Learning Outcomes Based Curriculum Framework

(With effect from 2020-21)

For

Dual Degree B.Sc. (Hons) Biotechnology-M.Sc. Biotechnology

BASED ON

CHOICE BASED CREDIT SYSTEM

Department of Bio and Nano Technology

Guru Jambheshwar University of Science & Technology,

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Learning Outcome based Curriculum Framework for Dual Degree B.Sc. (Hons) Biotechnology-M.Sc. (Biotechnology)

The National Biotechnology Development Strategy (2015 – 2020) and National Education Policy (2020) envisions a quality education system to produce graduates equipped with the knowledge, skills, attitudes and values that are required to lead a productive life and participate in the country's development process. Improving employability in this sector is heavily dependent on the overall curriculum of the educational programs. In view of the scientific advancements taking place globally in the field of biotechnology, it was highly desirable to update the current course accordingly and modify it based on the needs of both research and industry.

Learning outcome based approach to curriculum planning (LOCF) is a paradigm shift in the whole gamut of higher education such that it is based on first and foremost identifying the outcomes of the learning required for a particular subject of study, and then planning all components of higher education so as to achieve these outcomes. The learning outcomes-based course curriculum framework for Dual Degree B.Sc. (Hons) Biotechnology-M.Sc. (Biotechnology) is designed to persuade the subject specific knowledge as well as relevant understanding in the emerging areas of biotechnology. The curriculum envisions that the student, once graduate as specialists in biotechnology, may enter into job market as trained biotechnologist wherever required in the academia and industry.

Hallmark attributes of biotechnology graduate under the outcome-based teaching/ learning framework may encompass the following:

- **Preparation**: The curriculum is designed in such a way that in the first year the students are exposed to the fundamental aspects of physics, chemistry, mathematics and biology. Subsequently, they are made to learn basic subjects of botany, zoology, chemistry, biochemistry, microbiology, genetics followed by specialized aspects such as molecular biology, genetic engineering, immunology, genomics, animal biotechnology, plant biotechnology, and microbial biotechnology along with their practical applications.
- **Knowledge**: The students acquire strong theoretical background along with necessary skills and techniques in biological sciences and possess the ability to use these tools in industry, healthcare, community and institutes or other professions they wish to pursue.

- **Breadth**: Biotechnology assimilates in itself a number of disciplines. There is a great demand for biotechnologists in countless diversified industries and sectors such as, Agriculture, Animal Husbandry, Environmental Conservation, Ecology, Genetic Engineering, Healthcare, Medicine, Industrial Research and Development.
- **Professionalism**: The students who have acquired a graduate degree in biotechnology can easily find a suitable position in a number of industries engaged in processing and developing agricultural and biological products, bio-processing, pharmaceutics and biochemicals.
- **Evaluation**: Academic performance evaluation of a student comprises of Continuous Internal Evaluation (CIE) as well as Semester End Examination (SEE).

STRUCTURE / GUIDELINES FOR EXECUTION OF CURRICULUM

Dual Degree B.Sc. (Hons) Biotechnology-M.Sc. (Biotechnology) course would be of five years duration, divided into ten semesters. The contents have been drawn to accommodate the widening horizons of the biotechnology discipline. After successfully completing three year of course, student has the option to exit the program and will be awarded B.Sc. (Hons) Biotechnology degree. To meet the objectives of undergraduate program in Dual Degree B.Sc. (Hons) Biotechnology-M.Sc. (Biotechnology), Core Courses, Generic Elective Courses (Interdisciplinary courses), Elective Courses (Specializations from within Biotechnology and from allied disciplines), Skill Enhancement Courses and Ability Enhancement Compulsory Courses are envisaged. There will be broadly six categories of courses for Dual Degree B.Sc. (Hons) Biotechnology-M.Sc. (Biotechnology):

- The Core Courses are compulsory for a program and these include 19 theory courses of 4 Credits and 9 core courses of 2 credits assigned to the practical component. Thus, a candidate will have to pass 19 theory courses for earning 19 X 4 = 76 credits during the course. Likewise, for practical core courses candidates will have to pass 9 courses for earning 9 X 2=18 credits during this degree Programme. A total of 76 + 18 = 94 credits could be accumulated under these courses during the Honors degree program.
- The Elective Courses will be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/ subject/ domain or nurtures the candidate's proficiency / skill. The Elective

Courses will include: two Elective courses (2 credits); Seven Generic Elective Courses (Six of 4 credits and one of 2 credits); five Generic elective practical (2 Credits); Four Discipline Specific Elective (DSE) Courses (2 credits). Out of 12 DSE courses offered, a total of 4 courses will be opted by the candidates in 5^{th} and 6^{th} semester. These courses will be of 4 X 2 =8 credits each including 2 credits. These courses are discipline related and/ or interdisciplinary in nature.

- Ability Enhancement Compulsory Courses [AECC]: Ability Enhancement Courses are of two types; Ability Enhancement Compulsory Courses [AECC] and Skill Enhancement Courses [SEC]. The AECC courses are the mandatory courses based upon the content that leads to knowledge enhancement; I) English II) Environmental Science III) Hindi. All these are mandatory courses for obtaining degree in the subject of Biotechnology. A total of 3 X 2 = 06 credits could be accumulated under these courses during the Honors degree program. Skill Enhancement Elective (SEC) courses are value-based and/ or skill-based and are aimed at providing hands-on-training, competencies, skills etc. Two SEC courses (1st in III semester and 2nd in IV semester) for obtaining an Honors degree are selected amongst the total of six courses designed to provide value-based and/ or skill-based knowledge. The main purpose of these courses is to provide students life-skills in hands-on mode so as to increase their employability. A total of 2X 2 = 4 credits could be accumulated under SEC courses during the Honors degree program.
- One short educational trip will be planned to industry /research institutes in the 3^{rd} semester to aware the students on the importance of entrepreneurship for biotechnology specialists and to provide them with an entrepreneurial knowledge stock.
- Practical component has been included in every core subject offered during the programme. As biotechnology practical require individual attention for imparting correct and adequate hands – on training to the students, each practical batch would not have more than 20 students. The list of experiments to be performed has been provided alongside each of such courses. The marks (100 marks) for the practical examination will be split as follows:

S. No.	Type of Test		Marks
1	**External Evaluation**		**70**
	Major Test		20
	Performance of Practical		20
	Practical record/ notebook		10
	Viva voce		20
2	**Internal Assessment**		**30**
	A	Minor Test (Internal)	20
	B	Co-curricular Activities (Including Lab Manners and Discipline)	6
	C	Classroom Attendance Incentive	4

- A total of 100 marks have been allocated to each theory course. The distribution of marks will be as follows:

S. No.	Type of Test		Marks
1	**Major Test (External)**		**70**
2	**Internal Assessment**		**30**
	A	Minor Test (Internal)	20
	B	Co-curricular Activities (Including assignment)	6
	C	Classroom Attendance Incentive	4

- **Classroom Attendance Incentive**: The candidates who have greater than 65% attendance will be awarded Internal Assessment Marks as follows:

    a. 65% to 70 % = 1 Marks

    b. 71% to 75 % = 2 Marks

    c. 76% to 80 % = 3 Marks

    d. 81 % onwards = 4 Marks

- Each theory paper examination will be of 3 hours duration and practical examination will be of 4 hours duration.

