transfer in Biological reactions, Methods for determination of Mass Transfer Co- efficient , Scale-up principles; Principles of scale up, Criteria of scale up, Problems related to Scale-u	
Unit IV:Batch, Fed Batch & Continuous Fermentation	**18 hrs**
Comparison of batch and continuous fermentation, Analysis of single stage continuous culture, Cell recycle, Two stage continuous Culture, Fed batch fermentation.	

Course Learning Outcomes:

1. Apply unit operations of Biochemical Engineering for commercial purposes.
2. Recognize the mass- transfer and scale up problems in Bioreactor.
3. Selection of Bioreactor and it's mode of operation for specific applications.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages

Stanbury, P.F., Whitaker, A.N.R.	Fermentation Technology,	New York; Madrid : McGraw-Hill,	1997	978-0750645010	957
Doran, P. M.,	Bioprocess Engineering Principles,	Academic Press, California.	2009	0122208560	541

Biofertilizers and Biopesticides

L	T	P	Total Credits
4	0	0	4

Course Objectives: Investigate biofertilizers and biopesticides to understand their ecological impact, application methods, and potential contributions to sustainable agriculture and environmental conservation.

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.[Text Wrapping Break]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, Massinoculum production of VAM, field applications of *Ectomycorrhizae* and VAM. Bioinsecticides- General account of microbes used as bioinsecticides and their advantagesover synthetic pesticides, *Bacillus thuringiensis*, production, Field applications, Viruses –cultivation and field applications.	

Course Learning Outcomes:

1. Understand the symbiotic relationship of biofertilizers and plants.
2. Evaluate classification of biofertilizers and biopesticide

3. Perceive knowledge of host-pathogen interaction.

Text / Reference Books:

Author	**Title**	**Publisher**	**Ed/year**	**ISBN No**	**Pages**
Kannaiyan, S.	Bioetchnology ofBiofertilizers,	CHIPS, Texas	2003	1842650998	612
Cappucino, J.G.	Microbiology-A laboratory manual	Hoboken, N.J.: Pearson	2020	9780135203996	541

Research Project

L	T	P	Total Credits
0	0	12	12

Course objective: Undertake research work with an aim of conducting original research and gain proficiency in research methodologies and scholarly inquiries.

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) Microbiology- 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	BCH605	Advanced Enzymology	Core Course	4	0	0	0	0	4
3	BTY701	Advanced Bioinformatics	Core Course	4	0	0	0	0	4
4	PSY706	Professional Ethics and Responsibilities -I	Value Added Course	1	0	0	0	0	1
5	NTCC	Research Project	NTCC	0	0	12	0	0	12
		Total credits							25

Downstream in Biologicals

L	T	P	Total Credits
4	0	0	4

Course Objectives: By the end of this course, students will gain a comprehensive understanding of downstream processing in biologicals, including purification techniques, chromatography methods, and filtration processes. They will be equipped with the knowledge and skills to effectively design, optimize, and troubleshoot downstream processes, ensuring high product purity, yield, and quality in biopharmaceutical production.

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 ofdownstream processing techniques for a desired bio product.
2. Identify and understand the basic unit operations and primary separation techniques involved indownstream process
3. Learn how to apply various methods to purify biologically processed materials. 4.Analyze the estimation of operating parameters for membrane separation processes.
4. Appraise the best techniques used for the purification of bioproducts.
5. 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 - Principles and techniques	Prentice Hall of India, New Delhi	2010	1782164421	456
F. Stanbury, A. Whitaker, and S.J. Hall	Principles of Fermentation Technology	P Aditya Books	2004	97807506 45010	786

BCH605: Advanced Enzymology

L	T	P	Total Credits
4	0	0	4

Course 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.

Course content and syllabus

	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 models for 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, use of substrate analogues, enzyme modification by chemical procedures affecting amino acid side chains, treatment with class-specific inhibitors and site-directed mutagenesis, by studying the effect of changing pH. A brief account of investigation of three dimensional structure of active site, Structures & mechanisms of selected enzymes: Dehydrogenases, proteases, ribonuclease and lysozyme.	

