Semester-Wise Programme structure for M.Sc.(H) Biotechnology (2 Years)				
Sr. No.	**Year 1**		**Year 2**	
	Semester 1	**Semester 2**	**Semester 3**	**Semester 4**
1	Advanced Cell Biology [CU:4,L-4] {CC}	Immunology & Immunotechniques [CU:4,L-4] {CC}	Advanced Bioinformatics [CU:4,L-4] {CC}	Bioprocess Engineering and Technology [CU:4,L-4] {CC}
2	Bioanalytical Techniques [CU:4,L-4] {CC}	Molecular Biology & Gene Expression [CU:4,L-4] {CC}	Genetic Engineering and Recombinant DNA Technology [CU:4,L-4] {CC}	Plant and Animal Biotechnology [CU:4,L-4] {AC}
3	Metabolism of Biomolecules [CU:4,L-4] {CC}	Practicals in Biotechnology -II [CU:4,P-4] {CC}	Practicals in Biotechnology -III [CU:2,P-2] {CC}	SE6- [CU:4 , L-4] {SE}
4	Practicals in Biotechnology -I [CU:4,P-4] {CC}	SE3 [CU:4 ,L-4] {SE} {SE}	Fundamentals of BioEntrepreneurship [CU:2,L-2] {CC}	Professional Ethics - II [CU:1, L-1] {VAC}
5	SE1- [CU:4 ,L-4] {SE}	SE4- [CU:4 ,L-4]	Research Paper Presentation [CU:2,P-2] {NTCC}	Dissertation -II [CU:12,P-12] {NTCC}
6	SE2- [CU:4 ,L-4] {SE}	SE5- [CU:4 ,L-4] {SE}	Biostatistics [CU:2,L-2] {CC}	
7	Behavioral Sciences [CU:1,L-1] {VAC}	Behavioral Sciences [CU:1,L-1] {VAC}	Dissertation -I [CU:8,P-8] {NTCC}	-
8	Foreign Business Language (French/German) [CU:1,L-1] {VAC}	Foreign Business Language (French/German) [CU:1,L-1] {VAC}	Professional Ethics - I [CU:1, L-1] {VAC}	-
Credits	**26**	**26**	**25**	**25**
Total Programme Credits				**102**

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 M.Sc. (H) Biotechnology- 2 years (1st Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	P	FW	SW	
1	BCH601	Advanced Cell Biology	Core Courses	4	0	0	0	0	4
2	BCH602	Bioanalytical Techniques	Core Courses	4	0	0	0	0	4
3	BCH609	Metabolism of Biomolecules	Core Courses	4	0	0	0	0	4
4	BTY603	Practicals in Biotechnology-I	Core Course	0	0	4	0	0	4
		*Students will choose any two**	Specialization Elective Course						
	MBO601	1.General Microbiology and Microbial Genetics		4	0	0	0	0	4
	BTY602	2. IPR, Biosafety and Ethics		4	0	0	0	0	4
		3. MOOC							
6	PSY601	Behavioural Science	Value Added Courses	1	0	0	0	0	1
7	FOL101/FOL102	Foreign Business Language (French/German)	Value Added Courses	1	0	0	0	0	1
			Total Credits.						**26**

*The Specialization Elective Courses of 1st, 2nd and 4th Semesters will be pooled together.
* The Specialization Elective Courses can also be taken through MOOC

BCH601: Advanced Cell Biology

L	T	P/S	Total Credit Units
4	0	0	4

Course Objectives: To develop an advanced understanding of the cell, cellular signaling and communications and its genome organization.

Course Contents/syllabus:

	Hours
Unit I: Cell wall and Cell membrane	**18 hrs**
Cell wall and Cell Membrane: Physical structure of model membranes in prokaryotes and eukaryotes, and their constituents; structural organization and functions of cell organelles. **Transport of nutrients:** Ions and macromolecules across membranes. Different classes of pumps and their mechanism. Cellular energy transactions.	
Unit II: Organization of genomes	**18 hrs**
Organization of genomes: Genes and chromosomes, Operon, unique and repetitive DNA, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons. **Cell division and cell cycle:** Mitosis and meiosis, Cell cycle and its regulation, Apoptosis, Necrosis ,Autophagy and other forms of cell death. Contribution of Nobel laureates in elucidation of the DNA structure,cell death and cell cycle. **Cellular basis of differentiation and Development:** Meiosis, gametogenesis, fertilization and up to the formation of three germinal layers	
Unit III: Cell signaling	**18 hrs**
Cell signaling: Hormones and their receptors, cell surface receptor, and signalling mechanisms, bacterial chemotaxis and quorum sensing. **Cell transformation and cancer:** Oncogenes and proto-oncogenes, tumor suppressor genes, metastasis. Therapeutic interventions of uncontrolled cell growth.	
Unit IV: Cellular communication	**18 hrs**
Cellular communication: General principles of cell communication, cell adhesion and roles of different adhesion molecules, tight junctions, communicating junctions, neurotransmission and its regulation.	

Course Learning Outcomes:

- Understand about different component of cell, and cellular signalling and communication mechanisms in the cell.
- Discuss the basic differences in genome of prokaryotic and eukaryotic cells.
- Evaluate various modes of cell signaling and cell transformation mechanisms.
- Analyze the knowledge of nutrient transport mechanisms and cellular basis of differentiation and cellular development.

Pedagogy for Course Delivery:

Lectures: 50 sessions
Presentation / Seminar: 2
Class Test: 2 sessions
Quiz: 6 sessions

Total: 60 sessions

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN	Pages
De-Robertis, F.D.P. and De-Robertis Jr. E.M.F.	Cell and Molecular Biology, Saunders, Philadelphia.	New York: Lippincott Williams & Wilkins,	2011	9780781734936, 0781734932	734

BCH602: Bioanalytical Techniques

L	T	P	Total Credits
4	0	0	4

Course Objectives: Comprehensively understand the theoretical foundations underpinning bioanalytical techniques. Apply acquired knowledge to critically analyze and optimize methodologies for precise biomolecule quantification and analysis**.**

Course content and syllabus

	Teaching Hours
Unit I -Spectroscopy & Chromatography	**18 hrs**
Spectroscopy- Concepts of spectroscopy, Laws of photometry. Beer-Lambert's law, Principles and applications of colorimetry. UV-Visible absorption spectroscopy, Fluorescence spectrophotometry, Mass spectroscopy, CD, X-ray diffraction, X-ray spectroscopy and NMR. **Chromatography –** Principles and applications of paper, thin layer, ion exchange, affinity, gel permeation, adsorption and partition chromatography. HPLC and FPLC.	
Unit II: Centrifugation & Electrophoresis	**18 hrs**
Principle of centrifugation, concepts of RCF, different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation, determination of molecular weights and other applications, sub-cellular fractionation. Electrophoretic techniques – Principles of electrophoretic separation. Types of electrophoresis including paper, cellulose, acetate/nitrate and gel. Electroporation, Pulse field gel electrophoresis, 2D Gel Electrophoresis.	
Unit III: Microscopy	**18 hrs**
Microscopy – Bright field, Dark field, Phase contrast and Fluorescence microscopy, Transmission and scanning, freeze fracture techniques, specific staining of biological materials.	
Unit IV: Nano-biosensors	**18 hrs**
Introduction to Nano-biosensors and their biological applications.	