Scheme of Examination for Dual Degree B.Sc. (Hons) Biotechnology-M.Sc. Biotechnology

Dual Degree B.Sc. (Hons) Biotechnology-M.Sc. (Biotechnology) Semester I

Paper Code	Course	Nomenclature	Credits	Hr/week	Marks		
					Ext.	Int.	Total
BXL-101	Ability Enhancement Compulsory Course-I	English	2	2	70	30	100
BXL-102	Ability Enhancement Compulsory Course-II	Environmental Science	2	2	70	30	100
BBL-102	Core Course-I	Biology-I (Cell and Cellular Processes)	4	4	70	30	100
BCL-101	Generic Elective-I	Chemistry I	4	4	70	30	100
BPL-101	Generic Elective-II	Physics-I Mechanics	4	4	70	30	100
BML-101/ BBL-101	Generic Elective-III	Elementary Mathematics-I / Elementary Biology-I (Fundamentals of Biology)	4	4	70	30	100
BBP-101	Core Course Practical-I	Biology Lab-I	2	4	70	30	100
BCP-101	Generic Elective Practical-I	Chemistry Lab-I	2	4	70	30	100
BPP-101	Generic Elective Practical-II	Physics Lab-I	2	4	70	30	100
Total			**26**	**32**	**630**	**270**	**900**

Dual Degree B.Sc. (Hons) Biotechnology-M.Sc. (Biotechnology) Semester II

Paper Code	Course	Nomenclature	Credits	Hr/week	Marks		
					Ext.	Int.	Total
BXL-201	Ability Enhancement Compulsory Course-III	Hindi	2	2	70	30	100
BML-201/ BBL-201	Generic Elective-IV	Elementary Mathematics-II / Elementary Biology-II (Cell Biology)	4	4	70	30	100
BBL-202	Core Course-II	Biology-II (General Biochemistry)	4	4	70	30	100
BPL-201	Generic Elective-V	Physics-II (Heat and Thermodynamics)	4	4	70	30	100
BCL-201	Generic Elective-VI	Chemistry-II	4	4	70	30	100
BXL-202	Generic Elective-VII	Computer Science	2	2	70	30	100
BCP-201	Generic Elective Practical-III	Chemistry Lab-II	2	4	70	30	100
BPP-201	Generic Elective Practical-IV	Physics Lab-II	2	4	70	30	100
BXP-201	Generic Elective Practical-V	Computer Science Lab I	2	4	70	30	100
Total			**26**	**32**	**630**	**270**	**900**

Dual Degree B.Sc. (Hons) Biotechnology-M.Sc. (Biotechnology) Semester III

Paper Code	Course	Nomenclature	Credits	Hr/week	Marks		
					Ext.	Int.	Total
BBL-301	Core Course-III	Mammalian Physiology	4	4	70	30	100
BBL-302	Core Course-IV	Plant Anatomy and Physiology	4	4	70	30	100
BBL-303/ BCL-301	Core Course-V	Inorganic Chemistry-I (Atomic Structure and Chemical Bonding)	4	4	70	30	100
BBL-304/ BCL-302	Core Course-VI	Organic Chemistry (Hydrocarbons)	4	4	70	30	100
BBL-305	Core Course-VII	Interactions with Entrepreneurs in Biotechnology and Start-ups	2	2	70	30	100
BBL-306 / BBL-307	Elective Course-I	Any one Elective Course (EC-I) out of proposed 02 courses (list attached below)	2	2	70	30	100
BBL-308/ BBL-309/ BBL-310	Skill Enhancement Course -I	Any one Skill Enhancement Course (SEC-I) out of proposed 03 courses (list attached below)	2	2	70	30	100
BBP-311	Core Course Practical –III	Animal and Plant Physiology - Lab III	2	4	70	30	100
BBP-312/ BCP-301	Core Course Practical –IV	Inorganic Chemistry - Lab IV	2	4	70	30	100
Total			**26**	**30**	**630**	**270**	**900**

Dual Degree B.Sc. (Hons) Biotechnology-M.Sc. (Biotechnology) Semester IV

Paper Code	Course	Nomenclature	Credits	Hr/week	Marks		
					Ext.	Int.	Total
BBL-401	Core Course VIII	Basic Microbiology	4	4	70	30	100
BBL-402	Core Course IX	Microbial Physiology and Metabolism	4	4	70	30	100
BBL-403/ BCL-401	Core Course X	Inorganic Chemistry-II (Periodic Properties of Elements)	4	4	70	30	100
BBL-404/ BCL-402	Core Course XI	Organic Chemistry II (Functional group Chemistry)	4	4	70	30	100
BBL-405/ BBL-406	Elective Course-II	Any one Elective Course (EC-II) out of proposed 02 courses (list attached below)	2	2	70	30	100
BBL-407 / BBL-408/ BBL-409	Skill Enhancement Course -II	Any one Skill Enhancement Course (SEC-II) out of proposed 03 courses (list attached below)	2	2	70	30	100
BBP-410/ BCP-402	Core Course Practical –V	Organic Chemistry-Lab V	2	4	70	30	100
BBP-411	Core Course Practical-VI	Microbiology - Lab VI	2	4	70	30	100
Total			**24**	**28**	**560**	**240**	**800**

Dual Degree B.Sc. (Hons) Biotechnology-M.Sc. (Biotechnology) Semester V

Paper Code	Course	Nomenclature	Credits	Hr/week	Marks		
					Ext.	Int.	Total
BBL-501	Core Course XII	Genetics	4	4	70	30	100
BBL-502	Core Course XIII	Developmental Biology	4	4	70	30	100
BBL-503/ BCL-501	Core Course XIV	Inorganic Chemistry-III (Coordination Chemistry)	4	4	70	30	100
BBL-504/ BCL 504	Core Course XV	Pharmaceutical Chemistry	4	4	70	30	100
BBL-505/ BBL-506/ BBL-507	Discipline Specific Elective -I	Any one Discipline Specific Elective (DSE-I) out of proposed 03 courses (list attached below)	2	2	70	30	100
BBL-508 / BBL-509/ BBL-510	Discipline Specific Elective -II	Any one Discipline Specific Elective (DSE-II) out of proposed 03 courses (list attached below)	2	2	70	30	100
BBP-511	Core Course Practical-VII	Genetics and Developmental Biology- Lab VII	2	4	70	30	100
BBP-512/ BCP-501	Core Course Practical-VIII	Inorganic Chemistry - Lab VIII	2	4	70	30	100
Total			**24**	**28**	**560**	**240**	**800**

