Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF BIOSCIENCES AND TECHNOLOGY

M.Sc Integrated Biotechnology (5yr.)

Curriculum

(*2018-2019 admitted students*)

VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

World class Education: Excellence in education, grounded in ethics and critical thinking, for improvement of life.

Cutting edge Research: An innovation ecosystem to extend knowledge and solve critical problems.

Impactful People: Happy, accountable, caring and effective workforce and students.

Rewarding Co-creations: Active collaboration with national & international industries & universities for productivity and economic development.

Service to Society: Service to the region and world through knowledge and compassion.

VISION STATEMENT OF THE SCHOOL OF BIOSCIENCES AND TECHNOLOGY

To nurture high-quality bioengineers and science graduates with the potential to innovate, invent and disseminate knowledge for the benefit of society and environment.

MISSION STATEMENT OF THE SCHOOL OF BIOSCIENCES AND TECHNOLOGY

- To create opportunities for multi-disciplinary education, training and research in biotechnology and bio-sciences.
- To instill a spirit of innovation and creativity in young minds from across the globe with sound research aptitude.
- To foster ethically strong biologists who effectively contribute towards the growth of the nation.

VIT
Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

M.Sc Integrated Biotechnology (5yr.)

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. Graduates will be practitioners and leaders in their chosen field.

2. Graduates will function in their profession with social awareness and responsibility

3. Graduates will interact with their peers in other disciplines in their work place and society and contribute to the economic growth of the country

4. Graduates will be successful in pursuing higher studies in their chosen field

5. Graduates will pursue career paths in teaching or research.

M.Sc Integrated Biotechnology (5yr.)

PROGRAMME OUTCOMES (POs)

PO_02: Having a clear understanding of the subject related concepts and of contemporary issues and apply them to identify, formulate and analyse complex engineering problems.

PO_04: Having an ability to design and conduct experiments, as well as to analyse and interpret data, and synthesis of information

PO_05: Having an ability to use techniques, skills, resources and modern engineering and IT tools necessary for engineering practice

PO_06: Having problem solving ability- to assess social issues (societal, health, safety, legal and cultural) and engineering problems

PO_07: Having adaptive thinking and adaptability in relation to environmental context and sustainable development

PO_08: Having a clear understanding of professional and ethical responsibility

PO_09: Having cross cultural competency exhibited by working as a member or in teams

PO_10: Having a good working knowledge of communicating in English – communication with engineering community and society

PO_11: Having a good cognitive load management skills related to project management and finance

PO_12: Having interest and recognise the need for independent and lifelong learning

M.Sc Integrated Biotechnology (5yr.)

ADDITIONAL PROGRAMME OUTCOMES (APOs)

APO_01: Having an ability to be socially intelligent with good SIQ (Social Intelligence Quotient) and EQ (Emotional Quotient)

APO_02: Having Sense-Making Skills of creating unique insights in what is being seen or observed (Higher level thinking skills which cannot be codified) (University Elective)

APO_03: Having design thinking capability

APO_04: Having computational thinking (Ability to translate vast data in to abstract concepts and to understand database reasoning

APO_05: Having Virtual Collaborating ability

APO_06: Having an ability to use the social media effectively for productive use

APO_07: Having critical thinking and innovative skills

APO_08: Having a good digital footprint

M.Sc Integrated Biotechnology (5yr.)

PROGRAMME SPECIFIC OUTCOMES (PSOs)

On completion of M.Sc Integrated Biotechnology (5yr.) programme, graduates will be able to

- PSO1: Gain and apply knowledge to plan, analyze and find innovative solutions in the field of biological sciences.

- PSO2: Explore problems and provide valid solutions through the industry-academia interactions.

- PSO3: Acquire interdisciplinary knowledge in the areas of biological, chemical, environmental and technical sciences for the benefit of society.

M.Sc Integrated Biotechnology (5yr.)

CREDIT STRUCTURE

Category-wise Credit distribution

Category	Credits
University core (UC)	66
Programme core (PC)	70
Programmme elective (PE)	62
University elective (UE)	12
Bridge course (BC)	0
Total credits	210

M.Sc Integrated Biotechnology (5yr.)

DETAILED CURRICULUM

University Core

S. No.	Course Code	Course Title	L	T	P	J	C
1	BIY4098	Comprehensive Examination	0	0	0	0	2
2	BIY6099	Masters Thesis	0	0	0	0	16
3	CHY1003	Environmental Studies	2	0	0	4	3
4	CHY1005	Allied Chemistry	3	0	0	0	3
5	CSE1012	Introduction to Computers and their Applications	2	0	2	0	3
6	CSE2009	Computer Programming for Biologists	2	0	2	0	3
7	ENG1001	Basic English	0	0	2	4	2
8	ENG1012	Communicative English	0	0	2	4	2
9	HUM1032	Ethics and Values	1	0	0	4	2
10	MAT1001	Fundamentals of Mathematics	3	1	0	0	4
11	MAT1012	Statistical Applications	2	0	2	0	3
12	MGT1022	Lean Start-up Management	1	0	0	4	2
13	PHY1003	Physics	3	0	2	4	5
14	FLC4097	Foreign Language Course Basket	0	0	0	0	2
15	SET4001	Science, Engineering and Technology Project - I	0	0	0	0	2
16	SET4002	Science, Engineering and Technology Project - II	0	0	0	0	2
17	EXC4097	Co-Extra Curricular Basket	0	0	0	0	2
18	STS5097	Soft Skills Course Basket	0	0	0	0	8

M.Sc Integrated Biotechnology (5yr.)

Programme Core

S. No.	Course Code	Course Title	L	T	P	J	C
1	BIY1001	Biochemistry	3	0	2	0	4
2	BIY1002	Cell Biology	3	0	2	0	4
3	BIY1003	Biodiversity and Conservation Biology	2	0	0	4	3
4	BIY1004	Genetics	2	0	0	4	3
5	BIY1005	General Microbiology	2	0	2	4	4
6	BIY1006	Human Anatomy and Physiology	3	0	0	0	3
7	BIY1007	Molecular Biology	3	0	2	0	4
8	BIY1008	Research Methodology	3	0	2	0	4
9	BIY1009	Analytical Techniques	3	0	2	0	4
10	BIY1010	Immunology	3	0	2	0	4
11	BIY1011	Fundamentals of Chemical Engineering	3	0	0	0	3
12	BIY1012	Bioinformatics	2	0	2	4	4
13	BIY1013	Bioresource Management	2	0	0	4	3
14	BIY1014	Bio-Business and IPR	2	0	0	4	3
15	BIY2001	Microbial Genetics	3	0	0	0	3
16	BIY2002	Genetic Engineering	3	0	2	0	4
17	BIY2003	Bioprocess Principles	3	0	0	0	3
18	BIY2009	Genomics	3	0	0	0	3
19	BIY2011	Proteomics	3	0	0	0	3
20	BIY3001	Downstream Processing	3	0	2	0	4

M.Sc Integrated Biotechnology (5yr.)

Programme Elective

S. No.	Course Code	Course Title	L	T	P	J	C
1	BIY1015	Environmental Health	2	0	0	4	3
2	BIY1016	Behavioral Sciences	2	0	0	4	3
3	BIY1017	Pharmaceutical Biotechnology	3	0	0	0	3
4	BIY1018	Industrial Biotechnology	2	0	0	4	3
5	BIY1019	Nanobiotechnology	2	0	0	4	3
6	BIY1020	Vaccinology	3	0	0	0	3
7	BIY1021	Epidemiology	2	0	0	4	3
8	BIY1022	Nutraceuticals	3	0	0	0	3
9	BIY1023	Nutrition and Health	3	0	0	0	3
10	BIY1024	Computational Biochemistry and Biomedicine	3	0	0	0	3
11	BIY1025	Plant Biology	3	0	0	0	3
12	BIY1026	Forensic Science	3	0	0	0	3
13	BIY2004	Biophysics	3	0	0	0	3
14	BIY2005	Advanced Biochemistry	3	0	0	0	3
15	BIY2006	Clinical Biochemistry	2	0	0	4	3
16	BIY2007	Developmental Biology	3	0	0	0	3
17	BIY2008	Biological Databases	2	0	2	4	4
18	BIY2010	Plant Biotechnology	2	0	2	4	4
19	BIY2012	Enzymology	2	0	2	4	4
20	BIY2013	Molecular Endocrinology	3	0	0	0	3
21	BIY2014	Aquatic Biotechnology	2	0	0	4	3
22	BIY2015	Biological Spectroscopy	3	0	0	0	3
23	BIY2016	Stem Cell Technology	3	0	0	0	3
24	BIY2017	Neurobiology	3	0	0	0	3
25	BIY2018	Bioremediation	2	0	0	4	3

26	BIY2019	Molecular Evolution and Phylogeny	3	0	2	0	4
27	BIY3002	Environmental Genetics	3	0	0	0	3
28	BIY3003	Protein Engineering	2	0	0	4	3
29	BIY3004	Molecular Modeling and Drug Design	3	0	2	0	4
30	BIY4001	Cancer Biology	3	0	0	0	3
31	BIY4002	Food Science	2	0	2	4	4
32	BIY5001	Animal Biotechnology	3	0	0	0	3
33	BIY5002	Gene Therapy	3	0	0	0	3
34	BIY5003	Enzyme Technology	2	0	0	4	3
35	BIY5004	Food Biotechnology	2	0	0	4	3
36	BIY5005	Environmental Biotechnology	2	0	0	4	3
37	BIY5006	Medical Biotechnology	3	0	0	0	3

M.Sc Integrated Biotechnology (5yr.)

University Elective Baskets

Management courses

Sl.No	Code	Title	L	T	P	J	C
1	MGT1001	Basic Accounting	3	0	0	0	3
2	MGT1002	Principles of Management	2	0	0	4	3
3	MGT1003	Economics for Engineers	2	0	0	4	3
4	MGT1004	Resource Management	2	0	0	4	3
5	MGT1005	Design, Systems and Society	2	0	0	4	3
6	MGT1006	Environmental and Sustainability Assessment	2	0	0	4	3
7	MGT1007	Gender, Culture and Technology	2	0	0	4	3
8	MGT1008	Impact of Information Systems on Society	2	0	0	4	3
9	MGT1009	Technological Change and Entrepreneurship	2	0	0	4	3
10	MGT1010	Total Quality Management	2	2	0	0	3
11	MGT1014	Supply Chain Management	3	0	0	0	3
12	MGT1015	Business Mathematics	3	0	0	0	3
13	MGT1016	Intellectual Property Rights	3	0	0	0	3
14	MGT1017	Business Regulatory Framework For Start-ups	3	0	0	0	3
15	MGT1018	Consumer Behaviour	3	0	0	0	3
16	MGT1019	Services Marketing	3	0	0	0	3
17	MGT1020	Marketing Analytics	2	0	2	0	3
18	MGT1021	Digital and Social Media Marketing	3	0	0	0	3
19	MGT1022	Lean Start-up Management	1	0	0	4	2
20	MGT1023	Fundamentals of Human Resource Management	3	0	0	4	4
21	MGT1024	Organizational Behaviour	3	0	0	4	4

22	MGT1025	Foundations of Management And Organizational Behaviour	3	0	0	4	4
23	MGT1026	Information Assurance and Auditing	2	0	0	4	3
24	MGT1028	Accounting and Financial Management	2	2	0	4	4
25	MGT1029	Financial Management	2	1	0	4	4
26	MGT1030	Entrepreneurship Development	3	0	0	4	4
27	MGT1031	International Business	3	0	0	4	4
28	MGT1032	Managing Asian Business	3	0	0	4	4
29	MGT1033	Research Methods in Management	2	1	0	4	4
30	MGT1034	Project Management	3	0	0	4	4
31	MGT1035	Operations Management	3	0	0	0	3
32	MGT1036	Principles of Marketing	3	0	0	4	4
33	MGT1037	Financial Accounting and Analysis	2	1	0	4	4
34	MGT1038	Financial Econometrics	2	0	0	4	3
35	MGT1039	Financial Markets and Institutions	2	0	0	4	3
36	MGT1040	Personal Financial Planning	2	0	0	4	3
37	MGT1041	Financial Derivatives	2	1	0	4	4
38	MGT1042	Investment Analysis and Portfolio Management	2	0	0	4	3
39	MGT1043	Applications in Neuro Marketing	3	0	0	4	4
40	MGT1044	Global Brand Marketing Strategies	3	0	0	4	4
41	MGT1045	Industrial Marketing	3	0	0	4	4
42	MGT1046	Sales and Distribution Management	3	0	0	4	4
43	MGT1047	Social Marketing	3	0	0	4	4
44	MGT1048	Political Economy of Globalization	3	0	0	4	4
45	MGT1049	Sustainable Business Models	3	0	0	4	4
46	MGT1050	Software Engineering Management	2	0	0	4	3
47	MGT1051	Business Analytics for Engineers	2	2	0	0	3
48	MGT1052	Bottom of the Pyramid Operations	3	0	0	0	3

49	MGT1053	Entrepreneurship Development, Business Communication and IPR	1	0	2	0	2
50	MGT1054	Product Planning and Strategy	2	2	0	0	3
51	MGT1055	Design Management	2	2	0	0	3
52	MGT1056	Accounting and Financial Management	3	0	0	4	4
53	MGT6001	Organizational Behaviour	2	0	0	4	3

Humanities courses

Sl.No	**Code**	**Title**	**L**	**T**	**P**	**J**	**C**
1	HUM1001	Fundamentals of Cyber Laws	3	0	0	0	3
2	HUM1002	Business Laws	3	0	0	0	3
3	HUM1003	Basic Taxation for Engineers	3	0	0	0	3
4	HUM1004	Corporate Law for Engineers	3	0	0	0	3
5	HUM1005	Cost Accounting for Engineers	3	0	0	0	3
6	HUM1006	Business Accounting for Engineers	3	0	0	0	3
7	HUM1007	Contemporary Legal Framework for Business	3	0	0	0	3
8	HUM1009	International Business	3	0	0	0	3
9	HUM1010	Foreign Trade Environment	3	0	0	0	3
10	HUM1011	Export Business	3	0	0	0	3
11	HUM1012	Introduction to Sociology	3	0	0	0	3
12	HUM1013	Population Studies	3	0	0	0	3
13	HUM1021	Ethics and Values	2	0	0	0	2
14	HUM1022	Psychology in Everyday Life	2	0	0	4	2
15	HUM1023	Indian Heritage and Culture	2	0	0	4	2
16	HUM1024	India and Contemporary World	2	0	0	4	2
17	HUM1025	Indian Classical Music	1	0	2	4	1
18	HUM1033	Micro Economics	3	0	0	0	3
19	HUM1034	Macro Economics	3	0	0	0	3
20	HUM1035	Introductory Econometrics	2	0	2	0	2

21	HUM1036	Engineering Economics and Decision Analysis	2	0	0	4	2
22	HUM1037	Applied Game Theory	2	0	0	4	2
23	HUM1038	International Economics	3	0	0	0	3
24	HUM1039	Community Development in India	2	0	0	4	2
25	HUM1040	Indian Social Problems	3	0	0	0	3
26	HUM1041	Indian Society Structure and Change	3	0	0	0	3
27	HUM1042	Industrial Relations and Labour Welfare in India	3	0	0	0	3
28	HUM1043	Mass Media and Society	2	0	0	4	2
29	HUM1044	Network Society	3	0	0	0	3
30	HUM1045	Introduction to Psychology	2	0	2	0	2
31	HUM1706	Business Accounting for Engineers	3	0	0	0	3

UNIVERSITY CORES

BIY6099 Masters Thesis		L	T	P	J	C
		0	0	0	0	14
Pre-requisite	**As per the academic regulations**	**Syllabus version**				
		1.0				

Course Objectives:

To provide sufficient hands-on learning experience related to the area of specialization with a focus on research orientation

Expected Course Outcome:

At the end of the course, the student will be able to

1. Formulate specific problem statements for ill-defined real-life problems with reasonable assumptions and constraints.
2. Perform a literature search and/or patent search in the area of interest.
3. Design and Conduct experiments
4. Perform error analysis /benchmarking/costing
5. Synthesize the results and arrive at scientific conclusions
6. Document the results in the form of technical report/presentation

Student Learning Outcomes (SLO):	**9, 20**

9. Having problem-solving ability- solving social issues and engineering problems
20. Having a good digital footprint

Contents

1. It can be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, correlation and analysis of data, software development, applied research, and any other related activities.
2. The project can be for one or two semesters based on the completion of the required number of credits as per the academic regulations.
3. It should be individual work.
4. Carried out inside or outside the university, in any relevant industry or research institution.
5. Publications in the peer-reviewed journals / International Conferences will be an added advantage

Mode of Evaluation: Periodic reviews, Presentation, Final oral viva, Poster submission

Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th AC	Date	18.03.2016

Course code	Comprehensive Examination	L	T	P	J	C
BIY4098		0	0	0	0	2
Pre-requisite		Syllabus version				
		1.00				

Student Learning Outcomes (SLO):	2

[2] Having a clear understanding of the subject related concepts and of contemporary issues

Module 1:

Biochemistry: Foundation of biochemistry, Carbohydrates, Amino acids and Proteins, Lipids and Nucleic acids. Analytical Techniques in Biotechnology: Lab Practices and Sampling, Analytical Lab, Standard Operating Procedures, Physico-chemical analyses, Spectrometry, Electrophoresis and chromatography, Mass Spectrometry and NMR.

Module 2:

Cell Biology and Genetics: Cell structure and function, Transport across cell membranes, Cell signalling, motility and integration, Mechanisms of inheritance, Evolution and genetic applications. Molecular Biology: Chromosomes, DNA, Transcription, translation, Retroviruses and recombination - transformation, conjugation, transduction.

Module 3:

Immunology: The Immune System, Humoral Immune responses, Cellular Immune responses, Immunity to infection, Immunology of transplantation. Genetic Engineering: Concepts of Recombinant DNA technology, Tool enzymes, Vectors, Gene cloning strategies, Polymerase chain reaction.

Module 4:

Animal Biotechnology: Introduction to Physiology, Neurotransmitters and Nervous system, Animal Cell Technology and its applications, Animal Reproductive Biotechnology, Transgenic animals & transgenic engineering.

Module 5:

Microbiology: Tools in Microbiology, Morphology and Taxonomy, metabolisms of microorganism, Microbial growth, Applied Microbiology. Plant Biotechnology: Plant growth and development, Plant genome Organization and Tissue culture, Plant transformation, transgenic plants, Marker technology.

Module 6:

Pharmaceutical Biotechnology: General pharmacology, Pharmacology, Formulating Biotech

drugs, Biotech drugs, Clinical Trials & Regulations.			
Module 7			
Plant Biotechnology: Plant growth and development, Plant genome Organization and Tissue culture, Plant transformation, transgenic plants, Marker technology.			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th AC	40th AC	18-03-2016

Course code	Course title	L	T	P	J	C
CHY1003	Environmental Studies	3	0	0	0	3
Pre-requisite	None	Syllabus version				
		1.1				

Course Objectives: (C Ob) The course is aimed at

- To make students understand and appreciate the unity of life in all its forms and the implications of lifestyle on the environment.
- To broaden the understanding of global climate changes and the importance of renewable sources of energy.
- To give students a basic understanding of the major causes of environmental degradation on the planet, with specific reference to the Indian situation.
- To inspire students to find ways in which they can contribute personally and professionally to prevent and rectify environmental problems.

Course Outcomes: (CO):

At the end of the course, the student should be able to

[1] Know the importance of environment and awareness on natural resources to find the causes, effects, and consequences if not protected.

[2] Acquire knowledge of renewable and non-renewable energy resources to solve future problems on energy demand.

[3] Enriching the understanding of the need for eco-balance and the importance of biodiversity conservation.

[4] Identify the numerous causes for environmental pollutions, hazards, their management, and control methods.

[5] Find ways to protect the environment on global climatic changes and their mitigation.

[6] Recognise some of the social issues and gaining knowledge on the protection of the environment.

[7] Develop adequate knowledge of population, which enabling them to make better in life decisions as well as enter a career in an environmental profession or higher education.

Student Learning Outcomes (SLO) involved:2,10,11

2. Having a clear understanding of the subject related concepts and contemporary issues
10. Having a clear understanding of professional and ethical responsibility
11. Having an interest in lifelong learning

Module:1	Environment and Natural Resources	7 hours

Definition, scope, importance, the need for public awareness on natural resources Forest resources – use, exploitation, causes, and consequences of deforestation. Water resources – use of surface and subsurface water; dams - effect of drought, water conflicts. Land resources - Land degradation, soil erosion, and desertification. Indian Case studies. Food resources – Definition, world food problems, Traditional and modern agriculture, and its impacts and remedies.

Module:2	Energy Resources	7 hours

Definition of renewable and non-renewable energy resources. Non-renewable energy resources - oil, Natural gas, Coal, Nuclear energy. Renewable energy - Solar energy, Hydroelectric power, Ocean thermal energy, wind, and geothermal energy. Biomass energy and Bio Gas.

Module:3	Ecosystem and Biodiversity	5 hours
Concept of ecosystem, Structure, and functions of an ecosystem, Food chains, food webs. Energy flow in an ecosystem, ecological pyramids, and ecological succession. Case studies: Biomagnification of DDT. Biodiversity-Bio-geographical classification of India, hotspots, values of biodiversity. Threats to biodiversity - a Case study. Conservation of biodiversity. GM Crops		
.		
Module:4	**Environmental changes and Remediation**	**6 hours**
Air, water, soil, Thermal Pollution: Causes, effects and control measures; Nuclear hazard. Solid waste Management- Causes, Effects and control measures. Floods, earthquakes, cyclones, tsunami and landslides, Case studies.		
Module:5	**Global Climatic Change and Mitigation**	**5 hours**
Global climate change and the greenhouse effect – Kyoto Protocol, Carbon sequestration, Acid rain, Ozone depletion problem – Montreal Protocol.		
Module:6	**Social Issues and the Environment**	**6 hours**
Urban problems related to energy and sustainable development, Water conservation, Rainwater harvesting, Wasteland Reclamation. Environment Protection Act - Prevention and control of Pollution of Air and Water. Wildlife protection and Forest Conservation Acts.		
Module:7	**Human Population and the Environment**	**7 hours**
Population growth, variation among nations, population explosion, Family Welfare Programme, Environment, Women and Child Welfare, Human rights, HIV/AIDS, Role of information technology on the environment and human health. Discussion on current environmental issues/topics by an Industrial expert or faculty		
Module:8	**Contemporary issues**	**2 hours**
Industry Expert Lectures		
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Anubha Kaushik and C.P. Kaushik, Environmental Science and Engineering, 2016, 5th Edition, ISBN: 978-81-224-4013-3, New Age International.
2.	G. Tyler Miller Jr and Scott E. Spoolman, Living in the Environment, 2012. 17th Edition, ISBN-13: 978-0-538-73534-6, Brooks / Cole.

Reference Books

1.	Environmental Science and Engineering by Anjali Bagad, 2014, 1st Edition, ISBN-10: 9350997088, Technical Publications.
2.	Introduction to Environmental Engineering by Masters, 2015, 3rd Edition, ISBN-10: 9332549761, Pearson Education India.
3.	Basic Environmental Sciences For Undergraduates by Dr. Tanu Allen, Dr. Richa K. Tyagi Dr. Sohini Singh, 2014, 1st Edition, ISBN-10: 938375827, Vayu Education of India.

Mode of Evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & FAT

Recommended by Board of Studies	12-8-2017		
Approved by Academic Council	No.47	Date	05-10-2017

Course code	Course Title	L	T	P	J	C
CHY1005	Allied Chemistry	3	0	0	0	3
Pre-requisite	Chemistry at 12th standard or equivalent	Syllabus version				
		2.0				

Course Objectives

The course is aimed at

- To understand the interdependency of chemistry and biological systems and the relationship between chemical structure and biological activity
- To introduce analytical and separation techniques essential for biologists

Expected Course Outcomes:

At the end of the course, the students will
1. be able to acquire knowledge about the stereochemistry of organic and biomolecules
2. be able to acquire knowledge on various electronic effects in biological systems.
3. be familiar with the fundamental chemistry of the biomolecules
4. be familiar with the fundamental chemistry of chlorophyll and Haemoglobin
5. be able to acquire knowledge on the various functions of several metal ions and the complexes in the biological systems.
6. be able to acquire knowledge about the uses, mechanism of action of essential drugs, and their SAR.
7. Demonstrate basic knowledge of the separation and analytical techniques.

Student Learning Outcomes involved: 2,18

2. Having a clear understanding of the subject related concepts and contemporary issues
18. Having critical thinking and innovative skills

Module:1	Introduction to Stereochemistry	6 hours

Isomerism in organic compounds – structural, stereo, geometrical and optical isomerism-Chirality-Racemisation–Specific optical rotation-Enantiomeric Excess-Optical purity-Resolution–R-S notation–E-Z nomenclature

Module:2	Electronic effects	6 hours

Intermolecular bonding forces-ionic bonds, hydrogen bonds, Van der Waals interactions, Dipole-dipole and Ion-dipole interactions, Repulsive interactions, water, and hydrophobic interactions –Importance of these effects in biological systems.

Module:3	Chemistry of Biomolecules	6 hours

Amino acids, Proteins, and Enzymes - Chemical structure and function.

Module:4	Molecules of Life	4 hours

Structure and functions of Haemoglobin and Chlorophyll

Module:5	Role of metal ions in Biology	6 hours

Essential and toxic metals – metal ions deficiency and its treatment – metal ion toxicity – Fe, Cu, Cr, Pb, As, Hg, Cd – Natural detoxification – chelating drugs for detoxification – examples for Chelating drugs – Anti-arthritic gold drugs – psychiatric drug – Lithium – Anticancer drugs –

Module:6	**Antibiotics, Anti-ulcer and Analgesic drugs**	**9 hours**

Structure-activity relationship (SAR) – cell wall synthesis inhibitors - Penicillins, Cephalosporin-Protein synthesis inhibitors– tetracycline, chloramphenicol. SAR–H_2 antagonist–Ranitidine–Proton pump inhibitors – Pantoprazole –Omeprazole. NSAID- SAR – paracetamol – diclofenac sodium – ibuprofen.

Module:7	**Separation and Analytical Techniques**	**6 hours**

Chromatography – Adsorption, Absorption, Partition- HPLC, GC -Spectroscopy – the interaction of electromagnetic radiation with matter, type of interaction, the origin of IR, UV – Visible, Emission spectroscopy (fluorescence) and applications.

Module:8	**Contemporary issues:**	**2 hours**

Industry Expert Lecture

	Total Lecture hours:	**45 hours**

Text Book(s)

1. An Introduction to Medicinal Chemistry, Graham L. Patrick, VIth edition, Oxford University Press, 2017.
2. Organic Chemistry, Solomon, and Fryhle. Eighth Edition, Wiley India (P) Ltd. 2009.
3. Bioinorganic Chemistry, Asim K. Das, Books and Allied (P) Ltd, 2010.
4. Fundamentals of Analytical Chemistry, D. A. Skoog, D. M. West, and F. J. Holler, S.R. Crouch,9th Edition, Thomson Asia (P) Ltd., Singapore, 2014.

Reference Books

1. Stereochemistry of Organic Compounds by L. Eliel, Samuel H. Wilen, Wiley India (P) Ltd, 2010.
2. Instrumental Methods of Chemical Analysis, B. K. Sharma, Goel Publishing House, 24th edition,2005.
3. Basic Concepts of Analytical Chemistry, S. M. Khopkar, New Age International Publishers, 2009.

Mode of evaluation: Internal assessment (CAT, Quizzes, Digital Assignment) and FAT

Recommended by Board of Studies		**12.08.2017**	
Approved by Academic Council	**No.46**	**Date**	**24.08.2017**

Course code	Introduction to Computers and their Applications	L	T	P	J	C
CSE1012		2	0	2	0	3
Pre-requisite	None	Syllabus version				
		1.1				

Course Objectives:

1. Gaining foundation in the fundamentals of computers concerning computer components and their usage
2. Making students understand different web technologies and computer networks
3. Exploring the application suite of software for the betterment of presentation and management of data

Expected Course Outcome:

1. The students will have the knowledge and skills to describe the software and hardware components
2. Explain some of the web technologies and illustrate how these can be used to manage scientific data
3. Obtain and analyze information and data relating to specific word applications for fine document preparation and report writing.
4. Data computation using spreadsheet application and presentation application for scientific findings.
5. Perform practical data management techniques, including DDL and DML and database querying.

Student Learning Outcomes (SLO):	2,8

2. Having a clear understanding of the subject related concepts and contemporary issues
8. Having a clear understanding of professional and ethical responsibility

Module:1	History of Computers	4 hours

History of Computers, Basic Components of Computer Systems, CPU, Memory, I/O Devices, Operating system, DOS and Unix system commands

Module:2	Web Technologies	4 hours

Introduction to Internet - URL, WWW, HTML, Internet Protocols- HTTP, TCP/IP, E-Mail & FTP.

Module:3	Computer Networks	3 hours

Networks and Data Communications: LAN, MAN & WAN – Network Topologies. Basics of Network, Uses of the network, types of networks, Network topologies.

Module:4	Word Processing	4 hours

Word basics, Editing and formatting a document, layout and inserting and managing graphics, formatting tables

Module:5	Spreadsheets	4 hours

Spreadsheet basics, Editing worksheets, Form cells – formatting worksheets, formulas and function, data filtering and sorting, chart, and graphs.

Module:6	**Presentation**	**5hours**
Presentation basics, Creation of Presentation, editing presentation, formatting presentation, working with multimedia.		
Module:7	**Database Management**	**4 hours**
Database basics, advantages of Database, create a database, updating and manipulating data, DDL and DML command, database querying.		
Module:8	**Recent trends**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1. Peter Norton, 2017, Introduction to Computers, 7th Edition, Tata McGraw Hill Publications.
2. Joan Lambert, and Curtis Frye, 2017 Microsoft Office 2016 Step by Step, Microsoft Press

Reference Books

1. Rajaraman V, and Adabala N, 2014, Fundamentals of Computers, PHI Publication

Mode of Evaluation: Assignments, Continuous assessment tests and Final assessment test.

List of Experiments		**SLO: 2,8**
1.	Unix and DOS commands	
2.	Creating and Formatting Word document	
3.	Creating and Manipulating Tables in a document	
4.	Inserting any Graphics in a document	
5.	Create a Personal Resume	
6.	Using the Excel Formula and Functions	
7.	Representing Data in a Chart	
8.	Excel Using Pivot Table	
9.	Excel Using Functions	
10.	Working with Design Templates and Auto Content wizards by using PowerPoint	
11.	Formatting and editing slides	
12.	PowerPoint Slide design	
13.	Slide transition effects	

14.	Creating and querying a recipe database using a database program	
15.	Updating and manipulating database	
	Total Laboratory Hours	30 hours
Mode of Evaluation: Assignments, Continuous assessment tests and Final assessment test.		

Recommended by Board of Studies	12-8-2017		
Approved by Academic Council	No. 5.	Date	13-12-2018

Course code	Course Title	L	T	P	J	C
CSE2009	Computer Programming for Biologists	2	0	2	0	3
Pre-requisite	Introduction to Computers and their Applications	Syllabus version				
		1.1				

Course Objectives:

Course Objectives:

1. To make students understand and practice beginning and advanced skills in the areas of computer command line mode operations.
2. To broaden the understanding of Bash shell scripting to automate the workflow process, including pattern search.
3. To give a biology-specific programming language to concentrate on the string data structure.
4. To inspire students to find ways in which they can contribute to features prediction from biological sequences.

Course Outcomes: (CO):

At the end of the course, the student should be able to

[1] Know the importance of the bash environment and awareness on command line operations.
[2] Acquire knowledge on automating a list of command-line process.
[3] Enriching the understanding of regular expression in string data structure pattern finding.
[4] Identify the appropriate and essential functions to debug or troubleshoot programs.
[5] Find ways to protect the environment on global climatic changes and their mitigation.
[6] Recognise improved computational proficiency.
[7] Apply the powerful combination of shell and python programing to get expedite on the big data analysis.

Student Learning Outcomes (SLO) 2,7

2. Having a clear understanding of the subject related concepts and contemporary issues
7. Having computational thinking (Ability to translate vast data into abstract concepts and to understand database reasoning)

Module:1	**Shell Scripting**	**4 hours**	**CO: 1, 2**

Bash and Bash Scripts – Common Shell programs, Executing commands, Developing Good Scripts, Creating and running a script, Scripts basics, and Debugging bash scripts.

Module:2	**The Bash Environment and statements**	**4 hours**	**CO: 2, 3**

Shell initialization file, Variables, Quoting characters, Shell expansion, and Aliases, variables, condition statements, and loop statements.

Module:3	**Python Programming**	**3 hours**	**CO: 3, 6**

Python environment, printing and manipulating text- comments to annotate your code, error message and debugging, storing strings in variables, and manipulating strings.

Module:4	**List and Loops**	**4 hours**	**CO: 4, 5**

Creating a list and retrieving elements, list elements, loop, indentation error, splitting strings, iterating, and looping with ranges.

Module:5	**Functions and Conditional statements**	**5 hours**	**CO: 4, 5**
Function definition, calling and encapsulation, function argument and return value, Decision-making programs, if statements, if...else...elif statements, and while loops.			
Module:6	**Regular expression and Dictionaries**	**4 hours**	**CO: 1, 6**
Patterns in Biology, modules, patterns in a string, searching and extracting patterns and Positions, creating, and iterating dictionaries.			
Module:7	**Reading and writing files**	**4 hours**	**CO: 1, 7**
Reading text from files, file content and file name, dealing with newlines, writing text to files, closing files.			
Module: 8	**Recent trends**	**2 hours**	
Industry Expert Lectures			
	Total Lecture hours:	**30 hours**	

Text Book(s)

1.	Jason Cannon, 2014, Command Line Kung Fu: Bash Scripting Tricks, Linux Shell Programming, First edition, Create Space Independent Publishing Platform.
2.	Dr. Martin Jones, 2013, Python for Biologists: A complete programming course for beginners, First edition, Create Space Independent Publishing Platform.

Reference Books

1.	Martin C, 2018, Python: The Complete Reference, 4 edition, McGraw Hill Publisher.
2.	Richard Blum & Christine Bresnahan, 2015, Linux Command Line and Shell Scripting Bible, 3ed Wiley publisher.

	List of Challenging Experiments
1.	Basic Bash Shell commands
2.	Creating Bash Script
3.	Understanding Shell configuration files
4.	Control Statements
5.	Conditional Statements
6.	Python program to calculate AT content and Complement of a DNA Sequence.
7.	Splitting of Genomic DNA
8.	Processing DNA in a file

9.	Percentage of amino acid residue
10.	Printing out gene names for all genes between a specific length ranges.
11.	Printing accession names and double digestion
12.	DNA translation using python Dictionaries
	Total Lab Hours - 30

Mode of Evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & FAT			
Recommended by Board of Studies	12-8-2017		
Approved by Academic Council	No.53	Date	13-12-2018

Course code	Course title	L	T	P	J	C
ENG 1001	Basic English	0	0	4	0	2
Pre-requisite	None	Syllabus version				
		v. 1.2				

Course Objectives:

1. To make students understand and help in the right pronunciation
2. To prepare students to participate effectively in critical conversations and demonstrate the ability to communicate effectively.
3. To enable students to comprehend complex English texts

Expected Course Outcome:

1. Enhance the listening skills of the learners by exposing them to documentaries, speeches, etc.,
2. Comprehend language and communication skills in academic and social contexts.
3. Strengthen the informal, formal, and creative writing skills of the learners in social media.
4. Communicate clearly and precisely in formal and informal contexts
5. Describe and narrate incidents with clarity, coherence suitable for purpose and audience

Student Learning Outcomes (SLO): 15,16

15. Having an ability to use social media effectively for productive use
16. Having a good working knowledge of communicating in English

Module:1	Listening	**4 hours**

Active Listening, Casual Conversations
Activity: Medium level and answering MCQs

Module:2	Speaking	**6 hours**

Conversations Activity: Talking about the weather, current events, at the office, at a social event, out for a walk.

Module:3	Reading	**4 hours**

Reading Newspaper Articles: Activity: Answering factual comprehension questions

Module:4	Writing	**6 hours**

Letter Writing
Activity: Writing letters to the editor, leave letter, asking for general information.