Course Learning Outcomes:

1. Understand principles of various techniques to quantify and separate biomolecules.
2. Describe the methodology of various bioanalytical techniques employed in laboratories.
3. Discriminate between various techniques with respect to their applications.
4. Evaluate the impact of Nano-biosensors in the advancement of bioanalytical techniques.

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 978-0521178747	744
Plummer, David	An Introduction to Practical Biochemistry	Tata Mc Graw Hills	3rd edition/2017	0070994870 978-0070994874	332

BCH609: Metabolism of Biomolecules

L	T	P	Total Credits
4	0	0	0

Objectives: After studying this course, the students will be able to refresh their knowledge of biomolecules and their metabolism.

Course content and syllabus

	Teaching Hours
Unit I: Carbohydrate metabolism	**18 hrs**
Structure, function, properties, reactions, and classification of carbohydrates; Glycosidic linkage – types, occurrence, and functions of glycoconjugates, Carbohydrate metabolism – degradation and synthesis of carbohydrates, glycolysis, gluconeogenesis, glycogenesis, TCA cycle, Electron transport chain, regulation of carbohydrate metabolism and central carbon metabolism.	
Unit II: Protein metabolism	**18 hrs**
Amino-acids, peptides, and proteins – Classification, biological role, Zwitterion structure, isoelectric point and correlation to acidity and basicity of amino acids. Overview of primary, secondary, tertiary, and quaternary structure of proteins, denaturation of proteins. Amino acid metabolism – biosynthesis and catabolism, amino acids as carbon pool, Autophagy, Protein maturation and secretion	
Unit III: Nucleic acid metabolism	**18 hrs**
Nucleic acids - Structure and function of nucleotides. Primary, secondary and tertiary structure of nucleic acids, DNA forms and conformations. Nucleotides – Biosynthesis and degradation of purine and pyrimidine nucleotides and its regulation.	
Unit IV: Fat metabolism	**18 hrs**
Classification, structure, properties and functions of fatty acids, essential fatty acids, fats, phospholipids, sphingolipids, cerebrosides, steroids, bile acids, prostaglandins and lipoproteins. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol). Biosynthesis and degradation of tri-acylglycerols, phospholipids and sphingolipids, α-, ß- and ω- oxidation of fatty acids,	

Course Learning Outcomes:

1. Understand carbohydrate metabolism.
2. Understand protein metabolism
3. Understand nucleic acid metabolism
4. Understand fat metabolism.

Pedagogy for Course Delivery

Lectures: 60 sessions
Presentation / Seminar: 4 sessions
Class Test: 2 sessions
Surprise Test: 6 sessions
Total: 72 sessions

Text/Reference Books

AUTHOR	TITLE	Publisher	Year of publication	ISBN	Pages
Finar, I. L.	Organic Chemistry (Volume 1 & 2)	Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).	2002	1. 978-8177585421	966 pages
Voet, D. and Voet, J.	Biochemistry	Wiley	4th edition,2013	9781118092446	1616 pages
D.L. Nelson and M.M. Cox	Lehninger Principles of Biochemistry	McMillan North Publication	4th Edition 20	978-1319108243	1328 pages
L. Stryer	Biochemistry	Freeman &Co. New York.	5th Edition	978-0716746843	1050 pages

BTY603: Practicals in Biotechnology – I

L	T	P	Total Credits
0	0	4	4

Objective- this course will teach students about practical aspects of Genetics, Microbiology, Biochemistry and Bioanalytical techniques.

Course content and syllabus

	Weightage (%)	Teaching Hours
Unit I: Bioanalytical Techniques	**25**	**36 hrs**
1. Verification of Lambert-Beers law. 2. Preparation of standard curve. 3. Separation of amino acids by paper/thin-layer chromatography. 4. Plant pigment separation by paper/thin-layer chromatography.		
Unit II: Microbial Growth Studies	**25**	**36 hrs**
1. Preparation of solid/liquid culture media. 2. Isolation and purification of micro-organisms from soil/water/air. 3. Estimation of CFU count by spread/pour plate method. 4. Gram staining of bacterial culture 5. Preservation of microbial pure culture		
Unit III: Biochemistry Techniques	**25**	**36 hrs**
1. Preparation of buffers and solutions 2. Estimation of carbohydrates 3. Estimation of proteins by Bradford method 4. Estimation of proteins using uv-spectroscopy from its molar extinction coefficient. 5. Saponification value of fats/oils		
Unit IV: Molecular Biology and Genetic Techniques	**25**	**36 hrs**
1. Isolation of genomic DNA from bacteria. 2. Isolation of genomic DNA from plant. 3. Quantification of genomic DNA by spectroscopy and nanodrop. 4. Agarose gel electrophoresis.		

Course Learning Outcomes: this course will teach students to-

1. Preparation of culture media and isolation of microbes
2. Quantitative estimation of various biomolecules
3. Microbial growth and effect of different parameters on microbial growth
4. Use of spectroscopy and chromatography in biology

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Plummer, D.T.,	An Introduction to Practical Biochemistry	Tata McGraw-Hill	3rd	0-07-099487-0	332
Ponmurugan, P. and Prabhu, B. G.	Biotechniques	MJP Publishers	2021	978-8180941191	696

MBO601: General Microbiology & Microbial Genetics

L	T	P	Total Credits
4	0	0	4

Course Objectives: The course aims to provide advanced knowledge of methods used in microbiology. Knowledge of bacterial classification system, diversity, and parameters affecting microbial growth will be provided. An insight to bacterial genetics, viruses and their interaction with host cells will also be provided.

Course content and syllabus

	Teaching Hours
Unit I: Types of Microscopy and Principles of Microbiology	**18 hrs**
Microscopy: Bright field, phase contrast, fluorescence, confocal, and electron microscopy. **Principles of Microbiology**: Principles and applications of bright field, dark field, phasecontrast, fluorescence and scanning tunnelling microscopy. **Methods in microbiology:** Pure culture techniques, theory & practice of sterilization, principles of microbial nutrition, microbial culture media, enrichment culture techniques, culture collection, isolation and & preservation.	
Unit II: Bacterial Classification and Diversity	**18 hrs**
Bacterial Classification and Diversity: Importance of taxonomy conventional and modern methods; polyphasic approach of bacterial classification, 16S rRNA **Genomic Similarity:** Content of guanine (G)+ cytosine (C) (%GC), DNA-DNA homology, Fatty acid analysis; archaea as the earliest life forms, archaea vs eubacteria, bacteria producing important secondary metabolites. **Prokaryotic Cells:** Structure-function; cell walls of eubacteria and related molecules, outer membrane of Gram-negative and Gram-positive bacteria, capsules, slime layers, Pili, fimbriae and flagella, sporulation and regeneration of bacteria. **Microbial Growth:** Definition of growth, mathematical expression of growth, growth curve, diauxic & synchronous growth, continuous culture, effect of environmental factors like temperature, pH, water availability, dissolved oxygen, agitation and aeration etc., on the growth of microbes.	
Unit III: Bacterial Genetics and Virology	**18 hrs**

Bacterial Genetics and Virology: Transformation, transduction, conjugation, RecA, plasmids, their replication, copy number and compatibility, drug resistance; transposons, **Viruses**: General characteristics, classification, ultra-structure, purification & assay, viroids; virulent and temperate bacteriophages, γ- lytic cascades and lysogenic repression.	
Unit IV: Host-pathogen interaction	**18 hrs**
Host-pathogen interaction: Recognition and entry processes of different pathogens like bacteria, viruses and protozoans into animal and plant host cells, alteration of hostcell behaviour by pathogens, virus-induced cell transformation, pathogen-induceddiseases in animals and plants, cell-cell fusion in both normal and abnormal cells.	