Dual Degree B.Sc. (Hons) Biotechnology-M.Sc. (Biotechnology) Semester VI

Paper Code	Course	Nomenclature	Credits	Hr/week	Marks		
					Ext.	Int.	Total
BBL-601	Core Course XVI	Bioanalytical Tools	4	4	70	30	100
BBL-602	Core Course XVII	Recombinant DNA Technology	4	4	70	30	100
BBL-603	Core Course XVIII	Molecular Biology	4	4	70	30	100
BBL-604/ BCL-604	Core Course XIX	Polymer Chemistry	4	4	70	30	100
BBL-605/ BBL-606/ BBL-607	Discipline Specific Elective -III	Any one Discipline Specific Elective (DSE-III) out of proposed 03 courses (list attached below)	2	2	70	30	100
BBL-608 / BBL-609 / BBL-610	Discipline Specific Elective -IV	Any one Discipline Specific Elective (DSE-IV) out of proposed 03 courses (list attached below)	2	2	70	30	100
BBP-611	Core Course Practical-IX	Plant Biotechnology - Lab IX	2	4	70	30	100
BBP-612/ BCP-601	Core Course Practical-X	Inorganic Chemistry- Lab X	2	4	70	30	100
Total			**24**	**28**	**560**	**240**	**800**

C- Core Course, EC- Elective Course, AECC-Ability Enhancement Compulsory Course, SEC- Skill Enhancement Course, DSE- Discipline Specific Elective

Elective Course (EC): Choose any one from each group in Semester III & IV

Semester III			Semester IV		
EC-I	BBL-306	Plant Cell, Tissue and Organ Culture	EC-II	BBL-405	DNA Barcoding
	BBL-307	Economic Botany		BBL-406	Evolutionary Biology

Skill Enhancement Course (SEC): Choose any one from each group in Semester III & IV

Semester III			Semester IV		
SEC -I	BBL-308	Agri-Biotechnology Products	SEC-II	BBL-407	Mushroom Cultivation and Trading
	BBL-309	Basics of Forensic Science		BBL-408	Herbal Technology
	BBL-310	Any one MOOC through SWAYAM/NPTEL		BBL-409	Clinical Biochemistry

Discipline Specific Elective (DSE): Choose any two per semester one from each group in Semester V & VI

Semester V			Semester VI		
DSE-I	BBL-505	Plant Diversity	DSE-III	BBL-605	Animal Diversity
	BBL-506	Plant Biotechnology		BBL-606	Animal Biotechnology
	BBL-507	Plant Breeding		BBL-607	Immunology
DSE-II	BBL-508	Bioinformatics	DSE-IV	BBL-608	Food Biotechnology
	BBL-509	Biostatistics		BBL-609	Medical Microbiology
	BBL-510	Genomics and Proteomics		BBL-610	Industrial Biotechnology

Note:

i) Students who have studied Mathematics at 10+1 and 10+2 level shall opt Elementary Biology-I (Paper code: BBL-101) & Mathematics-I (BML-102) and those who have studied Biology shall opt Elementary Mathematics -I (BML-101) & Biology -I (BBL-102) in 1st semester.

ii) Semester-I & II will be common for all the four Dual Degree Programmes.

Ability Enhancement Compulsory Course-I	
BXL -101: English	**Credits: 2+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are: - ***1. To educate students in both the artistry and utility of the English language through the study of literature and other contemporary forms of culture.*** ***2. To provide students with the critical faculties necessary in an academic environment, on the job, and in an increasingly complex, interdependent world.*** ***3. To graduate students who are capable of performing research, analysis, and criticism of literary and cultural texts from different historical lectures and genres.***	***After successful completion of this course, students should be able to: -*** ***1. Be familiar with representative literary and cultural texts within a significant number of historical, geographical, and cultural contexts.*** ***2. Write analytically in a variety of formats, including essays, research papers, reflective writing, and critical reviews of secondary sources.*** ***3. Ethically gather, understand, evaluate, and synthesize information from a variety of written and electronic sources.*** ***4. Be proficient in oral communication and writing.***

UNIT-I **[7 Lectures]**

Syntax: Sentence structures, Verb patterns and their usage.

UNIT-II **[8 Lectures]**

Phonetics: Basic Concepts – Vowels, Consonants, Phonemes, Syllables; Articulation of Speech Sounds – Place and Manner of Articulation; Transcription of words and simple sentences, using International Phonetic Alphabet.

UNIT-III **[7 Lectures]**

Comprehension: Listening and Reading comprehension – Note taking, Reviewing, Summarising, Interpreting, Paraphrasing and Précis Writing.

UNIT-IV **[8 Lectures]**

Composition: Descriptive, Explanatory, Analytical and Argumentative Writing - description of simple objects like instruments, appliances, places, persons, principles; description and explanation of processes and operations; analysis and arguments in the form of debate and group discussion.

Recommended Textbooks and References:

1. *Roy A. & Sharma P.L. English for Students of Science, Orient Longman.1996*
2. *R.K. Bansal and J.B. Harrison, Spoken English for India, Orient Longman.1988*
3. *Tickoo M.L. & Subramanian A.E. Intermediate Grammar, Usage and Composition, Orient Longman.1976*
4. *Pink M.A. & Thomas S.E. English Grammar, Composition and Correspondence, S. Chand and Sons Pvt. Ltd., Delhi.*
5. *Thomson & Martinet A Practical English Grammar, OUP, Delhi.1997*
6. *Hornby A.S Guide to Patterns and Usage in English, OUP, Delhi.1997*
7. *Balasubramanian T. A Textbook of English Phonetics for Indian Students, MacMillan, Chennai.2012*

8. *O'Connor J.D. Better English Pronunciation, Cambridge Univ. Press, London.1998*
9. *McCarthy English Vocabulary in Use, Foundation Books (Cambridge University Press), Delhi.2017*
10. *Buck G. , Assessing Listening, Foundation Books (Cambridge University Press), Delhi.2002*

Ability Enhancement Compulsory Course-II	
BXL- 102: Environmental Science	**Credits: 2+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are: - ***1. To provide students with a broad interdisciplinary liberal arts framework for understanding the relationship between humans and environment.*** ***2. To provide students with informed perspectives on biological and physical processes relevant to environmental problems, to help students understand responsible environmental policy and practice, and to engage students in ethical reflection regarding environmental problems in local, regional, national, and global communities.***	***After successful completion of this course, students should be able to: -*** ***1. Gain in-depth knowledge on natural processes that sustain life, and govern economy.*** ***2. Develop critical thinking for shaping strategies (scientific, social, economic and legal) for environmental protection and conservation of biodiversity, social equity and sustainable development.*** ***3. Develop knowledge base covering all attributes of the environment and enable them to attain scientific/technological capabilities to find answers to the fundamental questions before the society with regards to human action and environmental effects with due diligence***

UNIT-I **[8 Lectures]**

The Multidisciplinary Nature of Environmental Studies: Definition, scope and importance, Need for public awareness. Natural resources: Renewable and non-renewable resources. Natural resources and associated problems. Forest resources: Use and over-exploitation, de-forestation. Water resources: Use and over-utilization of surface and ground water, floods and drought. Mineral resources: Use and exploitation, environmental effects of extruding.