Module:5	Listening and Responding	**4 hours**

TED Talks

Activity: Answering Critical Questions		
Module:6	Speaking	**6 hours**
Activity: Narrating Short stories/ Anecdotes		
Module:7	Reading	**4 hours**
Skimming and Scanning Activity: Reading a short story and summarizing it.		
Module:8	Writing	**4 hours**
Activity: Writing Blogs on Nature/Environment/Science/Technology		
Module:9	Listening	**4 hours**
Motivational Speeches Activity: Short Speeches on simple topics		
Module:10	Speaking	**4 hours**
Narrating Incidents Activity: Short Speeches on unforgettable incidents/happenings		
Module:11	Writing	**4 hours**
Sentence Patterns Activity: Analyzing different sentence patterns.		
Module:12	Speaking	**4 hours**
Describing People - Activity: Short Speeches on people's features		
Module:13	Writing	**6 hours**
Digital Writing Skills E-mail writing, SMS writing, Posting messages on social media		
	Total Practical hours:	**60 hours**

Text Book(s)	
1.	Thomson, Kenneth. **English for Meetings**. OUP: 2015
2.	Redston, Chris, Theresa Clementson, and Gillie Cunningham. *Face2face Upper Intermediate Student's Book.* 2013, Cambridge University Press.
Reference Books	

1.	ParulPopat. Communication Skills. Pearson Education: 2015.
	ArunaKoneru, Professional Speaking Skills, OUP, 2015
2.	Redston, Chris, Theresa Clementson, and Gillie Cunningham. *Face2face Upper Intermediate Teacher's Book*. 2013, Cambridge University Press.
3.	

Mode of Evaluation: MCQs, Presentation, Discussion, Assignments, Mini Projects		
List of Challenging Experiments (Indicative)		
1.	Creating a Digital Profile – LinkedIn (Résumé/Video Profile)	10 hours
2.	Crossword Puzzles	6 hours
3.	Writing SOPs	6 hours
4.	Exploring multi-cultural perspectives	6 hours
5.	Analyzing a challenging scenario	8 hours
6	Word games	6 hours
7	Writing slogans	6 hours
8	Roleplay	6 hours
9	Solving riddles in English	2 hours
10	Speaking on an imaginary situation (If I were) / Activities through VIT Community Radio	4 hours
	Total Practical Hours	**60 hours**
Mode of evaluation: Presentation, Discussion, Assignments, Mini Project		

Recommended by Board of Studies	22-07-2017			
Approved by Academic Council	No. 46	Date	24-08-2017	

Course code	Course title	L	T	P	J	C
ENG1012	Communicative English	0	0	4	0	2
Pre-requisite	Basic English	Syllabus version				
		v. 1.2				

Course Objectives:

1. To help the learners attain high-level proficiency in all four language skills.
2. To make the learners familiar with different types of communication.
3. To help the learners understand the barriers to communication.

Expected Course Outcome:

1. Familiarize learners with basic principles of formal communication.
2. Engage the learners in academic, business, formal, and informal communications activities.
3. Strengthen the informal, formal, and creative writing skills of the learners.
4. Develop skills to comprehend, analyze, and review creative works.
5. Enhance the listening skills of the learners by exposing them to documentaries, speeches, etc.,

Student Learning Outcomes (SLO):	16,18

16. Having a good working knowledge of communicating in English
18. Having critical thinking and innovative skills

Module:1	Listening	4 hours

Formal Conversation

Activity: Listening and responding to questions

Module:2	Speaking	6 hours

Formal Situations

Activity: Small talk

Module:3	Writing	4 hours

Paragraph Writing

Activity: Write a paragraph on your hobby/ interesting incident

Module:4	Reading	4 hours

Sports Articles

Activity: Reading for general information

Module:5	Listening	4 hours

Film Clippings/ Documentaries

Activity: Listening for specific information

Module:6	Speaking	4 hours

Short Discussions

Activity: Speak on issues		
Module:7	**Writing**	**4 hours**
Letter Writing		
Activity: Enquiry Letters, Complaint Letter		
Module:8	**Speaking**	**6 hours**
Interview skills		
Activity: Role play interview situations		
Module:9	**Writing**	**4 hours**
Précis writing		
Activity: Summarize the given passage		
Module:10	**Reading**	**4 hours**
Science articles		
Activity: Reading for factual information		
Module:11	**Listening**	**4 hours**
Speeches of renowned personalities		
Activity: Listen and respond to the given task		
Module:12	**Writing**	**4 hours**
Short stories		
Activity: Write the story using given hints		
Module:13	**Speaking**	**4 hours**
Extempore		
Activity: Short speeches on general topics		
Module:14	**Writing**	**4 hours**
Creative writing		
Activity: Writing an essay on general topics		
	Total Lecture hours:	**60 hours**

Text Book(s)	
1.	Scanlon, Jaimie, et al. *Q: Skills for success. Listening and Speaking*.2 Oxford University Press, 2015.
2	Caplan, Nigel A., and Scott Roy Douglas. *Q. Skills for Success: Reading and Writing*.2 Oxford University Press, 2011.
Reference Books	
1.	Joan Maclean & Tony Lynch, Study Speaking, Kenneth Anderson, CUP, 2013
2	**John Thill, Courtland L. Bovee, Excellence In Business Communication, 2016, Edition**

	12, Pearson, ISBN-13: 978-0134388175
3	Judith F Olson, Writing Skills: Success in 20 Minutes a Day, 2013, Edition 1, Goodwill Publishing House, ISBN-13: 978-8172452452
4	How to Speak and Write Correctly, Joseph Devlin, 2017, Edition 1, CreateSpace Independent Publishing Platform, **ISBN-13:** 978-1974637218
5.	MeenaAgarwal, English Communication, 2016, Edition 1, ISBN-13: 978-9351676737 Publisher

Mode of Evaluation: Quizzes, Presentations, Role play, Group Discussion, Assignments, Mini Project

List of Challenging Experiments (Indicative)		
1	Listening and responding to questions	4 hours
2	Small talk	6 hours
3	Write a paragraph on your hobby/ interesting incident	4 hours
4	Reading comprehension	4 hours
5	Group discussion	4 hours
6	Letter writing	4 hours
7	Write the story using given hints/Creative writing	4 hours
	Total Laboratory hours	**30 hours**

Recommended by Board of Studies	22-07-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
HUM1021 / HUM1032	Ethics and values	2	0	0	0	2
Pre-requisite	None	Syllabus version				
		1.1				

Course Objectives:

1. To understand and appreciate the ethical issues faced by an individual in profession, society, and polity
2. To understand the negative health impacts of certain unhealthy behaviors
3. To appreciate the need and importance of physical, emotional health and social health

Expected Course Outcome:

Students will be able to:

1. Follow sound morals and ethical values scrupulously to prove as good citizens
2. Understand various social problems and learn to act ethically
3. Understand the concept of addiction and how it will affect the physical and mental health
4. Identify ethical concerns in research and intellectual contexts, including academic integrity, use, and citation of sources, the objective presentation of data, and the treatment of human subjects
5. Identify the main typologies, characteristics, activities, actors, and forms of cybercrime

Student Learning Outcomes (SLO):	2,10,11,12

2. Having a clear understanding of the subject related concepts and contemporary issues
10. Having a clear understanding of professional and ethical responsibility
11. Having an interest in lifelong learning
12. Having adaptive thinking and adaptability

Module:1	Being Good and Responsible	5 hours

Gandhian values such as truth and non-violence – Comparative analysis on leaders of past and present – Society's interests versus self-interests - Personal Social Responsibility: Helping the needy, charity and serving the society

Module:2	Social Issues 1	4 hours

Harassment – Types - Prevention of harassment, Violence, and Terrorism

Module:3	Social Issues 2	4 hours

Corruption: Ethical values, causes, impact, laws, prevention – Electoral malpractices;
White collar crimes - Tax evasions – Unfair trade practices

Module:4	Addiction and Health	5 hours

Peer pressure - Alcoholism: Ethical values, causes, impact, laws, prevention – Ill effects of smoking - Prevention of Suicides;
Sexual Health: Prevention and impact of pre-marital pregnancy and Sexually Transmitted Diseases

Module:5	Drug Abuse	3 hours

Abuse of different types of legal and illegal drugs: Ethical values, causes, impact, laws, and prevention		
Module:6	**Personal and Professional Ethics**	**4 hours**
Dishonesty - Stealing - Malpractices in Examinations – Plagiarism		
Module:7	**Abuse of Technologies**	**3 hours**
Hacking and other cybercrimes, Addiction to mobile phone usage, Video games and Social networking websites		
Module:8	**Contemporary issues:**	**2 hours**
Guest lectures by Experts		
	Total Lecture hours:	**30 hours**

Reference Books

1. Dhaliwal, K.K, "Gandhian Philosophy of Ethics: A Study of Relationship between his Presupposition and Precepts,2016, Writers Choice, New Delhi, India.
2. Vittal, N, "Ending Corruption? - How to Clean up India?" 2012, Penguin Publishers, UK.
3. Pagliaro, L.A., and Pagliaro, A.M, "Handbook of Child and Adolescent Drug and Substance Abuse: Pharmacological, Developmental and Clinical Considerations," 2012Wiley Publishers, U.S.A.
4. Pandey, P. K (2012), "Sexual Harassment and Law in India," 2012, Lambert Publishers, Germany.

Mode of Evaluation: CAT, Assignment, Quiz, FAT, and Seminar

Recommended by Board of Studies	26-07-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course Code	Course title	L	T	P	J	C
MAT-1001	Fundamentals of Mathematics	3	2	0	0	4
Pre-requisite	None	Syllabus Version				
		1.0				

Course Objectives

The course is aimed at providing
[1] necessary and relevant background to understand the other important engineering mathematics courses
[2] basic knowledge for the non-mathematics students to learn further topics and apply it in solving real-world engineering problems

Course Outcomes

At the end of the course, the student should be able to
[1] Solve a system of linear equations by matrix method
[2] Apply the techniques of differentiation to find maxima and minima, and techniques of integration to evaluate areas and volumes of revolution
[3] Understand the concept of ordinary differential equations, and first and second-order linear differential equations
[4] Have a clear understanding of analytic geometry and vector algebra
[5] Apply concepts of mathematical logic and elementary probability to real-life problems

Student Learning Outcomes	2, 7,9

2. Having a clear understanding of the subject related concepts and contemporary issues
7. Having computational thinking (Ability to translate vast data into abstract concepts and to understand database reasoning
9. Having problem-solving ability- solving social issues and engineering problems

Module:1	Matrices	5 hours	

Matrices - types of matrices - operations on matrices - determinants - adjoint matrix – Inverse of a matrix - solution of a system of linear equations by inversion method – elementary transformations – the rank of a matrix - consistency, and inconsistency of the system of equations

Module:2	Differential Calculus	6 hours	

Differentiation of functions of a single variable – differentiation techniques physical interpretations - differentiation of implicit functions – higher-order derivatives – Taylor's, McClaurin's series - maxima and minima of functions of a single variable

Module:3	Integral Calculus	6 hours	

Partial fractions - Integration- integration techniques- integration by parts- definite integrals – properties- evaluation of area and volume by integration

Module:4	Linear Ordinary Differential Equations	6 hours	

Differential equations-definition and examples- formation of the differential equation- solving differential equations of the first order - solving second order homogenous differential equations with constant coefficients			
Module:5	**Analytic geometry**	**5 hours**	
Analytic geometry of three dimensions - direction cosines and direction ratios - plane, straight line and sphere, distance between points, distance to a plane			
Module:6	**Vector Algebra**	**7 hours**	
Vectors–operations on vectors-angle between two vectors-projection of one vector on another vector – equations of the plane, straight line, and sphere in vector forms-shortest distance between two skew lines - equation of a tangent plane to a sphere			
Module:7	**Logic and Probability**	**8 hours**	
Mathematical logic – propositions – truth table – connectives– tautology – contradiction. Permutations and combinations – probability – classical approach – addition law - conditional probability - multiplicative law - Bayes' theorem and applications			
Module:8	**Contemporary Issues**	**2 hours**	
Industry Expert Lecture			
	Total Lecture hours:	**45 hours**	
Tutorial	• A minimum of 10 problems to be worked out by students in every Tutorial Class • Another 5 problems per Tutorial Class to be given as homework Mode: Individual Exercises, Team Exercises, Online Quizzes, Online Discussion Forums	**30 hours**	

Text Book(s)

- Engineering Mathematics, K. A. Stroud, and Dexter J. Booth, 7th Edition, Palgrave Macmillan (2013).

Reference Books

- Elementary Engineering Mathematics, B. S. Grewal, 43rd edition, Khanna Publications, (2015).
- Discrete Mathematics, Seymour Lipschutz and Marc Lipson, 6th Edition, Tata McGraw -Hill (2017).
- Introduction to Probability and Statistics, Seymour Lipschutz and John Schiller, 3rd Indian Edition, Tata McGraw -Hill (2017).

Mode of Evaluation

Digital Assignments (Solutions by using a soft skill), Quiz, Continuous Assessments, Final Assessment Test

Recommended by Board of Studies	25-02-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course Code	Course title	L	T	P	J	C
MAT-1012	Statistical Applications	2	0	2	0	3
Pre-requisite	None	Syllabus Version				
		1.0				

Course Objectives:

[1] This course provides the meaning and scope of Statistical Applications.
[2] This enables the students to understand and use statistics in real-world problems.
[3] This course imparts comprehensive knowledge on data collection, presentation of data, pictorial representation, and measures of central tendency, measures of dispersion, control charts, correlation, regression, time series, probability, estimation, and inference.

Expected Course Outcome :

After completion of the course, a student will be able to

[1] Organize, present, and interpret statistical data, both numerically and graphically.
[2] Perform regression analysis and compute and interpret the coefficient of correlation
[3] Use various methods to compute the probabilities of events
[4] Analyse and interpret data using appropriate statistical hypothesis and parametric testing techniques.
[5] apply statistical quality control techniques
[6] implement SPSS code for statistical data

Student Learning Outcomes	2, 7

2. Having a clear understanding of the subject related concepts and contemporary issues
7. Having computational thinking (Ability to translate vast data into abstract concepts and to understand database reasoning)

Module:1	Introduction to Statistics and Data Collection:	5 hours

Importance of statistics, concepts of statistical population, and a sample - Methods of Random and Non -Random Sampling - quantitative and qualitative data - Measurement scales - nominal, ordinal, interval, and ratio - Primary and secondary data- Classification and tabulation of data. Diagrammatic and graphical representation of data-Histograms and Frequency Polygons.

Module:2	Describing Business Data:	5 hours

Measures of Central tendency- Mean, median, and mode- Measures of Dispersion, Range, Quartile deviation, Mean Deviation, Standard Deviation-The coefficient of Variation.

Module:3	Correlation and Regression Analysis:	4 hours

The Scatter Plot- Correlation-Types-Karl Pearson's Coefficient of Correlation-Spearman's Rank Correlation –Regression lines and coefficients- the coefficient of Determination-Residuals-the standard error of Estimate.

Module:4	**Probability**	**4 hours**
Probability, Random experiments, trial, sample space, events. Approaches to probability - classical, empirical, subjective, and axiomatic. Theorems on probabilities of events. Addition rule of probability. Conditional probability, independence of events, and multiplication rule of probability. Bayes theorem and its applications.		
Module:5	**Testing of Hypothesis**	**5 hours**
Testing of Hypothesis – Z- test, Student's t-test, F-test, Chi-square test.		
Module:6	**Statistical Quality Control Charts**	**5 hours**
Statistical Quality Control Charts- Introduction - Types of Control Charts – Setting up a Control Procedure – X bar (Mean) Chart and R Chart–c Chart–p Chart–Advantages and Limitations of Control Charts.		
Module:7	**Contemporary Issues**	**2 hours**
Industry Expert Lecture		
	Total Lecture hours:	**30 hours**

Text Book(s)

1.	Statistics for managers using MS-Excel, David. M. Levin, David. F. Stephen, and Cathryn. A. Szadat 7th Edition, Pearson Education (India), (2013).

Reference Books

1.	Business Statistics and Statistical Methods, S. P. Gupta, S. Chand Publication, New Delhi,2014.
2.	Probability and Statistics for Engineers and Scientists, Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying E. Ye, (9th Edition), Pearson Education (2015)
3.	Statistics For Management, Levin Richard and Rubin David, 7th Edition, Pearson Education, Dorling Kindersley,(2008, 2011-reprint).
4.	Discovering Statistics Using IBM SPSS Statistics, Andy Field, 4th Edition, Sage Publication, (2013).

Mode of Evaluation

Digital Assignments, Continuous Assessments, Final Assessment Test

List of Challenging Experiments (Indicative)

1	Tabulation and Pictorial representations of Various data types using Excel or SPSS.	2 hours
2	Calculation of Mean, Median, Mode, location measures, Variance and Box-Plot representations, calculation using Excel or SPSS.	2 hours
3	Plotting scatter diagram, computing correlation	2 hours
4	Fitting of linear regression	2 hours
5	Fitting of Multiple linear regression	2 hours
6	Plotting Mean and Range Charts, C chart, using Excel or SPSS.	2 hours
7	Plotting P chart, np chart, and C chart using Excel or SPSS.	2 hours

8	Z-test for means and Proportions-One sample and Two-sample tests	2 hours
9	t-test for single mean, a difference of Means and Proportions	2 hours
10	Test for variance and Contingency (Chi-Square -Cross Tab) Test Excel or SPSS.	2 hours
	Total Laboratory Hours	20 hours

Mode of Evaluation			
Weekly Assessments, Final Assessment Test			
Recommended by Board of Studies	12-06-2016		
Approved by Academic Council	No. 37	Date	16-06-2015

Course code	Course title	L	T	P	J	C
MGT1022	Lean Start up Management	1	0	0	4	2
Pre-requisite	None	Syllabus version				
		v.1.0				

Course Objectives: To develop the ability to

1. Learn methods of company formation and management.
2. Gain practical skills in and experience of stating business using a pre-set collection of business ideas.
3. Learn the basics of entrepreneurial skills.

Expected Course Outcome: On the completion of this course, the student will be able to:

1. Understand developing business models and growth drivers
2. Use the business model canvas to map out key components of the enterprise
3. Analyze market size, cost structure, revenue streams, and value chain
4. Understand build-measure-learn principles
   Foreseeing and quantifying business and financial risks

Student Learning Outcomes (SLO):	2,3, 5

2. Having a clear understanding of the subject related concepts and contemporary issues
3. Having an ability to be socially intelligent with good SIQ (Social Intelligence Quotient) and EQ (Emotional Quotient)
5. Having design thinking capability

Module:1	2 Hours

Creativity and Design Thinking (identify the vertical for business opportunity, understand your customers, accurately assess market opportunity)

Module:2	3 Hours

Minimum Viable Product (Value Proposition, Customer Segments, Build- measure-learn process)

Module:3	3 Hours

Business Model Development(Channels and Partners, Revenue Model and streams, Key Resources, Activities and Costs, Customer Relationships and Customer Development Processes, Business model canvas –the lean model- templates)

Module:4	3 Hours

Business Plan and Access to Funding(visioning your venture, taking the product/ service to market, a Market plan including Digital & Viral Marketing, start-up finance - Costs/Profits & Losses/cash flow, Angel/VC,/Bank Loans and Key elements of raising money)

Module:5	3 Hours

Legal, Regulatory, CSR, Standards, Taxes

Module:6	2 Hours

Lectures by Entrepreneurs

	Total Lecture	**15 hours**

Text Book(s)

1.	The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company, Steve Blank, K & S Ranch; 1st edition (March 1, 2012)
2	The Four Steps to the Epiphany, Steve Blank, K&S Ranch; 2nd edition (July 17, 2013)
3	The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Eric Ries, Crown Business; (13 September 2011)

Reference Books

1.	Holding a Cat by the Tail, Steve Blank, K&S Ranch Publishing LLC (August 14, 2014)
2	Product Design and Development, Karal T Ulrich, SD Eppinger, McGraw Hill
3	Zero to One: Notes on Startups, or How to Build the Future, Peter Thiel, Crown Business(2014)
4	Lean Analytics: Use Data to Build a Better Startup Faster (Lean Series), Alistair Croll & Benjamin Yoskovitz, O'Reilly Media; 1st Edition (March 21, 2013)
5	Inspired: How To Create Products Customers Love, Marty Cagan, SVPG Press; 1st edition (June 18, 2008)
6	**Website References:** 1. http://theleanstartup.com/ 2. https://www.kickstarter.com/projects/881308232/only-on-kickstarter-the-leaders-guide-by-eric-ries 3. http://businessmodelgeneration.com/ 4. https://www.leanstartupmachine.com/ 5. https://www.youtube.com/watch?v=fEvKo90qBns 6. http://thenextweb.com/entrepreneur/2015/07/05/whats-wrong-with-the-lean-startup-methodology/#gref 7. http://www.businessinsider.in/Whats-Lean-about-Lean-Startup/articleshow/53615661.cms 8. https://steveblank.com/tools-and-blogs-for-entrepreneurs/ 9. https://hbr.org/2013/05/why-the-lean-start-up-changes-everything 10. chventures.blogspot.in/ platformsandnetworks.blogspot.in/p/saas-model.html

Mode of Evaluation: Assignments; Field Trips, Case Studies; e-learning; Learning through research, TED Talks

Project		
1.	Project	60 hours
	Total Project	**60 hours**

Recommended by Board of Studies	08-06-2015		
Approved by Academic Council	37	Date	16-06-2015

Course code	Course title	L	T	P	J	C
PHY1003	Physics	3	0	2	4	5

Pre-requisite	None	Syllabus version
		1.0

Course Objectives:

To enable the student to understand the basic principles of Physics behind (a) those latest areas of biotechnology such as nanobiotechnology and (b) medical applications involving lasers, ultrasound and fiber optics

Expected Course Outcome: Students will be able to

1. Understand the concept of dual nature of the electromagnetic radiation and its verification
2. Understand the quantum physics concept by studying the behavior of the particle in a box.
3. Study the material properties as a function of particle size, especially at the nano level.
4. Explore the properties and types of LASERs and its application.
5. Understand the properties, production, and detection of Ultrasonic waves.
6. Get insight into the communication system through fiber optics.
7. Learn the applications of LASER, Ultrasonic and Fiber optics in the medical field and to appreciate the contemporary issues.
8. Demonstrate the ideas of quantum nature and ultrasonic waves-LAB
9. Carry out a mini project in the abovementioned topics-J COMPONENT

Student Learning Outcomes (SLO):	2,9,14,18

2. Having a clear understanding of the subject related concepts and contemporary issues

4. Having problem-solving ability- solving social issues and engineering problems

14. Having an ability to design and conduct experiments, as well as to analyze and interpret data

18. Having critical thinking and innovative skills

Module:1	Quantum Physics	7 hours

Dual nature of electromagnetic radiation, Compton effect (Qualitative), experimental verification-deBroglie waves- Davisson-Germer Experiment, Heisenberg uncertainty principle - Schrödinger equation.

Module:2	Applications of Quantum Physics	6 hours

Particle in a 1-D box (Eigen Value and Eigen Function), 3-D Analysis (Qualitative), Tunneling Effect (Qualitative), Scanning Tunneling Microscope, Atomic Force Microscope.

Module:3	Nanotechnology	6 hours

Introduction to Nano-materials, Properties of Nano-materials, Bionanomaterials, membranes, electrical properties of nano membranes, CNT, Applications of nanobiotechnology- longer-lasting medical implants, nanodrugs

Module:4	Lasers	6 hours

Laser characteristics, Einstein's theory of stimulated emission, pumping mechanisms-population inversion, three-level, four-level lasers, Nd-YAG, He-Ne-laser, CO2 laser.		
Module:5	**Ultrasonics**	**6 hours**
Properties of ultrasonics, generation- Magnetostriction method, Piezoelectric method, detection of ultrasonics.		
Module:6	**Fiber Optics**	**6 hours**
Light propagation through fiber, Acceptance angle, numerical aperture, types of fiber.		
Module:7	**Application of Lasers, Ultrasonics and Fiber Optics**	**6 hours**
Laser in surgery, ophthalmology, dentistry, ultrasonogram, POT-sensors- fiber-optic- biosensors, keyhole surgery.		
Module:8	**Contemporary issues:**	**2 hours**
Current Topics - Industry Experts Talk		
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Concepts of Modern Physics, Arthur Besier, Shobhit Mahajan, S. Rai Choudhury, 7th
2.	Edition, Tata - McGraw Laser Fundamentals, William Silfvast, 2nd edition, Cambridge University Press, Cambridge. 2008 [a Classic book on the subject of Laser]
3.	Fiber Optic Communication Technology, Djafar K. Mynbaev, and Lowell L. Scheiner, Addison Wesley Longman, Singapore, 2011
4.	Ultrasonics: Fundamentals, Technologies, and Application, Dale Ensminger, Leonard J. Bond, 3rd Edition, CRC Press, London, 2011

Reference Books

1.	Modern Physics, Raymond A. Serway, Clement J. Mosses, Curt A. Moyer, 3rd Edition, Cengage Learning, Boston, 2010
2.	Laser Systems and Applications, Nityanand Choudhary and Richa Verma, PHI Learning Private Ltd., New Delhi, 2011
3.	Lasers and Optical Instrumentation, S. Nagabhushana and B. Sathyanarayana, I.K. International Publishing House Pvt. Ltd., New Delhi, 2010
4.	Fundamentals and Applications of Ultrasonic Waves, J. David N. Cheeke, 2nd Edition, CRC Press, London, 2012

Mode of Evaluation: Quizzes, Digital Assignments, CAT-I and II and FAT

Recommended by Board of Studies	13.05.2017		
Approved by Academic Council	No. 45	Date	15.06.2017

List of Challenging Experiments (Indicative)

1.	Calculation of interplanar spacing of polycrystalline graphite from electron diffraction pattern (Module 1)	2 hrs
2.	Fabry Perot Interferometer: Determination of wavelength of the laser beam and finding spacing of the etalon (Module 4)	2 hrs

3.	Determination of wavelength of the laser source (He-Ne laser and diode lasers of different wavelengths) using diffraction technique (Module 4)	2 hrs
4.	Integrated optics: Determination of refractive index of the prism (Module 6)	2 hrs
5.	Determination of refractive index of various liquids (Module 6)	2 hrs
6.	Optical Fiber Characterization: determination of numerical aperture of a given multimode optical fiber (Module 6)	2 hrs
7.	Determination of the size of the fine particle using laser diffraction (Module 4)	2 hrs
8.	Determination of the track width (periodicity) in a written CD (Module 4)	2 hrs
9.	Analysis of crystallite size and strain in a nano-crystalline film using a given X-ray diffraction pattern (Module 3)	2 hrs
10.	Ultrasonic interferometer: Determination of velocity of the ultrasonic wave in different liquids and its adiabatic compressibility (Module 5)	2 hrs
11.	Numerical solutions of Schrödinger equation (e.g., particle in a box problem) (can be given as an assignment) (Module 1)	2 hrs
12.	Exploring the link between quantum confinement and Heisenberg's uncertainty principle (can be given as assignment). (Module 1+3)	2 hrs
	Total Laboratory Hours	24 hrs

Recommended by Board of Studies	13.05.2017		
Approved by Academic Council	No. 45	Date	15.06.2017

Course code	Course title	L	T	P	J	C
ESP1001	ESPAÑOL FUNDAMENTAL	2	0	0	0	2
Pre-requisite	None	Syllabus version				
		v.				

Course Objectives:

The course gives students the necessary background to:

- Demonstrate proficiency in reading, writing, and speaking in basic Spanish. Learning vocabulary related to profession, education centers, day-today activities, food, culture, sports and hobby, the family set up, workplace, market, and classroom activities is essential.
- Demonstrate the ability to describe things and will be able to translate into English and vice versa.
- Describe in simple terms (both in written and oral form) aspects of their background, immediate environment, and matters in areas of immediate need.

Expected Course Outcome:

The students will be able to

- Remember greetings, giving personal details and Identify genders by using correct articles
- Apply the correct use of SER, ESTAR and TENER verb for describing people, place, and things
- Create opinion about time and weather conditions by knowing months, days and seasons in Spanish
- Create opinion about people and places by using regular verbs
- Apply reflexive verbs for writing about the daily routine and create small paragraphs about hometown, best friend and family

Student Learning Outcomes (SLO):	2, 11

2. Having a clear understanding of the subject related concepts and contemporary issues
11. Having an interest in lifelong learning

Module:1	Abecedario, Saludos y Datos personales: Origen, Nacionalidad, Profesión	**3 hours**

Competencia Gramática: Vocales y Consonantes. Artículos definidos e indefinidos (Numero y Genero).
Competencia Escrita: Saludos y Datos personales

Module:2	Edad y posesión. Números (1-20)	**3 hours**

Competencia Gramática: Pronombres personales. Adjetivos. Los verbos SER y TENER.
Competencia Escrita: Escribe sobre mismo/a y los compañeros de la clase

Module:3	Vocabulario de Mi habitación. Colores. Descripción de lugares y cosas.	**5 hours**

Competencia Gramática: Adjetivos posesivos. El uso del verbo ESTAR. Diferencia entre SER y ESTAR.
Competencia Escrita: Mi habitación

Module:4	Mi familia. Números (21-100). Direcciones. Expresar la hora. Los meses del año.	**4 hours**

Competencia Gramática: Frases preposicionales. Uso del HAY. La diferencia entre MUY y MUCHO. Uso del verbo GUSTAR

Competencia Escrita: Mi familia. Dar opiniones sobre tiempo		
Module:5	Expresar fechas y el tiempo. Dar opiniones sobre personas y lugares.	**5 hours**
Competencia Gramática: Los verbos regulares (-AR, -ER, -IR) en el presente. Adjetivos demostrativos. Competencia Escrita: Mi mejor amigo/a. Expresar fechas. Traducción ingles a español y Español a Ingles.		
Module:6	Describir el diario. Las actividades cotidianas.	**3 hours**
Competencia Gramática: Los Verbos y pronombres reflexivos. Los verbos pronominales con e/ie, o/ue, e/i, u/ue. Competencia Escrita: El horario. Traducción ingles a español y Español a Ingles.		
Module:7	Dar opiniones sobre comidas y bebidas. Decir lo que está haciendo. Describir mi ciudad y Ubicar los sitios en la ciudad.	**5 hours**
Competencia Gramática: Los verbos irregulares. Estar + gerundio. Poder + Infinitivo. Competencia Escrita: Conversación en un restaurante. Traducción ingles a español y Español a Ingles. Mi ciudad natal. Mi Universidad. La clase. Mi fiesta favorita.		
Module:8	**Guest Lectures/ Native Speakers**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	**Text Book:"Aula Internacional 1", Jaime Corpas, Eva Garcia, Agustin Garmendia, Carmen Soriano Goyal Publication ; reprinted Edition, (2010)**
Reference Books	
1	"¡AcciónGramática!", Phil Turk and Mike Zollo, Hodder Murray, London 2006. "Practice makes perfect: Spanish Vocabulary," Dorothy Richmond, McGraw Hill Contemporary, USA,2012.
2	"Practice makes perfect: Basic Spanish," Dorothy Richmond, McGraw Hill Contemporary, USA 2009.
3	"Pasaporte A1 Foundation", Matilde Cerrolaza Aragón, Óscar Cerrolaza Gili, Begoña Llovet Barquero, Edelsa Grupo, España, 2010.

Recommended by Board of Studies	DD-MM-YYYY		
Approved by Academic Council	No. xx	Date	DD-MM-YYYY

Course code FRE2001	Français Progressif	L	T	P	J	C
		2	0	1	0	3
Pre-requisite	**Français quotidien**	**Syllabus version**				
		v.1				

Course Objectives:

The course gives students the necessary background to:

1. Understand isolated sentences and frequently used expressions in relation to immediate priority areas (personal or family information, shopping, close environment, work).
2. Communicate in simple and routine tasks requiring only a simple and direct exchange of information on familiar and habitual topics.
3. Enable students to describe with simply means his training, his immediate environment and evoke familiar and habitual subjects, evoke subjects that correspond to immediate needs.

Expected Course Outcome:

The students will be able to :

1. Understand expressions in French.
2. Create sentences by using frequent lexicon related to himself, his family, his close environment (family, shopping, work, school, etc).
3. Understand simple, clear messages on the internet, authentic documents.
4. Analyze predictable information in common documents, such as advertisements, flyers, menus, schedules, simple personal letters.
5. Create simple and routine tasks.
6. Create a simple and direct exchange of information on familiar activities and topics.

Student Learning Outcomes (SLO):	**2,11**

2. Having a clear understanding of the subject related concepts and contemporary issues
11. Having an interest in lifelong learning

Module:1	**Expressions simples**	**8 hours**

La vie quotidiennes - Le verbe pronominal - Le passé composé avec l'auxiliaire - avoir et être- le passé récent : venir de + infinitif - Le comparatif - Le superlatif - Les mots interrogatifs (les trois formes)

Savoir-faire pour : Faire des achats, faire des commandes dans un restaurant, poser des questions.

Module:2	**Les activitiés quotidiennes**	**6 hours**

La vie privée et publique (Les achats, Les voyages, les transports-La nourriture, etc.) - Les lieux de la ville - Les mots du savoir-vivre - Les pronoms indéfinis - Les pronoms démonstratifs - Les pronoms compléments objets directs/ indirects - La formation du future simple et future proche

Savoir-faire pour : Réserver les billets pour le voyage, réserver les chambres dans un hôtel, S'informer sur les lieux de la ville, indiquer la direction à un étranger.		
Module:3	**Les activités de loisirs**	**7 hours**
Les loisirs (sports/spectacles/activités) - Les moments de la journée, de l'année- La fête indienne et française – Les goûts - L'impératif - La négation de l'impératif-La place du pronom à l'impératif avec un verbe pronominal. **Savoir-faire pour :** Parler de ses goûts, raconter les vacances, formuler des phrases plus compliquées, Raconter les souvenirs de l'enfance, parler sur la tradition de son pays natal.		
Module:4	**La Francophonie**	**7 hours**
L'espace francophone - Première approche de la société française – La consommation alimentaire – caractériser un objet – décrire une tenue - Le pronom relatif (qui/que/dont/où) **Savoir-faire pour :** Articles de la presse-Portrait d'une personne-Cartes et messages d'invitation, d'acceptation ou de refus -Article de presse - rédaction d'un événement.		
Module:5	**La culture française**	**5 hours**
Parler de ses activités quotidiennes - les fêtes en France – Parler de sa famille – réserver un billet à l'agence - la gastronomie française		
Module:6	**La description**	**5 hours**
Décrire physiquement une personne – les vacances – les achats – réserver une chambre dans un hôtel – les plus grands français - raconter des évènements passés		
Module:7	**S'exprimer**	**5 hours**
Parler du climat - parcours francophone – placer une commande au restaurant –- la mode - parler de son projet d'avenir.		
Module:8	**Guest lecures**	**2 hours**
Guest lecures/ Natives speakers		
	Total Lecture hours:	**45 hours**
Text Book(s)		

1.	Alter Ego 1, Méthode de français, Annie Berthet, Hachette, Paris 2010.		
2.	Alter Ego 1, Cahier d'exercices, Annie Berthet, Hachette, Paris 2010.		
Reference Books			
1.	CONNEXIONS 1, Méthode de français, Régine Mérieux, Yves Loiseau,Les Éditions Didier, 2010.		
2	CONNEXIONS 1, Le cahier d'exercices, Régine Mérieux, Yves Loiseau, Les Éditions Didier, 2010		
3	Fréquence jeunes-1, Méthode de français, G. Capelle et N.Gidon, Hachette, Paris, 2010.		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies			
Approved by Academic Council	No.	Date	

Course code	Grundstufe Deutsch	L	T	P	J	C
Course code		2	0	0	0	2
Pre-requisite	None	Syllabus version				
		v.1				

Course Objectives:

The course gives students the necessary background to:

1. Demonstrate proficiency in reading, writing, and speaking in basic German. Learning vocabulary related to profession, education centers, day-to-day activities, food, culture, sports and hobby, the family set up, workplace, market, and classroom activities are essential.
2. Make the student's industry-oriented and make them adapt to the German culture.

Expected Course Outcome:

The students will be able to

1. Remember greeting people, introducing oneself, and understanding basic expressions in German.
2. Understand necessary grammar skills to use these in a meaning way.
3. Remember beginner's level vocabulary
4. Create sentences in German on a variety of topics with significant precision and detail.
5. Apply good comprehension of written discourse in areas of special interests.