Course Learning Outcomes:

1. Understand advanced Microbiology.
2. Evaluate bacterial classification and diversity
3. Compare effect of different environment factor on bacterial growth
4. Perceive knowledge of host-pathogen interaction

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Pelczar, M.J. Jr., Chan ECS and Krieg, N.R.	Microbiology: Concepts and Applications	New York; Madrid : McGraw-Hill,	1993	0070492581, 9780070492585	957
Cappucino, J.G.	Microbiology-A laboratory manual, 4th ed., Harlow, Addition-Wesley.	Hoboken, N.J.:Pearson	2020	0135188997, 9780135203996, 0135203996	541

BTY602: IPR, Biosafety and Bioethics

L	T	P	Total Credits
4	0	0	4

Objective: To teach students about the Intellectual Property Rights, Biosafety and ethics in Biology

Course content and syllabus

	Teaching Hours
Unit I: Introduction to IPR and Patent Database	**18 hrs**
Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications. **Protection of New GMOs:** International framework for the protection of IP. IPs ofrelevance 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, GEACetc. for GMO applications in food and agriculture; Environmental release of GMOs; RiskAnalysis; **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 management of 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; EthicalTerms; 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 evidencein 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 Book

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

PSY601: Behavioural Science: Understanding Self for Effectiveness

L	T	P	Total Credits
1	0	0	1

Course Contents/syllabus:

	Teaching time
Unit I: Self: Core Competency	**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 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	**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 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 perception of 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	9788126580027
Towers, Marc	Self Esteem	American Media	1995	9781884926297
Pedler Mike, Burgoyne John, Boydell Tom	A Manager's Guide to Self-Development	McGraw-Hill	2006	978-0077114701
Covey, R. Stephen	Seven habits of Highly	Simon & Schuster Ltd	2013	978-1451639612

	Effective People			
Khera Shiv	You Can Win	Macmillan	2005	978-03339374 02
Gegax Tom	Winning in the Game of Life	Harmony Books	1999	978-06096039 25
Singh, Dalip	Emotional Intelligence at Work	Publications	2006	97807619 35322
Goleman, Daniel	Emotional Intelligence	Bantam Books	2007	97805530 95036
Goleman, Daniel	ing with E.I	Bantam Books	1998	97805531 04622

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)	**5 hrs**
Introduction to German as a global language, Self-introduction and Greetings, DieAlphabeten, Phonetics: the sound of consonants and vowels, Wie buchstabieren Sie Ihren Name?	
Unit-II- Numbers and everyday conversation (die Zahl und Gespräche)	**4 hrs**
Counting in German from 1-100, Simple Calculation and verb 'kosten' - Wie vielkostet 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)	**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 hrs**
The Family, Work-life and Professions (Familienmitglieder und Berufe) Vocabulary: Professions and conjugation of the verb 'sein' Introduction to simplepossessive 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 themselvesin writing and orally in basic German. This course content focuses on the speech of the students in a lucid and a concurrent manner using appropriate vocabulary and pronunciation techniques. Extra stress will be given on their understanding of grammatical structures and the foreign accent of the language. At the end of the course, the student shall be able to:

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 Study Course German Guide	Wiley	2007	978-0470165515

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	**5 hrs**
• Description of objects, people and places • Nationalities • Speaking about one's professions • Expressing Actions using regular –er ending verbs; avoir, être; reflexive verbs –usage, conjuagation • Interview of celebrity	
Unit-IV- At the discotheque	**4 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 Internation al 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

Programme structure for M.Sc. (H) Biotechnology- 2 years (2nd Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	P	FW	SW	
1	IMM601	Immunology and Immunotechniques	Core Course	4	0	0	0	0	4
2	HGM603	Molecular Biology and Gene Expression	Core Course	4	0	0	0	0	4
3	BTY604	Practicals in Biotechnology-II	Core Course	0	0	4	0	0	4
4	 MBO604 BCH610 BCH605	*Students will choose any **three** from the given choices** 1. Food and Industrial Microbiology 2. Essentials in Biotechnology 3. Topics in Life Sciences 4. Advanced Enzymology 5. Nanobiotechnology 6. MOOC	Specialization Elective Course	 4 4 4	 0 0 0	 0 0 0	 0 0 0	 0 0 0	 4 4 4
5	PSY610	Behavioural Science	Value Added Course	1	0	0	0	0	1
6	FOL103/ FOL104	Foreign Business Language	Value Added Course	1	0	0	0	0	1
		Total Credits							**26**

*The Specialization Elective Course of 1st, 2nd and 4th semesters will be pooled together.

*The Specialization Elective Course can also be taken through MOOC

IMM601: 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 level that work together to protect the host, autoimmune disorders and Immunotechniques.

Course content and syllabus

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

Course Learning Outcomes:

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 altered self.
3. Students will develop ability to use this knowledge in the processes of immunization, antibody engineering, 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 (8th Edition)	WH Freeman and Company, USA	2012	978-1319114701	944
D. Male, J. Brostoff, D. Roth, I. Roitt	Immunology (8th Edition)	Saunders, Elsevier, USA	2012	978-0702045486	482
K. Murphy	Janeway's Immunobiology (8th Edition)	Garland Science, USA	2011	978-0815342908	887
A. Abbas, A. Lichtman, S. Pillai	Cellular and Molecular Immunology (8th Edition)	Saunders, Elsevier, USA	2014	978-8131264577	-

HGM603: Molecular Biology and Gene Expression

L	T	P	Total Credits
4	0	0	4

Course Objective: The objective of this course is to teach students the molecular details of the process of DNA replication, transcription and translation in prokaryotes and eukaryotes and regulation of gene expression.

Course content and syllabus:

	Teaching Hours
Unit I: DNA Replication	**18 hrs**
DNA replication in Prokaryotes: Initiation, Elongation and Termination. Regulation of replication. DNA replication in Eukaryotes: Initiation, Elongation and Termination. End-Replication problem.	
Unit II: RNA Transcription	**18 hrs**
RNA synthesis and processing in prokaryotes and eukaryotes: transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, spilicing, and polyadenylarion, structure and function of different types of RNA, non-coding RNA, RNA transport.	
Unit III: Translation of Proteins	**18 hrs**
Protein synthesis and processing in prokaryotes and eukaryotes: Ribosome structure, genetic code, aminoacylation of tRNA, tRNA-identity aminoacyl tRNA synthetases, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, translation proof-reading, translational inhibitors. Post-translational modifications of proteins.	
Unit IV: Regulation of Gene Expression	**18 hrs**
Regulation of Gene Expression in Bacteria: Concept of operon, lac operon, catabolite repression, trp operon Phages: control of lytic and lysogenic cycles Regulation of Gene Expression in Eukaryotes: Regulatory promoters, enhancers and silencers. Transcription activator protein. Role of mediator protein in transcription. Gal4 operon. Chromatin remodeling and Epigenetic modifications.	