Food resources: World food problems, changes caused by agriculture, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity.

Energy Resources: Growing energy needs, renewable and non-renewable energy sources use of alternative energy sources.

Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification

UNIT-II **[7 Lectures]**

Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem, Procedures, consumers and decomposers, Energy flow in the ecosystem, Ecological succession & Food chains, food webs and ecological pyramids.

Biodiversity and its conservation: Introduction – Definition: genetic, species and ecosystem diversity, Biogeographical classification of India, Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, National and local levels, India as a mega-diversity nation.

UNIT-III **[7 Lectures]**

Environmental Pollution: Definition, Causes, effects and control measures of: - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution & Nuclear hazards. Solid waste Management: Causes, effects and control measures of urban and industrial wastes.

UNIT-IV **[8 Lectures]**

Social Issues and the Environment: From Unsustainable to sustainable development, urban problems related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, Wasteland reclamation, Consumerism and waste products, environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environment legislation & Public awareness.

Recommended Textbooks and References:

1. *De, A.K. Environmental chemistry. New Age International. New Delhi. 2003.*
2. *Bharucha, E. Textbook of Environmental Studies for Undergraduate Courses. Universities Press, Hyderabad. 2005.*
3. *Cunningham, W.P., Cooper, T.H., Gorhani, E., & Hepworth, M.T. Environmental Encyclopedia. Jaico Publ. House, Mumbai. 2001.*
4. *Spellman, F.R. Environmental science and technology: concepts and applications. Bernan Press. 2017.*

CORE COURSE- I	
BBL- 102: BIOLOGY-I (Cell and Cellular Processes)	**(Credits: 4+0)**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are: - ***1. To familiarize the students with an overview of prokaryotic and eukaryotic cell and its inner components.*** ***2. To provide knowledge of processes of cell transport across membrane, protein synthesis, processing, trafficking and cell signalling***	***After successful completion of this course, students should be able to: -*** ***1. Understand the cell and cell organelles, cell membrane and transport across the membrane, cell division.*** ***2. Gain a brief overview of cell signalling, signal transduction, cell communication and carcinogenesis.***

UNIT-I **[15 Lectures]**

Overview of Cells: Prokaryotic and eukaryotic cells, Virus, Viroids, Mycoplasma, Prions.

Plasma Membrane: Various models of plasma membrane, Transport across membranes: Active and Passive transport, Facilitated transport. Cell-Cell Junctions: Tight junctions, Adhesive junctions, Gap junctions.

Cytoskeleton: Structure and functions of microtubules, microfilaments and Intermediate filaments.

UNIT-II **[15 Lectures]**

Endomembrane System: Structure and Functions: Endoplasmic Reticulum, Golgi apparatus, Lysosomes, Peroxisomes. Signal Hypothesis, Vesicular transport from ER to Golgi apparatus, Protein sorting and transport from Golgi apparatus.

UNIT-III **[15 Lectures]**

Mitochondria and Chloroplast: Mitochondria: Structure and Function, Endosymbiotic hypothesis. Chloroplast: Structure, function and composition; Chloroplast DNA, Semiautonomous nature of mitochondria and chloroplast.

Nucleus: Structure of Nucleus: Transport of molecules across nuclear membrane, Chromatin: euchromatin and heterochromatin and packaging (nucleosome). Nucleolus and ribosome formation.

UNIT-IV **[15 Lectures]**

Cell Division: Mitosis, Meiosis, Cell cycle and its regulation

Cell Signaling: Cell Signaling through GPCR and Role of secondary messenger: cAMP and Protein Kinase.

Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

Recommended Textbooks and References:

1. *Karp, G., Iwasa, J. & Marshall, W. Karp's Cell and Molecular Biology (9th Ed.). John Wiley & Sons. 2020.*
2. *Alberts, B., Johnson, A.D., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. Molecular Biology of the cell (6th Ed.). Garland Science. 2014.*
3. *Cooper, G.M. The Cell: A Molecular Approach (8th Ed.) Oxford University Press. 2018.*
4. *Becker, W. M., Kleinsmith, L. J., Hardin. J. & Bertoni, G. P. The World of the Cell (8th Ed.). Pearson Benjamin Cummings Publishing, San Francisco. 2016.*
5. *Campbell, N.A. and Reece, J. B. Biology (12th Ed.). Pearson Benjamin Cummings, San Francisco. 2020.*

Generic Elective-I	
BCL-101: Chemistry-I	**Credits: 4+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are to familiarize students about thermodynamic concepts, properties of thermodynamic systems, laws of thermodynamics, basic concepts of conductance and electrochemistry, fundamentals of organic chemistry, basics of stereochemistry and biomolecules.	***After successful completion of this course, students should be able to: -*** ***1. Understand the laws of thermodynamics, concept of state and path functions, extensive and intensive properties, derivation for the expression of ΔU, ΔH, ΔS, ΔG, ΔA for ideal gases under different conditions.*** ***2. Understand conductance, electrochemistry, fundamentals of electronic displacements, reactive intermediates, basics of stereochemistry and biomolecules.***

UNIT-I **[15 Lectures]**

Chemical Thermodynamics: Objectives and limitations of Chemical Thermodynamics, state functions, thermodynamic equilibrium, work, heat, internal energy, enthalpy. First Law of Thermodynamics: First law of thermodynamics for open, closed and isolated systems. Reversible isothermal and adiabatic expansion/compression of an ideal gas. Irreversible isothermal and adiabatic expansion. Enthalpy change and its measurement, standard heats of formation and absolute enthalpies. Kirchoff's equation.

Second and Third Law: Various statements of the second law of thermodynamics. Efficiency of a cyclic process (Carnot's cycle). Entropy: Entropy changes of an ideal gas with changes in P,V, and T. Free energy and work functions. Gibbs-Helmholtz Equation, Criteria of spontaneity in terms of changes in free energy. Introduction to Third law of thermodynamics.

UNIT-II **[15 Lecture]**

Conductance and Electrochemistry: Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance to measure degree of dissociation of weak electrolytes.

Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, application of electrolysis in metallurgy and industry. Chemical cells with examples; Standard electrode (reduction) potential.

UNIT-III **[15 Lectures]**

Fundamentals of Organic Chemistry: Electronic Displacements**:** Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure,

shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values.