Student Learning Outcomes (SLO):	2, 11

2. Having a clear understanding of the subject related concepts and contemporary issues
11. Having an interest in lifelong learning

Module:1		3 hours

Begrüssung, Landeskunde, Alphabet, Personalpronomen, Verben- heissen, kommen, wohnen, lernen, Zahlen (1-100), W-Fragen, Aussagesätze, Nomen- Singular und Plural, der Artikel - Bestimmter- Unbestimmter Artikel)

Lernziel :

Sich vorstellen, Grundlegendes Verständnis von Deutsch, Deutschland in Europa

Module:2		3 hours

Konjugation der Verben (regelmässig /unregelmässig),das Jahr- Monate, Jahreszeiten und die Woche, Hobbys, Berufe, Artikel, Zahlen (Hundert bis eine Million), Ja-/Nein- Frage, Imperativ mit „Sie''

Lernziel:

Sätze schreiben, über Hobbys, Berufe erzählen, usw

Module:3		6 hours

Possessivpronomen, Negation, Kasus (Bestimmter- Unbestimmter Artikel) Trennbareverben, Modalverben, Uhrzeit, Präpositionen, Lebensmittel, Getränkeund Essen, Farben, Tiere

Lernziel :

Sätze mit Modalverben, Verwendung von Artikel, Adjektiv beim Verb

Module:4		**4 hours**
Übersetzung: (Deutsch – Englisch / Englisch – Deutsch) **Lernziel :** Die Übung von Grammatik und Wortschatz		
Module:5		**5 hours**
Leserverständnis. Mindmap machen, Korrespondenz- Briefe und Email **Lernziel:** Übung der Sprache, Wortschatzbildung		
Module:6		**5 hours**
Aufsätze : Die Familie, Bundesländer in Deutschland, Ein Fest in Deutschland, **Lernziel :** Aktiver, selbständiger Gebrauch der Sprache		
Module:7		**4 hours**
Dialoge: a) Gespräche mit einem/einer Freund /Freundin. b) Gespräche beim Einkaufen ; in einem Supermarkt ; in einer Buchhandlung ; c) in einem Hotel - an der Rezeption ; ein Termin beim Arzt. d) Ein Telefongespräch ; Einladung–Abendessen		
Module:8		**2 hours**
Guest Lectures/ Native Speakers (Einleitung in die deustche Kultur und Politik		
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Netzwerk Deutsch als Fremdsprache A1, Stefanie Dengler, Paul Rusch, Helen Schmtiz, Tanja Sieber, Klett-Langenscheidt Verlag, München : 2013
Reference Books	
1.	Lagune, Hartmut Aufderstrasse, Jutta Müller, Thomas Storz, 2012.
2	Deutsche Sprachlehre für Ausländer, Heinz Griesbach, Dora Schulz, 2013
3	Studio d A1, Hermann Funk, Christina Kuhn, CorneslenVerlag, Berlin :2010
4	Tangram Aktuell-I, Maria-Rosa, SchoenherrTil, Max Hueber Verlag, Muenchen :2012
	www.goethe.de wirtschaftsdeutsch.de hueber.de klett-sprachen.de www.deutschtraning.org
Mode of Evaluation: CAT / Assignment / Quiz / FAT	
Recommended by Board of Studies	
Approved by Academic Council	No. Date

Course code	Course title	L	T	P	J	C
ESP2001	ESPAÑOL INTERMEDIO	2	0	2	0	3
Pre-requisite		Syllabus version				
		v.				

Course Objectives:

The course gives students the necessary background to:

- Enable students to read, listen and communicate in Spanish in their day to day life.
- Enable students to describe situations by using present, past, and future tenses in Spanish.
- Enable to develop comprehension skill in Spanish language.

Expected Course Outcome:

The students will be able to

- Create sentences in near future and future tenses and correctly using the prepositions like POR and PARA
- Create sentences in preterito perfecto and correctly use the direct and indirect object pronouns
- Create sentences related to likes and dislikes and also give commands in a formal and informal way
- Create sentences in past tense by using imperfecto and idefinido forms and describe past events
- Create conversations in Spanish at places like restaurants, hotels, Shops and Railway stations
- Understand different Spanish speaking countries and its culture and traditions.

Student Learning Outcomes (SLO):	2, 11

2. Having a clear understanding of the subject related concepts and of contemporary issues
11. Having interest in lifelong learning

Module:1	Números (101 – 1 millón). Expresar los planes futuros. Los números ordinales.	7 hours

Competencia Gramática: Futuros cercanos (Ir+a+Infinitivo). Futuros (Verbos regulares e irregulares). Uso del POR y PARA.
Competencia Escrita: Traducción ingles a español y español a Ingles.
Comprensión - Los textos y Videos

Module:2	Las ropas, colores y tamaños. Costar, valer, descuentos y rebajas	8 hours

Competencia Gramática: Pronombres objetivos directos e indirectos. El verbo Gustar y Disgustar.
Competencia Escrita: Traducción ingles a español y español a Ingles. Comprensión - Los textos y Videos

Module:3	Escribir un Correo electrónico formal e informal.	7 hours

Competencia Gramática: Imperativos formales e informales. Pretérito perfecto.
Competencia Escrita: Traducción ingles a español y español a Ingles.
Comprensión - Los textos y Videos

Module:4	**Currículo Vitae. Presentarse en una entrevista informal.**	**6 hours**
Competencia Gramática: Pretérito imperfecto. Pretérito indefinido. Competencia Escrita: Traducción ingles a español y español a Ingles. Comprensión - Los textos y Videos		
Module:5	**Introducción personal, Expresar los planes futuros.**	**5 hours**
Comprensión oral: Introducción personal, Expresar los planes futuros. ¿Qué vas a hacer en las próximas vacaciones? Comprensión auditiva: Las preguntas sobre un cuento auditivo. Relacionar el audio con las imágenes. Las preguntas basadas en canciones. Medio de transporte: Comprar y Reservar billetes.		
Module:6	**Diálogos entre dos**	**5 hours**
Comprensión oral: Diálogos entre dos (cliente y tendero de ropas, pasajero y empleado, en un restaurante, Reservación de habitación en un hotel). Presentación en una entrevista. Comprensión auditiva: Las preguntas basadas en canciones. Las preguntas basadas en diálogos.		
Module:7	**Presentación de los países hispánicos.**	**5 hours**
Comprensión oral: Dialogo entre un médico y paciente. Presentación de los países hispánicos. Describir su infancia. Describir vacaciones últimas o las actividades de último fin de semana. Comprensión auditiva: Rellenar los blancos del cuento en pasado. Las preguntas basadas en el cuento. Las preguntas basadas en un anuncio		
Module:8	**Guest Lectures/ Native Speakers**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	"Aula Internacional 1", Jaime Corpas, Eva Garcia, Agustin Garmendia, Carmen Soriano Goyal Publication; reprinted Edition, Delhi (2010)

Reference Books

1.	"¡AcciónGramática!", Phil Turk and Mike Zollo, Hodder Murray, London 2006.
2.	"Practice makes perfect: Spanish Vocabulary", Dorothy Richmond, McGraw Hill Contemporary, USA,2012.
3.	"Practice makes perfect: Basic Spanish", Dorothy Richmond, McGraw Hill Contemporary, USA 2009.
4.	"Pasaporte A1 Foundation", Matilde Cerrolaza Aragón, Óscar Cerrolaza Gili, Begoña Llovet Barquero, Edelsa Grupo, España, 2010.
	Authors, book title, year of publication, edition number, press, place

Recommended by Board of Studies	DD-MM-YYYY		
Approved by Academic Council	No. xx	Date	DD-MM-YYYY

Course code	Course title	L	T	P	J	C
STS 1021	Introduction to Softskills	3	0	0	0	1
Pre-requisite	None	Syllabus version				

Course Objectives:

- To enhance critical thinking and innovative skills
- To have a working knowledge of communicating in English
- To have critical thinking and innovative skills

Expected Course Outcome:

- Students will be able to exhibit appropriate presentation skills
- Students will be able to exhibit appropriate analytical skills
- The students will be able to deliver impactful presentations

Student Learning Outcomes (SLO):	10, 11, 12, 13

10. Having a clear understanding of professional and ethical responsibility
11. Having an interest in lifelong learning
12. Having adaptive thinking and adaptability
13. Having cross-cultural competency exhibited by working in teams

Module:1	Lessons on excellence	10 hours

Ethics and integrity
Importance of ethics in life, Intuitionism vs. Consequentialism, Non-consequentialism, Virtue ethics vs. situation ethics, Integrity - listen to conscience, Stand up for what is right
Change management
Who moved my cheese?, Tolerance of change and uncertainty, Joining the bandwagon, Adapting change for growth - overcoming inhibition
How to pick up skills faster?
Knowledge vs. skill, Skill introspection, Skill acquisition, "10,000 hours rule" and the converse
Habit formation
Know your habits? How habits work? - The scientific approach, How habits work? - The psychological approach, Habits and professional success, "The Habit Loop," Domino effect, Unlearning a bad habit
Analytic and research skills.
Focused and targeted information seeking, How to make Google work for you, Data assimilation

Module:2	Team skills	11 hours

Goal setting
SMART goals, Action plans, Obstacles -Failure management
Motivation
Rewards and other motivational factors, Maslow's hierarchy of needs, Internal and external motivation

Facilitation
Planning and sequencing, Challenge by choice, Full Value Contract (FVC), Experiential learning cycle, Facilitating the Debrief
Introspection
Identify your USP, Recognize your strengths and weakness, Nurture strengths, Fixing weakness, Overcoming your complex, Confidence building
Trust and collaboration
Virtual Team building, Flexibility, Delegating, Shouldering responsibilities

Module:3	**Emotional Intelligence**	**12 hours**

Transactional Analysis
Introduction**,** Contracting, Ego states**,** Life positions
Brain storming
Individual Brainstorming, Group Brainstorming, Stepladder Technique, Brain writing, Crawford's Slip writing approach, Reverse brainstorming, Star bursting, Charlette procedure, Round robin brainstorming
Psychometric Analysis
Skill Test, Personality Test
Rebus Puzzles/Problem Solving
More than one answer, Unique ways

Module:4	**Adaptability**	**12 hours**

Theatrix
Motion Picture, Drama, Role Play, Different kinds of expressions
Creative expression
Writing, Graphic Arts, Music, Art and Dance
Flexibility of thought
The 5'P' framework (Profiling, prioritizing, problem analysis, problem-solving, planning)
Adapt to changes(tolerance of change and uncertainty)
Adaptability Curve, Survivor syndrome

	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Chip Heath, How to Change Things When Change Is Hard (Hardcover), 2010, First Edition, Crown Business.
2.	Karen Kindrachuk, Introspection**,** 2010, 1st Edition.
3.	Karen Hough, The Improvisation Edge: Secrets to Building Trust and Radical Collaboration at Work, 2011, Berrett-Koehler Publishers

Reference Books

1.	Gideon Mellenbergh, A Conceptual Introduction to Psychometrics: Development, Analysis, and Application of Psychological and Educational Tests, 2011, Boom Eleven International.
2.	Phil Lapworth, An Introduction to Transactional Analysis, 2011, Sage Publications (CA)
Mode of Evaluation: FAT, Assignments, Projects, Case studies, Roleplays,3 Assessments with Term End FAT (Computer Based Test)	

Course code	Course title	L	T	P	J	C
STS 1022	Introduction to Business Communication	3	0	0	0	1
Pre-requisite		Syllabus version				
		1				

Course Objectives:

- To enhance critical thinking and innovative skills
- To have a working knowledge of communicating in English
- To have critical thinking and innovative skills

Expected Course Outcome:

- Students will be able to exhibit appropriate presentation skills
- Students will be able to exhibit appropriate analytical skills
- The students will be able to deliver impactful presentations

Student Learning Outcomes (SLO):	16, 18

16. Having a good working knowledge of communicating in English
18. Having critical thinking and innovative skills

Module:1	Presentation skills – Preparing presentation and Organizing materials and Maintaining and preparing visual aids and Dealing with questions	7 hours

10 Tips to prepare PowerPoint presentation, Outlining the content, Passing the Elevator Test, Blue sky thinking, Introduction, body and conclusion, Use of Font, Use of Color, Strategic presentation, Importance and types of visual aids, Animation to captivate your audience, Design of posters, Setting out the ground rules, Dealing with interruptions, Staying in control of the questions, Handling difficult questions

Module:2	Analytical Writing – Articulate and support complex ideas	6 hours

30 minute - Analyse an Issue, 30 minute - Analyse an Argument, Construct and Evaluate arguments¸ Focused and Coherent discussion

Module:3	Business Etiquette	9 hours

Social and Cultural Etiquette
Value, Manners, Customs, Language, Tradition
Writing Company Blogs
Building a blog, Developing brand message, FAQs', Assessing Competition
Internal Communications

Open and objective Communication, Two-way dialogue, Understanding the audience **Planning** Identifying, Gathering Information, Analysis, Determining, Selecting plan, Progress check, Types of planning **Writing a press release and meeting notes** Write a short, catchy headline, Get to the Point –summarize your subject in the first paragraph, Body – Make it relevant to your audience		
Module:4	**Listening and speaking skills**	**10 hours**
Debate, Idea generation, Research, Articulating, Style, Preparation of arguments –Rebuttal, Use of statistics, Types of Listening, Hearing, Focus, Voice, Verbal and Non-verbal messages Practice rounds, How to present a JAM, Public speaking.		
Module:5	**PEST Analysis & Lean Concepts**	**7 hours**
SLEPT, STEEPLE, 360 Feedback, Product life cycle, Waste reduction, Technology change, Product support		
Module:6	**Non Verbal Communication**	**6 hours**
Proximecs : Types of proximecs**,** Rapport building **Reports and Data Transcoding:** Types of reports **Negotiation Skill :**Effective negotiation strategies **Conflict Resolution :**Types of conflicts		
	Total Lecture hours:	**45 hours**

Reference Books

1.	Dale Carnegie,(1936) How to Win Friends and Influence People. New York City. Gallery Books
2.	Joyce Aemstrong and Carroll(1992) Integrated Teaching of Reading, Writing, Listening, Speaking, Viewing and Thinking. Korea. Libraries Unlimited Inc.
3.	Theo Theobald(2011) Develop your Presentation Skills. New Delhi. Kogan Page Limited.

Websites:

1.	www.chalkstreet.com
2.	www.skillsyouneed.com
3.	www.mindtools.com
4.	www.thebalance.com

5.	www.eguru.ooo

Mode of Evaluation: FAT, Assignments, Projects, Case studies, Roleplays,
3 Assessments with Term End FAT (Computer Based Test)

Course code	Course title	L	T	P	J	C
STS 2021	Fundamentals of Aptitude	3	0	0	0	1
Pre-requisite	None	Syllabus version				
		1				

Course Objectives:

- To enhance the logical reasoning skills of the students and improve the problem-solving abilities
- To strengthen the ability to solve quantitative aptitude problems
- To enrich the verbal ability of the students

Expected Course Outcome:

- Students will be introduced to basic concepts of Quantitative Aptitude, Logical reasoning, and verbal ability
- Students will be able to read and demonstrate good comprehension of text in areas of the student's interest
- Students will be able to demonstrate the ability to resolve problems that occur in their fields.

Student Learning Outcomes(SLO):	5, 9, 10, 12, 16

5. Having design thinking capability
9. Having problem-solving ability- solving social issues and engineering problems
10. Having a clear understanding of professional and ethical responsibility
11. Having interest in lifelong learning
12. Having adaptive thinking and adaptability
16. Having a good working knowledge of communicating in English

Module:1	Lessons on excellence	2 hours

Skill introspection, Skill acquisition, consistent practice

Module:2	Logical Reasoning	16 hours

Thinking Skill

- Problem Solving
- Critical Thinking
- Lateral Thinking

Taught through thought-provoking word and rebus puzzles, and word-link builder questions

Coding & decoding, Series, Analogy, Odd man out and Visual reasoning

- Coding and Decoding
- Series
- Analogy
- Odd Man Out
- Visual Reasoning

Sudoku puzzles

Solving introductory to moderate level sudoku puzzles to boost logical thinking and comfort with numbers

Attention to detail
Picture and word driven Qs to develop attention to detail as a skill

Module:3	**Quantitative Aptitude**	**14 hours**

Speed Maths

- Addition and Subtraction of bigger numbers
- Square and square roots
- Cubes and cube roots
- Vedic maths techniques
- Multiplication Shortcuts
- Multiplication of 3 and higher digit numbers
- Simplifications
- Comparing fractions
- Shortcuts to find HCF and LCM
- Divisibility tests shortcuts

Algebra and functions

Module:4	**Recruitment Essentials**	**5 hours**

Looking at an engineering career through the prism of an effective resume

- Importance of a resume - the footprint of a person's career achievements
- How a resume looks like?
- An effective resume vs. a poor resume: what skills you must build starting today and how?

Impression Management

Getting it right for the interview:

- Grooming, dressing
- Body Language and other non-verbal signs
- Displaying the right behaviour

Module:5	**Verbal Ability**	**8 hours**

Essential grammar for placements:

- Nouns and Pronouns
- Verbs
- Subject-Verb Agreement
- Pronoun-Antecedent Agreement
- Punctuations

Verbal Reasoning

	Total Lecture hours:	**45 hours**

Mode of Evaluation: FAT, Assignments, 3 Assessments with Term End FAT (Computer Based Test)

Text Book(s):

1. FACE, Aptipedia Aptitude Encyclopedia, 2016, 1st Edition, Wiley Publications, Delhi.
2. ETHNUS, Aptimithra, 2013, 1st Edition, McGraw-Hill Education Pvt.Ltd.
3. **SMART, PlaceMentor, 2018, 1st Edition, Oxford University Press.**
4. R S Aggarwal, Quantitative Aptitude For Competitive Examinations, 2017, 3rd Edition, S. Chand Publishing, Delhi.

Reference Book(s):

Arun Sharma, Quantitative Aptitude, 2016, 7th Edition, McGraw Hill Education Pvt. Ltd.

Course code	Course title	L	T	P	J	C
STS 2022	Arithmetic problem solving	3	0	0	0	1
Pre-requisite	None	Syllabus version				
		1				

Course Objectives:

- To enhance the logical reasoning skills of the students and improve the problem-solving abilities
- To strengthen the ability to solve quantitative aptitude problems
- To enrich the verbal ability of the students for academic purpose

Expected course outcome:

- Students will be able to show more confidence in solving problems of Quantitative Aptitude
- Students will be able to show more confidence in solving problems of Logical Reasoning
- Students will be able to show more confidence in understanding the questions of Verbal Ability

Student Learning Outcomes(SLO):	5, 9 and 16

5. Having design thinking capability
9. Having problem-solving ability- solving social issues and engineering problems
16. Having a good working knowledge of communicating in English

Module:1	Logical Reasoning	11 hours

Word group categorization questions
Puzzle type class involving students grouping words into right group orders of logical sense
Cryptarithmetic
Data arrangements and Blood relations

- Linear Arrangement
- Circular Arrangement
- Multi-dimensional Arrangement
- Blood Relations

Module:2	Quantitative Aptitude	18 hours

Ratio and Proportion

- Ratio
- Proportion
- Variation
- Simple equations
- Problems on Ages
- Mixtures and alligations

Percentages, Simple and Compound Interest

- Percentages as Fractions and Decimals
- Percentage Increase / Decrease
- Simple Interest
- Compound Interest
- Relation Between Simple and Compound Interest

Number System

- Number system
- Power cycle
- Remainder cycle
- Factors, Multiples
- HCF and LCM

Module:3	Verbal Ability	16 hours

Essential grammar for placements

- Prepositions
- Adjectives and Adverbs
- Tenses
- Forms and Speech and Voice
- Idioms and Phrasal Verbs
- Collocations, Gerund, and Infinitives

Reading Comprehension for placements

- Types of questions
- Comprehension strategies
- Practice exercises

Articles, Prepositions, and Interrogatives

- Definite and Indefinite Articles
- Omission of Articles
- Prepositions
- Compound Prepositions and Prepositional Phrases
- Interrogatives

Vocabulary for placements

- Exposure to solving questions of
- Synonyms
- Antonyms
- Analogy
- Confusing words
- Spelling correctness

	Total Lecture hours:	45 hours

Mode of Evaluation: FAT, Assignments, 3 Assessments with Term End FAT (Computer Based Test)

Text Book(s):

5. FACE, Aptipedia Aptitude Encyclopedia, 2016, 1st Edition, Wiley Publications, Delhi.
6. ETHNUS, Aptimithra, 2013, 1st Edition, McGraw-Hill Education Pvt.Ltd.
7. **SMART, PlaceMentor, 2018, 1st Edition, Oxford University Press.**
8. R S Aggarwal, Quantitative Aptitude For Competitive Examinations, 2017, 3rd Edition, S. Chand Publishing, Delhi.

Reference Book(s):

Arun Sharma, Quantitative Aptitude, 2016, 7th Edition, McGraw Hill Education Pvt. Ltd.

Course code	Course title	L	T	P	J	C
STS 3021	Getting started to skill enhancement	3	0	0	0	1
Pre-requisite	None	Syllabus version				
		1				

Course Objectives:

- To develop the students' logical thinking skills and apply them in the real-life scenarios
- To learn the strategies of solving quantitative ability problems
- To enrich the verbal ability of the students

Expected Course Outcome:

- Students will be able to demonstrate critical thinking skills, such as problem-solving related to their subject matters
- Students will be able to demonstrate competency in verbal, quantitative and reasoning aptitude
- Students will be able to perform good written communication skills

Student Learning Outcomes(SLO):	5, 9,16

5. Having design thinking capability
9. Having problem-solving ability- solving social issues and engineering problems
16. Having a good working knowledge of communicating in English

Module:1	Logical Reasoning	11 hours

Clocks, calendars, Direction sense and Cubes

- Clocks
- Calendars
- Direction Sense
- Cubes

Data interpretation and Data sufficiency

- Data Interpretation – Tables
- Data Interpretation - Pie Chart
- Data Interpretation - Bar Graph
- Data Sufficiency

Module:2	Quantitative Aptitude	18 hours

Time and work

- Work with different efficiencies
- Pipes and cisterns
- Work equivalence
- Division of wages

Time, Speed and Distance

- Basics of time, speed and distance
- Relative speed
- Problems based on trains
- Problems based on boats and streams
- Problems based on races

Profit and loss, Partnerships and averages

- Basic terminologies in profit and loss
- Partnership
- Averages
- Weighted average

Module:3	Verbal Ability	13 hours

Sentence Correction

- Subject-Verb Agreement
- Modifiers
- Parallelism
- Pronoun-Antecedent Agreement
- Verb Time Sequences
- Comparisons
- Prepositions
- Determiners

Sentence Completion and Para-jumbles

- Pro-active thinking
- Reactive thinking (signpost words, root words, prefix suffix, sentence structure clues)
- Fixed jumbles
- Anchored jumbles

Module:4	Writing skills for placements	3 hours

Essay writing

- Idea generation for topics
- Best practices
- Practice and feedback

	Total Lecture hours:	45 hours

Mode of Evaluation: FAT, Assignments, 3 Assessments with Term End FAT (Computer Based Test)

Text Book(s):

9. FACE, Aptipedia Aptitude Encyclopedia, 2016, 1st Edition, Wiley Publications, Delhi.
10. ETHNUS, Aptimithra, 2013, 1st Edition, McGraw-Hill Education Pvt.Ltd.
11. **SMART, PlaceMentor, 2018, 1st Edition, Oxford University Press.**
12. R S Aggarwal, Quantitative Aptitude For Competitive Examinations, 2017, 3rd Edition, S. Chand Publishing, Delhi.

Reference Book(s):

Arun Sharma, Quantitative Aptitude, 2016, 7th Edition, McGraw Hill Education Pvt. Ltd.

Course code	Course title	L	T	P	J	C
STS 3022	Enhancing problem solving skills	3	0	0	0	1
Pre-requisite	None	Syllabus version				
		1				

Course Objectives:

- To develop the students' logical thinking skills and apply them in the real-life scenarios
- To learn the strategies of solving quantitative ability problems
- To enrich the verbal ability of the students
- To strengthen the basic programming skills for placements
-

Expected Course Outcome:

- The students will be able to interact confidently and use decision-making models effectively
- The students will be able to deliver impactful presentations
- The students will be able to be proficient in solving quantitative aptitude and verbal ability questions effortlessly

Student Learning Outcomes(SLO):	5, 7, 9, 12, 16

5. Having design thinking capability
7. Having computational thinking (Ability to translate vast data into abstract concepts and to understand database reasoning)
9. Having problem-solving ability- solving social issues and engineering problems
12. Having adaptive thinking and adaptability
16. Having a good working knowledge of communicating in English

Module:1	Logical Reasoning	5 hours

Logical connectives, Syllogism and Venn diagrams

- Logical Connectives
- Syllogisms
- Venn Diagrams – Interpretation

Venn Diagrams - Solving

Module:2	Quantitative Aptitude	11 hours

Logarithms, Progressions, Geometry and Quadratic equations

- Logarithm
- Arithmetic Progression
- Geometric Progression
- Geometry
- Mensuration
- Coded inequalities
- Quadratic Equations

Permutation, Combination and Probability

- Fundamental Counting Principle
- Permutation and Combination
- Computation of Permutation
- Circular Permutations

- Computation of Combination

Probability

Module:3	Verbal Ability	4 hours

Critical Reasoning

- Argument – Identifying the Different Parts (Premise, assumption, conclusion)
- Strengthening statement
- Weakening statement
- Mimic the pattern

Module:4	Recruitment Essentials	7 hours

Cracking interviews - demonstration through a few mocks

Sample mock interviews to demonstrate how to crack the:

- HR interview
- MR interview
- Technical interview

Cracking other kinds of interviews

- Skype/ Telephonic interviews
- Panel interviews
- Stress interviews

Resume building – workshop

A workshop to make students write an accurate resume

Module:5	Problem-solving and Algorithmic skills	18 hours

- Logical methods to solve problem statements in Programming
- Basic algorithms introduced
-

	Total Lecture hours:	45 hours

Mode of Evaluation: FAT, Assignments, Mock interviews, 3 Assessments with Term End FAT (Computer Based Test)

Text Book(s):

13. FACE, Aptipedia Aptitude Encyclopedia, 2016, 1st Edition, Wiley Publications, Delhi.
14. ETHNUS, Aptimithra, 2013, 1st Edition, McGraw-Hill Education Pvt.Ltd.
15. SMART, PlaceMentor, 2018, 1st Edition, Oxford University Press.
16. R S Aggarwal, Quantitative Aptitude For Competitive Examinations, 2017, 3rd Edition, S. Chand Publishing, Delhi.

Reference Book(s):

Arun Sharma, Quantitative Aptitude, 2016, 7th Edition, McGraw Hill Education Pvt. Ltd.

Course code	Course title	L	T	P	J	C
STS 4022	Enhancing programming ability	3	0	0	0	1
Pre-requisite	None	Syllabus version				
		1				

Course Objectives:

- Ability to translate vast data into abstract concepts and to understand JAVA concepts
- To have a clear understanding of subject-related concepts
- To develop computational ability in Java programming language

Expected Course Outcome:

- Clear Knowledge about problem-solving skills in JAVA concepts
- Students will be able to write codes in Java
-

Student Learning Outcomes(SLO):	7, 18

7. Having computational thinking (Ability to translate vast data into abstract concepts and to understand database reasoning)
18. Having critical thinking and innovative skills

Module:1	Collections	12 hours

ArrayList, LinkedList, List Interface, HashSet, Map Interface, HashMap, Set
Programming questions based on collections
Real-world problems based on data structure

Module:2	Threads, Exceptions, LinkedList, Arrays	6 hours

Need of threads
Creating threads
Wait
Sleep
Thread execution

Need for exception handling
try, catch, throw, throws
Creating own exception (Java, Python)
Handling own exceptions

Solving programming questions based on linked list and arrays

Module:3	Stack and Queue, Trees	7 hours

Solving programming questions based on stacks and queues
How to implement a stack using queue?
How to implement a queue using stack?
Solving programming questions based on trees, binary trees, binary search trees

Module:4	JDBC Connectivity, JDBC Data	10 hours

JDBC Overview

Database Setup Install the MySQL Database Create New Database User in MySQL WorkbenchSelecting data from tables Inserting Data into the Database Updating Data in the Database Deleting Data from the Database Creating Prepared Statements		
Module:5	**Networking with Java**	**10 hours**
Working with URLs Sending HTTP Requests Processing JSON data using Java Processing XML data using Java		
	Total Lecture hours:	**45 hours**

Reference Books	
1.	Java The Complete Reference, 2014, 9th Edition by By Herbert Schildt, McGraw-Hill Education Pvt Ltd
2.	Introduction to Programming with Java: A Problem-Solving Approach by John Dean

Mode of Evaluation: FAT, Assignments, 3 Assessments with Term End FAT (Computer Based Test)

Course code	Course title	L	T	P	J	C
STS 4021	Introduction to programming skills	3	0	0	0	1
Pre-requisite	None	Syllabus version				
		1				

Course Objectives:

- Ability to translate vast data into abstract concepts and to understand JAVA concepts
- To have a clear understanding of subject-related concepts
- To develop computational ability in Java programming language

Expected Course Outcome:

- Clear Knowledge about problem-solving skills in JAVA concepts
- Students will be able to write codes in Java

Student Learning Outcomes(SLO):	7, 18

7. Having computational thinking (Ability to translate vast data into abstract concepts and to understand database reasoning)
18. Having critical thinking and innovative skills

Module:1	Object and Class, Data types	8 hours

Types of programming
Disadvantages of functional programming
Class & Objects
Attributes
Methods
Objects
Solving MCQs based on Objects and Classes
Solving tricky questions based on encapsulation
Solving frequently asked object-based questions

Data types
Data
Why data type
Variables
Available data types
Numeric – int, float, double
Character – char, string
Solving MCQs based on typecasting, data types
Solving debugging based MCQs

Module:2	Basic I / O, Decision Making, Loop Control	8 hours

Printing
Getting input from the user during run time
Command-line arguments
Solving programming questions based on CLA

Solving MCQs questions based on CLA Need for control statement if..else if..else if..else Nested if..else Switch case Common mistakes with control statements (like using = instead of ==) Solving frequently asked questions on decision making Types of looping statements Entry Controlled For While Exit Controlled do-while break and continue Demo on looping Common mistakes with looping statements (like using; at the end of the loop) Solving pattern programming problems, series problems Solving predict the output questions		
Module:3	**String, Date, Array**	**10 hours**
String handling, data handling Solving problems based on arrays like searching, sorting, rearranging, iteration) Multi-dimensional arrays Solving pattern problems using 2D arrays Real-time application based on 2D arrays		
Module:4	**Inheritance, Aggregation & Associations**	**12 hours**
Need Is A – Inheritance Types of inheritance supported Diagrammatic representation Demo on inheritance Has A – Aggregation Diagrammatic representation Demo on aggregation Uses A - Association Diagrammatic representation Demo on association Assignment on relationships Solving MCQs based on relationships between classes		
Module:5	**Modifiers, Interface & Abstract classes (Java specific), Packages**	**7 hours**

Types of access specifiers Demo on access specifiers Assignment on access modifiers Instance Members Solving MCQs based on modifiers Abstract Classes Need Abstract Classes Abstract Methods Interfaces Assignment on abstract classes and interface Need for packages Access specifiers & packages Import classes from other packages		
	Total Lecture hours:	**45 hours**

Reference Books	
1.	Java The Complete Reference, 2014, 9th Edition by By Herbert Schildt, McGraw-Hill Education Pvt Ltd
2.	Introduction to Programming with Java: A Problem-Solving Approach by John Dean

Mode of Evaluation: FAT, Assignments, 3 Assessments with Term End FAT (Computer Based Test)

PROGRAMME CORES

Course code	Course title	L	T	P	J	C
BIY1001	Biochemistry	3	0	2	0	4
Pre-requisite	None	Syllabus version				
		v. 1.1				

Course Objectives:

1. Demonstrate the structure and function of biomolecules
2. Outline different pathways involved in cellular metabolism
3. Relate inhibitors and activators of key metabolic reactions

Expected Course Outcome:

1. Compare and contrast the structural basis of biological macromolecules.
2. Analyze the chemical bonds of importance in carbohydrates, lipids, proteins, and nucleic acids.
3. Illustrate the catabolism and anabolism of carbohydrates
4. Summarize the energetics and regulation of metabolic pathways
5. Interpret experiments and techniques based on the significance of biomolecules.

Student Learning Outcomes (SLO):	2, 11,18

2.Having a clear understanding of the subject related concepts and contemporary issues
11. Having interest in lifelong learning
18. Having critical thinking and innovative skills

Module:1	Chemistry of Life	5 hours

Elements of life, chemical bonding, covalent, ionic, and weak chemical bonds. Water and buffers. Properties of water-solubility, ionization, and water as a reactant.

Module:2	Carbon the backbone of life	5 hours

Organic molecules and the origin of life. Properties of living system-review on cellular, chemical, physical, the genetic, and evolutionary background to Biochemistry.

Module:3	Fuel and building material	7 hours

Proteins, Carbohydrates, and lipids. Classification, structure, and function. Energy by oxidizing organic molecules: Catabolic pathway-glycolysis, TCA cycle

Module:4	Nucleotides structure and Biosynthesis of ATP	7 hours

Different nucleotide structures. ATP as cellular currency. Substrate level, oxidative, and photophosphorylation. Amino acids from glycolysis, TCA intermediates by transamination. Gluconeogenesis, Pentose phosphate pathway. Anaerobic respiration. ATP as important currency in cells.

Module:5	Amino Acids and their polymer proteins	6 hours

Classification, structure, and biological importance of amino acids. Zwitter ion nature. Peptide bond formation-polypeptide chain

Module:6	Proteins	6 hours

Structure, Classification and biological function, protein structure and function relationships concerning fibrous proteins such as keratin, collagen, silk fibroin and globular proteins such as hemoglobin and myoglobin, insulin, Protein denaturation

Module:7	Lipids a diverse group of hydrophobic molecules. Fatty acids. Lipids	7 hours
Classification, structure, properties, function, and metabolism of fatty acids. Classification, structure, properties, and biological function of Simple lipids – triacylglycerol and waxes. Compound lipids- phospholipids and glycolipids. Cholesterol- structure, properties, and importance. Eicosanoids		
Module:8	**Contemporary issues: Lectures by experts**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Nelson DL and Cox MM (2012) Lehninger's Principles of Biochemistry, Sixth Edition, WH Freeman, New York.
2. Rodwell VW, Bender D, Botham KM, Kennelly PJ (2015) Harpers Illustrated Biochemistry, 30th Edition, McGraw-Hill Companies, Inc. USA

Reference Books

1. Mathews CK, van Holde KE, Appling DR, Anthony-Cahill SJ (2012) Biochemistry, 4th Edition. Prentice-Hall

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)

1.	Laboratory practices in biochemistry and reagent preparation -% solution, molar solution, and saturated solution.	2 hours
2.	Preparation of buffers and pH change	2 hours
3.	Carbohydrates from biological sources fruits, sugarcane, corn, and milk.	4 hours
4.	Quantitative analysis of reducing sugars.	4 hours
5.	Use of Formal titration method to estimate glycine amino acid.	4 hours
6.	Colorimetric analysis of amino acids arginine, cysteine, histidine, tryptophan, and tyrosine.	4 hours
7.	Acid-Base titration of amino acids	2 hours
8.	Spectroscopic estimation of nucleic acids	2 hours
9.	Fatty acids- chromatographic separation	4 hours
10.	Revisions	2 hours
	Total Laboratory Hours	**30 hours**

Mode of evaluation:

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY1002	Cell Biology	3	0	2	0	4
Pre-requisite	None	Syllabus version				
		v. 1.1				

Course Objectives:

1. Develop a basic understanding of the unit of life that is cell
2. Relate the organization and function of different cell organelles
3. Extend the knowledge earned from the course

Expected Course Outcome:

1. Recall critical concepts, facts, and theories relevant to biological sciences
2. Correlate the functions of different organelles of the cell
3. Examine contemporary issues in related fields
4. Interpret data presented in pictorial or numerical form
5. Perceive recent developments in the field
6. Able to apply scientific knowledge to address the nature problems.