Course Learning Outcomes:

1. Molecular mechanisms of DNA replication in prokaryotes and Eukaryotes
2. DNA transcription in prokaryotes and eukaryotes
3. Protein synthesis in prokaryotes and eukaryotes
4. regulation of gene expression

Text / Reference Books:

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

BTY604: Practicals in Biotechnology-II

L	T	P	Total Credits
0	0	4	4

Objective- this course will teach students about practical aspects of Molecular biology, Immunology and Immunotechniques, Enzymology and Microbiology courses.

Course content and syllabus

	Weightage (%)	Teaching Hours
Unit I	**25**	**36 hrs**
1. Bacterial/Plant/animal DNA isolation. 2. Plasmid isolation and spectrophotometric estimation. 3. Restriction Digestion of given DNA sample. 4. Gel Electrophoresis.		
Unit II	**25**	**36 hrs**
1. To estimate the amount of chlorophyll from the given plant explants. 2. To estimate presence of amylase in the given sample. 3. To estimate presence of catalase in the given sample. 4. To estimate presence of peroxidase in the given sample.		
Unit III	**25**	**36 hrs**
1.Determine of growth of bacteria by turbidity method. 2. To study the effect of different heavy metals on bacterial growth. 3. Antibiotic sensitivity test-agar diffusion method/disc method. 4. Synthesis of Silver nanoparticles and characterization. 5. Antibacterial activity of silver nanoparticles.		
Unit IV	**25**	**36 hrs**
5. Blood Group Identification-Blood typing. 6. Immunodiffusion/Agglutination assays. 7. Immunoglobulin purification and analysis. 8. Dot ELISA.		

Course Learning Outcomes: this course will teach students to-

1. Understand principles of DNA isolation techniques.
2. Quantitative estimation of various important enzymes/biomolecules.
3. Microbial growth and effect of antibiotics and nanoparticles on microbial growth.
4. Use of immunology based techniques

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Plummer, D.T.,	An Introduction to Practical Biochemistry	Tata McGraw-Hill	2017	978-0070994874	332
Ponmurugan, P. and Prabhu, B. G.	Biotechniques	MJP Publishers	2021	978-8180941191	696

Maheshwari, D.K.,	Practical Microbiology	S Chand & Company	2010	978-8121921534	413

MBO604: Food and Industrial Microbiology

L	T	P	Total Credits
4	0	0	4

Objectives: After studying this course, the students will be able to understand the scope of food microbiology and food safety and will obtain the knowledge about microorganisms associate with food and their characteristics.

Course content and syllabus

	Teaching Hours
Unit I: Introduction to Food and Industrial Microbiology	**18 hrs**
Brief history, development and interrelated scope of food and industrial microbiology. Types of microorganisms associated with foods and industrial processes. Factors affecting growth and survival of food/industrial microbes. Instrumentation and control strategies in food microbiology.	
Unit II: Microbial Food Spoilage and Food-Borne Diseases	**18 hrs**
Sources of microorganisms in foods, some important food spoilage microorganisms; Microbial spoilage of industrially important food products- milk and dairy products, meat, poultry and seafood, fruits and vegetables and canned products. Types of food-borne diseases –infections, intoxications and toxi-infections; Origin and symptoms of common food borne diseases and their preventive measures; Recent outbreaks and emergence of food pathogens.	
Unit III: Principles and Methods of Food Preservation, Sanitation and Quality Management	**18 hrs**
Principles of food preservation: physical methods viz. high temperature preservation (D, Z and F Values). Preservation by drying, chemical preservatives and natural antimicrobials. Application of bio-protective cultures in food preservation. Advanced and modified packaging techniques used in industries for improvement in product shelf life. Food sanitation quality control and management – HACCP, FSSAI, Codex, ISO22000.	
Unit IV: Strategies for Industrial Food Production and Analysis	**18 hrs**
Microorganisms and processes involved in the production of single cell protein and industrial alcohol, beer and wine, organic acids (citric and lactic), antibiotics, enzymes and vitamins. Microorganisms and processes involved in the production	

of fermented foods. Qualitative and quantitative enumeration of food microbes; conventional and automated ones. Rapid methods- immunoassays, PCR, ELISA.	

Course Learning Outcomes:

- Understanding of interactions between microorganisms and the food environment, and factors influencing their growth and survival.
- Developing students' perspectives on the use of basic and advanced microbiological methods for analysis of industrial food products.
- Enhancing the ability of students for comparing various physical and chemical methods used in the control of microorganisms.
- Empowering students with a knowledge on production of different industrial products from microorganisms that might help them in enhancing their career building and entrepreneurship skills.

Pedagogy for Course Delivery

Lectures: 60 sessions
Presentation / Seminar: 04 sessions
Class Test: 02 sessions
Surprise Test: 06 sessions
Total: 72 sessions

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Frazier,W. C. and Westhoff, D. C. 2004	Food Microbiology. 5th edition	McGraw Hill	2017	978-1259062513	512
Jay, J. M. 1992	Modern Food Microbiology	Springer-Verlag New York Inc.	2002	978-0387231808	790
Okafor, N. 2007	Modern Industrial Microbiology and Biotechnology	CRC Press; 1st edition	2007	978-1578085132	550
Ray, B. 2004.	Fundamental Food Microbiology	CRC Press, Washington	2013	978-1466564435	665

	3rd	D.C. USA.			
Waites, M. J. 2001.	Industrial Microbiology : An Introduction.	Blackwell Science, London.	2001	978-0632053070	304
Crueger W and Crueger A. (2000).	Biotechnology: A textbook of Industrial Microbiology 2nd Edition	Panima Publishing Company, New Delhi.	2017	978-9385998638	192
Prescott, Harley and Klein's	Microbiology.9thEdition	McGraw Hill Higher education.	2013	978-0073402406	2272

Essentials in Biotechnology

L	T	P	Total Credits
4	0	0	4

Objective: The objective of this course is to provide students with in-depth knowledge of concepts significant to crack CSIR-NET, ICAR-JRF, ICMR-JRF, GATE-Biotechnology.

Course content and syllabus

	Teaching Hours
Unit I: Biomolecular structure and function	**18 hrs**
Structure of atoms, molecules and chemical bonds. Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins). Stablizing interactions. Principles of biophysical chemistry. Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers. F. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes. Protein and Nucleic acid structure and function.	
Unit II: Cellular Organization	**18 hrs**
Cell wall and cell membrane, structural organization and function of cell organelles, organization of genome, cell division and cell cycle (Mitosis, meiosis and regulation), autophagy, apoptosis, cell transformation and cancer.	
Unit III: Fundamental Processes	**18 hrs**
DNA replication, repair and recombination, RNA synthesis and processing, Protein synthesis and processing, Control of gene expression at transcription and translation level	
Unit IV: Recombinant DNA Technology	**18 hrs**
Enzymes-applications in RDT, DNA/RNA isolation and purification, Molecular cloning of DNA and RNA in bacterial and eukaryotic systems, Plasmid, phage, cosmid, BAC and YAC vectors, in vitro mutagenesis, DNA sequencing, nucleic acid amplification, DNA polymorphism-RFLP, RAPD, AFLP.	