UNIT-IV [15 Lecture]

Stereochemistry: Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (up to two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; *cis–trans* nomenclature; CIP Rules: R/ S (for up to 2 chiral carbon atoms) and E / Z Nomenclature (for up to two C=C systems).

Chemistry of Biomolecules: Occurrence, classification of Carbohydrates. Amino acids, peptides and their classification. α-Amino Acids. Zwitterions, pK_a values, isoelectric point, components of nucleic acids, nucleosides and nucleotides.

Recommended Textbooks and References:

1. *Atkins, P.W. & Paula, J. Physical Chemistry (10th Ed.). Oxford University Press, 2014.*
2. *Castellan, G.W., Physical Chemistry, Narosa Publishers.2004*
3. *Morrison, R.N. & Boyd, R.N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).2010*
4. *Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).2002*
5. *Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).2002*
6. *Eliel, E.L. & Wilen, S.H. Stereochemistry of Organic Compounds, Wiley: London, 1994.*
7. *Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.*
8. *McMurry, J.E. Fundamentals of Organic Chemistry (7th Ed.) Cengage Learning India Edition, 2013.*

Generic Elective-II	
BPL-101: PHYSICS-I (Mechanics)	**Credits: 4+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objective of this course is to teach the students fundamentals and applications of Newtonian mechanics, rigid body dynamics, concept of inverse square force and the special theory of relativity.	***After successful completion of this course, students should be able to: -*** ***1. Understand the behaviours of dynamical systems, different forces contributing towards equilibrium of systems, and applications of conservation laws to problems of physical world.*** ***2. Learn about global positioning systems, satellites & Geosynchronous orbits*** ***3. Understand the physical significance of massless particles, relativistic kinematics, and time dilation in the realm of special theory of relativity.***

UNIT – I [15 Lectures]

Fundamentals of Dynamics: Reference frames, Inertial and non-inertial frames of references, Conservative and non-conservative forces, Fictitious forces, Concept of potential energy, Energy diagram. Stable and unstable equilibrium, Elastic potential energy, Force as gradient of potential energy, Work & Potential energy, Impulse, Centre of Mass for a system of particles, Motion of centre of mass (discrete and continuous), Expression for kinetic energy, Linear momentum and angular momentum for a system of particles in terms of centre of mass values.

Collisions: Elastic and inelastic collisions between particles, Centre of Mass and Laboratory frames.

UNIT - II [15 Lectures]

Rotational Dynamics: Equation of motion of a rigid body, Rotational motion of a rigid body in general and that of plane lamina, Rotation of angular momentum vector about a fixed axis, Angular momentum and kinetic energy of a rigid body about principal axis, Torque, Principle of conservation of angular momentum, Moment of Inertia (discrete and continuous), Calculation of moment of inertia for rectangular, cylindrical and spherical bodies, Kinetic energy of rotation, Motion involving both translation and rotation, elementary GYROSCOPE.

UNIT – III [15 Lectures]

Inverse Square Law Force: Forces in nature (qualitative), Central forces, Law of gravitation, Gravitational potential energy, Inertial and gravitational mass, Potential energy and force between a point mass and spherical shell, a point mass and solid sphere, gravitational and electrostatic self-energy, two body problem and concept of reduced mass, Motion of a body under central force, Equation of orbit in inverse-square force field, satellite in Circular orbit & Geosynchronous orbits, Basic idea of GPS (Global Positioning System).

UNIT – IV **[15 Lectures]**

Special Theory of Relativity: Michelson-Morley Experiment and its outcome, Galilean transformation (velocity, acceleration)and its inadequacy, Postulates of Special Theory of Relativity, Lorentz Transformations, simultaneity, Lorentz contraction, Time dilation, Relativistic transformation of velocity, frequency and wave number, Relativistic addition of velocities, Variation of mass with velocity, Massless Particles, Mass-energy Equivalence, Relativistic Doppler effect, Relativistic Kinematics (decay, inelastic collision, Compton effect), Transformation of Energy, Momentum and force, Four Vectors.

Recommended Textbooks and References:

1. *Kleppner, D. & Kolenkow, R.J. An introduction to Mechanics. McGraw-Hill. 2007.*
2. *Mathur, D.S. Mechanics. S. Chand and Company Limited, 2012.*
3. *Resnick, R. Introduction to Special Relativity. John Wiley and Sons. 2005.*
4. *Seers, F.W., Zemansky, M.W. & Young, H.D. University Physic. Addison-Wesley Pub. Co.2015*
5. *Halliday, & Walker. Fundamentals of Physics. Resnick John Wiley & Sons, Inc. 2018*

Generic Elective-III	
BML-101: Elementary Mathematics-I	**Credits: 4+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are: - ***1. To familiarize the prospective biotechnologists with techniques of basic mathematics*** ***2. To equip the students with basic concepts of mathematics which they would find useful in their disciplines***	***After successful completion of this course, students will learn: -*** ***1. Basic operations on sets, sequences and series.*** ***2. About straight lines and trigonometrical results.*** ***3. About counting techniques and binomial expansions.*** ***4. Basic applications of probability and linear programming.***

UNIT – I **[15 Lectures]**

Sets, Relations and Functions: Sets and their Representations, The Empty Set, Finite and Infinite Sets, Equal Sets, Subsets, Universal Set, Venn Diagrams, Operations on Sets, Complement of a Set, Practical Problems on Union and Intersection of Two Sets, Cartesian Product of Sets, Relations, Functions.

Sequences and Series: Sequences, Series, Arithmetic Progression (A.P.), Geometric Progression (G.P.), Relationship Between A.M. and G.M.

UNIT – II **[15 Lectures]**

Straight Lines: Introduction, Slope of a Line, Various Forms of the Equation of a Line, General Equation of a Line, Distance of a Point from a Line.

Trigonometric Functions: Angles, Trigonometric Functions, Trigonometric Functions of Sum and Difference of Two Angles, Trigonometric Equations.

UNIT – III **[15 Lectures]**

Permutations and Combinations: Fundamental Principle of Counting, Permutations, Combinations.

Binomial Theorem: Introduction, Binomial Theorem for Positive Integral Indices, General and Middle Terms.

UNIT – IV **[15 Lectures]**

Linear Inequalities: Inequalities, Algebraic Solutions of Linear Inequalities in One Variable and their Graphical Representation, Graphical Solution of Linear Inequalities in Two Variables, Solution of System of Linear Inequalities in Two Variables.

Probability: Introduction, Random Experiments, Event, Axiomatic Approach to Probability, Addition Theorems on Probability, Conditional Probability, Multiplicative Law of Probability.