Student Learning Outcomes (SLO):	2, 9, 18

2.Having a clear understanding of the subject related concepts and contemporary issues
9. Having an interest in lifelong learning
18. Having critical thinking and innovative skills

Module:1	The fundamental unit of life-Cell	5 hours

Cell theory, diversity, and commonalty of cells and evolutionary relations between organisms. Structure of prokaryotic and eukaryotic cells; plant and animal cells.

Module:2	Cell structure and functions	9 hours

Biomembrane: lipid and protein constituents, cytoskeleton, cell wall, nucleus, mitochondria, chloroplast, endoplasmic reticulum, Golgi apparatus, peroxisome, vacuole, lysosome, ribosome, centrosome, and glyoxisome.

Module:3	The life cycle of cells	6 hours

Cell division in prokaryotes and eukaryotes, mitosis and meiosis, and regulation of cell cycle by mitogens, cyclins, and Cdks. Apoptosis in multicellular organisms.

Module:4	Transport across cell membranes	7 hours

Osmosis, endocytosis, exocytosis, passive diffusion, uniporters, symporters, antiporters, gated and non-gated ion channels, and ATP pumps.

Module:5	Cell signaling	5 hours

Primary and secondary signaling molecules. Autocrine, paracrine, and endocrine signal. Signal amplification, each with one example.

Module:6	**Signal transduction pathways**	**6 hours**
Introduction to major signaling pathways. G-protein coupled signal transduction pathway involving cAMP, cGMP, IP_3, DAG, and Ca^{2+} as second messengers.		
Module:7	**Cell motility and integration**	**5 hours**
Module content		
Role of motor proteins: kinesin, dynein, and myosin. Role of microtubules in the movement of cilia and flagella. Formation of microfilaments in lamellipodia and filopodia. Muscle contraction.		
Module:8	**Contemporary issues:** Lectures by experts	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Lodish H, Berk A Kaiser CA Krieger M, Bretscher A, Ploegh H, Amon A, Martin KC (2012) Molecular Cell Biology, 7th edition, W.H. Freeman. USA.

Reference Books

1.	Lynne B. Jorde, John C. Carey, Michael, J. Bamshad, and Raymond, L. White (2010) Medical genetics. 4th edition, Mosby. USA.
2.	Cooper GM and Hausman RE (2013) The Cell: A Molecular Approach. 6th edition. Sinauer Associates, Inc. USA.
3.	Alberts B, Johnson A, Lewis J, Morgan D, Raff M, Roberts K, and Walter P (2014) Molecular Biology of the Cell. 6th edition. Garland Science, USA.
	Authors, book title, year of publication, edition number, press, place

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)

1.	Principles and handling of microscopes.	2 hours
2.	Studying the diversity of cells using permanent slides.	2 hours
3.	Differentiating plant cells from animal cells using a basic, acidic, and a combination stain.	4 hours
4.	Subjecting cells to different pH, concentrations, and analyzing the structural changes occurring due to osmosis.	4 hours
5.	Imaging and visualization of sub-cellular organelles using a fluorescent microscope.	4 hours
6.	Fractionation of nucleus and mitochondria from cauliflower cells and visualization using methyl green pyronin under a bright-field microscope of 400x magnification.	4 hours
7.	Enumerating and finding out whether RBCs/WBCs are in the optimal range	2 hours

	in the sample and analyzing the results.	
8.	Growing root tips of different plants and comparing the chromosome number by fixing at the metaphase stage.	2 hours
9.	Comparison of various stages of Meiosis I and Meiosis II during microsporogenesis of *Rheodiscolor*.	4 hours
10.	Revisions	2 hours
	Total Laboratory Hours	30 hours

Mode of evaluation: Continuous assessment and Final assessment test.			
Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY1003	Biodiversity and Conservation Biology	2	0	0	4	3
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Demonstrate the concepts and values of biodiversity
2. Analyze the ways to protect the habitat
3. Formulate scientific intervention tools for conservation

Expected Course Outcome:

1. Illustrate the values of biodiversity
2. Summarize the genetic diversity and factors causing loss of genetic diversity
3. Demonstrate methods involved in species inventory and its richness.
4. Classify ecosystem types of the world and how to manage biodiversity.
5. Examine the process of evolution and various factors that govern a population.
6. Build possible measures to overcome species extension and loss of ecosystem.

Student Learning Outcomes (SLO):	2, 10

2. Having a clear understanding of the subject related concepts and contemporary issues
10. Having interest in lifelong learning

Module:1	Introduction to Biodiversity	4 hours

Biodiversity Scope and its constraints, causes for diversity, quantifying biodiversity, Maintenance of ecological biodiversity, Uses and Values of Biodiversity.

Module:2	Genetic diversity	4 hours

Importance of genetic diversity. Nature and origin of genetic variation, measurement of genetic variation, loss of genetic diversity, factors causing loss of genetic diversity, Genetic drift.

Module:3	Species diversity	4 hours

Species inventory, problems in inventorying species, monitoring, the total number of species of microbes, plants, and animals. Origin in species diversity, species richness, species abundance, toxic diversity, future of species diversity studies

Module:4	Ecosystem diversity	4 hours

Classification of the ecosystem, measuring ecosystem diversity, major ecosystem types of the world, agro ecosystem-, diversity of domesticated species-land races, advanced cultivars, wild relatives of cultivated plants, wild plants, urban and peri-urban diversity, loss of ecosystem diversity

Module:5	Evolutionary Genetics in a natural population	4 hours

Factors controlling the evolution of population, selection, and adaptation, Migration and gene flow, low genetic diversity in threatened species, mutation and selection balance

Module:6	Loss of Biodiversity	4 hours

Factors causing loss of biodiversity (Habitat degradation & loss, Overexploitation, Biological invasions, Climate change) Loss of agro, ecosystem, and species. The fate of endangered species

Module:7	**Conservation Biodiversity**	**4 hours**
Why conserve biodiversity? Ecological economics & nature conservation, Conservation of genetic and methodologies, species and ecosystem		
Module:8	**Contemporary issues:** Lectures by industrial experts	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1. Krishnamurthy KV (2017) An advanced textbook on Biodiversity, Principle and Practice, Oxford and IBH publishing Co. Pvt.
2. Frankham (2010), Jonathan D. Ballou, David A. Briscoe. Introduction to Conservation Genetics, 2nd edition, Cambridge.
3. Richard BP (2016) Principles of Conservation Biology, 4th edition, Sinauer Associates, Inc.

Reference Books

1. Reddy GV, Karanth KU, Samba Kumar N, Krishnaswamy J and Karanth KK (2016) Recovering biodiversity in Indian forests, Springer
   Talent JA (2012) Earth and Life, Springer

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY1004	Genetics	2	0	0	4	3
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Recall basic concepts in molecular genetics
2. Dissect classical experiments to understand gene transfer
3. Choose the correct experimental model organism

Expected Course Outcome:

1. Explain genetic inheritance through historical experiments
2. Discuss chromosome organization and sex determination
3. Relate genetic makeup of different organisms
4. Distinguish factors that alter allele frequencies under exemptions
5. Relationship between mutation and evolution
6. Demonstrate the metabolic pathway and to utilize it for improvement of the human race.

Student Learning Outcomes (SLO):	2, 10, 11

2. Having a clear understanding of the subject related concepts and contemporary issues
10. Having a clear understanding of professional and ethical responsibility
11. Having an interest in lifelong learning

Module:1	Principles of Inheritance	4 hours

Mendelian laws, Post Mendelian inheritance – Codominance; Incomplete dominance; Epistasis; Lethal Genes; Multiple alleles, Linkage, Crossing over and chromosomal mapping.

Module:2	Chromosomes structure and sex determination	4 hours

Prokaryotic and eukaryotic chromosome structure, variations in structure and number. Giant chromosomes - sex determination in plants and animals, dosage compensation. Sex chromosomes and sex-linked inheritance, Extrachromosomal inheritance.

Module:3	Model systems to study genetics	4 hours

Bacteriophage, E. coli, Neurospora crassa, yeast, Arabidopsis, maize, Drosophila, C. elegans, Zebra fish, Homo sapiens

Module:4	Forces that change allele Frequencies	4 hours

Hardy – Weinberg law and its applications, Factors affecting allele frequencies, selection, mutation, migration and genetic drift, inbreeding and outbreeding, Quantitative Genetics, C-value.

Module:5	Mutation	4 hours

Spontaneous and Induced mutations, and its role in evolution, Radiation injury and DNA repair mechanisms, Relationship between Mutations and Phenotypes, genetic toxicity testing.

Module:6	Biochemical Genetics	4 hours

Altered pathway of phenylalanine and tyrosine metabolism in humans, Eye pigmentation pathways of Drosophila melanogaster		
Module:7	**Eugenics and euthenics**	**4 hours**
Studies of twins, genetic disorders, Prenatal diagnosis with special emphasize on amniocentesis and chorionic villus sampling, artificial insemination, genetic counseling		
Module:8	**Contemporary issues:** Lectures by experts	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Snustad DP, Simmons MJ (2011) Principles of Genetics (6th Edition) John Wiley publications Bhaskar (2012) Textbook of genetics, Campus book international.
Reference Books	
1.	T A Brown (2011) Introduction to Genetics: A Molecular Approach Garland Science.
	'J' component: Experiments
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY1005	General Microbiology	2	0	2	4	4
Pre-requisite	None	Syllabus version				
		v. 1.1				

Course Objectives:

1. Recall necessary information related to all microorganisms in general
2. Elaborate on laboratory safety and specialized microbiological laboratory skills
3. Apply the knowledge gained towards research, diagnostic, and therapeutic purposes

Expected Course Outcome:

1. Demonstrates the structure, diversity, classification, and application of microorganisms
2. Compare the ubiquitous nature of microorganisms and their ecological niches
3. Outline the theoretical basis of the tools, technologies, and methods common to microbiology
4. Illustrate problem-solving skills and other concepts in microbiology
5. Relate the role of microbes in the fields of medicine and biotechnology
6. Utilize various research or internship activities in the field of microbiology

Student Learning Outcomes (SLO): 2, 10, 11

2. Having a clear understanding of the subject related concepts and of contemporary issues
10. Having a clear understanding of professional and ethical responsibility
11. Having an interest in lifelong learning

Module:1	Introduction	4 hours

Scope and branches of Microbiology, The Historical Foundations of Microbiology, General Characteristics of Microorganisms, Taxonomy: Naming, Classifying, and Identifying Microorganisms. Importance of Bergey's classification

Module:2	Methods of studying Microorganism	4 hours

Microscopes (light microscope, phase contrast microscope, dark ground microscope, fluorescent microscope, and electron microscope). Staining methods and identification of Bacteria. Different culture methods, techniques of pure culture and preservation of cultures

Module:3	Microbial Nutrition, transport and Growth	4 hours

Classification based on the nutritional requirements. Microbial growth, techniques of Measurement of growth, and enumeration. Factors affecting growth, growth curve

Module:4	Microbial Metabolism	4 hours

Respiratory metabolism of microbes – aerobic and anaerobic paths of energy production. Fermentative pathways – organisms, substrates, intermediates, and end-products. Excretory metabolism.

Module:5	Antimicrobial therapy	4 hours

Principles of antimicrobial therapy, Antimicrobial agents, tests for antimicrobial agents. Antimicrobial drug resistance and acquisitions

Module:6	Control of Microbial Growth	4 hours

Controlling microorganism growth by Physical and Chemical agents.		
Module:7	**Microbes in infectious disease**	**4 hours**
Normal Flora, Infection, and Methods of Transmission, Microbial Pathogenicity. Lab diagnosis (Sample collection, processing, and reporting)		
Module:8	**Contemporary issues:** Industrial expert lecture	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Tortora GJ, Funke BR, Case CL (2015) Microbiology: An Introduction / 12th Edition
2.	Willey JM, Sherwood LM, and Woolverton CJ (2016) Prescott's Microbiology 10thedition McGraw Hill
3.	Ananthanarayan R and Jayarama Panicker CK (2010) Text Book of Microbiology 8th edition by Orient Longman Ltd.
Reference Books	
1.	Jorgensen JH and Pfaller MA (2015) Manual of Clinical Microbiology11th Edition ASM Science
2.	Tille PM (2016) Bailey & Scott's Diagnostic Microbiology, 14thEdition Mosby Elsevier
	Project: 'J' component
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	

List of Challenging Experiments (Indicative)		
1.	Different methods to sterilization	2 hours
2.	Staining: Simple staining, differential staining, Capsule staining, Spore staining, acid-fast staining, and Lacto phenol cotton blue (LPCB).	4 hours
3.	Microbial specific media preparation: Solid and liquid media	2 hours
4.	Techniques to culture microbes on solid media: Pour plate, Spread plate, Streak plate, and Dilution techniques.	6 hours
5.	Biochemical test for identification of bacteria: Catalase test, Oxidase test, Urease test, IMViC test, LAO test, Gelatin liquefaction test, Starch degradation test, Carbohydrate fermentation.	6 hours
6.	Isolation of antibiotics producing microorganisms from soil	4 hours
7.	Kirby-Bauer method of antibiotic susceptibility test	4 hours
8.	Growth curve	2 hours
	Total Laboratory Hours	30 hours
Mode of evaluation: CAT / Assignments / FAT / Quiz		

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY1006	Human Anatomy and Physiology	3	0	0	0	3
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Define all the anatomical and medical terminologies in the field
2. Relate the functions of different organ systems in the human body
3. Examine the physiological basis for human diseases and identify treatment

Expected Course Outcome:

1. Infer the various medical terminologies and discuss with health professionals
2. Outline the functions of different blood cell types
3. Evaluate the functions of the digestive and excretory systems
4. Compare the functions of the male and female reproductive systems
5. Discuss the mechanics of respiratory and cardiovascular systems
6. Explain the basics of the brain and the nervous system

Student Learning Outcomes (SLO):	2, 11

2. Having a clear understanding of the subject related concepts and contemporary issues
11. Having interest in lifelong learning

Module:1	Introduction	5 hours

Introduction to human anatomy and physiology. Anatomical and medical terminology. Osteology, joints, and muscle cells. Body fluids and homeostasis

Module:2	Blood and its components	6 hours

Composition and functions of blood. Plasma proteins. Red blood cells, White blood cells, and platelets. Blood groups and blood clotting.

Module:3	Digestive and excretory system	7 hours

Organs of the digestive system. Salivary secretion, gastric secretion, and pancreatic secretion. Bile secretion and functions of bile. Absorption of food substances. Movements of the digestive tract. Structure and function of excretory organs such as kidney, skin, and liver.

Module:4	Endocrine and reproductive systems	7 hours

Types of hormones and hormone receptors. Adenohypophysis and neurohypophysis. The thyroid gland, parathyroid gland, and islets of Langerhans. Adrenal cortex and medulla. Male reproductive organs and functions of androgens. Female reproductive organs and functions of estrogen and progesterone.

Module:5	Respiratory system	6 hours

Organs of the respiratory system. Structure of the lungs. Mechanics of respiration. Lung volumes and capacities. Transport of oxygen in the blood. Transport of carbon dioxide in the blood. Regulation of respiration

Module:6	Cardiovascular system	6 hours

Structure of heart and blood vessels. Conducting system of the heart and electrocardiogram. Factors are maintaining arterial blood pressure. Regulation of arterial blood pressure.		
Module:7	**Nervous system**	**6 hours**
Structure of neuron. Resting membrane potential and action potential. Brain and spinal cord, reflex action. Functions of the cerebral cortex, Basal ganglia, Thalamus, hypothalamus, and cerebellum.		
Module:8	**Contemporary issues: Lectures form industry/Hospital**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Ross JS, Wilson KJ, and Waugh A (2014) Ross and Wilson Anatomy and Physiology in Health and Illness: Allison Grant: Books, 11th Edition, IRL press (Oxford University Press, USA)

Reference Books

1.	Richard S. Snell (2011) Clinical Anatomy 9th edition Lippincott Williams
2.	Keele CA, Neil E, Joels N (2015) Samson Wright's Applied Physiology, 13th edn Oxford University Press, Hong Kong

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY1007	Molecular Biology	3	0	2	0	4
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Illustrate the molecular concepts of life.
2. Explain the organization and functions of DNA, RNA, and proteins
3. Demonstrate the regulation of various biological processes

Expected Course Outcome:

1. Recall key concepts, facts, and theories relevant to biological macromolecules
2. Outline the contemporary issues in related fields
3. Correlate the different steps in the translation of genetic information.
4. Apply the knowledge gained to address various problems
5. Perceive recent developments in the field
6. Interpret biological data presented in pictorial or numerical forms

Student Learning Outcomes (SLO):	2, 11, 18

2. Having a clear understanding of the subject related concepts and contemporary issues
11. Having interest in lifelong learning
18. Having critical thinking and innovative skills

Module:1	Genome organization	6 hours

Molecular Biology – An Overview – Structure of DNA - denaturation, and renaturation of DNA - Genome organization in prokaryotes and eukaryotes - DNA packaging in nucleosome - chromatin and chromosome.

Module:2	Genetic Material / Replication enzymes	6 hours

DNA as genetic material. Central dogma concept. Semi-conservative replication. Enzymes in DNA replication -prokaryotic and eukaryotic DNA polymerases, fidelity, and processivity of polymerases. Genetic code: commaless, non-ambiguous, degenerate, triplet code and its feature, wobble hypothesis, universality of genetic code.

Module:3	DNA Replication	6 hours

Replication in prokaryotes-origin of replication, replication fork, leading and lagging strand replication. Okazaki fragments. Elongation, termination of replication. Eukaryotic DNA replication. Inhibitors of replication.

Module:4	RNA and Transcription	6 hours

RNA structure, types of RNA, RNA polymerases, transcription in prokaryotes-initiation and elongation, promoters, termination of transcription. Eukaryotic promoters.

Module:5	Post Transcriptional process	6 hours

Distinction between pro and eukaryotic transcription. Post¬transcriptional processing and modifications of RNA -mRNA, t-RNA, and r-RNA, reverse transcription.

Module:6	Translation	6 hours

Translation initiation, elongation, and termination in prokaryotes. Translation in eukaryotes. Post-translational modifications. Antibiotics-inhibitors of protein synthesis.		
Module:7	**Post Translational Modification**	**7 hours**
Protein structure-folding of the polypeptide chain, alpha-helix and secondary beta structures. Principles of regulation - Cis-acting sites, and transacting molecules - feedback inhibition and allosteric regulation - The lac operon - trp operon, regulation of mRNA stability - Eukaryotic regulation.		
Module:8	**Contemporary issues: Lecture by industrial experts**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Alberts B, Johnson A, Lewis J, Morgan D, Raff M, Roberts K, and Walter P (2014) Molecular Biology of the Cell. 6th edition. Garland Science, USA.
2.	Bender D, Botham KM, Kennelly PJ (2015) Harper's Illustrated Biochemistry, 29th Edition, McGraw-Hill Companies, Inc. The USA.

Reference Books

1.	Mathews C K, van Holde K E, Appling D R, Anthony-Cahill S J (2012) Biochemistry, 4th Edition. Prentice-Hall Bench Marked with 1.
2.	Cooper G M and Hausman R E (2013) The Cell: A Molecular Approach. 6th edition. Sinauer Associates, Inc. The USA.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)

1.	Learning Molarity, normality, and molality by preparing various buffers used in the molecular biology lab	4 hrs
2.	Understanding differences in the absorption of light by DNA, RNA, and protein by using a spectrophotometer	6 hrs
3.	Measuring absorption of DNA at different temperatures and understanding the theory behind the melting curve	2 hrs
4.	Learning how to separate DNA and RNA molecules by using agarose gel electrophoresis	4 hrs
5.	Understanding the role played by different reagents in isolating genomic DNA from plants	2 hrs
6.	Isolation and classification of RNA by separating on agarose gel electrophoresis	4 hrs

7.	Learning Beer Lambert's law by performing protein estimation by Lowry's method	2 hrs
8.	Separation of given proteins based on molecular weight by SDS-PAGE	4 hrs
9.	Western blotting (Demonstration)	2 hrs
	Total Laboratory Hours	30 hours

Mode of evaluation: Assignments, Continuous assessment tests and Final assessment test.			
Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY1008	Research Methodology	3	0	2	0	4
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Identify the essential components of research
2. Design the various strategies involved in experimental research
3. Recommend the importance of statistical analysis in research

Expected Course Outcome:

1. List the various modalities that are to be followed while conducting research
2. Compare the various methodologies that are available in higher education
3. Develop an understanding of ethical as well as safety aspects for good quality research
4. Analyze systematic methods for data collection, data processing, and data analysis
5. Evaluate statistical methods to assess the outcome of the research
6. Build various steps involved in the conduct of proper research

Student Learning Outcomes (SLO):	2, 3

2. Having a clear understanding of the subject related concepts and contemporary issues
3. Having an ability to be socially intelligent with good SIQ (Social Intelligence Quotient) and EQ (Emotional Quotient)

Module:1	What is Research Methodology	6 hours

Module content

Research Methodology: Research – Qualities of Researcher – Components of Research Problem – Various Steps In Scientific Research – Types of Research, Research approaches, purpose, and significance Hypotheses poses. Research Design – Survey Research & Case Study Research.

Module:2	Research Methods Vs. Methodology	5 hours

Module content

Library research, Field research, and laboratory research

Module:3	Testing of Hypothesis and Lab design	6 hours

Module content

Formulation of hypothesis, the concept of Null hypothesis. Testing the significance of the Null hypothesis. Lad design- Basic, containment.

Module:4	Biosafety Guidelines	6 hours

Module content

Microbiological risk assessment, Biosafety levels, laboratory animal facilities, guidelines for lab facility commissioning, certification, biosecurity, safety cabinets, Good microbial practices, biosafety and recombinant DNA technology, chemical, fire, and electrical safety, safety organization and training, safety for support staff, safety checklist

Module:5	Data Collection	6 hours

Module content

Sources of Data – Primary Data – Secondary Data - Procedure Questionnaire – Sampling Methods – Merits and Demerits – Experiments – Observation Method – Sampling Errors - Type-I Error & Type-II Error.

Module:6	Statistical Analysis	6 hours

Module content		
Introduction To Statistics – Probability Theories – Conditional Probability, Poisson Distribution, Binomial Distribution and Properties of Normal Distributions – Hypothesis Tests – One-Sample Test – Two-Sample Tests / Chi-Square Test, Association of Attributes - Standard Deviation – Co-Efficient of Variations		
Module:7	**Research Reports**	**6 hours**
Module content		
Structure and Components of Research Report – Types of Report, Characteristics of Good Research Report, Pictures and Graphs, writing a field report. Role of computer in research. Introduction To SPSS.		
Module:8	**Research Methodology of the present and future: problems and perspectives**	**4 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Kothari C.R. (2013) Research Methodology – Methods and Techniques – 3rd edition. New age international publishers. New Delhi
2.	Kothari C.R. and Gaurav Garg (2019) Research Methodology: Methods and Techniques

Reference Books

1.	Trochim W, Donnelly JP, Arora K 2015. Research Methods: the essential knowledge base. Cengage Learning. USA
2.	Statistical Methods by SP Gupta (2012)
3.	Blaxter L, Hughes C and Tight M (2010), How to Research – 4th edition. McGraw Hill UK

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)		
1.	Using and calibration of instruments generally used in the laboratory	2 hours
2.	Understanding the purpose of using different biosafety cabinets	2 hours
3.	Methods to dispose of microbial plates	2 hours
4.	Methods and place to store different chemicals	2 hours
5.	Understanding the differences between qualitative and quantitative research	2 hours
6.	Purpose of using animals on research and ethics involved	2 hours
7.	Disposal methods for laboratory waste disposal	2 hours
8.	Disposal methods for cell culture waste / sharp materials	2 hours
9.	Methods to dispose of the sharp waste	2 hours
10.	Different sterilization technique	2 hours
11.	Laboratory safety from chemical, fire, and electricity	2 hours
12.	Animal house rules and regulations	2 hours
13.	Importance of labeling and methods of labeling laboratory animals	2 hours
14.	Different chemicals used as disinfectants in Microbial spill and containment	2 hours
15.	Designing a laboratory (Microbiology lab / Cell culture / Animal dissection / Plant culture lab / Biosafety lab III and IV)	2 hours

		Total Laboratory Hours	30 hours
Mode of evaluation: CAT / Assignments /Quiz / FAT			
Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY1009	Analytical Techniques	3	0	2	0	4
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Demonstrate the principle and applications of various techniques in biotechnology
2. Analyze various samples using appropriate techniques
3. Utilize analytical instruments for biomolecular estimation

Expected Course Outcome:

1. List the various Good Laboratory Practices (GLPS)
2. Recall concepts related to solution preparation
3. Outline the principles of various analytical instruments
4. Summarize the role of instrumentation
5. Infer the applications of various analytical instruments
6. Demonstrate advanced analytical instruments to carry out an estimation of various biomolecules

Student Learning Outcomes (SLO):	2, 11, 13

2. Having a clear understanding of the subject related concepts and contemporary issues
11. Having an interest in lifelong learning
13. Having cross-cultural competency exhibited by working in teams

Module:1	GoodLab Practices	7 hours

Analytical Lab – record maintenance. Documentation - Standard Operating Procedures- Analytical Methods and Validations- Laboratory Notebooks - Specifications and Report Sheets - Calibration and Maintenance Logs.

Module:2	Biological Solutions	6 hours

Types of the solution- molarity, percent solutions, buffers- Henderson hasselbach equation, types of buffers. Preparation of buffers, pH meter.

Module:3	Advanced microscopy	6 hours

Principle, construction, and working of Bright-field, SEM, and TEM – image formation, resolving power and magnification.

Module:4	Chromatography	6 hours

The principle, column, and planar chromatography. Classification based on separation mechanism. Applications.

Module:5	Electrophoretic Techniques	5 hours

Principle and working of Gel Electrophoresis, Pulse field, Zone, Isoelectric focussing, Capillary, Gel filtration, and Affinity.

Module:6	Spectrophotometry	6 hours

Fluorometry, colorimetry, polarimetry, nephelometry, and turbidimetry- principle and applications. The absorption laws of spectrophotometry. Methods used in single-beam and double - beam spectrophotometry.		
Module:7	**Radioisotope Techniques**	**6 hours**
Basics, GM and Scintillation counter, Medical, Agricultural and Industrial application		
Module:8	**Contemporary issues:** Lecture by industry experts	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Rajan Katoch (2011) Analytical Techniques in Biochemistry and Molecular Biology Springer Science & Business Media
2.	Wilson K and Walker J (2016) Principles and Techniques of Biochemistry and Molecular Biology 8th Ed. Cambridge University Press.

Reference Books

1.	Boyer RF (2012) Biochemistry Laboratory: Modern Theory and Techniques, Prentice-Hall.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)		
1.	Maintenance of Lab Notes and Records	1 hour
2.	Collection, storing and transport of different types of samples	2 hour
3.	Buffer preparation	3 hour
4.	pH measurement	1 hour
5.	Calorimetry	3 hour
6.	Estimation of BSA sodium using UV Spectrophotometer	2 hour
7.	Estimation of BSA sodium using VIS Spectrophotometer	2 hour
8.	Conductivity Meter	3 hour
9.	Estimation of sodium by Flame photometer	3 hour
10.	Analysis of samples by HPLC	3 hour
11.	Demonstration of IR Spectrophotometer	2 hour
12.	Demonstration of SEM	2 hour
13.	Demonstration of TEM	2 hour

		Total Laboratory Hours	**30 hours**
Mode of evaluation: Assignments, Continuous assessment tests and Final assessment test.			
Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY1010	Immunology	3	0	2	0	4
Pre-requisite	BIY 1002	Syllabus version				
		v. 1.1				

Course Objectives:

1. Recall the basics of immunology and facilitate the understanding of core immunology
2. Develop skills necessary for the critical analysis of contemporary literature on topics related to health and diseases.
3. Outline the molecular and cellular basis of the development and function of the immune system in states of health and disease.

Expected Course Outcome:

1. Describe the role of the immune cells in both maintaining health and contributing to disease.
2. Identifying the cellular and molecular basis of antigen processing and immune responses.
3. Distinguish and define the molecular basis of complex cellular processes involved in immune disorders.
4. Translate theoretical immunology into clinical decision-making and cancer diagnosis.
5. Effectively interpret underlying mechanisms of disease and therapeutic implications of vaccines.
6. Build a strong foundation for more advanced courses in immunology.

Student Learning Outcomes (SLO):	2, 11, 18

2. Having a clear understanding of the subject related concepts and contemporary issues
11. Having interest in lifelong learning
18. Having critical thinking and innovative skills

Module:1	Introduction	5 hours

Overview of the immune system, innate immunity, acquired immunity, cells, and organs of the immune system, antigens, structure of antigen, and its different types.

Module:2	Immune cells	6 hours

Biology of T and B lymphocytes, functions of T cells, and B cells. Antibodies, structure, types, and their functions. TCR structure. Antibody structure and types. Molecular basis of TCR and antibody diversity.

Module:3	Defense strategies in immune system	6 hours

Complement Pathways, biological consequences and deficiencies. Immune response:humoral immune response and cell mediated immune response.

Module:4	MHC and immune system	6 hours

Major Histocompatibility Complex, Class-I, II, and III, Antigen processing and presentation. Transplantation immunology

Module:5	Immune related disorders	6 hours

Immune tolerance, auto-immunity, autoimmune disorders, immunotherapy for autoimmune disorders, hypersensitivity reactions, types and treatment. AIDS.

Module:6	Cancer and Immunology	6 hours

Tumor immunology, Immunotherapy to tumors. Role of immune cells in preventing cancer and metastasis.		
Module:7	**Molecular basis of vaccination and techniques used in immunology**	**8 hours**
Immunodeficiency diseases, Immunization: active and passive immunization. Different types of vaccines with examples. Antigen-antibody reactions, Immunoelectrophoresis, ELISA, Immunoblotting, Immunohistochemistry, Radioimmunoassay, Monoclonal antibodies, and its production and uses.		
Module:8	**Contemporary issues in Immunology**	**2 hours**
Lecture by Industrial experts		
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Janis Kuby (2013), Immunology, 7th edition. W.H Freeman and company.
2.	Abbas AK, Lichtman AH, and Pillai S (2012) Basic immunology: functions and disorders of the immune system. 4th edition Elsevier health sciences.

Reference Books

1.	Chapel H, Haeney M, Misbah S and Snowden N,(2014) Essentials of Clinical Immunology 6th Edition, Wiley Blackwell.
2.	Murphy K and Weaver C (2017) Janeway's Immunobiology, 9thedition, Garland Science Publishing.
3.	Abbas AK, Lichtman AH, Pillai S (2011) Cellular and molecular immunology, 8th edition, Elsevier Health Sciences.
	Authors, book title, year of publication, edition number, press, place

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)

1.	Detection of antibody against pathogen from patient's serum by slide agglutination	3 hours
2.	Detection of blood group by Rh typing	2 hours
3.	Antigen quantitation by Single Radial Immuno Diffusion (SRID) method	4 hours
4.	Antibody Titration by Ouchterlony Double Diffusion	4 hours
5.	Determination of IgM, IgG, and IgA in the given serum by Immunoelectrophoresis	4 hours
6.	Detection of interaction between antigen and antibody by ELISA	4 hours
7.	Visual differentiation of Blood cells with Wright's stain	2 hours
8.	Lymphatic system and organs of the immune system (demo only)	3 hours
9.	Methods to raise antibodies in animals (Demo only)	4 hours
	Total Laboratory Hours	30 hours

Mode of evaluation: Assignments, Continuous assessment tests and Final assessment test.

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY1011	Fundamentals of Chemical Engineering	3	0	0	0	3
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Relate basic laws of chemical engineering about the calculation for processes
2. Demonstrate knowledge on solving heat transfer, material and energy balances for chemical process systems
3. Interpret fluid mechanics to analyze the complexities involved in solving fluid flow problems and ideal reactors

Expected Course Outcome:

1. Choose problems related to units and conversions and fit given data using methodologies
2.Solve problems related to material and energy balance concepts and design reactors for biochemical processes
3. Illustrate the types and design of a heat exchanger
4. Utilize the knowledge gained on different types of flow and losses of flow in pipes
5. Select the right choice of pipes, valves, and pumps
6. Design ideal batch, mixed flow, and plug flow reactors

Student Learning Outcomes (SLO):	2, 9, 18

2. Having a clear understanding of the subject related concepts and contemporary issues
9. Having problem-solving ability- solving social issues and engineering problems
18. Having critical thinking and innovative skills

Module:1	Dimensions and system of units	7 hours

Module content

Fundamental quantities, derived quantities and conversions- Basic chemical engineering calculations, Atomic, molecular and equivalent weights, molar concepts, concentration units for pure components, vapour pressures, moles, mixtures and solution, Molarity, normality and partial pressures, composition of mixtures and solutions, weight fraction, mole fraction, volumetric composition, partial pressures, density and specific gravity.

Module:2	Gases	6 hours

Module content

Properties of gases, Ideal gas law, ideal mixtures and solution, Dalton's Law of Additive pressures, Amagot's Law of Additive volumes.

Module:3	Material Balance	6 hours

Module content

Law of conservation of mass, meaning of material balance and its applications, process flow sheet, drawing material balance on non reacting steady system, recycling, bypassing, material balance on steady-state reacting systems with recycling and bypassing.

Module:4	Energy Balance	6 hours

Module content

Law conservation of Energy, the meaning of Energy balance and its importance inputs of energy balance, specific heat and sensible heat, Latent heat and heats of transition, sublimation, enthalpy of solutions, chemical reactions, conversion, yield, standard heats of reaction, Hess Law, Kirchoff's Law

Module:5	**Heat transfer**	**5 hours**
Module content		
Introduction, classification, performance, and application of types of the heat exchanger, Different methods of heat exchange, Design of Heat Exchanger, Estimation of heat exchange area		
Module:6	**Fluid Mechanics**	**6 hours**
Module content		
Concept of fluid, the behavior of Newtonian and non-Newtonian fluids, types of fluid flow, nature of the flow, Fluid head and manometry, the basic equation of fluid flow, continuity and Bernoulli's equation, application Bernoulli's equation, the concept of friction factor piping system and its components		
Module:7	**Pipes, Valves and Pumps and Ideal reactors**	**7 hours**
Module content		
Factors and selection of pipe size, good piping system, types of valves, and fitting. Transportation devices, pumps, and their working. Design for homogeneous systems, Design equation for the Batch reactor, Stirred tank reactor, and tubular flow reactor.		
Module:8	**Contemporary issues: Lecture by Industrial expert**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Bhatt B. I and Thakore S B. (2017) Stoichiometry, 5th edition, Tata McGraw Hill.
2. McCabe W, Smith J, and Harriott P, (2017) Unit operations of Chemical Engineering, 7th Edn, McGraw Hill International Editions.