(Total Teaching = 72 hrs)

Course Learning Outcomes:

1. Gain knowledge about various biomolecules and their associated functions.
2. Understanding the concepts of cellular organization and regulation.
3. Perceive knowledge of central dogma of life.
4. Develop ability to use various techniques of RDT in research work.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Lubert Stryer, John L Tymoczko and Gregory J. Gatto	Biochemistry	W.H. Freeman Company	2015	1319114652	1208
H. Lodish	Molecular cell biology	W.H. Freeman Company	2016	978-1464187445	1280
Watson JD, Baker TA, Stephen PB, Alexander G, Lewin M, Losick R	Molecular Biology of the gene	Pearson Ed.	$_7$th	978-9332585478	912
J. Sambrook, E.F. Fritsch and T. Maniatis	Molecular cloning: a laboratory manual	Cold Spring Harbour Laboratory Press	1989	0879695756	2344

BCH610: Topics in Life Sciences

L	T	P	Total Credits
4	0	0	4

Objective: The objective of this course is to provide students with in-depth knowledge of conceptssignificant to crack CSIR-NET, ICAR-JRF, ICMR-JRF, GATE-Biotechnology.

Course content and syllabus:

	Teaching Hours
Unit I: Inheritance Biology	**18 hrs**
Mendelian principles: Dominance, segregation, independent assortment. Concept of gene: Allele, multiple alleles, pseudo allele, complementation Tests. Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited, and sex influenced characters. Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants. Extra chromosomal inheritance: Inheritanceof Mitochondrial and chloroplast genes, maternal inheritance. Recombination: Homologous and non-homologous recombination including transposition.	
Unit II: Genetic Variations	**18 hrs**
Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. **Quantitative genetics:** Polygenic inheritance, heritability and its measurements, QTL mapping. **Mutation:** Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.	
Unit III: Cell Communication and Cell signaling	**18 hrs**
G-Protein Molecular Organization, Structural Features of G Protein Activation, Structural Determinants of Receptor–G-Protein Specificity; Cytokine Signalling Proteins: JAK Structure and Localization, JAK-STAT pathway, RTK, Nuclear receptors , STAT Structure and Function, Inhibition of Cytokine Signalling Integrins, cadherins, Ras-MAPK pathway, Hedgehog, PI3K, Notch, Serine/Threonine pathways, lipid signalling	
Unit IV: Developmental Biology	**18 hrs**
Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development. Use of Drosophila as model organism for studying developmental biology.	

Production of gametes, cell surface molecules in sperm-egg recognition in animals; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis.	

Course Learning Outcomes:

1. Gain knowledge about Mendelian principles and various exceptions to it.
2. Understanding the concepts of enzymes and biochemical processes.
3. Perceive knowledge of mechanisms used by the human body to fight foreign agents anddisease-causing pathogens.
4. Discriminate between various techniques with respect to their applications.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Gardner EJ, Simmons MJ, Snustad DP	Principles of Genetics	Wiley-India	6th/2008	978-0471291312	480
Peter F Stanbury, Allan Whitaker, Stephen J Hall	Principles of Fermentation Technology	Butterworth-Heinemann Press. UK	2016	978-0070492585	367
J. Owen, J. Punt, S. Stranford	Kuby Immunology (8th Edition)	WH Freeman and Company, USA	2018	978-1319114701	944
D. Male, J. Brostoff, D. Roth, I. Roitt	Immunology (8th Edition)	Saunders, Elsevier, USA	2017	978-1118415771	576
Wilson K., Walker J.	Principle and Techniques of Biochemistry and Molecular Biology	Cambridge University Press	2010	978-0521178747	744

BCH605: Advanced Enzymology

L	T	P	Total Credits
4	0	0	4

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

	Teaching Hours
Unit I: Enzyme Kinetics	
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).	**18 hrs**
Unit II: Chemical mechanisms of enzyme catalysed reactions	
Methods of pre-steady state analysis: Rapid mixing and sampling techniques, Relaxation methods, Absolute concentration of enzymes, Sigmoidal Kinetics: Cooperativity phenomenon for protein ligand binding, symmetric & sequential models for action of allosteric enzymes and their significance, Hill and Scatchard plots.	**18 hrs**
Unit III: Investigating the active site structure	
Identification of active site of enzymes: By trapping of enzyme-substrate complex, use of substrate analogues, enzyme modification by chemical procedures affecting amino acid side chains, treatment with class-specific inhibitors and site-directed mutagenesis, by studying the effect of changing pH. A brief account of investigation of three dimensional structure of active site, Structures & mechanisms of selected enzymes: Dehydrogenases, proteases, ribonuclease and lysozyme.	**18 hrs**
Unit IV: Enzyme turnover	
Enzyme turnover: Kinetics of turnover, methods for measuring rates of enzymes turnover, Correlation between rates of turnover and the structure and functions of enzymes, Mechanism of enzyme degradation, significance of enzyme turnover.	**18 hrs**

Course Learning Outcomes:

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

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Ram Sarup Singh, Reeta Rani Singhania, Ashok Pandey, Christian Larroche	Advances in Enzyme Technology - A volume in Biomass, Biofuels, Biochemicals	Elsevier	2019	978-0-444-64114-4	-

N. S. Punekar	Enzymes: Catalysis, Kinetics and Mechanisms	Springer	2018	978-981-13-0784-3	562

Nanobiotechnology

L	T	P	Total Credits
4	0	0	4

Course Objectives: The objective of this course is to acquaint students with the fundamentals of nanomaterials and potential aspects of utilization of nanomaterials in various domains of biotechnological applications.

Course content and syllabus

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

Course Learning Outcomes:

Students will be able to

1. Comprehend the concept of "nanotechnology" and its interdisciplinary aspects.

2. Learn various approaches of synthesizing nanomaterials, their advantages, and limitations.

3. Gain knowledge about various techniques used for characterizing nanomaterials.

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

Text / Reference Books:

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

PSY610: Behavioural Science

L	T	P	Total Credits
1	0	0	1

Course Contents/syllabus:

	No. of Session
Unit-1- Individual differences & Personality	**5 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	**4 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	**5 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	**4 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	978-8131704172	266
Umang Malhotra	Individual, Society, and the World	iUniverse	2004	978-0595662401	188
Tonja R. Conerly & Kathleen Holmes	Introduction to Sociology 3e	Openstax	2015	9781711493978	458
Daksh Tyagi	"A Nation of Idiots"	Every Protest	2019	978-8194275015	350

FOL103: French Grammar

L	T	P	Total Credits
1	0	0	1

Course content and syllabus

	Teaching Hours
Unit I: My family and my house	**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 simpleway on everyday topics. This course content focuses on the speech of the students in a lucid and a concurrent manner using appropriate vocabulary and pronunciation techniques. Extra stress will be given on their understanding of grammatical structures and the foreign accent of the language. At theend 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	978-9380809069	---
Collins Dictionaries	Easy Learning French Complete Grammar, Verbs and Vocabulary	Collins	2016	978-0008141721	---
Nikita Desai, Samapita DeySarkar	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	**5 hrs**
• Introduction of time • Read text related to time and teach the students the time expressions • Exercises related to Time • Adverbs of time and time related prepositions • Vocabulary: Countries, Nationalities, and their languages • Negation: “nicht/ kein” • Ja/Nein Fragen. • All the colors and color related vocabulary, adjectives, and opposites • Exercises and comprehension for the same	
Unit II: Irregular verbs (unregelmässige Verben)	**4 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)	**4 hrs**
• Introduction to the concept of object (Akkusativ) • Formation of sentences along with the translation and difference between nominative and accusative articles • Usage of accusative Definite articles • Usage of accusative Indefinite articles	
Unit IV: Accusative case: possessive pronouns (Akkusati Kasus: Possessivpronomen) Family and Relationship	**5 hrs**
• Accusative Personal Pronouns: - Revision of the nominative personal pronouns and introduction of accusative. Applicability of pronouns for both persons and things. • Usage of accusative Personal Pronouns • Introduction of accusative possessive pronouns • Difference between nominative and accusative possessive pronouns • usage of accusative possessive pronouns	

Course Learning Outcomes: After completing these modules, the students will be

capable of constructing sentences with possessive and demonstrative adjectives in German. In addition, they willbe proficient in formulating meaningful sentences as they will be capable of applying their knowledgeof all the irregular verbs they have learnt during the session. They will also have an idea of German culture by studying about various German festivals.