Unit IV: Enzyme turnover	18 hrs
Enzyme turnover: Kinetics of turnover, methods for measuring rates of enzymesturnover, 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 volumein 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

BTY701: Advanced Bioinformatics

L	T	P	Total Credits
4	0	0	4

Course Objectives: By the end of this course, the students will have acquired a solid foundation in bioinformatics, encompassing essential concepts, tools, and techniques for the analysis of biological data.

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 method of 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

1. Search various biological database and extract biologically relevant information
2. Perform pair-wise and multiple sequence alignment
3. Search sequence database to identify homologous sequences in other organisms
4. Predict secondary and tertiary structure of proteins
5. Predict gene, promoter and regulatory elements
6. 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 University Press	2014	978-0198724674	376

PSY706: Professional Ethics and Responsibilities -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 genetically modified organisms and food	

Course Learning Outcomes:

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

Text / Reference Books:

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

NTCC: Research Project

L	T	P	Total Credits
0	0	12	12

Course objective: Undertake research work with an aim of conducting original research and gain proficiency in research methodologies and scholarly inquiries.

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) Microbiology- 5 years (10th Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	PS	FW	SW	
1	HGM602	Omics Technology 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* 1. Protein Engineering 2. Advanced Immunology and Immunotechniques 3. Structural Biology and Pharmacogenomics 4. MOOC	Specialization Elective Course	4	0	0	0	0	4
4	PSY710	Professional Ethics and Responsibilities -II	Value Added Course	1	0	0	0	0	1
5		Research Project	NTCC	0	0	12	0	0	12
		Total Credits							**25**

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

HGM602: Omics Technology and its Applications

L	T	P	Total Credits
4	0	0	4

Course Objectives: Explore the principles and methodologies of genomics, transcriptomics, proteomics, metabolomics, and microbiomics. Learn to apply cutting-edge bioinformatics tools for data analysis in various fields.

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:

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

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Thomas J. Dougherty and Steven J. Projan	Microbial Genomics and Drug Discovery	CRC	2003	978-0824740412	264
A. Malcolm Campbell, Laurie J. Heyer	Discovering Genomics, Proteomics and Bioinformatics	Pearson Education	2007	978-8131715598	464

Advanced Microbiology

L	T	P	Total Credits
4	0	0	4

Course Objectives: Master advanced microbiological concepts, techniques, and methodologies for conducting sophisticated research and addressing complex challenges in microbiology

Course content and syllabus

	Teaching Hours
Unit I Microbial Physiology	**18 hrs**
Discovery of microbial world, controversy over spontaneous generation, concept of pure culture. Theory and practice of sterilization. Isolation of microorganisms, staining methods, microscopy, preservation of 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:

1. Gain in depth knowledge about microbial diversity, taxonomy and dynamics of microbial interactionswith other populations
2. Understand and define the basic principles of microbiology.
3. Develop the knowledge of microbial cell structure, growth and metabolism
4. Overall understanding about applied aspects of microbiology

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Tortora, Funke and Chase	Microbiology An Introduction	Benjamin Cummings	9th/2006	9780321733603	578
Stanier, Ingraham, Wheelis	General Microbiology	MacMillan	5th/1987	9780333417683	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

Course Objectives: Develop a deep understanding of protein structure, function, and engineering principles. Gain proficiency in designing novel proteins with tailored properties for applications in biotechnology and medicine.

Course content and syllabus

	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:

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

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Voet D. and Voet G.,	Biochemistry	John Wiley and Sons,	3rd /2001	9780321733603	1178
Branden C. and Tooze J.	Introduction to Protein Structure	Garland Publishing, NY, USA	1999	456879994	345

Structural Biology and Pharmacogenomics

L	T	P	Total Credits
4	0	0	4

Course Objectives: Explore the intricate relationship between molecular structures and pharmacogenomics. Learn to analyze and manipulate biological macromolecules for drug discovery and personalized medicine.