Reference Books

1. Himmelblau D.M. and Riggs JB (2015) Basic Principles and Calculations in Chemical Engineering, 8th Edn, Pearson education India
2. White F.M. Fluid Mechanics in S I units, 2017, 8th Edition, McGraw Hill Inc.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY1012	Bioinformatics	2	0	2	4	4
Pre-requisite	None	Syllabus version				
		v. 1.1				

Course Objectives:

1. Recall the basic practical techniques of bioinformatics
2. Extend the knowledge of bioinformatics and biological databases to solving real research problems
3. Formulate the use of a wide variety of tools, servers, biological databases and apply them in appropriate fields

Expected Course Outcome:

1. Choose knowledge of the basic principles of biology, computer science, and mathematics
2. Evaluate biological databases using bioinformatics algorithms
3. Build existing software effectively to extract information from large databases and apply the information in computer modeling
4. Assess problem-solving skills, including the ability to develop new algorithms and analysis methods
5. **Perceive knowledge about analyzing big datasets statistically and bioinformatically**
6. Improve skills in a professional environment via an industrial or academic internship in bioinformatics

Student Learning Outcomes (SLO):	2, 11

2. Having a clear understanding of the subject related concepts and contemporary issues
11. Having interest in lifelong learning

Module:1	Important contributions	4 hours

Aims and tasks of Bioinformatics - applications of Bioinformatics - challengees, and opportunities

Module:2	Knowledge of various databases	5 hours

Literature databases: PubMed, Nucleic acid sequence databases: GenBank, EMBL. Protein sequence databases: UniProt, PDB. Sequence submission databases – BankIt

Module:3	Sequence analysis	4 hours

Various file formats for bio-molecular sequences: genbank, FASTA, GCG, nbrf-piretc-Basic concepts of sequence similarity, identity and homology- Sequence-based Database Searches-BLAST and FASTA algorithms

Module:4	Sequence Alignment	4 hours

Dot plot and Dynamic Programming - Local alignment smith waterman algorithm - and Global alignment - Needleman-Wunsch - (algorithm and example) –sequence formats

Module:5	Multiple sequence alignment	3 hours

Multiple sequence alignment for analysis of Nucleic acid and protein sequences and interpretation of results– Clustal W algorithm - Feng Doolittle algorithm. Definition and description of phylogenetic trees and various types of trees

Module:6	**Structural Bioinformatics**	**4 hours**
3D structure prediction – Homology modeling – folds recognition &Ab-initio methods. Visualization of structures using SPDBViewer or PyMol		
Module:7	**Pharma-informatics**	**4 hours**
Bioinformatics in the Pharmaceutical Industry- Drug discovery		
Module:8	**Contemporary issues:** Lecture by industrial experts	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Pevsner J (2015) Bioinformatics and functional genomics 3rd edition John Wiley, UK
2.	Lesk A (2013) Introduction to Bioinformatics 4th edition Oxford University Press UK
Reference Books	
1.	Mount D (2014) Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, New York.
2.	Higgs PG and Attwood TK (2013) Bioinformatics and molecular evolution. John Wiley UK

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)		
1.	Nucleotide sequence from primary nucleotide database	2 Hrs
2.	Protein sequence from protein database	2 Hrs
3.	Protein structure from a structure database	2 Hrs
4.	Access of secondary biological data from various Biological database	2 Hrs
5.	Pairwise alignment using a dot plot	2 Hrs
6.	Pairwise alignment using dynamic programming	2 Hrs
7.	Heuristic Sequence Alignment using BLAST/ FASTA	4 Hrs
8.	Multiple sequence alignment	2 Hrs
9.	Construction of Phylogenetic tree	2 Hrs
10.	Gene prediction analysis	2 Hrs
11.	Prediction of the secondary structure of the protein.	4 Hrs
12.	Visualization of Protein Structure	4 Hrs
	Total Laboratory Hours	30 hours

Mode of evaluation: Assignments, Continuous assessment tests and Final assessment test.			
Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY1013	Bio Resource Management	2	0	0	4	3
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Explain the significance of biological wealth in day-to-day life
2. Illustrate the various approaches used for the management of biological resources
3. Justify the socio-economic issues involved with bio-resource management

Expected Course Outcome:

1. Recall knowledge on bio-resource management of various ecosystems
2. Develop theoretical expertise in socio-economy of biodiversity and biotechnology
3. Integrate the knowledge of various disciplines of sciences
4. Assess the economic values of flora and fauna in the environment
5. Create knowledge on the loss and cause of biodiversity
6. Formulate the management of various socio-economic dimensions in the environment

Student Learning Outcomes (SLO):	2, 10, 11,18

2. Having a clear understanding of the subject related concepts and contemporary issues
10. Having a clear understanding of professional and ethical responsibility
11. Having interest in lifelong learning
18. Having critical thinking and innovative skills

Module:1	Natural resources and human population	4 hours

Bioresource – Plant and Animal: Aquatic and terrestrial, Natural resources and human populations Genetics resources, human resources – biosystematics, productivity, and working practices.

Module:2	Ecological Values, Economic value	4 hours

Species, habitats, and ecosystem, poverty, cultural values, ethics, and equity. Living plant (produce) collections, botanical gardens, zoo and aquaria, marine stations.

Module:3	Biodiversity loss, causes of Biodiversity loss	4 hours

Biological Resources – rules, property rights, and intellectual resource rights; Fair and Equitable benefits sharing. Legal measures – traditional, national, and international laws. Biodiversity Act, 2002, and Biodiversity Rules 2004.

Module:4	Sustainable use of biodiversity	4 hours

Biodiversity information management -data collection, tools and techniques, Protected Area Network (PAN), Measures for conservation and sustainable use of biodiversity in natural resource management; Biodiversity and Biotechnology – sustainable use of bioresources.

Module:5	Socio-economic Dimensions of Environmental Management	4 hours

Population explosion and social factors are affecting development. Impact of development on the environment - changing patterns of land use, land reclamation, deforestation, resource depletion, pollution, and environmental degradation.

Module:6	**Socio-economic Dimensions of Environmental Management**	**5 hours**
Managing biodiversity, protecting and restoring ecosystems, ecofeminism, socio-economic strategies – ecotourism, community management, Eco-technology –industry, reuse, and recycle.		
Module:7	**Biotechnological approaches in bio-resource Management**	**5 hours**
Afforestation, Biotechnological methods of bioresource management building capacity for management.		
Module:8	**Contemporary issues: lecture by industrial expert**	**2 hours**
Project: 'J' Component		
	Total Lecture hours:	**30 hours**

Text Book(s)

1. umar D, Rajendran KV and Jahageerdar S (2011) Bioresource Management and Climate Change Studium Press (India) Pvt. Ltd.
2. Raju NJ, Gossel W, Ramanathan AL, and Sudhakar M (2014) Management of water, energy, and Bioresources in the era of climate change: emerging issues and challenges. Springer.

Reference Books

1. Thangadurai D and Sangeetha J (2017) Industrial Biotechnology: Sustainable production and Bioresource utilization, Apple Academic Press.
2. Etingoff K (2014) Agricultural resource use and management Apple academic press NJ.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY1014	Bio Business & IPR	2	0	0	4	3
Pre-requisite	None	Syllabus version				
		v..1				

Course Objectives:

1. Interpret the various terminologies involved in bio business
2. Develop cGMP, cGLP skills and become aware of the importance of business models
3. Estimate the possibilities of IP rights and the various ways of securing national and international protection

Expected Course Outcome:

1. Identify the origin of bio business and the current scenario
2. Evaluate the various sectors of bio business
3. Determine different types of business models viz. product, subscription and integrated
4. Adopt international standards and certifications for cGMP and cGLP
5. Perceive the role of IPR in bio business
6. Utilize IP rights in business effectively
7. Decide on patenting procedures, types and filing

Student Learning Outcomes (SLO):2,10,18

2. Having a clear understanding of the subject related concepts and contemporary issues
10. Having a clear understanding of professional and ethical responsibility
18. Having critical thinking and innovative skills

Module:1	Fundamentals of Bio business:	Hours 6

History of evolution of Bio Business, Importance of Finance for Bio business –Sectorial support by Government of India - policies, and frameworks.

Module 2	Overview of Bio business in various sectors	Hours 5

Healthcare, Industrial life-Sciences, Agriculture and Agri-biotechnology, Environment and Environmental Biotechnology.

Module:3	Business Models in Bio business-	Hours 6

Product Based-Service Based-Subscription Based-Integrated Models.

Module:4	BestPractices	Hours 6

Current Good Manufacturing Practices (cGMP), Current Good Laboratory Practices (cGLP).

Module:5	IPR	Hours 8

Determining "patentability"; Industry-wise implications; use of patents – relevant case studies highlighting its importance. Importance of IPR in the Pharmaceutical Industry- Drug development-Product/Process Patenting- Marketing.

Module:6	**IPR Rights**	**Hours 6**
Rights conferred by different types of intellectual property; interpreting the rights conferred by a patent; the patent-granting system, Patent trends.		
Module:7	**Applications forms and procedures**	**Hours 6**
Patent costs and values; and the post-grant processes for enforcing, Safeguarding IPR.		
Module:8	**Recent updates**	**Hours 2**
Group Project Presentation: Case studies of different business models and IPR, eg. Biocon is protecting cancer medicine.		
	Total Lecture hours	**Hours 45**

Text Book(s)

1. Principles of gene manipulation and Genomics - Primrose S.B. and Twyman R.M. Blackwell Scientific Publications, 2008.
2. Genes IX - Benjamin Lewis. Oxford University & Cell Press, 2008.
3. Shahi, G. BioBusiness in Asia: How Asian Countries Can Capitalize on the Life Science Revolution. Pearson Prentice Hall. 2004.
4. Hirsch RD & Peters MP, "Entrepreneurship," Tata McGraw Hill Publishers, New Delhi, 2002.
5. Holt DH, "Entrepreneurship – New Venture Creation," Prentice Hall of India, 1999.

Reference Books

Project : 'J' component

Mode: Use of technology in teaching, lecture by industry

Mode of Evaluation: Written Examination, Projects, and assignments

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY2001	Microbial Genetics	3	0	0	0	3
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Outline the regulation of gene expression
2. Explain the importance of mutations
3. Illustrate chromosome inheritance pattern

Expected Course Outcome:

1. Recall key concepts about the organization of genes and the process of replication
2. Compare different methods of gene transfer and their related mechanisms
3. Discuss the basis of mutations and gene arrangements
4. Summarize DNA repair mechanisms
5. Elaborate on gene recombination processes

Student Learning Outcomes (SLO):	2, 11

2. Having a clear understanding of the subject related concepts and contemporary issues
11. Having interest in lifelong learning

Module:1	Organization of Genes and Replication	8 hours

Module content

Introduction to genetics. Eukaryotic, Prokaryotic, and Viral Genome and their replication. Pathogenicity island

Module:2	Gene Transfer and Mechanism	8 hours

Module content

Lateral and Horizontal gene transfer. Conjugation, Transformation, and Transduction (Generalized transduction and specialized transduction) Transformation and & its mechanism. Griffith experiment.

Module:3	Mutation and Gene arrangement	3 hours

Module content

Classes of mutations, spontaneous and induced mutation, mutagens, Reversion and suppression mutations, Ames test. Genetic characterization of mutants.

Module:4	DNA repair	4 hours

Module content

DNA damage and causative agents. The mechanism that reverse, excise, or tolerate DNA repair.

Module:5	Genetic Recombination	6 hours

Module content

Homologous Recombination, enzymes, and models (Double-stranded invasion model and Meselson and Radding model). Site-specific recombination (Bacteriophage lambda). Short sequence recombination

Module:6	Transposition	4 hours

Module content

Transposons, structure ,types and mechanism

Module:7	Bacteriophage and Natural Plasmids	6 hours

Module content

Bacteriophage structure, lifecycle (lytic and non-lytic cycle), superinfection, Restriction, and modification of DNA. Plasmid types, replication, copy number, incompatibility, and amplification. Genes carried by plasmids.		
Module:8	**Contemporary issues:**	**6 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Chaudhuri K (2012) Microbial Genetics The Energy and Resources Institute, TERI
2.	Snyder L, Peters JE, Henkin TM, Champness W (2013) Molecular Genetics of Bacteria, 4thEdition ASM press

Reference Books

1.	Krebs JE Lewin B, Goldstein ES and Kilpatrick ST (2014) Lewin's GENES XI Jones & Bartlett Publishers

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY2002	Genetic Engineering		0	2	0	4
Pre-requisite	BIY1007	Syllabus version				
		v. 1				

Course Objectives:

1. Recall different DNA modifying enzymes used in recombinant DNA technology
2. Compare different vectors and their applications in recombinant DNA technology
3. Illustrate different techniques used in genetic engineering

Expected Course Outcome:

1. Choose from different DNA modifying enzymes to modify given DNA as per requirement
2. Design different vectors for cloning and expression of genes in various expression systems
3. Apply appropriate techniques to research in various fields of biotechnology
4. Evaluate different strategies for cloning of gene from various cDNA libraries
5. List the risks associated with genetic engineering experiments
6. Modify genes for higher yield of biotechnology-derived products

Student Learning Outcomes (SLO): 2,11,18

2. Having a clear understanding of the subject related concepts and contemporary issues
11. Having interest in lifelong learning
18. Having critical thinking and innovative skills

Module:1	Enzymes used in genetic engineering	6 hours

Polymerases, ligases, E. coli, alkaline phosphatase, polynucleotide kinases, terminal transferases. Endonucleases with special reference to restriction enzymes; properties, creation of sticky and blunt ends, restriction digestion, double digestion, restriction mapping, star activity, Isoschizomers, neoschizomers. Linkers and adapters.

Module:2	Vectors for gene cloning	6 hours

Plasmids, Bacteriophage; λ phage and M13 phage, hybrid vectors; cosmids and phagemids. Vectors for eukaryotic cell; yeast vector, chromosomal vector; BAC, YAC, Ti and Ri vectors, Bacculovirus vectors. Advantages and disadvantages of these vectors one over the other, with examples.

Module:3	Methods to locate gene in the genome and modifying cloned genes	7 hours

Transposon tagging, chromosome walking, and chromosome jumping. Site-directed mutagenesis, deletion mutants, and fusion proteins.

Module:4	Nucleic acid hybridization	5 hours

Southern and Northern blotting; procedure and application.

Module:5	Methods for gene cloning from the genome of prokaryotes and eukaryotes	6 hours

Genomic DNA library screening, cDNA library screening. PCR and RT-PCR.

Module:6	Introduction of a foreign gene into	6 hours

	organisms	
Methods for gene transfer in bacteria, yeast, plant, and animal cells — selection markers used for the selection of recombinants from non-recombinants.		
Module:7	**Gene expression and regulation**	**6 hours**
Features of expression vectors, constitutive, inducible, and tissue-specific promoters. Regulation of gene expression with the example of lac and trp promoters.		
Module:8	**Contemporary issues:** Lecture by industrial experts	**3 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Old RW and Primrose SB (2014) Principles of gene manipulation, 7th edn Wiley Blackwell Scientific Publications.
2. Jogdand SN (2016) GENE biotechnology 4th Edn Himalaya publishing group

Reference Books

1. Somnath De (2016) Basic Concept of Recombinant DNA Technology Createspace Independent Publications India
2. Sambrook and Russel. Molecular cloning Vol. 1-3, CSH Press (from 2001 till date updated protocols)

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)

1.	Preparation of competent cells (BL -21).	4 hours
2.	Transformation of BL-21 competent cells with pGEX 4T-1 vector.	4 hours
3.	IPTG induction of BL-21 cells containing pGEX 4T – 1 and isolation of proteins from control and induced cells.	4 hours
4.	Analysis of the protein profile of 3rd experiment on SDS-PAGE	4 hours
5.	Purification of GST protein from whole cell lysate obtained from 3rd experiment	4 hours
6.	Cloning of the PCR product in TA cloning vector – transformation in DH5 α bacteria.	4 hours
7.	Screening for recombinant plasmid for experiment 6 by i) colony PCR ii) Restriction digestion.	4 hours
	Total Laboratory Hours	30 hours

Mode of evaluation: Assignments, Continuous assessment tests and Final assessment test.

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY2003	Bioprocess Principles	3	0	0	0	3
Pre-requisite	None	Syllabus version				
		v. 1.1				

Course Objectives:

1. Summarize the basics of different types of fermentors
2. Recall the basics of sterilization procedures and metabolic stoichiometry
3. Demonstrate the growth kinetics, production kinetics, and inhibition models.

Expected Course Outcome:

1. Design appropriate bioreactor configurations and operation modes based upon the nature of bioproducts
2. Evaluate model required for the microbial growth and can design own batch thermal sterilization
3. Formulate medium using various kinetics for maximum production of metabolites and biocatalyst for commercial applications
4. Model the kinetics of living cells and to develop a strategy to solve the issues emerging during fermentation processes
5. Choose better yield using gene manipulation of microorganisms and integrate research lab and industry
6. Identify problems and seek practical solutions for large scale implementation of biotechnology

Student Learning Outcomes (SLO): 2, 9

2. Having a clear understanding of the subject related concepts and contemporary issues
9. Having problem-solving ability- solving social issues and engineering problems

Module:1	Overview of Fermentation Processes	6 hours

The fermentation process and its development, general requirements of fermentation processes. Factors affecting fermentation

Module:2	Fermentor and its types	6 hours

The basic configuration of fermentor and ancillaries, main parameters to be monitored and controlled in fermentation processes. Different types of fermentor with example

Module:3	Medium and Sterilization	5 hours

Thermal death kinetics of microorganisms, batch and continuous heat, sterilization of liquid media, filter sterilization of liquid media, Air, Design of sterilization equipment

Module:4	Metabolic Stoichiometry	6 hours

Stoichiometry of Cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield coefficients of biomass and product formation

Module:5	Energetics	7 hours

Maintenance coefficients energetic analysis of microbial growth and product formation, oxygen consumption, and heat evolution in aerobic cultures, the thermodynamic efficiency of growth.

Module:6	**Kinetics of microbial growth and product formation**	**7 hours**
Phases of cell growth in batch cultures, Monod model, Growth associated (primary) and non-growth associated (secondary) product formation kinetics, Leudeking-Piret models		
Module:7	**title**	**6 hours**
Substrate and product inhibition on cell growth and product formation. Gene manipulation of microorganisms for better yield with examples.		
Module:8	**Contemporary issues:** Inhibition Models	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Stanbury P.F., Whitaker A, Hall S.J (2016) Principles of Fermentation Technology, Butterworth Heinemann, 3rd edition. UK
2. Shuler M.L and Kargi F (2017) Bioprocess Engineering: Basic concepts Prentice Hall, 2nd edition.

Reference Books

1. Doran PM (2013) Bioprocess Engineering Principles Elsevier, 2nd edition.
2. Cornish-Bowden A, (2012) Fundamentals of Enzyme Kinetics, Butterworth group, 4th edition.
3. Okafor N (2016) Modern Industrial Microbiology and Biotechnology, SP publishers.

Mode of Evaluation: Assignments, Continuous assessment tests and Final assessment test.

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No.46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY 2009	Genomics	3	0	0	0	3
Pre-requisite	BIY1012	Syllabus version				
		v. 1.1				

Course Objectives:

1. Build a foundation in the fundamental principles of genomics
2. Compare different methods available to study DNA and RNA sequence analyses
3. Apply genomic data to provide new insights in the fields of biology and medicines

Expected Course Outcome:

1. Improve the knowledge and skills to differentiate recent advances in genome complexities between eukaryotic and prokaryotic genomes and their database.
2. Summarize current updates on genome sequencing technologies to appreciate the differences between these technologies and illustrate the pros and cons of each method
3. Analyze information relating to Human Genome Project towards ELSI, with GWAS, SNP and miRNA techniques using specific databases and bioinformatics tools
4. Design and evaluate expression profiling using different methods such as microarray acquisition and analysis and tag-based profile analysis
5.Extend the concept of pharmacogenomics and toxicogenomics towards personalized medicine
6. Formulate the concept, methods, and application of metagenomics in phylogeny and novel gene identification

Student Learning Outcomes (SLO):	2,8,10

2. Having a clear understanding of the subject related concepts and contemporary issues
8. Having Virtual Collaborating ability
10. Having a clear understanding of professional and ethical responsibility

Module:1	Genome structure and organization	6 hours

Genomes-Prokaryotes, Eukaryotes, Organelles (Mitochondria, Chloroplast), Overview of Genome organization. Various genome databases and their uses.

Module:2	NGS Sequencing platforms and principles	7 hours

SOLiD™- Applied Biosystems, GS-FLX-Roche, Ion-Torrent- Thermo Fisher, and Illumina Solexa

Module:3	The story of the Human Genome	7 hours

Genome Mapping, Goals and Benefits of HGP, Drawback and ELSI issues, HapMap, GWAS, Micro RNA sequences

Module:4	Techniques in Comparative Genomics	7 hours

Traditional and global analysis of RNA expression: spotted DNA arrays, printed oligonucleotide chips – data acquisition and analysis – SAGE, MPSS, DDRTPCR, expression profiling in human diseases

Module:5	Pharmacogenomics	6 hours

Concepts and Tools in Pharmacogenomics, Pharmacogenetics Vs. Pharmacogenomics; Understanding drug responses, Gene-disease association; the concept of Personalized Medicine.

The bridge between pharmacogenomics and toxicogenomics		
Module:6	**Metagenomics**	**6 hours**
Concept, Methods, and Techniques, Metagenome projects and applications		
Module:7	**Ethical issues in the classification of the human genome**	**4 hours**
Ethical issues and Genetic Discrimination: Genetic Information Non discrimination Act 2007		
Module:8	**Contemporary issues:** Lecture by industrial experts	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	S. C. Rastogi N. Mendiratta P. Rastogi (2013) Bioinformatics: Methods And Applications: (Genomics, Proteomics And Drug Discovery), Edition 4, PHI Learning Pvt. Ltd

Reference Books

1.	Schmidt D (2014) Using the Biological Literature: A Practical Guide, Fourth Edition by CRC Press
2.	Primrose SB, Twyman R (2013) Principles of Gene Manipulation and Genomics, 7th Edition: 2013, Wiley-Blackwell

Mode of Evaluation: Assignments, Continuous assessment tests and Final assessment test.

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY2011	Proteomics	3	0	0	0	3
Pre-requisite	None	Syllabus version				
		v. 2.1				

Course Objectives:

1.. Describe the basics in the field of proteomics
2. Classify various techniques that are used in the study of proteomics
3. Illustrate the biological importance of protein-protein interaction, modeling and protein database, and their clinical relevance

Expected Course Outcome:

1. Recall the basics of proteomics
2. Utilize various techniques in protein separations
3. Choose different methods to identify proteins
4. Explain the importance of protein-protein interactions

Student Learning Outcomes (SLO):	2,20

2. Having a clear understanding of the subject related concepts and contemporary issues
20. Having a good digital footprint

Module:1	Overview of Proteomics	4 hours

Proteomics – Introduction, Applications in scientific research, Proteomics in post-genomic era, Human proteome draft

Module:2	Protein Separation Techniques	8 hours

Proteomics experimental workflow, Basics of protein separation-Centrifugation, Ultrafiltration, Chromatography - GC-MS, LCMS, Electrophoresis – 1-D, 2-D, and DIGE

Module:3	Protein Identification Techniques	8 hours

Introduction to Mass spectrometry, Experimental design, Sample preparation, Quantitative and qualitative proteomics by mass spectrometry - Basics, ionization techniques and mass analyzers, electrospray ionization (ESI) and matrix adsorption laser dissociation ionization (MALDI) and triple quadrupole (QQQ), SELDI, Peptide mass fingerprinting, Protein Microarray, protein sequencing, FRET analysis, NMR, X-ray crystallography. Analysis of post-translational modifications - Phosphorylation, ubiquitination, acetylation nitration, glycosylation, Sumoylation etc.

Module:4	Protein-protein/Protein-DNA Interaction Studies	6 hours

Mapping of protein interactions using mass spectrometry-based approaches (ICAT, ITRAQ, SILAC approaches) Yeast Two-Hybrid, Phase Display. Protein-DNA interactions- Identification of ligand-receptor pairing and transcriptional regulators.

Module:5	Protein Modeling	6 hours

Steps in homology modeling, tools, databases, side-chain modeling, loop modeling. Predicting Protein Structures by Threading using related soft wares

Module:6	**Clinical Proteomics**	**5 hours**
Proteomics in the study of diseases, Storage transportation and processing of clinical samples, Proteomic analysis of body fluids, IHC, Western Blotting		
Module:7	**title**	**6 hours**
Uniprot-KB: SWISS-PROT, TrEMBL, UniParc; Structure Databases: PDB, NDB, PubChem, ChemBank		
Module:8	**Contemporary issues:** Lecture by industrial experts	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Lesk AM (2014) Introduction to Bioinformatics, 4th Edition, Oxford University Press UK
2. R.M. Twyman (2013) Principles of Proteomics, Taylor and Francis, Garland Science, UK

Reference Books

1. Mirzaei H and Carrasco M (2016) Modern Proteomics – sample preparation, analysis and practical applications. Springer publications

Mode of Evaluation: Assignments, Continuous assessment tests and Final assessment test.

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No.46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY3001	Downstream Processing	3	0	2	0	4
Pre-requisite	Bioprocess Principles	Syllabus version				
		v. 1				

Course Objectives:

1. Utilize the unique properties of proteins to separate them from each other
2. Demonstrate the importance of protein purification techniques
3. Assess different stages and techniques involved in protein purification and polishing

Expected Course Outcome:

1. Summarize the basic concepts of protein structure
2. Examine the methods to track a protein of interest during different stages of purification
3. Decide upon the type of technique to break the cell and purify the required analyte
4. Apply different enrichment techniques for protein concentration
5. Compare different chromatography technique used for protein purification
6. Develop methods for product polishing and assess different types of vectors available for expression and purification of recombinant proteins

Student Learning Outcomes (SLO):	2,18

2. Having a clear understanding of the subject related concepts and contemporary issues
18. Having critical thinking and innovative skills

Module:1	Role of Downstream Processing in Biotechnology	5 hours

Role and importance of downstream processing in biotechnological processes. Economics of downstream processing in Biotechnology. Importance of obtaining pure biological products. Advantages of obtaining biologically relevant compounds through biological method over chemical method.

Module:2	Overview of purification of Bio-molecules	6 hours

Basics related to protein structure and purification strategies. Characteristics of biological mixtures. Qualitative and Quantitative assays for protein detection and quantification through different stages of protein purification.

Module:3	Terminologies used in biological samples purification	6 hours

Enzyme activity, specific activity, enzyme unit, chiral carbon, plane-polarized light, Absorption, Absorption maximum, enantiomers, optical activity, and viscosity.

Module:4	Cell lysis methods, separation of solids and liquids	6 hours

Mechanical and Chemical methods of cell lysis. Solid-liquid separation techniques: Flocculation and Sedimentation, centrifugation, and filtration methods. Centrifuge models used in industries

Module:5	Enrichment operations	7 hours

Precipitation methods (with salts, organic solvents and polymers). Extractive separations: Solvent extraction, Aqueous two phase extraction, Riverse micelle extraction, supercriticial

extraction. Membrane-based separations: Porous and dense membrane separations, Dialysis, Reverse osmosis, Ultrafiltration, Electrodialysis, Pervaporation, Gas permeation, Liquid membranes.		
Module:6	**Product Resolution**	**7 hours**
Chromatographic principles: distribution coefficients, retention parameters, qualitative and quantitative aspects of chromatography, column efficiency, selectivity and resolution, Gel permeation chromatography, Ion exchange chromatography, Reverse Phase Chromatography, Affinity chromatography. Adsorption chromatography, HPLC		
Module:7	**Product polishing and advanced methods for protein purification**	**6 hours**
Crystallization, Drying, and product formulation, Lyophilization. Vectors designed for protein purification.		
Module:8	**Contemporary issues:** Lecture by industrial experts	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Wilson K and Walker J (2010) Principles and Techniques of Biochemistry and Molecular Biology 7th Edn Cambridge University Press
2.	Roe S (2010) Protein Purification Techniques: A Practical Approach 2nd edition Oxford University Press

Reference Books

1.	Belter PA, Cussler EL, and Hu WS (2011) Bioseparations: Downstream Processing for Biotechnology Paperback Wiley

Mode of Evaluation: Written examinations, assignments, and quizzes.

List of Challenging Experiments (Indicative)		
1.	Protein estimation	2 Hours
2.	Cell lysis followed by protein estimation	2 Hours
3.	Precipitation of proteins (ammonium sulfate)	2 Hours
4.	Precipitation of proteins (Acetone)	2 Hours
5.	Aqueous two-phase extraction	2 Hours
6.	Reverse micelle extraction	2 Hours
7.	Size Exclusion Chromatography	2 Hours
8.	Affinity chromatography	2 Hours
9.	Dialysis	2 Hours
10	Crystallization	2 Hours
11	HPLC (Demonstration)	2 Hours
12	Fraction collector used in chromatography (Demonstration)	2 Hours
13	Lyophilization (Demonstration)	2 Hours
	Total Laboratory Hours	**30 hours**

Mode of evaluation: Assignments, Continuous assessment tests and Final assessment test.			
Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

PROGRAMME ELECTIVES

Course code	Course title	L	T	P	J	C
BIY1015	Environmental Health	2	0	0	4	3
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Describe genetic, physiologic and psychosocial factors that affect susceptibility to adverse health outcomes following exposure to environmental hazards
2. Identify current environmental health issues and environmental contaminants
3. Evaluate methods of collection, treatment, disposal, and recycling of solid waste and describe the health hazards associated with improper management of these wastes

Expected Course Outcome:

1. Outline the physical, chemical, and biological hazards associated with water pollution, as well as the importance of water quality related to contamination, protection, and monitoring of water supplies
2. Distinguish between health risks associated with indoor and outdoor air pollutions and methods of hazard control
3. Explain the significant sources and types of environmental agents
4. List the transport and fate of these agents in the environment
5. Classify the carriers or vectors that promote the transfer of these agents from the environment to the human
6. Analyze the interaction of agents with biological systems and the mechanisms by which they exert adverse health effects.

Student Learning Outcomes (SLO):	2,9,10,18

2. Having a clear understanding of the subject related concepts and contemporary issues
9. Having problem-solving ability- solving social issues and engineering problems
10. Having a clear understanding of professional and ethical responsibility
18. Having critical thinking and innovative skills

Module:1	Emerging global environmental health Issues	4 hours

Municipal waste - Industrial waste - Hazardous waste - Air and water pollution.

Module:2	Environmental issues in Human	4 hours

Biomarkers and risk analysis - Mutagenesis and carcinogenesis - Chromosomal analysis - Congenital anomalies - Congenital disabilities and infertility.

Module:3	Environmental Toxicology	4 hours

Classification of toxicants in the environment - Factors affecting toxicity – Mutagenesis – Teratogenesis - Carcinogens – Hallucinogens - Phytotoxins and animal toxins.

Module:4	Toxicity transformation	4 hours

Absorption and distribution of toxicants in animal body; Biotransformation of toxicants; Antidotes treatment and detoxification of toxicants; Bio-accumulation.

Module:5	Environmental Quality Assessment and Monitoring	4 hours

Definition for environmental quality – Deterioration and assessment of environmental quality - Matrix method and system diagram technique.		
Module:6	**Environmental Impact Assessment**	**4 hours**
Environmental Impact Assessment techniques - Adhoc method - Checklist method - Overlay mapping method - Network method - Simulation and modeling technique - Merits and Demerits of EIA studies.		
Module:7	**Survey studies**	**4 hours**
Short term studies/surveys - Rapid assessment - Continuous short and long term monitoring.		
Module:8	**Contemporary issues-** Lecture by industry experts	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1.	Zimeri AM (2012) Introduction to environmental health: A Global Perspective, Revised Edition, Cogenella Academic Publishing.
2.	Moeller DW (2011) Environmental Health, Fourth Edition, Cambridge: Harvard University Press.

Reference Books

1.	Nadakavukaren, A (2011) *Our global environment: A health perspective. Seventh Edition.* Prospect Heights: Waveland Press, Inc.

	Project: ‘ J’ component	

Mode of Evaluation: CAT / Assignments / FAT			
Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY1016	Behavioral Science	2	0	0	4	3
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Interpret the behavior of individuals with society
2. Deduce how communication changes behavioral patterns
3. Relate interrelationship with society

Expected Course Outcome:

1. Choose from different methods available to study human behavior
2. Explain how modern communication network is changing human behavior
3. Summarize various body activities controlled by the human brain such as processing, integrating, and coordinating the information it receives from the sense organs and making decisions as to the instructions sent to the rest of the body
4. Demonstrate that the outcome of repeated conscious effort becomes a habit and how it needs enough practice to become a habit
5. Infer behavioral activities explored by various applied disciplines that are practiced in the context of everyday life for counseling
6. Perceive communication as a fundamental life process that is necessary as individuals and to our relationships, groups, organizations, cultures, and societies

Student Learning Outcomes (SLO):	2,10,18

2. Having a clear understanding of the subject related concepts and contemporary issues
10. Having a clear understanding of professional and ethical responsibility
18. Having critical thinking and innovative skills

Module:1	Behavior Sciences study methods and societal role	3 hours

Introduction, Methods of studying Behavior Science, Scope, Experimental and non-experimental approaches of research

Module:2	Evolution of Human Behavior	3 hours

Chronobiological, Comparison of traditional lifestyle and modern lifestyle. Electronic Gadgets, Social networks affecting behaviors, Netoholic, Whatsapp…..etc

Module:3	Brain, Sensory organs and Intelligence	4 hours

Brain- parts of the brain, the role of each part. The conscious and subconscious mind. Role of the nervous system and endocrine system in behavior. Sensory process (Vision, auditory, touch, taste, vestibular and kinesthesis); Perception; Cognition (Concepts, language and thought, problem-solving and decision – making); Intelligence (Characteristics, assessment, the role of creativity)

Module:4	Habit-forming & Personality Development	5 hours

Learning and memory (Principles, types and effective methods); Individual development across the life span; Psychological disorders (Types – moods, anxiety, depression, suicide); Overview of therapies

Module:5	**Application of Behavioral Sciences**	**3 hours**
Counseling, Conflict Resolution, Crisis Intervention, Eugenics, Dealing with Special Kids		
Module:6	**Communication and Human Behavior**	**4 hours**
Behavioural Emotional and Social Difficulties (BESD), SLCN, Language, Culture, and Cognition, Linguistic Relativity of Thought, A Post-Whorfian Approach, Body movement, and interpersonal communication, Gesture and posture		
Module:7	**Social concepts**	**4 hours**
Social perceptions; social influences; social relationships; the dynamic interplay of culture and society.		
Module:8	**Contemporary issues:**	**4 hours**
Lecture by industrial expert		
	Total Lecture hours:	**30 hours**

Text Book(s)

1. Weiten W, Dunn D S, Hammer E Y (2014) Psychology Applied to Modern Life: Adjustment to the Turn of the Century, Cengage Learning.

Reference Books

1. Becker G S (2013) The Economic Approach to Human Behaviour. Chicago: University of Chicago Press
2. West R and Turner LH (2010) Understanding Interpersonal Communication: Making Choices in Changing Times, Cengage Learning

Project: 'J' Component

Mode of Evaluation: CAT / Assignments / FAT

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY1017	Pharmaceutical Biotechnology	3	0	0	0	3
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Outline the importance of fundamental and conceptual aspects of pharmacological sciences
2. Illustrate the mechanistic aspects of specific categories of drugs including manufacturing and quality control issues
3. Elaborate upon the mechanistic aspects of other drug categories and extend knowledge in Biopharmaceuticals

Expected Course Outcome:

1. Recall the essential aspects of pharmacokinetics/pharmacodynamics and solve pharmacokinetics and pharmacodynamics-related problems
2. Classify different drugs based on the mechanism of action and improve fundamental comprehension
3. Discuss manufacturing and quality control issues and develop competencies relevant to the Pharmaceutical Industry
4. Outline the importance of developing biopharmaceuticals in the future
5. Build on the necessary knowledge and be able to demonstrate the ability to recall the salient aspects of clinical trials and regulatory issues

Student Learning Outcomes (SLO): **2,11**

2. Having a clear understanding of the subject related concepts and contemporary issues
11. Having an interest in lifelong learning

Module:1	**Overview**	**6 hours**

Development of drugs, Pharmacodynamics - Antagonists, and Agonists

Module:2	**Pharmacokinetics**	**6 hours**

Pharmacokinetics – Absorption, Distribution, Metabolism, and Excretion. Routes of drug administration, Prodrugs

Module:3	**General Pharmacology**	**6 hours**

Antacids, Antiseptics, NSAIDs, Local Anesthetics, Pharmacotherapy of cough, and peptic ulcer.

Module:4	**Oral Dosage Forms**	**6 hours**

Manufacturing, quality control and packaging requirements of tablets, capsules, and solutions

Module:5	**Parenteral and Topical Dosage Forms**	**7 hours**

Manufacturing, quality control and packaging requirements of parenteral, ointments, aerosols, and modified dosage forms

Module:6	**Biologics**	**6 hours**

Monoclonal antibodies, rDNA drugs, Therapeutic proteins, Hormones, Immunobiologicals,

Vaccines.		
Module:7	**Clinical Trials and Regulatory affairs**	**6 hours**
Phases, Design, ICH GCP, FDA Regulations, Indian Drug Regulations. Regulatory aspects of pharmaceutical and bulk drug manufacturers		
Module:8	**Contemporary topics**	**2 hours**
Lecture by industrial experts		
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Loyd, V., Jr. Howard C A and Ansel (2013) Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, Publisher: Wolters Kluwer Health
2. Satoskar RS, Rege N, Bhandarkar SD (2015) Pharmacology and Pharmacotherapeutics, 24thedn Elsevier India.