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

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

Programme structure for M.Sc. (H) Biotechnology- 2 years (3rd Semester)

S.No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	P	FW	SW	
1	BTY701	Advanced Bioinformatics	Core Course	4	0	0	0	0	4
2	BTY702	Genetic Engineering and Recombinant DNA Technology	Core Course	4	0	0	0	0	4
3	BTY703	Practicals in Biotechnology-III	Core Course	0	0	2	0	0	2
4	CBA705	Fundamentals of BioEntrepreneurship	Core Course	2	0	0	0	0	2
5	STA701	Biostatistics	Core Course	2	0	0	0	0	2
5	NTCC	Seminar	NTCC	0	0	2	0	0	2
6	NTCC	Dissertation -I	NTCC	0	0	8	0	0	8
6	PSY706	Professional Ethics and Responsibilities -I	Value Added Course	1	0	0	0	0	1
		Total Credits							**25**

BTY701: Advanced Bioinformatics

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

Course objective: The student will be able to extract information from biological databases and using existing softwares will be able to analyse and use this information to better understand the biological system

	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. Molecular visualization softwares: RasMol, Pymol, Cn3D, VMD etc. Information retrieval from biological databases- NCBI resource, Entrez, Pubmed, MEDLINE.	
Unit II: Sequence Alignment	**18 hrs**
Introduction to sequence alignment: Pairwise Sequence Alignment, Global alignmentand Local alignment, general, gap and affine penality. DotPlot, Scoring functions, Substitution Matrices- PAM and BLOSUM matrices. Dynamic Programming- implementation of the Needleman and Wunsch algorithm and Smith Waterman Algorithm for pairwise alignment and testing alignment score Multiple Sequence Alignment- consensus sequence, motifs and profiles. SP (Sum of Pairs) measure.Progressive method of of Sequence Alignemnt: Clustal W, Clustal X, T- COFFEE	
Unit III: Sequence Database search and Protein Structure Prediction	**18 hrs**
Sequence database search using BLAST and FASTA. Word method and k-tuple methodof sequence alignment. Significance of alignment score: E-value and bit-score, p-vaue. Variants of BLAST-blastN, blastP, blastX, TblastN, TblastX. Hidden Markov Model, Position Specific Scoring Matrix Methods to predict secondary structure of proteins Methods to predict tertiary structure of proteins: Homology modelling, threading, ab-initio modelling	
Unit IV: Gene Prediction and Phylogenetics	**18 hrs**
Prediction of Genes in Prokayrotes and EukaryotesPrediction 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 protein structure, gene promoter and regulatory elements and compare

genomes.

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

BTY702: Genetic Engineering and Recombinant DNA Technology

L	T	P	Total Credits
4	0	0	4

Course Objectives: Explore the fundamental principles of genetic engineering and recombinant DNA technology. Develop a deep understanding of techniques for gene manipulation and their applications in biotechnology and medicine.

Course content and syllabus

	Teaching Hours
Unit I: Genetic Recombination	**18 hrs**
Basic laws of Mendelian Genetics, Yeast Genetics as a tool to understand unlinked and liked genes, Tetrad analysis, linkage analysis, Measurement of genetic distance, Single nucleotide polymorphisms, Haplotype analysis, Haplotype as a tool for measuring genetic variation and relatedness,	
Unit II: Genetic manipulation mechanisms	**18 hrs**
Restriction-Modification systems in bacteria, cloning by complementation and selection, screening versus selection, Molecular mechanism of genetic recombination- homologous recombination, non homologous end-joining, RecBCD, Rec A and RuvABC systems, Eukaryotic recombinases like Rad51, Cre-Lox system of recombination, Gene knockout and knock-in strategies, CRISPR, TALENs, ZFN nucleases, Gene therapy	
Unit III: Gene knock-down strategies	**18 hrs**
Heterochromatin and euchromatin, Anti-sense methods of gene silencing, RNA interference, discovery and mechanisms in plants, animals and yeast, role of Dicer, Rdp and Ago1, Role in RNA degradation and link with heterochromatin silencing, miRNA and translational suppression and applications, gene silencing and DNA methylation, X-inactivation, role of RNA in X-inactivation	
Unit IV: Other genetic manipulation approaches	**18 hrs**
Other recombination systems, like RNA splicing, protein splicing, RNA editing, DNA cloning vectors in bacteria, yeast, plants and animals, bacteriophage vectors and systems of transformation, Design of expression vectors in different species, library construction vectors, DNA elimination in Trypanosomes	

Course Learning Outcomes:

Students will be able to:

1. Understand basic concepts of DNA integrity and genetic alterations.
2. Understand the concept of DNA cloning and vector
3. Understanding objectives and methods of knock-in and knockout techniques
4. Understand various genetic tools available for genetic manipulation in different organism

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
J. Sambrook, E. F. Fritsch, and T. Maniatis, 2nd Edn.,	Molecular cloning: A laboratory manual,	Cold Spring Harbor Laboratory Press	3rd Ed	978-0879695767	2344
T.A. Brown	Gene Cloning and DNA Analysis - An introduction	Wiley - Blackwell	2010	9781405181730	338
D. Voet, J. G Voet and C. W. Pratt	Fundamentals of Biochemistry, 5th Edition	John Wiley	5th edition, 2016	978-1-118-91840-1	1184
D.L. Nelson and M.M. Cox	Lehninger Principles of Biochemistry	Mcmillan	8th Edition	13: 978-1-319-32234-2 (epub)	4381

BTY703: Practicals in Biotechnology-III

L	T	P	Total Credits
0	0	2	2

Objective- This course will teach students about procedures routinely conducted in a biotechnology laboratory.