Recommended Textbooks and References:

1. *Mathematics Text Book for Class XI, National Council of Educational Research and Training.2020*
2. *Verma, R.S. & Sukla, K.S. Text Book on Trigonometry, Pothishala Pvt. Ltd, Allahabad.1999*
3. *Gupta, S.C. & Kapoor, V.K. Fundamentals of Mathematical Statistics, S. Chand & Sons.2002*
4. *Ivo Duntsch and Gunther Gediga, Set, Relations, Functions, Methodos Publishers.2000*

Generic Elective-III	
BBL- 101: Fundamentals of Biology	**Credits: 4+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are to sensitize the students to the fact that as we go down the scale of magnitude from cells to organelles to molecules, the understanding of various biological processes. The course shall make the students aware of various theories of origin of life and evolution	***After successful completion of this course, students should be able to: -*** ***1. Learn about biomolecule, prokaryotic and eukaryotic cell and cell organelles, cell membrane and transport across the membrane, cell division*** ***2. Understand origin of life and various theories of evolution and documentary evidence***

UNIT-I [15 Lectures]

Molecules of Life: pH and Buffers in Biology. Chemistry of water. Chemical Bonding and various types of bonds, Carbohydrate: Sugars and polysaccharides. Lipids: Fat, phospholipids and steroids. Proteins: polypeptides, protein confirmation and function. Nucleic acids as information molecules. DNA and RNA.

UNIT-II [15 Lectures]

Cell Structure and Cell Processes: Prokaryotic cells and eukaryotic cells Organelles of eukaryotic cell: Nucleus, endoplasmic reticulum, Golgi apparatus, vesicles, peroxisomes, Mitochondria and Plastid. The evolution of eukaryotic organelles.

UNIT-III [15 Lectures]

Membranes as Fluid Layers of Lipid: The phospholipids bilayer. The fluid mosaic model. Model Membranes Membrane proteins. Passive transport across membranes: Diffusion, facilitated diffusion, Osmosis. Active transport

UNIT-IV [15 Lectures]

Origin of Life and Evolution: Different theories of origin of life, Experimental evidences supporting different theories. Lamarck, Darwinism and other theories of evolution, Documentary evidences supporting different evolution theories.

Recommended Textbooks and References:

1. *Campbell, N.A. & Reece, J. B. Biology (12th Ed.). Pearson Benjamin Cummings, San Francisco. 2020.*
2. *Raven, P., Johnson, G., Mason, K., Losos, J. & Duncan, T. Biology (12th Ed.) Tata McGraw Hill Publications, New York. US. 2020.*

Core Course Practical	
BBP- 101: Biology - Lab I	**Credits: 0+2**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**4 H**

Course Objectives	Student Learning Outcomes
The objectives of this laboratory course are to develop an understanding about structural aspects of prokaryotic and eukaryotic cell and its inner components. ***It will also insight into the anatomy of stem, leaf and root***	***After successful completion of this course, students should be able to: -*** ***1. Perform fixation, staining and visualize various stages of cell division*** ***2. To analyse the anatomy of stem, root and leaf*** ***3. To understand the structure of eukaryotic and prokaryotic cell***

List of Experiments:

1. To learn a) use of microscope b) principles of fixation and staining.
2. Preparation of Normal, molar and standard solutions, phosphate buffers, serial dilutions
3. Use of micropipettes
4. Measurement of cell size by cytometry
5. To perform gram staining of bacteria.
6. To study the cytochemical distribution of nucleic acids and mucopolysaccharides with in cells/tissues from permanent slides.
7. To study of plasmolysis and deplasmolysis of *Rhoeo* leaf.
8. To study prokaryotic cells, Bacteria/fungi and eukaryotic cells.
9. To prepare squash from root tip of *Allium cepa* and study various stages of mitosis.
10. To prepare the slide and study for various stages of meiosis.
11. To identify the blood cell types in human blood smear.
12. To prepare Buccal smear for Identification of Barr Body.
13. To prepare microscope slide for dicot leaf section.
14. To prepare permanent slide of plant stem/root/leaf.
15. Preparation of nuclear, mitochondrial & cytoplasmic fractions.

Recommended Textbooks and References:

1. *Karp, G., Iwasa, J. & Marshall, W. Karp's Cell and Molecular Biology (9th Ed.). John Wiley & Sons. 2020.*
2. *De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology (8th Ed.). Lippincott Williams and Wilkins, Philadelphia. 2017.*
3. *Cooper, G. M. The Cell: A Molecular Approach (8th Ed.). Oxford University Press. ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA. 2018.*
4. *Becker, W. M., Kleinsmith, L. J., Hardin. J. & Bertoni, G. P. The World of the Cell (8th Ed.). Pearson Benjamin Cummings Publishing, San Francisco. 2016.*
5. *Campbell, N.A. and Reece, J. B. Biology (12th Ed.). Pearson Benjamin Cummings, San Francisco. 2020.*
6. *Raven, P., Johnson, G., Mason, K., Losos., J. & Duncan, T. Biology (12th Ed.) Tata McGraw Hill Publications, New York. US. 2020.*
7. *Griffiths, A.J.F., Doebley, J., & Peichel, C. An Introduction to Genetic Analysis (12th Ed.). W.H. Freeman & Co. NY. 2020*
8. *Choinski J.S. Dimaculangan, D. and Barwick J.* Molecular and Cell Biology Laboratory Manual. Indo-American Books. 2005

Generic Elective Practical- I	
BCP- 101: Chemistry Lab-I	**Credits: 0+2**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**4 H**

Course Objectives	Student Learning Outcomes
The objectives of this course are to train the students to prepare standard chemical solutions, redox and iodometric titrations, to determine surface tension and viscosity of given liquids and purification methods for organic compounds.	***After successful completion of this course, students should be able to: -*** ***1. Perform redox and iodometric titrations*** ***2. Determine surface tension and viscosity of given liquids*** ***3. Purify given organic compounds using distillation, sublimation and recrystallization.***

List of Experiments:

1. Preparation of reference solutions.
2. Redox titrations: Determination of Fe^{2+}, $C_2O_4^{2-}$(using $KMnO_4$, $K_2Cr_2O_7$)
3. Iodometric titrations: Determination of Cu^{2+} (using standard hypo solution).
4. To determine the surface tension of at least two liquids using stalagmometer by drop number and drop weight methods (Use of organic solvents excluded).
5. To study the effect of surfactant on surface tension of water.
6. To determine the viscosity of at least two liquids by using Ostwald's viscometer (use of organic solvents excluded).
7. To study the process of (i) sublimation (ii) Crystallization of camphor and phthalic acid
8. Preparation and purification through crystallization or distillation and ascertaining their purity through melting point or boiling point
   i. Iodoform from ethanol (or acetone)
   ii. p-Bromo acetanilide from acetanilide

Recommended Textbooks and References:

1. *Vogel, A. I., Tatchell A.R., Furnis B.S., Hannaford A.J., Smith P.W.G. Vogel's Text Book of Practical Organic Chemistry (5th Ed.) ,Pubs: ELBS. 1989.*
2. *Pavia D.L., Lampanana G.M. & Kriz G.S. Jr., Introduction to Organic Laboratory Techniques (3rd Ed.). Pubs: Thomson Brooks/Cole. 2005.*
3. *Mann F.G. & Saunders. P.C. Practical Organic Chemistry. Pubs: Green & Co. Ltd., London, 1978.*
4. *Svehla, G., Vogel's Qualitative Inorganic Analysis (revised) (7th Ed.) Pubs: Orient Longman, 1996.*
5. *Bassett, J., Denney, R.C., Jeffery, G.H. & Mendham, J., Vogel's Textbook of Quantitative Inorganic Analysis (revised) (4th Ed.) Pubs: Orient Longman, 1978.*
6. *Yadav J. B., Advanced Practical physical Chemistry.2015*

Generic Elective Practical- II	
BPP- 101: Physics Lab-I	**Credits: 0+2**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Course Objectives	Student Learning Outcomes
The objective of the course is to practically teach the methods for measuring lengths at various length scales and observing random errors, determination of g- value using Bar Pendulum, determination of the height of a building using a Sextant, determination of the Moment of Inertia of a Flywheel, etc.	***After successful completion of this course, students should be able to: -*** ***1. Use the calipers, screw gauge and travelling microscope for measuring lengths*** ***2. Use Sextant for measurement of physical sizes of distant objects*** ***3. Understand dynamics of Flywheel and its applications*** ***4. Learn simple harmonic motion***

List of Experiments:

1. Measurements of length (or diameter) using vernier calliper, screw gauge and travelling microscope.
2. To study the random error in observations.
3. To determine the height of a building using a Sextant.
4. To study the Motion of Spring and calculate (a) Spring constant, (b) **g** and (c) Modulus of rigidity.
5. To determine the Moment of Inertia of a Flywheel.
6. To determine g and velocity for a freely falling body using Digital Timing Technique
7. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
8. To determine the Young's Modulus of a Wire by Optical Lever Method.
9. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
10. To determine the elastic Constants of a wire by Searle's method.
11. To determine the value of g using Bar Pendulum.
12. To determine the value of g using Kater's Pendulum.

Recommended Textbooks and References:

1. *Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop,, Asia Publishing House. 1971*
2. *Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition reprinted, Heinemann Educational Publishers.1985*
3. *A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Edn, , KitabMahal.2011*
4. *Engineering Practical Physics, S. Panigrahi& B.Mallick, Cengage Learning India Pvt. Ltd.2015*
5. *Practical Physics, G.L. Squires, 4th Edition, Cambridge University Press.2015*

Ability Enhancement Compulsory Course -III	
BXL-201: हिन्दी	**Credits: 2+0**

परीक्षा अंक	**70**
आंतरिक मूल्याकंन	**30**
कुल अंक	**100**
समय	**3 घण्टे**

परीक्षा सम्बन्धी निर्देश:- सभी प्रश्न अनिवार्य हैं।

1. खण्ड (क) में निर्धारित पाठ्यपुस्तक में से व्याख्या के लिए चार अवतरण पूछे जाएँगे, जिनमें से परीक्षार्थी को किन्हीं दो की सप्रसंग व्याख्या करनी होगी। प्रत्येक व्याख्या 6 अंक की होगी। पूरा प्रश्न 12 अंक का होगा।

2. खण्ड (क) में निर्धारित कवियों में से किन्ही दो कवियों के साहित्यिक परिचय पूछे जाएँगे, जिनमें से किसी एक कवि का साहित्यिक परिचय लिखना होगा। यह प्रश्न 8 अंक का होगा।

3. खण्ड (क) में पाठ्यपुस्तक से निर्धारित आलोचनात्मक प्रश्नों में से दो प्रश्न पूछे जाएँगे ,जिनमें से परीक्षार्थी को एक प्रश्न का उत्तर देना होगा। *यह प्रश्न 10 अंक का होगा।*

4. खण्ड(ख) में निर्धारित आलोचनात्मक प्रश्नों में से दो प्रश्न पूछे जाएँगे, जिनमें से किसी एक का उत्तर देना होगा। यह प्रश्न 10 अंक का होगा।

5. खण्ड(ख) से 12 अति लघूत्तरात्मक प्रश्न पूछे जाँएगे। प्रत्येक प्रश्न एक-एक अंक का होगा। पूरा प्रश्न 12 अंक का होगा।

6.खण्ड (ग) में निर्धारित अलंकारों में से दो अलंकार पूछे जाएँगे, जिनमें से एक अलंकार उदाहरणो सहित लिखना होगा। जो 8 अंक का होगा।

7. खण्ड (घ) से दस मुहावरों और लोकोक्तियों में से किन्ही पाँच मुहावरों का अर्थ एंव वाक्य प्रयोग लिखना होगा। जो 10 अंक का होगा।

पाठ्यक्रम के उद्देश्य –	***पाठ्यक्रम के अपेक्षित परिणाम-***
हिन्दी भाषा व भक्तिकालीन साहित्य की जानकारी प्रदान करना।	*1. भक्तिकालीन कविता का बोध होगा। हिंदी भाषा के ज्ञान के माध्यम से भाषा के सैद्धांतिक पहलुओं तथा उसके परिवर्तन की दिशाओं का बोध होगा।* *2. हिंदी साहित्य के भक्तिकाल की विभिन्न धाराओं व परंपराओं की समझ विकसित होगी। विभिन्न धाराओं व रचनाकारों के साहित्य की विशिष्टताओं की समझ बढ़ेगी।* *3. साहित्य के सौंदर्य, कला तथा वैचारिक मूल्यों के प्रति विवेक का निर्माण होगा। विद्यार्थी व्यावहारिक जीवन में हिंदी भाषा का सही प्रयोग कर सकेंगे। मध्यकालीन भाषा व अभिव्यक्ति के विभिन्न रूपों की पहचान होगी।*

	4. *भारत की समृद्ध सांस्कृतिक परंपरा का ज्ञान महापुरुषों की वाणियों के माध्यम से होगा तथा विद्यार्थियों का आध्यात्मिक व नैतिक विकास होगा।*

खण्ड (क)

निर्धारित कवि- 1 कबीरदास 2 सूरदास 3 मीराबाई 4 रसखान

खण्ड (ख)

हिन्दी साहित्य का इतिहास भक्तिकालः पाठ्यक्रम में निर्धारित आलोचनात्मक प्रश्न- 1. सन्तकाव्य की प्रवृत्तियाँ 2. सूफी काव्य की प्रवृत्तियाँ 3. कृष्ण काव्य की प्रवृत्तियाँ 4. राम काव्य की प्रवृत्तियाँ 5. भक्तिकाल काः स्वर्णयुग

खण्ड (ग)

अलंकार-अनुप्रास, श्लेष, यमक, उपमा, रूपक, अतिशयोक्ति, मानवीकरण, अन्योक्ति व समासोक्ति आदि।