Reference Books

1. Brunton L, Chabner BA and Knollman B (2011) Goodman and Gilman's The Pharmacological Basis of Therapeutics, McGraw Hill Education; 12th edition.
2. Khar RK and Vyas SP (2013) Lachman/Liebermans: The Theory and Practice of Industrial Pharmacy, Publisher: CBS; 4th edition.
3. Milligan GN and Barrett A (2015) Vaccinology: An Essential Guide Publisher: Wiley-Blackwell; 1st edition.

Mode of Evaluation: CAT / Assignment / FAT

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY1018	Industrial Biotechnology	2	0	0	4	3
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Recall knowledge on medium formulation and strain improvement for enhanced production of bioproducts
2. Develop fundamental knowledge to explore microbes for the production of industrially relevant primary and secondary metabolites
3. Extend knowledge on the industrial method of fermentation processes for the production of bioproducts

Expected Course Outcome:

1. Outline process-flow sheeting for the industrial fermentation processes
2. Demonstrate the methods of cell culture under various conditions, formulate and optimize media and apply strain improvement to enhance the production
3. Apply the knowledge of kinetics for microbial growth and product formation
4. Choose from the production processes for primary and secondary metabolite
5. Explain the production of commercially critical recombinant proteins

Student Learning Outcomes (SLO):	2,14,18

2. Having a clear understanding of the subject related concepts and contemporary issues
14. Having an ability to design and conduct experiments, as well as to analyze and interpret data
18. Having critical thinking and innovative skills

Module:1	Introduction to industrial bioprocess	4 hours

A historical overview of industrial fermentation processes and products. Outline of the various unit operation involved in an integrated bioprocesses; process flow-sheeting; a brief survey of organisms, processes, products and market economics relating to modern industrial biotechnology

Module:2	Fermentation process	4 hours

Isolation, preservation, and improvement of industrial micro-organisms for overproduction of primary and secondary metabolites: medium requirements for fermentation process-carbon, nitrogen, minerals, vitamins, and other nutrients-examples of complex media.

Module:3	Kinetics of Microbial growth and Product formation	4 hours

Batch cultivation and continuous cultivation. Simple unstructured models for microbial growth, Monod model, growth of filamentous organisms, product formation kinetics - Leudeking- Piret models, substrate and product inhibition on cell growth and product formation. Biomass estimation – Direct and Indirect methods

Module:4	Production of primary metabolites	4 hours

Commercially essential organic acids (e.g. Citric acid, itancoic acid, acetic acid, glucanoic acid, etc). Aminoacids (glutamic acid, lysine, aspartic acid, phenylalnineetc). Alcohols (ethanol, 2, 3, butanediol

Module:5	**Production of secondary metabolites**	**4 hours**
The concept of biocatalysis- Importance of microbial products over chemically synthesized products – ill effects of chemicals - Bacterial pigments – prodigiosin – violacein and deoxyviolacein -fungal monascin - bacterial and algal carotenoids – astaxanthin –production and application		
Module:6	**Production of commercially important enzymes**	**4 hours**
Proteases, amylases, lipases, cellulases, pectinases, isomerases, and other commercially essential enzymes for the4 food and pharmaceutical industries.		
Module:7	**Production of commercially important recombinant proteins**	**4 hours**
Production of recombinant proteins having therapeutic and diagnostic applications: production of vaccines. Specially bio-products for agricultural, food and pharmaceutical industries-bio-pesticides, biofertilizers and plant growth factors: natural bio-preservatives (nisin), biopolymers (xanthan gum and PHB): single-cell protein		
Module:8	**Contemporary topics**	**2 hours**
Lecture by Industrial experts		
	Total Lecture hours:	**30 hours**

Text Book(s)

1. Peter F Stanbury, Allan Whitaker, Stephen J Hall, "Principles of Fermentation Technology" Butterworth Heinemann, Third Edition,2016.
2. WulfCrueger, AnnelieseCrueger, K.R.Aneja, " Biotechnology -A textbook of Industrial Biotechnology" Medtech,2017

Reference Books

1. Colin Ratledge, Bjorn Kristiansen, "Basic Biotechnology" Cambridge University Press, Third Edition,2006
2. Thangadurai D and Sangeetha J (2017) Industrial Biotechnology: Sustainable production and Bioresource Utilization. CRC press
3. Michael L Shuler, FikretKargi, Mathew DeLisa (2017) Bioprocess Engineering, Third Edition, Prentice-Hall International Series

Authors, book title, year of publication, edition number, press, place

Mode of Evaluation: CAT / Assignments / FAT

Project: 'J' component

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY1019	Nanobiotechnology	2	0	0	4	3
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Recall the basics of nanotechnology
2. Explain potential applications of nanobiotechnology
3. Compare existing and new concepts, methodologies and research results and apply them in an academic or industrial research environment

Expected Course Outcome:

1. Appraise students about basic concepts and theories of the subject
2. Demonstrate the applications of analytical techniques in examining nanostructures/ particles
3. illustrate the scope of biomacromolecules in nanotechnology
4. Explain the potential of nanobiotechnology in consumer applications and diagnostics
5. Create a necessary foundation for training in research
6. Infer the importance of risk assessment in the usage of nanostructures/particles in various applications

Student Learning Outcomes (SLO):	2,10,14

2. Having a clear understanding of the subject related concepts and contemporary issues
10. Having a clear understanding of professional and ethical responsibility
14. Having an ability to design and conduct experiments, as well as to analyze and interpret data

Module:1	The science of nano-bio interface	3 hours

History and development of nanobiotechnology; Structure-property relationships.

Module 2	Types of biologically relevant nanomaterials	4 hours

Self-assembly as in proteins, lipids, and nucleic acids; Polymeric nanoparticles; Inorganic nanoparticles- quantum dots, silica-based nanostructures; metallic nanoparticles like silver and gold; nanotubes, nanowires, and nanofibers.

Module:3	Synthesis and production	4 hours

Physical, Chemical, and Biological means of synthesis; Biomimetic approaches of production: case studies- ferritins, silica in diatoms, FeNPs in magnetosomes; Merits and demerits of bio-based approaches.

Module:4	Characterization of nanomaterial	4 hours

Optical techniques like UV-Vis and fluorescence spectroscopy; FTIR spectroscopy; electron microscopy (TEM and SEM); Atomic Force Microscopy, dynamic light scattering, zeta potential measurement, XRD (with emphasis on how these techniques to aid in characterizing nanoparticles).

Module:5	Functional nanomaterials for biological applications	5 hours

Strategies for chemical and biological functionalization; Applications in tissue engineering & regenerative medicine.		
Module:6	**Nanoparticles in biological labelling and cellular imaging**	**4 hours**
Nanoparticles as a reporter: metallic nanoparticles and quantum dots in rapid diagnostics tools; FRET and Molecular Beacons; SPR and SERS-based imaging.		
Module:7	**Biosafety and Potential risks of nanomaterials**	**4 hours**
Routes of exposure; Fate of nanoparticles- short and long term; Cellular interaction; environmental safety; Risk assessment and regulatory mechanisms.		
Module:8	**Contemporary topics discussion:** Lecture by industrial experts	**2 hours**
Project: " J" COMPONENT		
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Bhushan B (2010) Handbook of Nanotechnology, Springer-Verlag, Berlin, Heidelberg,Germany
Reference Books	
1.	Xie Y (2012) The Nanobiotechnology Handbook CRC Press
2.	Eddy G and Poinern J (2014) A Laboratory Course in Nanoscience and Nanotechnology by CRC Press
	Authors, book title, year of publication, edition number, press, place

Mode of Evaluation: CAT / Assignments / FAT

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY1020	Vaccinology	3	0	0	0	3
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Demonstrate the concepts of vaccines and their mechanisms
2. Outline the up-to-date knowledge, skills and expertise on new and current vaccines and immunization programs
3. Examine the current and emerging challenges to immunization

Expected Course Outcome:

1. Recall the historical background of the most critical vaccines
2. Illustrate the immunological and epidemiological mechanisms of vaccine action
3. Summarize the infectious diseases and their vaccines
4. Distinguish the advantages and disadvantages of current vaccines
5. Examine the challenges in the development of new vaccines
6. Justify the use of current vaccines and reflect upon the challenges and opportunities of new vaccine strategies

Student Learning Outcomes (SLO): 2,5,11

2. Having a clear understanding of the subject related concepts and contemporary issues
5. Having design thinking capability
11. Having an interest in lifelong learning

Module:1	Overview of Vaccination	5 hours

Concept of vaccines, vaccination against infectious disease, Immunization and eradicating infectious diseases; Effectiveness of vaccines: efficacy and safety

Module:2	Vaccines and their types	6 hours

Classification of vaccines: conventional vaccines-inactivated or killed vaccines and live attenuated vaccines, recombinant vaccines against viral diseases; Viral and recombinant vaccine production, adjuvant in vaccine and their development

Module:3	DNA Vaccines	6 hours

DNA Vaccines and induction of immunity, factors influencing the immune response after genetic vaccination-method of plasmid delivery, a dose of injected DNA

Module:4	Chimeric DNA Vaccines	6 hours

Antigenic form of the expressed protein, cocktail DNA vaccines and co-stimulatory molecules, immuno-stimulating sequences

Module:5	Novel Genetic vaccines	6 hours

Multigene vaccines, Suicidal DNA Vaccine, DISC virus vaccines, Expression library immunization

Module:6	Marker vaccines and edible vaccines	6 hours

Pseudorabies virus DIVA vaccines, classical swine fever virus DIVA vaccines, bovine viral

diarrhea virus (BVDV) DIIA vaccines, DIVA vaccines in disease eradication and prospects for human DIVA vaccines. Edible vaccines vis-à-vis mucosal and systematic immunity, working principles of edible vaccines, current status of edible vaccines for infectious diseases, issues of concern in developing a feasible edible vaccine		
Module:7	**IAP – Immunization**	**5 hours**
Immunization, Indian Academy of Pediatrics – Recommendations, Guidelines, Immunization schedule		
Module:8	**Contemporary issues:**	**5 hours**
Hospital/Industry expert lectures		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	John W, Morrow W, Sheikh NA, Schmidt CS and Davies DH (2012) Vaccinology: principles and practice Wiley Blackwell
2.	Karstak E (2010) Modern Vaccinology Springer US
Reference Books	
1.	Barrett A (2015) Vaccinology: an essential guide Wiley Blackwell
Mode of Evaluation: CAT / Assignments / FAT	

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No.46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY1021	Epidemiology	2	0	0	4	3
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Relate epidemiology and biostatistics in disease control and the improvement of human health
2. Demonstrate a basic understanding of epidemiologic methods and study design
3. Combine appropriate epidemiological concepts and statistical methods

Expected Course Outcome:

1. Summarize the use of epidemiology in the evaluation of screening process
2. Analyze the impact of epidemiology on national and local policies
3. Describe the influence of epidemiology on ethical and professional issues
4. Outline the epidemiology of infectious and non-infectious diseases, problem-solving skills and other concepts
5. Evaluate study design, bias, errors and causal inference in epidemiologic studies
6. Choose disciplines in research or internship activities in the field of epidemiology

Student Learning Outcomes (SLO):	2,10,18

2. Having a clear understanding of the subject related concepts and contemporary issues
10. Having a clear understanding of professional and ethical responsibility
18. Having critical thinking and innovative skills

Module:1	What is epidemiology?	5 hours

Pioneers in epidemiology. The nature and scope of biological, social, and ecological science and of epidemiological variables and outcomes. Epidemiology is a science and practice. Concepts of Disease and health problem: interdependence of clinical medicine and epidemiology

Module:2	Study Design	5 hours

Incidence studies (Incidence studies / Incidence case-control studies) Prevalence studies (Prevalence studies / Prevalence case-control studies) complex study designs (Other axes of classification/ Continuous outcome measures / Ecologic and multilevel studies)

Module:3	Study Design Issues	5 hours

Precision (Basic statistics / Sample size calculation and power) Validity (Confounding/ Selection bias /information bias)Effect modification(Concepts of interaction/ Additive and multiplicative models /Joint effects)

Module:4	Conducting a Study	5 hours

Measurement of exposure and health status (Exposure/Health status) Cohort studies (Defining the source / population and risk period/Measuring exposure/Follow-up) Case-control studies (Defining the source population and risk period/Selection of cases/Selection of controls/Measuring exposure) Prevalence studies (Defining the source / population/ Measuring health status/ Measuring exposure)

Module:5	**Analysis and interpretation of studies**	**5 hours**
Data analysis (Basic principles/Basic analyses/Controlling for Confounding) Interpretation (Appraisal of a single study/ Appraisal of all of the available evidence) Meta-analysis.		
Module:6	**Epidemiology of communicable disease and prevention**	**2 hours**
Influenza, Tuberculosis, Ebola. Vaccines and therapeutics.		
Module:7	**Epidemiology of non-communicable disease and prevention**	**2 hours**
Coronary heart disease, diabetes and lung cancer. Vaccines and therapeutics.		
Module:8	**Contemporary topics**	**1 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1. Rothman KJ, Lash TL, Greenland S (2012) Modern Epidemiology, Wolters Kluwer Health-Lippincott Williams and Wilkins Publishers.

Reference Books

1. Szklo M, Nieto J (2014) Epidemiology: Beyond the Basics, 3rd Edition Burlington, Massachusetts: Jones & Bartlett Learning
2. Gordis L (2014) Epidemiology: with STUDENT CONSULT, 5th Edition Elsevier Saunders.
3. Park, K. (2015). Textbook of Preventive and Social Medicine, 23rd Edition, Banarsidas Bhanot Publishers.

Authors, book title, year of publication, edition number, press, place

Project : "J" component

Mode of Evaluation: CAT / Assignments / FAT

Mode of evaluation: Assignments, Continuous assessment tests and Final assessment test.

Recommended by Board of Studies	24-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY1022	Nutraceuticals	3	0	0	0	3
Pre-requisite	None	Syllabus version				
		v..1				

Course Objectives:

1. Explain the nutraceutical constituents in different foods and their role in human health
2. Demonstrate the health benefits of functional foods
3. Illustrate the technologies and processing procedures used to extract functional ingredients from a natural source

Expected Course Outcome:

1. Outline the basis of various phytochemical compounds in maintaining normal physiological function
2. Build awareness about the latest investigations on nutraceutical and functional food components
3. Identify the different sources of nutraceuticals, their extraction methods, and their metabolism
4. Discover various food products that are used as nutraceuticals in making functional foods
5. Relate the role of various nutraceuticals in combating major health problems such as diabetes, obesity, cardiovascular diseases, cancer, and osteoporosis
6. Extend the safety and efficacy of functional foods and regulatory issues

Student Learning Outcomes (SLO):	2, 11, 14

2. Having a clear understanding of the subject related concepts and contemporary issues
11. Having an interest in lifelong learning
14. Having an ability to design and conduct experiments, as well as to analyze and interpret data

Module:1	Introduction to nutraceuticals and functional foods	4 hours

Definition, the concept of nutraceuticals, classification of nutraceuticals, dietary supplements, fortified foods, functional foods, scope involved in the industry- Indian and global scenario.

Module:2	Importance of nutraceuticals	6 hours

The food pyramid, nutritional assessment, recommended dietary intake, glycemic index, basal metabolic rate, nutraceuticals in fruits, vegetables and grains with health benefits, nutraceuticals about sports and exercise.

Module:3	Extraction, analysis, physiology, processing of nutraceuticals	6 hours

Nutraceutical extraction and isolation; nutraceutical analysis; absorption, disposition, metabolism, and elimination of nutraceuticals.

Module:4	Nutraceuticals of plant and animal origin	7 hours

Phytochemicals as nutraceuticals- sources and applications in preventive medicine; animal metabolites- sources and applications in preventive medicine; protein and peptide-based nutraceuticals, lipid-based nutraceuticals.

Module:5	**Microbial and marine nutraceuticals**	**7 hours**
Concept, applications of prebiotics and probiotics as nutraceutical agents, microbial nutraceuticals and their applications, marine nutraceuticals and their applications.		
Module:6	**Nutraceuticals in disease prevention**	**8 hours**
Nutraceuticals for- cardiovascular health, HIV and cancer risk reduction, bone and joint health, diabetes, hypertension, hypercholesterolemia, immune system, oxidative stress, cognitive function, anti-aging, maternal and infant health, gut health, reproductive health.		
Module:7	**Marketing, regulation, health claims, clinical trials**	**4 hours**
Assessment of safety and efficacy of functional foods and ingredients, regulatory issues and health claims, use of animal models, and pre-clinical and clinical trials involved.		
Module:8	**Contemporary topics:** Lecture by experts	**3 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Bagchi D, Preuss HG, Swaroop A (2015) Nutraceuticals and Functional Foods in Human Health and Disease Prevention, CRC Press.

Reference Books

1.	Mine Y, Li-Chan E, and Jiang B (2010) Bioactive Proteins and Peptides as Functional Foods and Nutraceuticals, Blackwell Publishing Ltd.
2	Hurst WF (2010) Methods of analysis for functional foods and nutraceuticals. Taylor & Francis Group, CRC Press.

Mode of Evaluation: CAT / Assignments / FAT

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY1023	Nutrition and Health	3	0	0	0	3
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Outline an overview on general aspects of nutrition, health, and food intake
2. Identify different types of foods, nutritive values, and nutritional disorders
3. Relate the assessment of nutrition status based on different criteria/indices

Expected Course Outcome:

1. Recall the influence of food on human health
2. Identify different types of functional foods
3. Summarize the metabolism of various food types
4. Formulate healthy diets to prevent lifestyle diseases
5. Construct a balanced diet based on the knowledge gained from the course

Student Learning Outcomes (SLO):	2,11,12

2. Having a clear understanding of the subject related concepts and contemporary issues
11. Having an interest in lifelong learning
12. Having adaptive thinking and adaptability

Module:1	Introduction to health	4 hours

Importance and value of health; Dimensions involved- physical, cognitive, cultural, and environmental.

Module:2	Food Choices	4 hours

Food sources- cereals, pulses, vegetables, fruits, confectionery, meat, egg, seafood, dairy, and beverages. Case Study- Evaluating information from various sources- media, supermarkets, internet

Module:3	Nutrients Vs. Health	4 hours

Categories of nutrients- carbohydrates, proteins, lipids, vitamins, minerals, and bioactive components; Process of digestion and absorption; factors influencing the process. Case Study- Effect of processing on the nutrients

Module:4	Food to fuel	4 hours

Extraction of energy from nutrients; biosynthesis, and storage of nutrients. Case Study- energy turn over during fasting and feasting

Module:5	Fluids and health	4 hours

Importance of electrolyte balance; sources of electrolytes. Case study- Delicate balance between water and electrolytes.

Module:6	Complementary nutrition	4 hours

Dietary supplements; functional foods; alternative medicines and health. Case study- Symbiotic role in health.			
Module:7	**Assessment of nutritional status**		**4 hours**
Anthropometric measurements, biochemical tests, molecular markers, clinical observations, dietary assessment, others- personal family history, socio-economic, occupational conditions. Case study-facts and fallacies involved in obesity assessment			
Module:8	**Contemporary issues:**		**2 hours**
Lecture by industrial experts			
	Total Lecture hours:	**30 hours**	

Text Book(s)

1.	Paul Insel , Don Ross, Kimberley McMahon, Melissa Bernstein 4rth edition**. 2012.** Discovering Nutrition. Jones and Bartlett Publishers, Inc;

Reference Books

1.	Catherine Sanderson and Mark Zelman. 2015. EssentIal Health, 1st EdItIon.G-W publIshers

Mode of Evaluation: CAT / AssignmentS / FAT /			
Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY1024	Computational Biochemistry and Biomedicine	3	0	0	0	3
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Outline the modern computational methods for handling bio-molecules
2. Demonstrate the principle of Biomolecular interactions and their respective mechanism
3. Solve some biochemical problems using computer-assisted methods

Expected Course Outcome:

1. Outline significant biotransformation reactions and the applications of computer technology in biochemistry
2. Explain the underlying mechanism of biomolecular interactions, as well as protein-carbohydrate interactions
3. Demonstrate the mechanism of protein-protein interactions and protein-nucleic acid interactions
4. Solve problems using analytical thinking skills in performing molecular modeling towards the prediction of protein function
5. Relate the terminology of biochemistry and pathogenesis with various genetic disorders
6. Formulate the concept of in silico mutational and drug discovery studies

Student Learning Outcomes (SLO):	2,17,18

2. Having a clear understanding of the subject related concepts and contemporary issues
17. Having an ability to use techniques, skills and modern engineering tools necessary for engineering practice
18. Having critical thinking and innovative skills

Module:1	The computing of Physical principles	6 hours

Significant biotransformation reactions in a biological system, Energy contribution and distance of non-covalent interactions in biomolecules, computation of intra-molecular and inter-molecular interactions

Module 2	Biomolecular Interaction I	6 hours

Binding of Oxygen to heme, Mechanism of Allosteric change, Protein-Carbohydrate Interaction-Mechanism of Lysozyme action, Mechanism, and Regulation of Multienzyme complex.

Module:3	Biomolecular Interaction II	6 hours

Protein-Protein and Protein- Nucleic Acid Interaction: Mechanism of chymotrypsin action, DNA Ligase action, Intron-Splicing mechanism.

Module:4	Discovering Biomolecular Mechanisms	6 hours

Deriving Biological Function of Genome Information with sequence and structure Analysis-Reliable and Specific Protein Function Prediction by Combining Homology with Genomic(s) context - Clues from Three-Dimensional Structure Analysis and Molecular Modeling - Prediction of Protein Function, Obtaining, viewing and analyzing structural data.

Module:5	Biochemistry and Medicine	6 hours

The major cause of the diseases, Metabolic basis of disease –An aberration of lipid metabolism -

Inborn errors of metabolism - Mechanism - Neonatal Aminoacidopathies - Phenylketonuria - Online Mendelian Inheritance in Man (OMIM).		
Module:6	**Pathogenesis**	**6 hours**
Genetic basis of disease- - 3 significant classes of Genetic Disorders -Chromosomal, Monogenic, Multifactorial - Genetic Variation - Types of mutation - Molecular Consequences of Mutation - Hemoglobin Disorders - Molecular basis of Diabetes & Cystic Fibrosis.		
Module:7	***In silico* mutational studies and Drug design**	**6 hours**
Sequence-based approach, structure-based approach, diverse models, Drug resistance mechanism – SBDD – active site-directed drug design -pharmacogenomics.		
Module:8	**Contemporary issues**	**3 hours**
Industry-related / Invited talk		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Moran LA, Horton RA, Scrimgeour G, and Perry M (2011) Principles of Biochemistry, 5th Edition. ISBN-10: 0321707338, Publisher: Prentice-Hall.
Reference Books	
1.	Muppalaneni NB and Gunjan VK (2015) Computational Intelligence Techniques for Comparative Genomics, Springer Singapore
Mode of Evaluation: CAT / Digital-Assignment / FAT	

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY 1025	Plant Biology	3	0	0	0	3
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Recall the concepts central to the study of plant science
2. Apply a comprehensive exposure to the subject of plant physiology
3. Summarize cutting edge technologies employed in contemporary plant biology

Expected Course Outcome:

1. Demonstrate the basics of plant biology and the organization of plants
2. Relate physiological mechanisms of plant growth, function, and development
3. Translate the fundamental concepts of plant physiology
4. Outline the plant metabolism
5. Illustrate mineral nutrition in plants
6. Extend a broad overview of the geographical distribution of plants

Student Learning Outcomes (SLO):	2,11

2. Having a clear understanding of the subject related concepts and contemporary issues
11. Having an interest in lifelong learning

Module:1	Water and transpiration	6 hours

Water relations - diffusion, permeability, osmosis, water potential, and its components. Absorption of water - apoplast, and symplast. Mechanism - passive and active. Transpiration - types and significance. Stomatal mechanisms.

Module:2	Plant Growth hormones	6 hours

Plant growth regulators (auxins, gibberellins, cytokinins, ethylene, and abscisic acid) - mechanism of action and Practical application. Mineral nutrition - macro and micronutrients and deficiency symptoms.

Module:3	Plant Physiology	6 hours

Photomorphogenesis - photoperiodism, vernalization, phytochromes. Dormancy (seed and bud), seed viability, and germination.

Module:4	Photosynthesis	6 hours

Plant pigment system: Absorption and action spectrum – Phosphorescence and fluorescence. Light reaction - Pathways of carbon fixation C3, C4 subtypes, and CAM.

Module:5	Respiration	5 hours

Aerobic - Glycolysis, Krebs Cycle, electron transport system, oxidative phosphorylation, respiratory quotient.

Module:6	Nitrogen assimilation	6 hours

Role of Nitrogen and sources, Conversion of nitrate to ammonia - assimilation of ammonia.

Molecular nitrogen, mechanism of biological nitrogen fixation.		
Module:7	**Phytogeography**	**6 hours**
Principles of Phytogeography, Phytogeographical regions of India. Vegetational types in Tamil Nadu. A detailed study of the vegetation types - Evergreen, deciduous, scrub jungle, and mangrove forest.		
Module:8	**Contemporary issues**	**4 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Jain VK (2014) Fundamentals of Plant Physiology 19 edition, S Chand publishing
Reference Books	
1	Kochhar SL and Gujral SK (2011) Comprehensive Practical Plant Physiology Lakshmi publications

Mode of Evaluation: CAT / Assignments/ FAT

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY1026	Forensic Science	3	0	0	0	3
Pre-requisite	+ 2 Biology	Syllabus version				
		v .1				

Course Objectives:

1. Demonstrate the methods, principles, and applications of forensic science in criminal investigations
2. Improve basic scientific principles of forensic science applied in solving criminal cases
3. Outline the concepts of forensic sciences such as crime scene investigation, forensic photography, digital forensics, ballistics, fingerprinting, court and police organizational structures, and forensic DNA analysis.

Expected Course Outcome:

1. Explain the basics of forensic science
2. Assess the organizational structure and procedures within forensic science
3. Illustrate the concepts, principles, and significance of impression evidence.
4. Summarize the practices behind collection, analysis, and interpretation of evidence.
5. Demonstrate the capabilities, in theory, laboratory techniques in analyzing body fluids, and other evidence analysis.

Student Learning Outcomes (SLO):	2, 7

2. Having a clear understanding of the subject related concepts and contemporary issues
7. Having computational thinking (Ability to translate vast data into abstract concepts and to understand database reasoning)

Module:1	Historical Background of Forensic Science	6 hours

Past and present scenarios. Forensic Science Laboratories, Experts and Divisions, Organizational set up of Forensic Science Laboratories at central and state level. Body Farm.

Module:2	Crime Scene Profiling	6 hours

Crime Scene: Role of Investigator in evaluation, evidence collection, protection, and documentation of crime scene. Sketching technique, types of Sketches, Searching Methods.

Module:3	Evidence and Documentation	7 hours

Impression based evidence analysis: Fingerprint Types and techniques, Modus Operandi Sheet preparation. Fingerprint use in Biometric system .Tool markings, Tire, Footwear markings. Bite-mark analysis, Fibers, and polymers. Handwriting analysis, Question documents.

Module:4	Ballistics:	6 hours

Types, application, forensic ballistic procedures (internal, external, and terminal ballistics) and identification of firearms, Available ballistic databases.

Module:5	Blood, Toxicology, Pathology Profiling in Forensic Evaluation	6 hours

Serological analysis (blood, saliva, semen, etc.), Blood Splatter- Origin of impact study Abusive Drug types, Poisons, and analysis. DNA fingerprinting in Forensics: Forensic Medicine DNA

fingerprinting: RFLP and PCR. Forensic pathology: Time of death analysis; Entomology and pathology in death analysis.		
Module:6	Forensic Photography and Digital Criminalistics	**6 hours**
The principle application of SLR-camera, Digital camera, CCTV in forensic analysis, Forensic Facial Reconstruction. Cyber Forensics: Computer, Mobile phone data analysis, Ethical hacking, drones. Deception detection tests (DDT): polygraph, narco-analysis, and brain-mapping		
Module:7	Forensic and Legal proceedings	**6 hours**
Forensic and Legal proceedings in India: Legal proceedings in forensics, CSI in India: problems and perspectives.		
Module:8	Case studies & Expert Guest lectures	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Criminalistics: An Introduction to Forensic Science, 11/E, Richard Saferstein, ISBN-10:0133458822 • ISBN-13: 9780133458824, 2015 • Prentice Hall.

Reference Books

1.	Forensic DNA Typing, 2nd Edition, Biology, Technology, and Genetics of STR Markers, J Butler, 2005, Imprint: Academic Press, eBook ISBN: 9780080470610, Print Book ISBN: 9780121479527, Pages: 688
2.	Introduction to Criminalistics: The Foundation of Forensic Science, 2009, by Barry A.J. Fisher, William J. Tilstone, Catherine Woytowicz, Elsevier Academic Press USA, 2009.
3.	Hendry Lee's Crime Scene Handbook, H.C. Lee, T. Palmbach, M.T. Miller (Academic Press), Published: June 2001, ISBN: 978-0-12-440830-2

Mode of Evaluation: Assignments, Continuous assessment tests and Final assessment test.

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24.08-2017

Course code	Course title	L	T	P	J	C
BIY2004	Biophysics	3	0	0	0	3
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Analyze physics concepts applied in biology
2. Deduce importance of molecular machines, membrane logistics, and macromolecular transition
3. Utilize various biophysical techniques and their applications

Expected Course Outcome:

1. Recall the molecular forces and their interactions and various physical laws
2. Identify the various types of kinetics and models involved in cell dynamics
3. Determine the applied aspects of biophysics through membrane logistics, and networks
4. Recognize macromolecular transition
5. Evaluate the function of molecular machines.
6. Apply the principles and applications of various biophysical methods/techniques

Student Learning Outcomes (SLO):2,5,18

2. Having a clear understanding of the subject related concepts and contemporary issues
5. Having design thinking capability
18. Having critical thinking and innovative skills

Module:1	Chemical and Physical setup of the cell	6 hours

Intra and intermolecular forces, chemical bonds, bond length, bond angle, dipole moment, electrostatic interactions and Hydrogen bonding interactions, small molecules, and macromolecules.

Module 2	Mathematical Biophysics	6 hours

Boltzmann Distribution, Fick's law, Graham's law, Gibbs free energy, Reynolds number, Fokker–Planck equation, Gibbs–Donnan effect, Nernst equation

Module:3	Cell functioning models	6 hours

Michaelis-Menten kinetics, Goldbeter-Koshland kinetics, Hodgkin–Huxley model, Vector field models, Bifurcation theory, Deterministic and Stochastic models

Module:4	Methods in Structural Biology	6 hours

Mass Spectrometer, NMR, Circular dichroism, XRD, FTIR, SEM and TEM

Module:5	Macromolecular transition	6 hours

Polymer elasticity and stretching, Effects of physical factors on Polymers, Allostery

Module:6	Molecular machines and enzymes	6 hours

Enzyme saturation kinetics, Catalytic transition, Energy landscape, Cytoskeletal-rotary polymerization -rotary motors

Module:7	**Membrane logistics and Bioelectrical networks**	**7 hours**
Osmotic effects, Membrane potential, Ion pumping, Chemiosmotic mechanism in mitochondria. Action potential, Ohmic conductance, Voltage gating, Neuromuscular junction		
Module:8	**Contemporary Issues:**	**2 hours**
Industry expert lectures on contemporary issues		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Nelson P (2013) Biological Physics with New Art. First edition, MacMillan Higher Education.
Reference Books	
1.	Buxbaum E (2011) Biophysical Chemistry of Proteins: An Introduction to Laboratory Methods, Springer

Mode of Evaluation: CAT / Assignment / Quiz / FAT

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY2005	Advanced Biochemistry	3	0	0	0	3
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Recall the structure, composition, and functions of various biomolecules.
2. Demonstrate the properties of biomolecules involved in various metabolic pathways
3. Extend the significance of these biomolecules to solve biotechnological problems

Expected Course Outcome:

1. Discuss the structure of glycans, membrane lipids, and proteoglycans
2. Summarize the structure of glycosaminoglycans and bacterial polysaccharides
3. Compare the biological functions of macromolecules, amino acids, and protein
4. Elaborate the higher-order organization of proteins and function
5. Relate the organization and functions of biomembranes
6. Illustrate the transport of vital molecules across the membrane
7. Assess the significance of redox reactions in cellular metabolism and the importance of bioenergetics

Student Learning Outcomes (SLO):	2, 11

2. Having a clear understanding of the subject related concepts and contemporary issues
11. Having an interest in lifelong learning

Module:1	Carbohydrates	6 hours

Classification, Stereochemistry, N-Glycans, O-Glycans, Glycosphingolipids, Glycophospholipid Anchors, Proteoglycans

Module:2	Glycobiology	6 hours

Glycosaminoglycans, Classes of Golgi-derived glycans, Sialic acids, Bacterial polysaccharides

Module:3	Amino acids	6 hours

Types of amino acids. Metabolism of phenylalanine, tyrosine, tryptophan, and sulfur-containing amino acids, inborn errors of amino acids metabolism.

Module:4	Protein Science	6 hours

Primary, secondary, tertiary, and quaternary structures of protein, protein folding and dynamics, molecular chaperones. Proteins architecture and functions.

Module:5	Bio-membranes & cellular transport	7 hours

Tri-glycerols, phospholipids, steroids, membrane lipids, artificial membranes (vesicles and black). Structural receptors, signal transduction, channels, and transporters. Physicochemical properties of nucleic acids and their polymers.

Module:6	Metabolic diversity	6 hours

Energy from the oxidation of inorganic electron donors, Iron oxidation, Methanotrophy and

methylotrophy, Nitrate and sulfate reduction, Acetogenesis, Methanogenesis, Fermentation-energetics, and redox constraints, Examples: Calvin cycle, Reverse citric cycle.		
Module:7	**Bioenergetics**	**6 hours**
Principles of thermodynamics, Bioenergetics, and oxidative phosphorylation, Mitochondrial bioenergetics, Electron transport complexes: Complex I (NADH-Q reductase), Complex II (Succinate-Q reductase), Complex III (ubiquinol-cytochrome C reductase), Complex IV (cytochrome c Oxidase).		
Module:8	**Contemporary Issues**	**2 hours**
Lecture by industrial expert		
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Singh SP (2015) Textbook of Biochemistry, Sixth Edition, CBS Publishers.
2.	Lapsley M W, Day A and Ayling R (2014) Clinical Biochemistry: Metabolic and Clinical Aspects**.** Churchill Livingstone, UK

Reference Books

1.	Berg JM, Tymoczko JL, Gatto GJ, Jr Stryer L (2015) Biochemistry, Eighth Edition, Macmillan learning.
2.	Nelson, DL and Cox M M (2012) Lehninger's Principles of Biochemistry, Sixth Edition, WH Freeman, New York.

Mode of Evaluation: CAT / Assignments / FAT

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY2006	Clinical Biochemistry	2	0	0	4	3
Pre-requisite	None	Syllabus version				
		v.1				

Course Objectives:

1. The purpose of this course is to relate the safety, quality assurance and quality control in Clinical Biochemistry
2. Compare the changes in the levels of biochemical analytes under normal and abnormal conditions and to correlate test results with patient conditions
3. Analyze the pathophysiological processes and their manifestations that determine the health and disease states of the human body

Expected Course Outcome:

1. Perceive factors that affect the analytical results of a specimen from its collection to processing stage
2. Deduce the functioning and dynamics of a clinical laboratory
3. Outline fundamental scientific principles underpinning laboratory medicine and core cellular and molecular processes underlying health and disease
4. Apply logical, systemic thinking and high-level critical analysis to solve problems using diagnostic techniques and methodologies in the chosen areas of clinical laboratory specialization
5. Build advanced knowledge of core clinical specialty disciplines such as laboratory medicine and advanced management skills
6. Relate pathophysiology of disease in the study of body functions
7. Summarize recent updates on laboratory diagnostic methods

Student Learning Outcomes (SLO): 2,11,18

2. Having a clear understanding of the subject related concepts and contemporary issues
11. Having an interest in lifelong learning
18. Having critical thinking and innovative skills

Module:1	Basic Concepts of Clinical Biochemistry	4 hours

Methods for collection, handling, and analysis of clinical samples. Quality control in biochemical analysis: commonly measured analytes and normal values.