Course content and syllabus

	Teaching Hours
Unit I: Biological Databases	**18 hrs**
1. Retrieve protein, DNA sequences from databases. 2. Identify exons, introns, and promoter regions in a DNA sequence. 3. Identify motifs and conserved domains in a protein sequence. 4. Retrieve 3D structures of proteins and DNA-protein complexes	
Unit II: DNA and Protein Sequence Analysis	**18 hrs**
1. Pairwise and Multiple sequence alignment of DNA using clustal (or any other software) 2. Phylogenetic tree construction using maximum likelihood algorithm 3. Creating heatmaps, volcano plots, and principal component analysis of Omics data	
Unit III: Polymerase Chain Reaction	**18 hrs**
1. Polymerase Chain Reaction – Instrumentation and usage 2. Primer design for gene cloning, gene tagging, gene expression cassette, gene deletion cassette, site directed mutagenesis 3. Hot Start PCR, and applications. 4. Quantitative PCR, RT-PCR	
Unit IV: DNA Cloning – Basic and advanced	**18 hrs**
1. Gene cloning – Concepts and design of vectors 2. Restriction digestion of PCR fragments, Gel extraction 3. Klenow fragment, Alkaline phosphatase, T4 polynucleotide kinase and their application in Gene cloning 4. DNA ligation – basic; concepts of NEB Builder assembly, and Golden Gate assembly 5. Gene Transformation in *E. coli* and selection of positive clones	

Course Learning Outcomes: This course will teach students to-

1. use basic bio-informatic procedures needed in a biotechnology lab
2. conduct sequence alignments and create phylogenetic tree based on it
3. perform PCR and learn variants to create different modifications in a DNA fragment
4. perform DNA cloning using vectors and learn the use of different enzymes used in the procedure

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
T A Brown	GENE CLONING AND DNA ANALYSIS: AN INTRODUCTION	Wiley Blackwell	8th Edition	978-1119640783/ 1119640784	432

CBA705: Fundamentals of 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 hrs**
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: Understanding Creativity and Innovation	**9 hrs**
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	
Unit III: Product Planning and Development Process & Business Plan Development	**9 hrs**
Product Planning and Development Process – Idea Stage, Concept Stage, Product Development Stage, Test Marketing Stage, and Commercialization Stage; Technology Readiness Levels; Intellectual Property Rights; 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	
Unit IV: Sources of Capital and Institutional Support for Entrepreneurs	**9 hrs**
Sources of Funding for Entrepreneurs: Bootstrapping, Friends and Family Members, Crowdfunding, Angel Investment, Venture Capital, Financial Institutions, Bank Loans, Trade Credit, Initial Public Offerings/Issue of Shares, Debentures; Role of Government in Promoting Entrepreneurship: Atal Innovation Mission, Biotechnology Industry Research Assistance Council, Department of	

Science and Technology, Digital India, Jan Dhan-Aadhaar-Mobile, Make in India, National Skill Development Mission, Pradhan Mantri Kaushal Vikas Yojana, Science for Equity Empowerment and Development, Stand-Up India, Start-Up India, Support to Training and Employment Programme for women, Trade-Related Entrepreneurship Assistance and Development, USAID	

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

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

List of Professional Skill Development Activities (PSDA):

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

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

Lectures: 25 sessions
Presentation / Seminar: 5
Mid Term Test and End Term Test: 2 sessions
Assignment: 2 sessions
PSDA: 2 sessions
Quiz: -
Total: 36 sessions

Text / Reference Books:

Author	Title	Publisher	Year of publication	ISBN	Pages
Evan J. Douglas	Entrepreneurial Intention: Past, Present, and Future Research	Edward Elgar Publishing	2020	978-1-78897-522-3	216

Justin G. Longenecker, J. William Petty, Leslie E. Palich, and Frank Hoy	Small Business Management: Launching & Growing Entrepreneurial Ventures (20th Edition)	Cengage	2023	978-0-3577-1880-3	712
Mike Kennard	Innovation and Entrepreneurship	Routledge	2021	978-0-367-51057-2	114
Debasish Biswas and Chanchal Dey	Entrepreneurship Development in India	Routledge	2021	978-0-367-76219-3	117
Robert D. Hisrich, Micheal P. Peters, Dean A. Shepherd, Sabyasachi Sinha	Entrepreneurship (11th Edition)	McGraw Hill	2020	978-9390113309	696
Donald F. Kuratko and Jeffrey S. Hornsby	New Venture Management: The Entrepreneur's Roadmap for Development, Management, 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,	Springer	2017	978-3-319-50465-0	230

	Planning, Risk Management, and Organization				
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	

STA701: Biostatistics

L	T	P	Total Credits
2	0	0	2

Course Objectives: Master statistical methods applied to biological data analysis. Develop skills to interpret and critically assess research findings in biological sciences.

Course Contents/syllabus:

	Teaching Hours
Unit I	**9 hrs**
Introduction to probability, measures of central tendency and measures ofdispersion. Fundamentals Random variables: discrete and continuous and their properties	
Unit II	**9 hrs**
Transformation of random variable and Probability integral transformation, Discrete distributions and continuous distributions	
Unit III	**9 hrs**
Multiple random variable, Joint and Marginal distributions, Bivariate transformation, Covariance and correlation	
Unit IV	**9 hrs**
Random sample, and properties of random sample, Fundamental of Sampling distribution and hypothesis testing	

Course Learning Outcomes: On the successful completion of this course the student will be able tounderstand the:

1. basics of the probability
2. concept of random variable and transformation of random variable
3. statistical distributions and their applications in the real-world problems
4. random sample and their properties

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
Rohatgi V. K. andSaleh, A.K. Md. E.	An Introduction toProbability and Statistics	2nd Edition, John Wiley and Sons	2009	9788126519262, 9788126519262
Casella G. andBerger R. L.	Statistical Inference	2nd Edition, Cengage Learning India	2002	9788131503942, 9788131503942
Hogg R. V., Mckean J. andCraig A. T	Introduction to Mathematical Statistics	7th Edition, Pearson Education India	2013	9789332519114, 9789332519114

Mukhopadhyay P	Mathematical Statistics	Books and Allied	2016	9788187134930

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]	**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 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 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]	**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

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Text / Reference Books:

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

NTCC: Research Paper Presentation

L	T	P	Total Credits
0	0	2	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

Students will present the latest research/review article published in a reputed international peer-reviewed journal.

NTCC: Dissertation -I

L	T	P	Total Credits
0	0	8	8

Course objectives: 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 M.Sc. (H) Biotechnology- 2 years (4th Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	PS	FW	SW	
1	BTY601	Bioprocess Engineering and Technology	Core Course	4	0	0	0	0	4
2	BTY705	Plant and Animal Biotechnology	Allied Course	4	0	0	0	0	4
3	 HGM602 HGM601	*Students will choose any one from the given choices** 1. Synthetic Biology and Biofuels 2. Omics Technology and Applications 3. Stem Cell and Regenerative Medicine 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	NTCC	Dissertation -II	NTCC	0	0	12	0	0	12
		Total Credits							**25**

*The Specialization Elective Course of 1st, 2nd, and 4th semesters will be pooled together.

*The Specialization Elective Course can also be taken through MOOC.

BTY601: Bioprocess Engineering and Technology

L	T	P	Total Credits
4	0	0	4

Objective: The objectives of this course are to educate students about the fundamental concepts of bioprocess technology and its related applications, thus preparing them to meet the challenges of the new and emerging areas of biotechnology industry.