Course content and syllabus

	Teaching Hours
Unit I Structural Biology of Proteins and DNA	**18 hrs**
Hierarchial proteins structure, amino acid properties; optical, acid base and absorption, Secondary structures, Peptide bond, Ramachandran plots, Structure of polysaccharides (Cellulose, Starch, Glycogen, peptidodoglycan), Lipids (Phospholipids, Sphingolipids) Common motifs, Helix turn Helix, Greek Key, Tertiary structures, domains, Domains in DNA-binding proteins. Tertiary structures of DNA, ribose ring conformations and puckering, Hoogstein base pairing, Triple helices, DNA topology, Supercoiling, Chou-Fasman method.	
Unit II Introduction to Pharmacogenomics	**18 hrs**
Introduction to pharmacogenomics , Pharmacological and pharmacogenomics approachesto improve drug delivery clinical Outcomes, Genetic polymorphism of CYP isoenzymes and drug transporters, Advancements in molecular pharmacology, informatics, nanotechnology and genomics forthe new drug development era, New pharmacological classes of drugs (antibodies, antisense RNAs, siRNAs, aptamers)	
Unit III: Personalized Drugs	**18 hrs**
Personalized medicine and drug prescription, Pharmacology and pharmacogenomics of cardiovascular system, Clinical pharmacogenomics and drug interactions; Practical utility of various pharmacogenomics resources in the clinical setting.	

Unit IV: Pharmacogenomics of antibodies	18 hrs
Protein drugs and the development of biotherapeutics, Pharmaceutical biotechnology of monoclonal antibodies (mAbs); Pharmacodynamics and pharmacokinetics of mAbs; Pharmacogenomics of mAbs, Development of new innovativemolecularly-targeted cancer therapeutics; Cancer pharmacogenomics and biotherapeutics	

Course Learning Outcomes:

1. Understand basic and variations in structures of DNA and proteins.
2. Gain knowledge about basics of Pharmacogenomics.
3. Understanding about personalized medicine and how genetics play a role in same.
4. Perceive knowledge of antibodies with respect to pharmacogenomics.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Gary Walsh	Pharmaceutical Biotechnology: Concepts and Applications.	John Wiley &Sons: West Sussex.	2007	978-0470012451	807
Daan J. A. Crommelin, Robert D. Sindelar, Bernd Meibohm	Pharmaceutical Biotechnology: Fundamentals and Applications.	Informa Healthcare :New York.	2008	9781420044386	1359
J. Licinio andM.-L. Wong	Pharmacogenomics: The Search for Individualized Therapies.	Wiley-Blackwell	2009	978-3-527-61630-5	599

Nelson, D.L and Cox, M.M	ehringer Principles of Biochemistry	W. H. Freeman;	2021	978-1319228002 1319228003	1248

Advanced Immunology and Immunotechniques

L	T	P	Total Credits
4	0	0	4

Course 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 levelthat 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, MHCrestriction 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:

1. Understanding of mechanisms used by the human body to fight foreign agents and disease-causing pathogens.
2. Students will be able to devise strategies to combat infection or diseases produced by alteredself.
3. Students will develop ability to use this knowledge in the processes of immunization, antibodyengineering, vaccine development, transplantation, and cancer therapy.
4. 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	WH Freeman and Company, USA	2012	978- 1319114701	944
D. Male, J. Brostoff, D.	Immunology	Saunders, Elsevier, USA	2012	978- 0702045486	482

Roth, I. Roitt					
K. Murphy	Janeway's Immunobiology	Garland Science, USA	2011	978-0815342908	887
A. Abbas, A. Lichtman, S. Pillai	Cellular and Molecular Immunology	Saunders, Elsevier, USA	2014	978-8131264577	-

PSY710: Professional Ethics and Responsibilities - 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 aRepresentative 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 theimportance 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:

1. Understand basic concepts of morality in mixed cultures.
2. Learn to resolve the issues in research.
3. Learn to create a bias free work culture.

4. To learn the concept of Sustainability and Responsibility

Text / Reference Books:

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

NTCC: Research Project

L	T	P	Total Credits
0	0	12	12

Course objective: Undertake research work with an aim of conducting original research and gain proficiency in research methodologies and scholarly inquiries.

Course content and syllabus

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