Module:2	Diseases Related to Carbohydrate Metabolism	4 hours

Blood Glucose regulation; hypo and hyperglycemia, Diabetes mellitus-types, clinical features, GTT.

Module:3	Inborn errors of amino acid metabolism	4 hours

Aminoacids-Cystinuria, phenylketonuria, alkaptonuria, albinism, and tyrosinemia.

Module:4	Lipids and Lipoproteins	4 hours

Cholesterol, plasma lipoproteins-structure, types, and functions, hyper and hyperlipoproteinemia, risk factors for atherosclerosis and fatty liver.

Module:5	**Liver function tests**	**4 hours**
Metabolism of bilirubin, jaundice-types, clinical features, and test for bile pigments in blood and urine.		
Module:6	**Kidney function tests**	**4 hours**
Clearance principle, Clearance tests- urea, creatinine, and insulin.		
Module:7	**Gastric function tests**	**4 hours**
The stimulus for the secretion of gastric juice, gastric juice – constituents and composition. Gastric sampling, gastric function tests using a test meal, tubeless gastric analysis, and analysis of gastric contents.		
Module:8	**Recent topics in clinical biochemistry**	**2 hours**
Lectures by doctors		
	Total Lecture hours:	**30 hours**

Text Book(s)

1.	Chatterjee and Shinde (2012) Textbook of Medical Biochemistry. Published by Jaypee Medical Publishers, New Delhi

Reference Books

1.	Devlin T M (2010) Text Book of Biochemistry with clinical correlations. 7th edition, Wiley Liss, New York.
2.	BaynesJ W and Dominiczak M (2014) Medical Biochemistry. Fourth Edition, Saunders Elsevier.

Project: 'J' Component			
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2018

Course code	Course title	L	T	P	J	C
BIY2007	Developmental Biology	3	0	0	0	3
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Outline the basic principles and different model systems used in developmental biology.
2. Infer the establishment of the body plan invertebrates and their corresponding cellular and genetic mechanisms
3. Assess modern implications of developmental biology by imparting knowledge regarding gene knockout animals, microarray and teratogens

Expected Course Outcome:

1. Explain the contributions of sperm and egg to the zygote and structure informing function
2. Apply critical thinking and logical analysis in the assessment of embryonic developmental events including germ layer development, extra-embryonic membranes, embryo implantation, and significance of placental formation.
3. Determine when cells become specified, fate determined, and initiate organ development.
4. Utilize the principles and techniques of molecular biology to identify the genes involved in embryo development
5. Translate the knowledge on cellular mechanisms of development to identify the genetic and molecular elements involved in the development of an embryo
6. Outline principles of sex determination occur during embryo development

Student Learning Outcomes (SLO):	2, 18

2. Having a clear understanding of the subject related concepts and contemporary issues
18. Having critical thinking and innovative skills

Module:1	Gametes structure and fertilization	6 hours

Structure of sperm and egg. Egg contents and membrane structure concerning fertilization and embryogenesis. Gametes binding and recognition in mammals, gamete fusion, and the prevention of polyspermy. Events that occur in external and internal fertilization with one example up to embryo formation.

Module:2	Differential gene expression and embryogenesis	6 hours

Different methods of differential gene expression that occur during embryo development. Mechanism of cellular differentiation. Different types of cell to cell communication in embryogenesis

Module:3	Techniques to study embryo development	7 hours

I am using mutants, microarray, Transgenic, and knockout mice to study the role played by a gene in embryo development.

Module:4	Cleavage & Gastrulation	6 hours

Cleavage: Characteristics of cleavage, the role played by Cyclins and CDKs. Patterns of embryonic cleavage in Frog, drosophila, and mammals. Gastrulation: Events that occur in the embryo during the transition from cleavage to gastrulation. Mid gastrula phase, cell movement,

asymmetry in egg, cell differentiation, and gastrula formation. Ectoderm, Mesoderm, and Endoderm.		
Module:5	**Cellular differentiation and organogenesis**	**6 hours**
Mechanism of differentiation and organogenesis, With the example of Neurulation, limb, and Eye development.		
Module:6	**Axis specification**	**6 hours**
Genetics of axis specification with the mechanism. Establishment of left-right body axis with one example.		
Module:7	**Sex determination and role of environment on embryogenesis**	**6 hours**
Genetic and environmental sex determination. Role of sex chromosomes and genes involved in sex determination in mammals. Ethics in the pre-natal sex determination of humans. Regulation of normal development by the environment, disruption of normal development by teratogens.		
Module:8	**Contemporary Topics: Lectures by experts**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Gilbert S F (2016) Developmental Biology, Illustrated edition, Sinauer Associates.

Reference Books

1.	Hillis S and Berenbaum H (2014) LIFE: The Science of Biology, Tenth Edition. Sinauer Associates Inc
	Mode of Evaluation: Assignments, Continuous assessment tests and Final assessment test.

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY2008	Biological Databases	2	0	2	4	4
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Appraise different formats and data-types of molecular sequence and structures
2. Demonstrate the significance of resources before starting the research
3. Interpret biological data in a meaningful way complimentary to biological research

Expected Course Outcome:

1. Identify data resources and fetch the right content from open-source biology databases
2. Utilize the appropriate database and allied tools to solve the puzzles in biological research
3. Analyze nucleotide and protein data from various databases
4. Build adequate skills to challenge the upcoming big-data content analysis and interpretation
5. Examine the data from biology and perform a pattern search
6. Design database to slice and dice the biological data from different biological data resources and bridge the ontological information in research.

Student Learning Outcomes (SLO):	2,20

2. Having a clear understanding of the subject related concepts and contemporary issues
20. Having a good digital footprint

Module:1	Important contributions	4 hours

Submission of sequences to the database, sequence formats, conversion of one sequence into another.

Module:2	Regulatory databases	4 hours

Regulatory sequence databases-TRANSFAC, the exon-intron database (EID).

Module:3	Secondary protein databases	4 hours

Pfam-protein Family, PRINTS & Blocks, ProDom.

Module:4	Macromolecular databases	4 hours

MMDB- Molecular Modeling Database, Protein Databank in Europe (PDBe), Mod Base, PDBsum.

Module:5	Genome Browser	4 hours

Types of genome browsers, ENSEMBL, UCSC.

Module:6	Mutation databases	4 hours

HGMD, Pathway Database-Kyoto Encyclopedia of Genes and Genomes(KEGG Database).

Module:7	Protein-protein and other molecular interactions	4 hours

STRING, Drug Bank, Therapeutic Target Database.		
Module:8	**Contemporary issues:** Lecture by experts	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Attwood TK and Parry-Smith DJ (2014) Introduction to bioinformatics, Pearson Education.
Reference Books	
1.	Mount D (2014) Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, New York.
2.	Most of the topics will be covered using online resources

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)		
1.	Conversion of sequence from one database format to another using file format converter	3 hours
2.	Extraction of real matrices and identification of promoter motifs by TRANSFAC	3 hours
3.	Identification of protein domains using Pfam	3 hours
4.	MMDB- Molecular Modeling Database	3 hours
5.	Evaluation of comparative protein structure models by Mod Base	2 hours
6.	Comparing genes and genomes with Ensembl	2 hours
7.	Variation data in Ensembl	2 hours
8.	Finding features that regulate genes – the Ensembl Regulatory Build	2 hours
9.	Determining Protein Physico-Chemical Properties using PDBsum	2 hours
10	Analysis of inherited and complex disease using HGMD	2 hours
11	Understanding high-level functions and utilities of the biological systemKyotoEncyclopedia of Genes and Genomes	2 hours
12	Reactions took from KEGG ENZYME and additional reactions taken from the metabolic pathway maps in KEGG PATHWAY using KEGG REACTION	2 hours
13	Visualization of protein-protein interaction using STRING	2 hours
	Total Laboratory Hours	30 hours

Projects: 'J' Component	
Mode of evaluation: Assignments, Continuous assessment tests and Final assessment test.	

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY2010	Plant Biotechnology	2	0	2	4	4
Pre-requisite	None	Syllabus version				
		v. .1				

Course Objectives:

1. Explain the developmental processes operating in plants
2. Demonstrate plant tissue culture methods
3. Analyze biotechnological tools for engineering plants in agriculture and industry

Expected Course Outcome:

1. Outline the importance and fundamentals of plant tissue culture
2. Summarize the applications of tissue culture
3. Design vectors for plant transformation
4. Create clean and green transformation protocols
5. Measure the suitability of transgenics to consumers, industrialists, and environment
6. Apply tissue culture techniques and get employed in a plant biotechnology-based industry

Student Learning Outcomes (SLO):	2, 14

2. Having a clear understanding of the subject related concepts and contemporary issues
14. Having an ability to design and conduct experiments, as well as to analyze and interpret data

Module:1	Plant Tissue Culture I	4 hours

Plant cell culture – history and importance; Explant, sterilization techniques, culture media, their constituents, and culture types; Role of plant growth regulators in tissue culture

Module:2	Plant Tissue culture II	4 hours

Organogenesis; Somatic embryogenesis; Hardening; Somaclonal variation; Applications of tissue culture

Module:3	Vector components for plant transformation	4 hours

Selectable markers, reporter genes, promoters, terminators and expression cassettes; Optimization of vector components; Gene silencing

Module:4	Indirect Plant transformation	4 hours

Agrobacterium-mediated gene transfer - Ti plasmid, the molecular mechanism of T-DNA transfer and integration, binary, RNAi and Gateway vectors, advantages and disadvantages of Agrobacterium-mediated gene transfer

Module:5	Direct Plant Transformation Methods	4 hours

Particle bombardment, protoplast fusion, electroporation, advantages and disadvantages of direct gene transfer; Clean gene technology and plastid transformation

Module:6	Transgenic Plant Technology I	5 hours

Case studies on the production of genetically modified plants for herbicide tolerance, biotic and biotic stress tolerance and improvement of quality traits

Module:7	**Transgenic Plant Technology II**	**3 hours**
Molecular pharming; importance and risks of transgenes in the ecosystems; technology protection systems		
Module:8	**Contemporary issues:**	**2 hours**
Lecture by an Industrial Expert		
	Total Lecture hours:	**30 hours**

Text Book(s)

1. Adrian Slater, N W Scott, M Fowler, Plant Biotechnology: The Genetic Manipulation of Plants, Second Edition, 2014, Oxford University Press.
2. M.K. Razdan. 2014. Introduction to Plant Tissue Culture. 2nd Edition, Oxford and IBH Publishing Company, India.

Reference Books

1. Wang, Aiming, and Ma, Shengwu. 2014. Molecular Farming in Plants: Recent Advances and Future Prospects. Springer, New York, USA.
2. Gamborg OL and Phillips GC. 2013. Plant Cell, Tissue, and Organ Culture: Fundamental Methods. Springer-Verlag.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)		
1.	Media preparation for plant cell culture	4 Hours
2.	Preparation of media for bacterial culture	4 Hours
3.	Sterilization techniques	2 Hours
4.	Instruments required for plant cell culture	2 Hours
5.	Explant isolation methods	2 Hours
6.	Different methods of sterilization for explants	2 Hours
7.	Callus induction	2 Hours
8.	Co-culturing of Agrobacterium containing an engineered plasmid	2 Hours
9.	Agrobacterium-mediated transformation	2 Hours
10	Screening of transformed plant cells with the help of a marker assay	2 Hours
11	Protoplast isolation and fusion techniques	2 Hours
12	Shoot induction	2 Hours
13	Root induction and Hardening	2 Hours
	Total Laboratory Hours	30 hours

Project	**'J' Component**	
Mode of evaluation: Assignments, Quiz, Continuous assessment tests and Final assessment test		

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY2012	Enzymology	2	0	2	4	4
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Relate basic knowledge of enzymology with its useful applications in health care, Environment and industries
2. Illustrate enzyme kinetics and parameters of enzymatic reactions through a practical approach
3. Apply knowledge on mechanistic enzymology.

Expected Course Outcome:

1. Summarize structure, function, and properties of enzymes
2. Define rate equations for enzyme-catalyzed reaction and how key factors affect enzyme reactions rates
3. Classify the types of enzyme inhibitions and their mechanisms
4. Evaluate enzyme activity and its regulation in maintaining cellular structure and function
5. Analyze enzyme mutations and their role in protein engineering
6. Solve industrial problems using enzymes

Student Learning Outcomes (SLO):	2,5,18

2. Having a clear understanding of the subject related concepts and contemporary issues
5. Having design thinking capability
18. Having critical thinking and innovative skills

Module:1	Introduction	4 hours

Importance of enzymes, the nature of the enzyme, functional organization of enzyme- domains, (multi-enzyme complex); active site of enzyme- standard features.

Module:2	Enzyme classification and nomenclature	4 hours

IUBMB, Kinases, phosphatases, Oxido-reductases, transferases, hydrolases, lyases, isomerases and ligases

Module:3	Kinetics	4 hours

Free energy, activation energy, enzyme-substrate complex, transition state, binding energy, enzyme reaction coordinate diagram. Kinetics-. Michaelis – Menten kinetics; kinetic parameters- Km, Vmax, Kcat; Lineweaver Burk plot, Factors affecting enzyme activity; Enzyme inhibition – types of inhibition

Module:4	General mechanism of action	4 hours

Catalytic strategies- covalent, general acid-base, approximation, metal ions, protease, restriction endonuclease, kinase, and phosphatase

Module:5	Regulation of enzyme activity	4 hours

Mechanisms of enzyme regulation in metabolism- - reversible covalent modification, allosteric regulation, proteolytic cleavage, isozymes, compartmentalization

Module:6	Methods to obtain mutant enzymes with	4 hours

	desired features	
Methods to induce mutations and screening in microorganisms, Site-directed mutagenesis.		
Module:7	**Application of enzymes**	**4 hours**
Industrial processes, molecular biology, diagnostics and therapeutics		
Module:8	**Contemporary issues:**	**2 hours**
Lecture by industrial expert		
	Total Hours	**34 hours**

Text Book(s)

1.	Gray N, Calvin M, and Bhatia SC (2010) Enzymes Biotechnology CBS Publishers and Distributors Pvt Limited Edition
2.	Nelson, D.L., and Cox MM. (2012) Lehninger's Principles of Biochemistry, Sixth Edition, WH Freeman, New York.

Reference Books

1.	Shanmugam S, Sathishkumar T, and Shanmugaprakash M (2012) Enzyme technology 2nd edition IK international publishing House Pvt. Ltd

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)		
1.	Determination of the activity of Enzymes: Protease, amylase, lipase	4 hours
2.	Determination of the specific activity of alkaline phosphatase.	4 hours
3.	Glucose estimation using glucose oxidase.	4 hours
4.	Determination of Vmax and Km for a given enzyme	4 hours
5.	Effect of pH on Enzyme activity - pH 2- 10 6. Effect of temperature on Enzyme activity (10- 800C)	4 hours
6.	Effect of Inhibitors (PMSF, EDTA, Iodoacetate) on enzyme activity	4 hours
7.	Effect of Substrate concentration on enzyme	4 hours
	Total Laboratory Hours	**28 hours**
Project: J component		

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No.46	Date	24-08-2017

Course code	Molecular Endocrinology	L	T	P	J	C
BIY 2013		3	0	0	0	3
Pre-requisite	Molecular Biology	Syllabus version				
		v. 1				

Course Objectives:

1. Discuss different endocrine organs and hormones secreted by them
2. Illustrate the molecular mechanism of modulation of gene expression by steroid and non - steroid hormones
3. Asses hormonal dysfunction leading to endocrine disorders and techniques used in molecular endocrinology

Expected Course Outcome:

1. Compare the physiological role of hormones and the mechanism of regulation of hormone levels in humans
2. Outline how steroid hormones along with its receptors interact with other proteins to regulate gene expression
3. Summarize different signal transduction pathways regulated by non-steroid hormones leading to differential gene expression
4. Determine the molecular reason behind endocrine disorders
5. Evaluate how environmental pollutants disturb the endocrine system
6. Apply the knowledge gained in this subject for researching the field of molecular biology and molecular endocrinology

Student Learning Outcomes (SLO):	2,11

2. Having a clear understanding of the subject related concepts and contemporary issues
11. Having an interest in lifelong learning

Module:1	Basic principles	5 hours	

Endocrine organs. Pituitary and hypothalamus as master glands. Characteristics of hormones and types of hormones and their receptors.

Module:2	Mechanisms of hormone action and regulation	6 hours	

Negative and positive feedback effect with example. Hormone receptor down-regulation, Desensitization of hormone receptor. Mechanism of hormone elimination from the system

Module:3	Extra cellular receptors	6 hours	

Types of membrane receptors, its structure, and function: Extracellular domain, Transmembrane domain, Intracellular domain; Role in signal transduction; G-protein linked receptors; Ion channel linked receptor; Enzyme-linked receptor. Role of second messengers in signal transduction

Module:4	Steroid receptor	6 hours	

Examples of Nuclear Receptors (NR). NR superfamily – structural organization of NR; domains (N-terminal regulatory domain, DNA binding Domain, Hinge region, Ligand binding Domain, C-terminal domain), hormone response elements, homodimers, and heterodimers. Transactivation and Trans repressor Nuclear receptor co-activators, Nuclear receptor co-repressor and its role in the regulation of gene expression

Module:5	**Hormones involved in Reproduction**	**6 hours**	
Role of estrogen in females and males. Lessons from ERKO mice. Androgen functions in males. Lessons from ARKO mice.			
Module:6	**Endocrine disorders**	**6 hours**	
Molecular mechanism of hormone role in causing a) Cancer b) Diabetes c) reproductive system malfunction and d) Obesity. Hormone, receptor mutations, and related diseases. Environment pollutants as hormone analogues and their effect on human health			
Module:7	**Techniques used in Endocrinology**	**8 hours**	
Orphan receptors and methods to identify ligand for the orphan receptors. CHIP assay, ELISA, RIA, Real-Time PCR, and Microarray.			
Module:8	**Contemporary issues:** Lecture by industrial experts	**2 hours**	
	Total Lecture hours:	**45 hours**	

Text Book(s)

1. Bolander FF (2010) Molecular Endocrinology, 3rd edn Elsevier Academic Press
2. Kramer IM, (2015) Signal Transduction Third Edition, Academic press

Reference Books

1. Park-Sarge OK and Curry Jr TE (2010) Molecular Endocrinology: Methods and protocols springer protocols
2. .Leonard F (2010) Molecular Biology of steroid and nuclear hormone receptors Birkhauser

Mode of Evaluation: Written examinations, Projects, and assignments

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No.46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY2014	Aquatic Biotechnology	2	0	0	4	3
Pre-requisite	None	Syllabus version				
		v. .1				

Course Objectives:

1. Explaining the evolution of marine biology.
2. Summarize aquatic habitats to acquire knowledge
3. Translate the significance of biotechnological implementations in marine and aquatic sector

Expected Course Outcome:

1. Elaborate on the importance of marine and aquatic sector in day to day life
2. Outline how steroid hormones along with its receptors interact with other proteins to regulate gene expression
3. Summarize different signal transduction pathways regulated by non-steroid hormones leading to differential gene expression
4. Determine the molecular reason behind endocrine disorders
5. Evaluate how environmental pollutants disturb the endocrine system.
6. Outline various bioactive compounds isolated to aquatic systems

Student Learning Outcomes (SLO):	2,11,18

2. Having a clear understanding of the subject related concepts and contemporary issues
11. Having an interest in lifelong learning
18. Having critical thinking and innovative skills

Module:1	Introduction to marine and freshwater environments	4 hours

History of Biotechnology, Importance of Fresh and Sea Waters - Abiotic and biotic factors of aquatic environment - Food chain – Biological characters of aquatic habitats

Module:2	Aquatic resources	4 hours

Culturing of various aquatic living organisms - Fisheries potential of freshwater and salt waters. Capture and culture fisheries

Module:3	Diseases in aquaculture	4 hours

World organization of Aquatic animal health listed diseases in aquaculture - pathogens, signs, and epidemiology.

Module:4	Diagnosis of Diseases	4 hours

Conventional diagnostic methods, Antibody, and nucleic acids based diagnostic methods with examples.

Module:5	Aquatic animal health management	4 hours

Antimicrobials and chemotherapeutics in aquaculture. Probiotics, Case studies, Vaccination and disease control.

Module:6	Aquaculture food processing	4 hours

Processing, chilling, freezing, and drying. Quality control in seafood processing: Microbiological analysis — quality standards of seafood.		
Module:7	**Marine conservation**	**4 hours**
Marine conservation – Threats to marine biodiversity, physical alternations of coastal habitats, marine pollution action plan to conserve marine bio-resources, biofouling, bio-corrosion		
Module:8	**Contemporary issues:** Expert lecture from Aquaculture Industry	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1.	Lucas JS, and Paul C. (2012) Aquaculture: Farming aquatic animals and plants. Southgate, eds. John Wiley & Sons.

Reference Books

1.	Dunham, RA (2011) Aquaculture and fisheries biotechnology: genetic approaches. CABI,
2.	Manual of Diagnostic Tests for Aquatic Animals, 7th edition 2015 Renouf Publishing Company Limited

Project: 'J' component	
Mode of Evaluation: Assignments, Continuous assessment tests and Final assessment test.	

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No.46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY2015	Biological Spectroscopy	3	0	0	0	3
Pre-requisite	BIY1001 Biochemistry	Syllabus version				
		v. 1				

Course Objectives:

1. Discuss spectroscopic techniques such as visible (VIS), fluorescence, near-infrared (NIR), infrared (IR), Raman and nuclear magnetic resonance (NMR) spectroscopy
2. Infer various spectroscopic tools for biomolecular quantitation and characterization
3. Formulate interdisciplinary methods to solve biological problems using physical and chemical engineering techniques

Expected Course Outcome:

1. Outline the physics involved in most abundant non-destructive spectroscopic techniques
2. Apply spectroscopy for on- or at-line process monitoring and quality control in the modern food, pharma or biotech industry
3. Discuss the practical use of spectroscopy, problems involved and tricks of the trade-in relation to the quantitative use of spectroscopy such as spectroscopic calibration and optimal sample presentation to the spectrometer
4. Summarize advantages and disadvantages of spectroscopic measurements

Student Learning Outcomes (SLO):	9,18

2. Having a clear understanding of the subject related concepts and contemporary issues
18.Having critical thinking and innovative skills

Module:1	Basics of quantum mechanics	5 hours

Schrodinger wave equation; atomic and molecular structures; transition energy states.

Module:2	UV-Visible spectroscopy	5 hours

Selection rules; biological chromophores including charge transfer complexes; surface plasmon resonance

Module:3	Fluorescence spectroscopy	6 hours

Biological fluorophores – intrinsic and extrinsic; quenching mechanisms; fluorescence probes; Fluorescence resonance energy transfer

Module:4	Infrared spectroscopy	6 hours

Selection rule; fundamental and harmonic transitions; normal mode analysis; amide bands I and II – characterization and their application; ATR

Module:5	Raman spectroscopy	6 hours

Instrumentation; Strokes and anti stokes – Rayleigh scattering; selection rules; Amide bands I and II; Coherent Anti Stokes Raman Scattering

Module:6	XPS	5 hours

Instrumentation; XPS patterns; Spin orbital Splitting; Quantitative analysis; Chemical effect; Chemical shift

Module:7	1D NMR	6 hours

Boltzmann distribution; coupling constants; dipolar coupling; nuclear overhauled effect; NMR spectra of selected nuclei (H, C, P, F, N). Multidimensional NMR and other advanced Techniques: Multidimensional NMR; application to larger biomolecules; electron paramagnetic resonance, Auger electron spectroscopy		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Atkins P and de Paula J Atkins' Physical Chemistry, 10th edition, (2014).Oxford University Press, UK.
Reference Books	
1.	Marques M.P., de Carvalho B, L.A.E., Haris, P.I (2013) Spectroscopy of Biological Molecules IOS Press, Netherlands.
2.	Principles of Fluorescence Spectroscopy, 3rd edition by Joseph R. Lakowicz, Springer (2007)
Mode of Evaluation: Assignments, Continuous assessment tests and Final assessment test.	

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY2016	Stem Cell Technology	3	0	0	0	3
Pre-requisite	None	Syllabus version				
		v. .1				

Course Objectives:

1. Recall the fundamental concepts of stem cells
2. Dissect mechanistic details about stem cells and regeneration (horizontal and vertical integration)
3. Extend these concepts in the industrial and academic sectors

Expected Course Outcome:

1. Relate the fundamental aspects of stem cell technology
2. Illustrate the principles and methodologies about the mechanistic aspects
3. Determine the commonalities and distinguish between embryonic and adult stem cells
4. Apply the knowledge gained in regenerative aspects and therapeutic potential
5. Formulate solutions in a socially and ethically responsible manner concerning the use of stem cells and state-of-the-art technologies

Student Learning Outcomes (SLO):	2,10 ,18

2. Having a clear understanding of the subject related concepts and contemporary issues
10. Having a clear understanding of professional and ethical responsibility
18. Having critical thinking and innovative skills

Module:1	Introduction	6 hours

Embryonic stem cells, Blastula, Inner cell mass, Totipotent, pluripotent, multipotent and Induced pluripotent stem cells characterization, potency, self-renewal, cell division, and differentiation

Module:2	Pathways involved in stem cell proliferation, differentiation, and dedifferentiation	6 hours

Signal transduction pathways and signaling molecules involved cellular proliferation, differentiation, and dedifferentiation. Relationship between cellular proliferation and differentiation concerning stem cells

Module:3	Embryonic stem cells	7 hours

How embryonic stem cells are obtained, in vitro multiplication: embryonic stem cells gene manipulation and nuclear transfer technology.

Module:4	Adult stem cells	6 hours

Methods to obtain stem cells from adults (Amniotic fluid, cord blood cells, Mesenchymal stem cells, etc). Induced pluripotent technology (IPS), genes, and their mode of action in inducing stemness in adult cells. Advantages and disadvantages of IPS technology

Module:5	Organ regeneration using Stem cells	6 hours

Heart regeneration, angiogenesis, kidney regeneration, a neurodegenerative disorder, spinal cord injury, tissue engineering

Module:6	Application of stem Cells	6 hours

Overview of embryonic and adult stem cells for therapy in Neurodegenerative diseases; Parkinson's, Alzheimer's, Spinal Code Injuries and other brain Syndromes; Tissue system Failures; Diabetes; Cardiomyopathy; Kidney failure; Liver failure; Cancer; Hemophilia, etc.		
Module:7	**Ethics in using Embryonic stem cells**	**5 hours**
Human stem cell research: Ethical consideration; Stem cell religion consideration; Stem cell-based theories: Preclinical regulatory consideration, and Patient advocacy.		
Module:8	**Contemporary issues:** Lectures by experts	**3 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Cherian E (2011) Stem cells JP brothers medical publishers

Reference Books

1.	Atala A (2012) Progenitor and Stem Cell Technologies and Therapies Woodhead publishing
2.	Phinney DG (2011) Adult stem cells: Biology and methods of analysis Humana press

Mode of Evaluation: Assignments, Continuous assessment tests and Final assessment test.

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY2017	Neurobiology	3	0	0	0	3
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Develop a basic understanding of neuroanatomy
2. Build a basic understanding of neurophysiology
3. Elaborate on the biological basis of behavior

Expected Course Outcome:

1.Relate basic brain structure and function from the molecular to the systemic level
2. Illustrate the properties of cells that make up the nervous system including the propagation of electrical signals used for cellular communication
3. Discuss the various aspects of the pathogenesis of the nervous system
4. Interpret the contribution of the nervous system to sensory experiences, thoughts, emotions, and behavior
5. Criticise primary literature at the cognitive, behavioral, and cellular level
6. Formulate a research question based on adequate insights into the current knowledge

Student Learning Outcomes (SLO):	2,10,18

2. Having a clear understanding of the subject related concepts and contemporary issues
10. Having a clear understanding of professional and ethical responsibility
18. Having critical thinking and innovative skills

Module:1	What is Neurobiology?	6 hours

History of Neurosciences, Perspectives in studying the brain, Structure, and function of neurons, glial cells, molecular and cellular organization of neuronal differentiation, characterization of neuronal cells, the blood-brain barrier.

Module:2	Neural Signaling	6 hours

Electrical Signals of Nerve Cells, Voltage-Dependent Membrane Permeability, Channels and Transporters, Synaptic Transmission, Neurotransmitters, Receptors, and Their Effects, Molecular Signaling within Neurons.

Module:3	Neuro-anatomy	6 hours

Organization of Central Nervous System, the autonomous nervous system, Peripheral Nervous System, Meninges, and cerebrospinal fluids.

Module:4	Sensation and Sensory Processing	6 hours

The Somatic Sensory System, Pain, Vision: The Eye, Central Visual Pathways, The Auditory System, The Vestibular System, The Chemical Senses.

Module:5	Complex Brain Functions	6 hours

The Association of Cortices, Language and Speech, Sleep and Wakefulness, Emotions, Sex, Sexuality, and the Brain, Memory.

Module:6	**Neurological disorders**	**6 hours**
Neurodegenerative conditions. Stroke. Epilepsy. Syndromes and sensory impairments, Amnesias, Parkinson disease, Alzheimer's disease, Schizophrenia, Mood disorders: depression, mania, and anxiety. Alien-hand syndrome.		
Module:7	**Current techniques in Neurobiology**	**6 hours**
Optogenetics, Electrophysiology, behavioral analyses, measuring neurochemistry in vivo by microdialysis and amperometry, crayfish sensory or motor neurons.		
Module:8	**Contemporary issues:** Lecture by industrial experts	**3 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Purves D, Augustine GJ, Fitzpatrick D, Hall WC, LaMantia AS, and White LE (2012)Neuroscience.Sinauerpublications Fifth Edition.
2. Zupanc, G. K. H. (2010) Behavioral Neurobiology: An Integrative Approach, Oxford University Press. 2nd edition

Reference Books

1. Ropper AH, Samuels MA, and Klein JP (2014) Adams and Victor's principle of neurology McGraw Hill Education 10 Edn

Mode of Evaluation: Assignments, Continuous assessment tests and Final assessment test.

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY2018	Bioremediation	2	0	0	4	3
Pre-requisite	None	Syllabus version				
		v. .1				

Course Objectives:

1. Create awareness on environmental issues
2. Relate the role of microbes and plants in environmental remediation.
3. Identify appropriate biological approaches for remediation of environmental contaminants.

Expected Course Outcome:

1. Outline the concept of pollution and bioremediation methods to control it
2. Evaluate the use of different microbes for remediation of pollutants
3. Outline the metabolism of microbes and the genes and enzymes involved in the process
4. Make use of different types of microbes and plants to clean pollutants present in the atmosphere
5. Analyze the conventional wastewater treatment strategies
6. Experiment with biotechnological techniques to remediate the environment

Student Learning Outcomes (SLO):	2,11,18

2. Having a clear understanding of the subject related concepts and contemporary issues
11. Having an interest in lifelong learning
18. Having critical thinking and innovative skills

Module:1	Introduction to bioremediation	4 hours

Basics and terminologies in bioremediation, sources of pollution, Nature and Toxic effects of the pollutants on various trophic levels, Permissible limits and its agencies – APHA, EPA and Indian standards

Module:2	Microbes and bioremediation	4 hours

Microbes and its degradative capabilities, Screening for useful microbe for the bio-removal of toxic compounds, Bioremediation of specific pollutants - pesticides, Dye, petroleum hydrocarbons and other xenobiotic compounds

Module:3	Metabolism of Microbes	6 hours

Metabolism of Microbial degradation, Bacterial resistance mechanism - towards toxic compounds, Detection of candidate genes and enzymes involved in the process of degradation – Application of KEGG pathway in bioremediation

Module:4	Fungal Biodegradation	3 hours

Fungal Biodegradation and Phycoremediation, Biodegradation in biofuel production, Co2Sequestration

Module:5	Types of phytoremediation	4 hours

Phytoremediation and its types, rhizoremediation strategy and processes, a case study in the removal of heavy metals and other toxic compounds (Chernobyl accident) onsite

Module:6	Wastewater treatment	4 hours

Conventional wastewater treatment strategies, Bioreactors - slurry, batch and continuous

processes, Application of GMO's in Bioremediation, natural gene transfer in the environment		
Module:7	**Application of Proteomics and Metabolomics in bioremediation**	**3 hours**
Superbugs as super savers, engineered enzymes, products involved in biodegradation, Application of Proteomics and Metabolomics in bioremediation		
Module:8	**Contemporary issues:** Lecture by industrial expert	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Thankur IS (2011) Environmental biotechnology: Basic concepts and applications. Second Edition (revised), I.K. International.
Reference Books	
1.	Maier RM, Pepper IL, Gerba CP (2011) Environmental Microbiology, Second Edition, Academic Press.
2.	Alexander M (2014) Biodegradation and Bioremediation, Second Edition, Academic Press.

Mode of Evaluation: Assignments, Continuous assessment tests and Final assessment test.	
Project: 'J' Component	**CO: 6**

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY2019	Molecular Evolution and Phylogeny	3	0	2	0	4
Pre-requisite	None	Syllabus version				
		v..1				

Course Objectives:

1. To understand the evolutionary relationship between the various kingdom of life.
2. To gain knowledge on existing algorithmic approaches make the evolutionary and phylogenic prediction more interesting
3. To develop new methods on evolutionary analysis using biological sequences.

Expected Course Outcome:

1. To understand the evolutionary relationship between the various kingdom of life.
2. Apply apt algorithmic approaches for specific sequence datasets.
3. Build phylogeny and analyze evolutionary relationships based on different algorithms.
4. Compare different algorithms and optimize them to give a better relationships than the existing ones.
5. Students will compare and contrast different molecular evolution techniques
6. Gain significant new knowledge about the function of biological molecules and structures.

Student Learning Outcomes (SLO):	2, 20

2. Having a clear understanding of the subject related concepts and contemporary issues
20. Having a good digital footprint

Module:1	Molecular Archeology	7 hours

Introduction to molecular evolution, driving forces in evolution, evolutionary changes in nucleotide sequences.

Module:2	Phylogenetic Trees	7 hours

Molecular phylogenetics, phylogenetic trees, trees, and distances.

Module:3	Phylogeny Algorithms	7 hours

Measuring genetic change, Genetic distance-Measuring evolutionary change on the tree- kinds of data.

Module:4	Methods of reconstruction	6 hours

Distance matrix methods, Maximum parsimony methods, Maximum likelihood methods

Module:5	Evolutionary Analysis	4 hours

Models of Molecular evolution, Functional constraints, and the rate of substitution patterns of codon usage and base composition.

Module:6	Molecular Evolution theory	5 hours

Evolutionary clocks, Neutral Theory, Genetic variation within species, Natural selection.		
Module:7	**Applications of molecular phylogenetics**	**5 hours**
Organismal phylogeny, what does evolutionary medicine to offer, host-parasite co-speciation?		
Module:8	**Contemporary issues:**	**4 hours**
Lecture by industrial expert		
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Bromham L (2016) An Introduction to Molecular Evolution and Phylogenetics 2nd Edn oxford University press
2.	Graur D and Li WH (2010) Fundamentals of Molecular Evolution,., three eds. Sinauer Associates,

Reference Books

1.	Pevsner J (2015) Bioinformatics and Functional Genomics, 3rd Edition Wiley-Blackwell.
2.	Page R, and Holmes EC (2010) Molecular evolution, A phylogenetic approach, Blackwell Science Inc;

Mode of Evaluation: Written examinations, assignments, and quizzes.