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: Bioreactor design and analysis	**18 hrs**
Batch and continuous fermenters; modifying continuous reactors: chemostat with recycle, fed-batch operations- Variable Volume fed -batch, fixed volume fed-batch ; conventional fermentation v/s biotransformation; immobilized cell systems; large scale animal and plant cell cultivation; upstream processing: media formulation and optimization; sterilization; aeration, agitation and heat transfer in bioprocess; scale up and scaledown;measurement and control of bioprocess parameters.	
Unit III: Downstream processing and product recovery	**18 hrs**
Separation of insoluble products - filtration, centrifugation, sedimentation, flocculation; Celldisruption;separation of soluble products: liquid-liquid extraction, precipitation, chromatographic techniques, reverse osmosis, ultra and micro filtration, electrophoresis; final purification: drying; crystallization; storage and packaging	
Unit IV: Applications of enzyme technology in food processing	**18 hrs**
Mechanism of enzyme function and reactions in process techniques; enzymatic bioconversions e.g. starch and sugar conversion processes; high-fructose corn syrup; interesterified fat; hydrolyzed protein etc. and their downstream processing; baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing; cheese making by proteases, and various other enzyme catalytic actions in food processing. (α amylase, pectinase, lactase)	

Course Learning Outcomes:

Students will be able to:

- Recall the concepts of design and formulation of production media for fermentation.
- Explain design and operations of various fermenters
- Identify unit operations together with the fundamental principles for basic methods in production technique for bio-based products.
- Compare different microbial/enzymatic industrial processes in food and fuel industry.

Text / Reference Books:

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

BTY705: Plant and Animal Biotechnology

L	T	P	Total Credits
4	0	0	4

Objective: This course will provide students with the fundamental and advanced concepts of the principles, practices and application of animal biotechnology, plant tissue culture, plant and animal genomics, genetic transformation and molecular breeding of plants and animals.

Course content and syllabus

	Teaching Hours
Unit I: Plant tissue culture and animal cell culture	**18 hrs**
Plant tissue culture: historical perspective; totipotency; organogenesis; Somatic embryogenesis; establishment of cultures – callus culture, cell suspension culture, media preparation – nutrients and plant hormones; sterilization techniques; applications of tissue culture - micropropagation; somaclonal variation; androgenesis and its applications in genetics and plant breeding; germplasm conservation and cryopreservation; synthetic seed production; protoplast culture and somatic hybridization - protoplast isolation; culture and usage; somatic hybridization - methods and applications; cybrids and somatic cell genetics; plant cell cultures for secondary metabolite production. **Animal cell culture:** brief history of animal cell culture; cell culture media and reagents; culture of mammalian cells, tissues and organs; primary culture, secondary culture, continuous cell lines, suspension cultures; application of animal cell culture for virus isolation and in vitro testing of drugs, testing of toxicity of environmental pollutants in cell culture, application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.	
Unit II: Plant genetic manipulation	**18 hrs**
Genetic engineering: Agrobacterium-plant interaction; virulence; Ti and Ri plasmids; opines and their significance; T-DNA transfer; disarmed Ti plasmid; Genetic transformation - Agrobacterium-mediated gene delivery; cointegrate and binary vectors and their utility; direct gene transfer - PEG-mediated, electroporation, particle bombardment and alternative methods; screenable and selectable markers; characterization of transgenics; chloroplast transformation; marker-free methodologies; advanced methodologies - cisgenesis, intragenesis and genome editing; molecular pharming - concept of plants as biofactories, production of industrial enzymes and pharmaceutically important compounds.	
Unit III: Animal reproductive biotechnology and vaccinology	**18 hrs**
Animal reproductive biotechnology: structure of sperms and ovum; cryopreservation of sperms and ova of livestock; artificial insemination; super ovulation, embryo recovery and in vitro fertilization; culture of embryos; cryopreservation of embryos; embryo transfer technology; transgenic manipulation of animal embryos; applications of transgenic animal technology; animal cloning - basic concept, cloning for conservation of endangered species; Vaccinology: history of development of vaccines, introduction to the concept of vaccines, conventional methods of animal vaccine production, recombinant approaches to vaccine production, modern	

vaccines.	
Unit IV: Molecular mapping and marker assisted selection	**18 hrs**
Molecular markers - hybridization and PCR based markers RFLP, RAPD, STS, SSR, AFLP, SNP markers; DNA fingerprinting-principles and applications; introduction to mapping of genes/QTLs; marker-assisted selection - strategies for Introducing genes of biotic and abiotic stress resistance in plants: genetic basis for disease resistance in animals; molecular diagnostics of pathogens in plants and animals; detection of meat adulteration using DNA based methods.	

Course Learning Outcomes:

Students will be able to:

1. Gather knowledge about plant cell culture and transformation.
2. Acquire in depth knowledge about several techniques used in Recombinant DNA Technology for use of plant biotechnology.
3. Apply in depth knowledge about isolation and maintenance of animal cells in culture and their application in the production of human and animal viral vaccines, antibodies and pharmaceutical proteins.
4. Apply knowledge of different molecular diagnostic techniques for various applications.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Ralf Pörtner	Animal Cell Biotechnology : Methods and Protocols.	Springer Protocols, Humana Press	4th/ 2020	978-1071601907	413
Bernard R. Glick, Cheryl L. Patten	Molecular Biotechnology: Principles and Applications of Recombinant DNA	ASM Press	6th/2022	978-1683673644	896
S. H. Mantell, J. A. Matthews, R. A. McKee	Principles of Plant Biotechnology: An Introduction to Genetic Engineering in Plants	Blackwell Science Inc	2008	978-0632012152	269
B.B. Buchanan, W. Gruissem, and R.L Jones	Biochemistry & Molecular Biology of Plants.	John Wiley and Sons	2nd/2015	978-0470714218	1280

Synthetic Biology and Biofuels

L	T	P	Total Credits
4	0	0	4

Objectives: After studying this course, the students will be able to understand the fundamentals of synthetic and system biology and apply them in their research areas

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 genetic oscillators and toggle switches, consequences of gene expression variability, examples of synthetic networks – Biofuels and green chemicals.	
Unit III: [Fundamentals of System Biology]	**18 hrs**
Stochastic gene expression in prokaryotes and eukaryotes- extrinsic and intrinsic noise, re-wiring of genetic networks to perform cellular functions, Identification of functional units ("network motifs") within large gene interaction networks, a classic study of variability in bacterial gene expression, a classic study of variability in cultured cells, and quantitative PCR-based methods to count mRNAs in individual cells	
Unit IV: [Biofuels]	**18 hrs**
First, Second, third and fourth generation biofuels and technologies; types, microbial production of biofuels, lignocellulose - structure, degradation and role of enzymes, co-utilization of mixed sugars, cost analysis, genome editing of microbes to produce ethanol, butanol, jet-fuels, biodiesel, and bio-hydrogen	

Course Learning Outcomes:

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

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Bas JHM Rosier, Tom FA de Greef	Synthetic Biology: How to make an oscillator	eLife Sciences Publications, Ltd	2015		
Edited By: Paul S Freemont (Imperial College, UK)	Synthetic Biology — A Primer	World scientific	2012	ISBN: 978-1-84816-863-3	196

and Richard I Kitney (Imperial College, UK)					
Uri Alon,	An Introduction to Systems Biology: Design Principles of Biological Circuits	Chapman & Hall/CRC	2006	ISBN-13978-1584886426	

HGM602: Omics Technology and 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:

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

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages

Thomas J. Dougherty and Steven J. Projan	Microbial Genomics and Drug Discovery	CRC	2003	978-0824740412	264
A. Malcolm Campbell, Laurie J. Heyer	Discovering Genomics, Proteomics and Bioinformatics	Pearson Education	2007	978-8131715598	464

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

Course Learning Outcomes:

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

Text / Reference Books:

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

Dissertation -II

L	T	P	Total Credits
0	0	12	12

Course objectives: 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 a research work under the supervision of a faculty member.