List of Challenging Experiments (Indicative)

1.	Exploration and retrieval of DNA and Protein Sequence database	2 hours
2.	Retrieval of published sequence datasets for evolutionary reports	3 hours
3.	Evolutionary tools for molecular data: File format conversion	2 hours
4.	Aligning multiple sequences with CLUSTAL-W	3 hours
5.	Selecting Evolution and Phylogenetic models	3 hours
6.	Phylogenetic analyses of DNA or protein sequences using maximum likelihood.	3 hours
7.	A simple user interfaces for creating input files to run BEAST.	2 hours
8.	LogCombiner program to combine log and tree files from multiple runs of BEAST	2 hours
9.	TreeAnnotator program for summarizing the information in a sample of trees produced by BEAST	3 hours
10.	Bayesian Evolutionary Analysis Sampling Trees.	2 hours

11.	Virus Pathogen Database and Analysis Resource (ViPR) Bacterial dataset analysis.	2 hours
12.	ML program for estimating mutation rates using cancer mutation databases.	3 hours
Total Laboratory Hours		30 hours

Mode of Evolution: Assignments, Continuous assessment tests and Final assessment test.			
Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY 3002	Environmental Genetics	3	0	0	0	3
Pre-requisite	None	Syllabus version				
		v. 1.1				

Course Objectives:

1. Relate environmental factors affecting life through interaction with genes/DNA
2. Explain the factors involved in mutagenesis
3. Discuss antimutagens with suitable examples

Expected Course Outcome:

1. Perceive the influence of various environmental factors on biological systems through the introduction of changes in DNA sequences
2. Illustrate the roles of chromosomes and genes in heredity
3. Summarize the roles of genes and the environment in the determination of phenotype.
4. Categorize the sources of irradiation (e.g., UV x-rays) in the environment and describe their genetic significance.
5. Describe sources of mutagenic, carcinogenic, and teratogenic chemicals in the environment and identify their known effects
6. Analyze the human genome and identify common chromosome and gene disorders

Student Learning Outcomes (SLO):	2, 11

2. Having a clear understanding of the subject related concepts and contemporary issues
11. Having an interest in lifelong learning

Module:1	MUTATION	6 hours

Mutagenesis - Spontaneous and induced mutation – Somatic and germ cell Mutations; Gene mutations and chromosomal mutations. Physical, chemical and biological agents, Interaction of chemical mutagens and radiation with genetic material- electromagnetic spectrum- biological effects of ionizing radiation and ultraviolet rays

Module:2	ANTIMUTAGENS	5 hours

Modification of mutagenic damage- anti-mutagenesis and de-mutagenesis in yeast, Neurospora, Drosophila- and C. elegans life cycle

Module:3	Molecular techniques to induce mutation	6 hours

Mutagenicity assessment- Salmonella (Ames test), Methods to induce genetic variation in single genes: Insertional mutagenesis - transposon and TDNA mutagenesis; In vitro mutagenesis; Oligonucleotide and PCR mediated site-specific mutagenesis; TILLING; RNAi mutagenesis.

Module:4	Techniques to detect mutations	6 hours

Mouse-cytogenetic procedures and techniques to assess gene mutations. In vitro mammalian systems for mutagenicity evaluation- human lymphocytes, fibroblasts, and Chinese hamster cells in culture- Unscheduled DNA synthesis, Chromosomal aberrations, Sister chromatid exchanges, gene mutation- HGPRT and TK.

Module:5	**Mutation induced cancer and congenital disabilities**	**7 hours**
The interrelationship between mutagenesis and Carcinogenesis, Tests for evaluation. Teratogenesis- Mouse as test system congenital anomalies-teratogens in comparison with mutagens and carcinogens- congenital disabilities in man radiosensitizers.		
Module:6	**Environmental factors affecting reproduction**	**6 hours**
DNA repair defects in man. Biomonitoring of human population - chromosomal analysis, Environmental factors affecting human reproduction		
Module:7	**Mechanisms involved in the protection of genome from environmental mutagens**	**7 hours**
Various DNA repair mechanisms involved in the protection of genome from mutagens.		
Module:8	**Contemporary topics:**	**2 hours**
Lectures by industrial expert		
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Hayes AW, Kruger CL(2014) Haye'sPrinciples and Methods of Toxicology, Sixth Edition, CRC Press.

Reference Books

1.	Kilbey BJ, Legator M, Nichols W, and Ramel C (2012) Handbook of Mutagenicity test procedures, Elsevier, Amsterdam.
2.	Scott Hawley.R, Michelle Walker 2003 Advanced Genetic Analysis Finding Meaning in a Genome, Wiley-Blackwell Publishing.
3.	Philip Meneely 2009 Advanced Genetic Analysis: Genes, Genomes, and Networks in Eukaryotes **1st Edition, Oxford University Press.**
	Mode of Evaluation: Assignments, Continuous assessment tests and Final assessment test.

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY 3003	Protein Engineering	2	0	0	4	3
Pre-requisite		Syllabus version				
		v. 1				

Course Objectives:

1. Recall the basics concepts of protein engineering
2. Summarize the necessary elements of protein overexpression systems in bacteria.
3. Illustrate the importance of engineering the proteins and their novel applications

Expected Course Outcome:

1. Explain about different techniques for protein analysis
2. Formulate and purify proteins
3. Discuss advanced biophysical techniques for protein analysis, their relative merits and interpret data from those techniques
4. Evaluate the steps required to produce an expression system for a new protein
5. Outline the techniques for modifying proteins
6. Utilize various software for protein visualization and modeling

Student Learning Outcomes (SLO):	2 ,11,18

2. Having a clear understanding of the subject related concepts and contemporary issues
11. Having an interest in lifelong learning
18. Having critical thinking and innovative skills

Module:1	Overview of Protein Structure and Function	4 hours

Properties of proteins; Levels in protein structure – folding pattern, 3D structures; Covalent chemical modification of proteins – covalent and non-covalent forces are determining protein structure; Overview of protein synthesis & degradation.

Module:2	Techniques for the study of proteins structures	4 hours

UV spectroscopy, Circular dichroism, Fluorescence, Mass spectrometry, Nuclear magnetic, Resonance spectroscopy, X-ray diffraction technique.

Module:3	Protein stability and dynamics	4 hours

Factors determining the intrinsic and extrinsic stability of proteins, thermodynamic stability versus kinetic stability of proteins, unfolding and folding of proteins, induced molecular conformational changes in proteins, molecular dynamics of proteins.

Module:4	Design of Recombinant Proteins	4 hours

Types of mutagenesis, Recombinant protein production – Differences in the host cells, Over-expression of proteins, Directed Evolution Strategy, High throughput production, and analysis of recombinants, proteins, inclusion bodies, co-expression of proteins with specific properties, stabilization of proteins.

Module:5	**Techniques in Protein Engineering**	**4 hours**
Expressing and analyzing protein in Prokaryotic and eukaryotic systems, Identification and analysis of sequence-specific DNA- binding proteins. Enhanced recovery and folding of recombinant proteins using fusion protein strategies; protein engineering for affinity purification; stabilization of enzymes by protein engineering, engineering specificity of enzymes.		
Module:6	**Covalent Modifications and Protein Engineering by Semi Synthesis**	**4 hours**
Susceptibility of amino acid side chains for chemical modification, residue-specific modifications, reagents for modifications; cross-linkers in protein modifications; insulin and cytochrome c semi-synthesis; press-stud conjugations; Application of protein conjugates.		
Module:7	**Peptidomics and Peptidomimetics**	**4 hours**
Engineering antibodies and vaccines; hormones & receptors; Combinatorial Enzyme Engineering, Engineering Proteins for degradation of recalcitrant compounds, Peptidomimetics in Medicinal chemistry, and drug design.		
Module:8	**Contemporary issues:** Lecture by invited experts.	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1. Cleland JL and Craik CS (2010) Protein Engineering: Principles and Practice, Wiley publishers
2. Ramya M and Ponmurugan P (2015) Protein Engineering Narosa publishing house

Reference Books

1. Park S and Cochran J (2010) Protein Engineering and Design CRC Press
.
2. Creighton TE (2010) Protein Function – A Practical Approach (2nd ed.,), Oxford University Press, Oxford, UK

Authors, book title, year of publication, edition number, press, place

Projects: 'J' Components

Mode of Evaluation: Assignments, Continuous assessment tests and Final assessment test.

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Molecular Modelling and Drug Designing	L	T	P	J	C
BIY3004		3	0	2	0	4
Pre-requisite	None	Syllabus version				
		v. 1.1				

Course Objectives:

1. Outline preliminary concepts in molecular modeling using molecular dynamics
2. Utilize basic modeling techniques to explore biological phenomena at the molecular level
3. Perceive knowledge in protein-ligand interaction study by docking and visualization tools for molecular dynamics.

Expected Course Outcome:

1. Illustrate the concepts of Molecular modeling using Molecular Dynamics
2. Utilize basic modeling techniques to explore biological phenomena at the molecular level
3. Experiment with protein-ligand interaction study by docking.
4. Translate the understanding of visualization tools for molecular dynamics
5. Apply the information gained in various chemistry and biochemistry courses toward solving problems pertinent to drug designing
6. Demonstrate the relative importance of molecular modeling and drug designing

Student Learning Outcomes (SLO):	2, 18

2. Having a clear understanding of the subject related concepts and contemporary issues
18. Having critical thinking and innovative skills

Module:1	Quantum mechanics & concepts in molecular modeling	7 hours

Coordinate systems, potential energy surfaces. Introduction to quantum mechanics.

Module 2	Force Fields	7 hours

Bond stretching; angle bending. torsional terms; non-bonded interactions; electrostatic interactions; Vander Waals interactions

Module:3	Molecular Dynamics and Monte Carlo simulation	7 hours

Design constraints, Potentials in MD simulation, Molecular dynamics algorithms.

Module:4	Analysis and Properties	6 hours

Geometry optimization, Vibrational frequencies: potential energy surface, harmonic vs. fundamental frequencies, zero-point vibrational energies.

Module:5	Modeling	5 hours

Homology modeling, Ab initio, Protein Threading.

Module:6	Drug design	6 hours

Structure-based methods to identify lead compounds: finding lead compounds by searching 3D databases; de novo ligand design.

Module:7	**Molecular Docking**	**5 hours**
Docking - molecular modeling in drug design – structure-based drug design – pharmacophores - QSAR.		
Module:8	**Contemporary issues:**	**2 hours**
Lectures by industrial expert		
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Leach AR (2010) Molecular Modeling, Principles & Applications, (Dorling Kindersley(India) (P)Ltd with Pearson education Ltd, UK.
2. Arjun S (2103) Drug Discovery, Design & Development Lambert Academic publishing.

Reference Books

1. Clark T, Thurston DE, and Banting L (2012) Drug Design Strategies: Computational Techniques& Applications Royal society of chemistry

Authors, book title, year of publication, edition number, press, place

Mode of Evaluation: Assignments, Continuous assessment tests and Final assessment test.

List of Challenging Experiments (Indicative)

1.	Exploration of small molecule and macromolecule database	3 hours
2.	Small molecule drawing and optimization using Chem Sketch	2 hours
3.	Macromolecular visualization using PyMOL	3 hours
4.	Macromolecular visualization using SPDBV	2 hours
5.	Homology modeling of the drug target protein	2 hours
6.	Protein structure exploration with active site prediction	2 hours
7.	Protein-Protein interaction using HADDOCK	2 hours
8.	Protein-Ligand interaction using Autodock	3 hours
9.	Quantitative structure-activity relationships modeling tools	3 hours
10.	Molecular Mechanics for small molecules	2 hours
11.	Avogadro for molecular mechanics	2 hours
12.	Pharmacophore screening of small molecules	2 hours
13.	Quantitative structure-activity relationship	2 hours
	Total Laboratory Hours	30 hours

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY4001	Cancer Biology	3	0	0	0	3
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Illustrate the cellular and molecular mechanisms that are dysregulated in cancerous cells.
2. Summarize the genomic technologies and develop critical thinking skills in cancer research
3. Analyze traditional chemotherapy and novel targeted therapeutic approaches

Expected Course Outcome:

1. Infer cancer causing mutations and specific therapeutic targets.
2. Compare the biological treatment processes and development of suitable technologies
3. Determine the challenging sides of using cancer models in cancer research
4. Interpret the data published in scientific articles
5. Relate the molecular biology of cancer with clinical aspects of the disease

Student Learning Outcomes (SLO): **2,18**

2. Having a clear understanding of the subject related concepts and contemporary issues
18. Having critical thinking and innovative skills

Module:1	Cell cycle and molecular mechanism of carcinogenesis	7 hours

Cell cycle and molecular players involved in the cell cycle. Deregulation of cell cycle and causes for deregulation of cell cycle. Role of an oncogene, proto-oncogene, tumor suppressor proteins, and oncoviruses in cancer. Cancer and its types. Molecular mechanisms of mutagens such as Chemical carcinogen and radiation. Types of carcinogen and their mode of action with an example.

Module 2	Evading apoptosis in cancer	6 hours

The apoptotic mechanism, altered pathways in cancer cells that can evade apoptosis. Pathways are regulating tumor initiation and/or its progression.

Module:3	Genomic instability	6 hours

Types of genomic instability: instability due to micro and mini satellite sequence, Loss of DNA repair mechanisms, Dysfunction of telomerase. Chromosomal aberrations that cause cancer. Single nucleotide polymorphisms and cancer.

Module:4	Angiogenesis and Metastasis	6 hours

Tumor angiogenesis, Clinical significance in invasion, Three-step theory of invasion, Proteinases, and tumor cell invasion.

Module:5	Cancer stem cells	6 hours

The stem cell theory of cancer, tumor heterogeneity, Origin of cancer stem cells, and controlling cancer by targeting cancer stem cells.

Module:6	**Cancer Therapeutics and Diagnosis**	**7 hours**
Detection of Cancers, Prediction of aggressiveness of cancer, Advances in cancer detection. Different forms of therapy, Chemotherapy, Radiation Therapy, Targeted therapy: Monoclonal antibody, and kinase blockers.		
Module:7	**In vitro and In vivo models to study cancer**	**5 hours**
Cell culture techniques: MTT assay, colony-forming assay, and matrigel assay. Animal models used to study cancer: Nude mice, Transgenic and knockout mice, Cre mice, and patient-derived xenografts (PDXs).		
Module:8	**Contemporary Topics: Lecture by experts**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	. The Biology of Cancer – Robert Weinberg. Edition – 2nd ISBN:9780815342205 - 2013

Reference Books

1.	Textbook readings; primary literature; in-class discussion. The Molecular Biology of Cancer: A Bridge from Bench to Bedside. Stella Pelengaris, Mike Khan -2nd Edition - 2013
2.	Molecular Biology of Cancer. Lauren Pecorina, 4th edition. Oxford University Press – 2016.
3.	Introduction to cancer biology, Robin Hesketh, Cambridge University Press – 2013.
	Mode of Evaluation: Assignments, Continuous assessment tests and Final assessment test.

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No.46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY4002	Food Science	2	0	2	4	4
Pre-requisite		Syllabus version				
		v. 1				

Course Objectives:

1. Demonstrate the basic principles involved in food science
2. Illustrate the chemical and physical properties of food
3. Explain the role of microbes in food.

Expected Course Outcome:

1. Relate the basic concepts of food science and the different components of food.
2. Appraise the physical and chemical characteristics of food for application in various food industries.
3. Demonstrate the association of microbes with foods.
4. Relate the principles of processing in food preservation.
5. Appraise the sensory attributes of food and its evaluation.
6. Evaluate the role of regulatory agencies governing food production and processing.

Student Learning Outcomes (SLO):	2, 18

2. Having a clear understanding of the subject related concepts and contemporary issues
18. Having critical thinking and innovative skills

Module:1	Product	4 hours

Characteristics of raw materials-cereals, legumes, fruits, vegetable nut, meat, dairy, egg, and seafood.

Module:2	Physical characteristics of food	4 hours

Salient physical properties in foods- viscosity, specific gravity, surface tension. Colloids-sols, gels, emulsions, foams.

Module:3	Chemical characteristics of food	4 hours

Chemical constituents (macromolecules and bioactive compounds) of food; major chemical changes during food processing.

Module:4	Microbiology of food	4 hours

Overview of microbes in food; Underlying principles in food spoilage.

Module:5	Principles of food processing	4 hours

Basic principles of food preservation and processing; emerging techniques in processing and packaging

Module:6	Sensory properties of food	4 hours

Significance of sensory characteristics in food; Overview of methods of sensory evaluation.

Module:7	Food quality and analysis	4 hours

General principles; critical regulatory bodies, quality assurance programs Comparison of methods for proximate analysis; significant minerals, vitamins, and bioactive compounds in food. Case Study- Anti-oxidant analysis in food.

Module:8	**Contemporary issues:** Lecture by industrial experts	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1. Ward JD(2013) Principles of food science, 3rd edition. G-W Publishers
2. Jay JM, Loessner MJ, and Golden DA (2012) Modern food microbiology. Fifth Edition, An Aspen Publication.

Reference Books

1. Jeantet R, Croguennec T, Schuck P, and Brule G (2016) Handbook of Food Science and Technology 3: Food Biochemistry and Technology. Wiley and Sons Publishers.

Authors, book title, year of publication, edition number, press, place

Mode of Evaluation: Assignments, Continuous assessment tests and Final assessment test.

List of Challenging Experiments (Indicative)		**CO: 07**
1.	Determination of Quality of Milk sample by Methylene Blue Dye Reduction (MBRT) Test	2 Hours
2.	Qualitative Testing of Adulterated food samples	2 Hours
3.	Examination of spoiled food products	2 Hours
4.	Fermented foods	2 Hours
5.	Examination of wheat flour for gluten	2 Hours
6.	Determination of Acid Value of Fat sample	2 Hours
7.	Study of chemical properties of food	2 Hours
8.	Experiment title Bioreactor – demonstration	2 Hours
9.	Isolation of lactic acid bacteria from foods	2 Hours
10.	Examination of yeast from foods	2 Hours
11.	Stages of sugar cookery	2 Hours
12.	Malting, puffing, and popping of grains	2 Hours
13.	Visit food processing unit	2 Hours
	Total Laboratory Hours	**30 Hours**
	Project: 'J' Component	**CO: 07**

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY5001	Animal Biotechnology	3	0	0	0	3
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives :

1. Explain the methods of gene manipulations in animal cells and embryonic stem cells
2. Develop breeding and conservation approaches in animals
3. Appraise the legal and ethical issues related to animal maintenance.

Expected Course Outcome:

1. Extend the best practices followed during maintenance of cell lines
2. Apply different techniques to manipulate the genome of animal cells.
3. Formulate ideas for the production of genetically modified organisms.
4. Organize different approaches in reproduction technology
5. Utilize the concept of molecular techniques involved in animal conservation

Student Learning Outcomes (SLO):	2,10 and 18

2. Having a clear understanding of the subject related concepts and contemporary issues
10. Having a clear understanding of professional and ethical responsibility
18. Having critical thinking and innovative skills

Module:1	Animal cell culture and applications	6 hours

Primary cells and cell lines. Methods to transform primary cells. Choice of animal cells for protein production, Viral vaccine production. Scale-up of animal cell culture. Applications of animal cell culture with examples.

Module:2	Gene transfer methods in animal cells	6 hours

Transformation, Transfection, and Electroporation. Selection of cells for stable transfection and continuous production of protein from the transgene. Methods to knockdown the expression of endogenous genes.

Module:3	Gene manipulations in Animals	6 hours

Embryonic stem cells, gene manipulations in embryonic stem cells, transgenic, knockout, and Cre/LOXP mice. Cloning of animals.

Module:4	Animal breeding methods for better traits	6 hours

Artificial insemination-estrous synchronization; superovulation; embryo transfer, pregnancy, and parturition control; monitoring reproductive status in animals, in-vitro fertilization, sperm and embryo sexing; pre-implantation genetic diagnosis.

Module:5	Conservation of Animals	6 hours

Animal and human Genome projects genetic linkage maps; polymorphic DNA markers; Physical map; integrating genetic linkage and physical map; DNA sequencing; Molecular techniques in genetic conservation of Farm Animals, and detection of Animal Diseases.

Module:6	Genetically modified animals and their applications	7 hours

Genetically modified animal models used in biomedical research such as Cancer, Diabetes, Immunology, and Toxicology		
Module:7	**Ethics and social problems**:	**6 hours**
a) Classification based on genome, b) genetically modified organism, c) Cloning, d) Stem cell technology		
Module:8	**Contemporary topics:** Lecture by industrial experts	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Singh B, Gautam SK, and Chauhan M S (2015) Textbook of Animal Biotechnology, TERI. New Delhi
2.	Panno J(2014) Animal Cloning: The Science of Nuclear Transfer.

Reference Books

1.	Freshney RI (2010) Culture of Animal Cells: A Manual of Basic Technique and Specialized applications John Wiley & Sons, Inc.
2.	Evans J (2012) Genetic Engineering of Animals: An Agricultural Perspective Springer Science & Business Media
	Authors, book title, year of publication, edition number, press, place

Mode of Evaluation: Assignments, Continuous assessment tests and Final assessment test

Recommended by Board of Studies	03-08-2018		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY5002	Gene Therapy	3	0	0	0	3
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Recall various forms of therapeutic nucleic acids, and compare their significance with those of chemical, protein and cell-based therapies
2. Dissect different methods that are currently available to deliver therapeutic genes into target cells, and distinguish challenges of each method
3. Evaluate various regulatory considerations for a clinical trial, and infer from previously conducted gene therapy clinical trials for specific human diseases

Expected Course Outcomes:

1. Relate the principle of gene therapy with its potential use a future drug
2. Adapt different gene delivery methods based on the nature of the disease, therapeutic threshold, and type of target tissue involved
3. Choose different genetic elements (both viral and non-viral) based on their roles in viral titration, gene expression, and gene silencing
4. Design novel viral vectors by pseudotyping (retrovirus) or serotyping (adenovirus) to broaden their tropism for multiple different tissues
5. Identify potential disease models (both in vitro and in vivo) to test a candidate vector carrying a specific therapeutic gene
6. Criticize severe adverse events of a gene therapy clinical trial due to vector-related genotoxicity and immunotoxicity

Student Learning Outcomes (SLOs): 2,11,12

2. Having a clear understanding of the subject related concepts and contemporary issues
11. Having an interest in lifelong learning
12. Having adaptive thinking and adaptability

Module:1	Introduction to Gene Therapy	5 hours

Genes as drugs; Therapeutic nucleic acids: antisense oligonucleotides, ribozymes, aptamers, siRNAs and miRNAs

Module:2	Physical and Chemical Methods of gene Delivery	5 hours

Cellular barriers to gene delivery; Direct inoculation of DNAs and RNAs; Physical methods: electroporation, hydroboration, sonoporation, gene gun, and jet injection; Chemical methods: liposomes and cationic lipids, cationic polymers and proteins

Module:3	Viral Vectors for Gene Therapy	8 hours

Viral genome organization, vector construction, production and properties of gamma retroviral, lent viral, adenoviral and adeno-associated virus vectors; Overview of foamy and herpes simplex virus vectors for gene therapy applications

Module:4	Overview of Preclinical and Clinical Testing	6 hours

Therapeutic gene expression in cell lines; Comparison of small and large animal models; Phases of clinical trials; Types of transplant therapies; Gene transfer into stem cells; Regulatory considerations for gene therapy		
Module:5	**Clinical Applications of Gene Therapy I**	**7 hours**
Gene therapy for severe combined immune deficiencies, X-SCID and ADA-SCID; Gene therapy for cystic fibrosis; Gene therapy for muscular dystrophies; Gene therapy for hemophilia A and B		
Module:6	**Clinical Applications of Gene Therapy II**	**7 hours**
Gene therapy for cancer; Gene therapy for neurodegenerative disorders, Alzheimer's and Parkinson's diseases; Gene therapy for eye diseases, retinitis pigmentosa, and Leber's congenital amaurosis; Gene therapy for HIV infection		
Module:7	**Ethical and Social Problems of Gene Therapy**	**5 hours**
Safety of clinical experimentation; Germline gene therapy; In utero gene therapy; Gene therapy of the embryo; Gene transfer for the cosmetic appearance and gene doping		
Module:8	**Contemporary issues**	**2 hours**
Gene editing using CRISPR/Cas9 technology; Status of gene therapy in India and abroad		
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Giacca M (2010) Gene Therapy First Edition, Springer Press, USA
2.	Elsersawel A (2016) Gene Editing, Epigenetic, Cloning, and Therapy. Author house publishing

Reference Books

1.	Herzog RW and Zolotukhin S (2010) A Guide to Human Gene Therapy (First Edition) World Scientific Publishing Co, UK
2.	Daniel S (2013) Advanced Textbook On Gene Transfer, Gene Therapy And Genetic Pharmacology: Principles, Delivery And Pharmacological And Biomedical Applications Of Nucleotide-based Therapies(Volume 1 of Icp Textbooks In Biomolecular Sciences) World Scientific publishers, Singapore
3.	Jayandharan GR (2018)Gene and Cell Therapy: Biology and Applications (First Edition) Springer Nature, Singapore

Mode of Evaluation: Assignments, Continuous assessment tests and Final assessment test.

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY 5003	Enzyme Technology	2	0	0	4	3
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Discuss the concepts of food biotechnology
2. Relate the role of biotechnology in the food industry
3. Explain the consumer perception of food biotechnology

Expected Course Outcome:

1. Select suitable purification techniques
2. Evaluate the optimization of enzyme activity
3.Infer recent types and advantages of immobilization techniques
4. Outline the modern techniques used in enzyme engineering
5. Categorize applications of enzymes
6. Design new processes with the use of enzymes

Student Learning Outcomes (SLO):	2, 5, 9

2. Having a clear understanding of the subject related concepts and contemporary issues
5. Having design thinking capability
9. Having problem-solving ability- solving social issues and engineering problems

Module:1	Enzymes purification	4 hours

Introduction of Enzymes, Isolation of Enzymes, Objectives, and strategy in enzyme purification, Choice of source, Methods of homogenization, Methods of separation, Success of purification, Examples of purification procedures

Module:2	Large scale production and purification of enzymes	4 hours

Methods involved in Large scale production of enzymes and large scale purification of Enzymes, recombinant enzymes.

Module:3	Optimization of enzyme activity	4 hours

Enzymatic reactions in biphasic liquid systems, The stabilization of enzymes in biphasic aqueous-organic systems, Equilibria in biphasic aqueous-organic systems, Use of aqueous 2-phase systems, Practical examples of the use of enzymes 'in reverse'.

Module:4	Immobilization techniques	4 hours

Immobilization of enzymes and cells, Effect of immobilization on enzyme properties, Application of immobilized enzymes and cells, Syrup production from corn starch, L-aminoacids from racemic mixtures, Acrylamide synthesis, Therapeutic applications of immobilized enzymes

Module:5	Enzymes in the clinical industry	4 hours

Enzymes for clinical diagnosis, Role of biosensors in diagnosis, Use of enzymes to determine the concentration of metabolites of clinical importance. Enzyme inhibitors and drug design, Enzyme therapy: Treatment of genetic deficiency disease, Cancer therapy

Module:6	**Microbial enzymes in industry**	**4 hours**
Application of microorganisms in brewing, cheese making, organic chemicals, Isolated enzymes in industrial processes		
Module:7	**Modification of enzymes for industrial use**	**4 hours**
Methods to modify enzymes for improvement of enzyme activity as per the industrial requirement with examples.		
Module:8	**Contemporary issues:** Lecture by industrial experts	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1. Khan MY and Khan F (2015) Principles of Enzyme `Technology PHI learning India
2. Bhatt SM (2011) Enzymology and Enzyme Technology, S Chand publishing India

Reference Books

1. books published after 2010 (preferably after 2015) to be given (please give complete bibliography)

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BIY5004	Food Biotechnology	2	0	0	4	3
Pre-requisite	None	Syllabus version				
		v. 1				

Course Objectives:

1. Discuss the concepts of food biotechnology
2. Relate the role of biotechnology in the food industry
3. Explain the consumer perception of food biotechnology

Expected Course Outcome:

1. Recall critical concepts in food production and contemporary issues in the field
2. Extend the principles of fermentation and its application in the processing of food
3. Demonstrate the role of enzymes in the food industry
4. Appraise the role of biotechnology in designing novel food products
5. Build quality assurance and control systems for specific food industries
6. Justify the management of food waste, global food trade, and related national and international laws

Student Learning Outcomes (SLO):	2,18

2. Having a clear understanding of the subject related concepts and contemporary issues
18. Having critical thinking and innovative skills

Module:1	Introduction to Food Biotechnology	3 hours

Definition; scope in the food industry; Interdisciplines involved; overview of biotechnological methods in the food sector.

Module:2	Microbial biotechnology	5 hours

Fermentation- principles, types, starter cultures, advantages, disadvantages. Chemicals used in processing, Case study-fermented milk products;

Module:3	Biotechnology for improved food process	4 hours

rDNA chymosin; overview of enzymes in the food industry. Case study-HFCS production through biotechnology.

Module:4	Novel products through biotechnology	3 hours

GM foods-regulatory systems, Functional foods; designer foods; nano foods.

Module:5	Molecular food diagnostics	4 hours

Molecular methods- overview, types, comparison with conventional techniques. Case study-molecular detection of Salmonella in food matrices.

Module:6	Utilization of food waste	4 hours

Characteristics and types of food wastes; value-added products from food wastes.

Module:7	Food biotechnology and Consumerism	4 hours

Consumer perception-national and international scenario; factors influencing the consumers, impact on global food trade, import, and export laws.

Module:8	**Contemporary issues:** Lectures by experts	**3 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Joshi VK, Singh RS (2013) Food Biotechnology: Principles and Practices. I K International Publishing House Pvt. Ltd; First Edition.
Reference Books	
1.	Lee BH (2014) Fundamentals of Food Biotechnology, 2nd Edition.John Wiley & Sons.
2.	Pometto A, Shetty K, Paliyath G, and Levin RE (2005) Food Biotechnology. Second edition. CRC Press.
	Authors, book title, year of publication, edition number, press, place
Mode of Evaluation: Assignments, Continuous assessment tests and Final assessment test.	
Project: 'J' Component	

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No.46	Date	24-08-2017

Course code	Environmental Biotechnology	L	T	P	J	C
BIY5005		2	0	0	4	3
Pre-requisite		Syllabus version				
		v.1.2				

Course Objectives:

1. Elaborate on the various types of pollutants and ways to control them
2. Illustrate microbial-mediated bioremediation and their types
3. Choose suitable methods to protect the environment

Expected Course Outcome:

1. Assess the different types of pollution and the role of biogeochemical cycles in the environment
2. Utilize the knowledge in the field of bioremediation to remediate the environment
3. Demonstrate the types of solid waste and their management
4. Build bioremediation and phytoremediation-mediated environmental cleanup technologies.
5. Formulate GMOs for degradation and bioremediation through extremophiles
6.Examine environmental pollution and develop models to resolve it

Student Learning Outcomes (SLO):	2,10

2. Having a clear understanding of the subject related concepts and contemporary issues
10. Having a clear understanding of professional and ethical responsibility

Module:1	Pollutants and its type	4 hours

Sources of pollution, Physico-chemical parameters of the pollutants, molecular detection of the microbial community (Metagenomics), Role of living organisms in primary biogeochemical cycles C, N, S, and P - disruption of biogeochemical cycles -Causes and effects.Eutrophication, Environmental Qualitative and Quantitative detection of the toxic compounds from the polluted site.

Module:2	Microbial mediated Bioremediation	4 hours

Microbial degradative pathways (Aromatic and aliphatic compounds), metal microbe interactions, Biohydrometallurgy and Biomining, biomagnification, Biosorption, Bioaccumulation and Biodegradation, Bioremoval of xenobiotic compounds

Module:3	Types of Bioremediation	4 hours

Bioremediation - In-situ – Bioaugmentation, Bioventing, and other technologies, Ex-situ – solid waste management (Landfarming, composting, and Biopiles).

Module:4	Bioremediation Techniques	4 hours

Technologies in bioremediation – Biofilms based removal (Quorum sensing)-. activated sludge (suspended growth), N and P removal - lagoons, trickling filter (attached growth) - Rotating Biological contactors (RBC)

Module:5	Phytoremediation	4 hours

Phytoremediation and its types, rhizome remediation strategy and processes, a case study in the removal of heavy metals and other toxic pollutants

Module:6	Bioreactors for Bioremediation	4 hours

Aerobic and anoxic type bioreactor for biodegradation- solid, liquid and air (slurry, batch, and continuous processes), Application of GMO's in Bioremediation		
Module:7	**Extremophiles in bioremediation**	**4 hours**
Microbial habitat in various ecological niches, Extremophiles, and its types, Hydrothermal vent ecosystem and its biotechnological potentials, Ecofriendly Bioproducts		
Module:8	**Contemporary issues:** Lecture by industrial experts	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1.	**Ansari** AA, **Gill** SS, **Gill** R, **Lanza** G, **Newman** L (2017) Phytoremediation Management of Environmental Contaminants. Springer international publication
2	Jördening HJ and Winter J(2010)Environmental biotechnology: concepts and applications. John Wiley & Sons.

Reference Books

1.	Rathoure AK and Dhatwalia VK (2015) Toxicity and Waste Management Using Bioremediation, IGI global publishers
	Authors, book title, year of publication, edition number, press, place

Mode of Evaluation: Assignments, Continuous assessment tests and Final assessment test

Project: J component			
Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No.46	Date	24-08-2017

Course code	Medical Biotechnology	L	T	P	J	C
BIY5006		3	0	0	0	3
Pre-requisite		Syllabus version				
		v. 1				

Course Objectives:

1. Outline the biology and diagnostics for various diseases
2. Appraise host-microbe interactions in causing infectious diseases and different methods of their relative diagnosis and prophylaxis
3. Utilize medical engineering to take up research in challenging areas of therapy and diagnosis

Expected Course Outcome:

1. Evaluate the biology of various diseases
2. Discover various diagnostic methods and imaging techniques
3. Assess disease etiology, respective diagnosis, and molecular therapeutic approaches
4. Relate histocompatibility, transplantation and stem cell culture
5. Appraise the principles of teratogenesis
6. Formulate the use of automated systems in therapeutics

Student Learning Outcomes (SLO):	2 and 10

2. Having a clear understanding of the subject related concepts and contemporary issues
10. Having a clear understanding of professional and ethical responsibility

Module:1	An Introduction to Human Diseases	5 hours

Human health and Disease, Characteristics of Disease, Classification of Disease (Congenital / Hereditary / Inflammatory/ Degenerative / Metabolic / Neoplastic Disease).

Module:2	Principles of Diagnosis	7 hours

History, Physical Examination, Treatment, Differential Diagnosis, Tests and procedure (Clinical laboratory test, Tests using Radioisotopes, Endoscopy, Ultrasound, X-Ray, MRI, CT scan, PET scans, cytologic and Histologic examination of cells and tissue from patients).

Module:3	Host – Microorganism Interaction	6 hours

Microorganism entry, colonization, invasion, outcome, and Prevention of Disease. Microbial Virulence factors and pathogenicity Island. Epidemiology and investigation of recent pandemics (SARS). Antimicrobial resistance and Detection (MRSA/MDRTB).

Module:4	Transplantation	6 hours

Blood screening, cross matching, and transfusion. Histocompatibility Testing Methods – HLA typing (serology and Molecular method/ Cytotoxic (Cell-Based) Antibody Screening) stem cell culture – organ culture – artificial blood.

Module:5	Teratogenesis	5 hours

Teratology, Causes of congenital anomalies, surveillance, Cytogenetics Versus Teratology, Teratology Correlated with Chromosome Alteration, Carcinogen-Induced Point Mutations, Mutation, and Abnormal Development.

Module:6	Diagnostics	7 hours

Microbiological semi-automated and automated identification systems (Vitek system / The

phoenix system / BACTEC Blood culture system, BACTEC 460TB) Biosensors – as diagnostics. Detection and quantitation of antigen, Immuno-detection of antigen in cells and tissues. Molecular virology (PCR for diagnosis / Quantitative Realtime PCR for therapeutic protocols/detection of mutation and drug resistance).		
Module:7	**Medical Engineering and Therapeutics**	**7 hours**
Antibody (polyclonal & monoclonal) Engineering. Therapeutics such as vitamins, laxatives, analgesics, non – steroidal contraceptives, and biological hormones. Therapeutic proteins & enzymes– Vaccine development – gene therapy.		
Module:8	**Contemporary issues:** Lecture by experts	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Amanullah M (2012) Medical Biochemistry and Biotechnology LAP Lambert Academic Publishing
2.	Orlicki R, Cieńciala C, Krylova LP, Pielichowski J, and Zaikov GE (2013) Pharmaceutical and Medical Biotechnology: New Perspectives Nova publishers UK Ed.

Reference Books

1.	Wilson BA, Salyers AA (2011) Bacterial Pathogenesis: A molecular approach ASM Press, 3rd edition.
2.	Delves PJ, Martin SJ, Burton DR, Roitt IM (2011) Roitt's Essential Immunology Wiley-Blackwell 12th Edition
	Authors, book title, year of publication, edition number, press, place

Mode of Evaluation: Assignments, Continuous assessment tests and Final assessment test.

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017