खण्ड (घ)

मुहावरे एवं लोकोक्तियाँ।

अनुशंसित पाठ्यपुस्तकें और संदर्भ-

खण्ड(क) के लिए निर्धारित पाठ्यपुस्तक-

1. *मध्यकालीन काव्य-कुंज : सं. डॉ रामसजन पाण्डेय प्रकाशनः खाटूश्याम प्रकाशन, 1276/5 पीर जी मोहल्ला,प्रताप टाकीज, रोहतक।*
2. *हिन्दी साहित्य का इतिहास- रामचन्द्र शुक्ल*
3. *मध्यकालीन बोध और साहित्यः- हजारी प्रसाद द्विवेदी*
4. *तुलसीदास और उनका युग- डॉ. रामविलास शर्मा*
5. *कबीर एक नई दृष्टि- रघुवंश*
6. *कबीर के आलोचक- डॉ. धर्मवीर*
7. *कबीर- गोविन्द त्रिगुणायत*
8. *कबीर- हजारी प्रसाद द्विवेदी*
9. *मीराबाई- परशुराम चतुर्वेदी*
10. *हिन्दी व्याकरण: कामता प्रसाद गुरु*
11. *सामान्य हिन्दी: हरदेव बाहरी*

Generic Elective –IV	
BML-201: Elementary Mathematics-II	**Credits: 4+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objective	Student Learning Outcomes
The objective of this course is to train the students with fundamental elements of mathematics which they would find useful in biological studies / research	***After successful completion of this course, students will learn: -*** ***1. Matrices and their properties.*** ***2. About differentiation and integration to solve the linear equation.*** ***3. About construction and solutions of ordinary differential equations.*** ***4. About construction and solution of partial differential equations and basic about vectors.***

UNIT-I **[15 Lectures]**

Matrix Algebra: Introduction, types of matrices, addition and multiplication of matrix, transpose of matrix, concept of elementary row and column operations. Determinant and its properties, minors, cofactors. Application of determinants in finding area of triangle. Adjoint and inverse of square matrix. Solution of homogeneous and non-homogeneous linear equations and condition for solution.

UNIT-II **[15 Lectures]**

Differential Calculus: Differentiation of standard functions including function of afunction (Chain rule). Differentiation of implicit functions, logarithmic differentiation, parametric differentiation, elements of successive differentiation.

Integral Calculus: Integration as inverse of differentiation, indefinite integrals of standard forms, integration by parts, partial fractions and substitution. Formal evaluation of definite integrals.

UNIT-III **[15 Lectures]**

Ordinary Differential Equations: Definition and formation of ordinary differential equations, equations of first order and first degree, variable separable, homogeneous equations, linear equations (Leibnitz form) and differential equations reducible to these types, Linear differential equation of order greater than one with constant coefficients, complementary function and particular integrals.

UNIT-IV **[15 Lectures]**

Partial Differential Equations: Introduction and formation of P.D.E., solution of P.D.E., linear equation of first order (Lagrange's Equation), Non-Linear Equation of first order.

Vector Calculus: Differentiation of vectors, scalar and vector point functions, gradient of scalar field and directional derivative, divergence and curl of vector field and their physical interpretation.

Recommended Textbooks and References:

1. *Shanti Narayan: Differential and Integral Calculus, S. Chand.*
2. *S.L. Ross: Differential Equations, John Wiley and sons inc., Ny, 1984*
3. *Shanti Narayan: A Textbook of Matrices, S. Chand.*
4. *Ian N. Snnedon: Elements of Partial Differential Equations, McGraw Hill.*
5. *Murray R. Spiegal: Vector Analysis Schaum Publishing*

Generic Elective –IV	
BBL-201: ELEMENTARY BIOLOGY-II (Cell Biology)	**Credits: 4+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objective of the course is to help the students to learn and develop an understanding of a cell as basic unit of life. This course is design to make them able to understand the construction of a cell, functions of cellular organelles and how a cell carries out and regulate cellular functions	**After successful completion of this course, students should be able to: -** ***1. Understand fundamental principles of cell biology such as difference between prokaryotic and eukaryotic cells, their structure and composition, microscopic and cytochemical techniques to study them.*** ***2. Understand how cells grow, divide, survive, die and regulate these important processes.*** ***3. Understand the process of cell signaling and its role in cellular functions.*** ***4. Gain an insight of how defects in functioning of cell organelles and regulation of cellular processes can develop into diseases.***

UNIT I **[15 Lectures]**

Cell: Introduction and classification of organisms by cell structure, cytosol, Compartmentalization of eukaryotic cells, Cell fractionation.

Cell Membrane and Permeability: Chemical components and organization of biological membranes, Fluid Mosaic Model, Membrane as a dynamic entity, Cell recognition and membrane transport.

UNIT II **[15 Lectures]**

Endo Membranous System and Cytoskeleton: Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion. Lysosomes: Vacuoles and micro bodies, Structure and function of microtubules, Microfilaments, Intermediate filaments.

UNIT III **[15 Lectures]**

Mitochondria and Chloroplast, Nucleus and Ribosome: Mitochondria: Structure and function, genomes, biogenesis. Chloroplasts: Structure and function, genomes, biogenesis. Nucleus: Structure and function, chromosomes and their structure and functions. Ribosomes: Structures and function including role in protein synthesis.

UNIT IV **[15 Lectures]**

Cell Division: Mitosis, Meiosis, Cell cycle and its regulation

Signal transduction: Cell Signaling through GPCR and Role of secondary messenger: cAMP and Protein Kinase.

Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

Recommended Textbooks and References:

1. *Karp, G., Iwasa, J. & Marshall, W. Karp's Cell and Molecular Biology (9th Ed.). John Wiley & Sons. 2020.*
2. *Alberts, B., Johnson, A.D., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. Molecular Biology of the cell (6th Ed.). Garland Science. 2014.*
3. *Cooper, G. M. The Cell: A Molecular Approach (8th Ed.). Oxford University Press. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA. 2018.*
4. *Becker, W. M., Kleinsmith, L. J., Hardin. J. & Bertoni, G. P. The World of the Cell (8th Ed.). Pearson Benjamin Cummings Publishing, San Francisco. 2016.*
5. *Campbell, N.A. and Reece, J. B. Biology (12th Ed.). Pearson Benjamin Cummings, San Francisco. 2020.*

Core Course –II	
BBL-202: BIOLOGY- II (General Biochemistry)	**Credits: 4+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are: - ***1. To provide fundamental knowledge about the structure, function and properties of major biomolecules.*** ***2. To introduce students to metabolic pathway of selected biomolecules.***	***After successful completion of this course, students should be able to: -*** ***1. Describe the relationship between the structure and function of biomolecules*** ***2. Classify the enzymes and explain mechanism of action and structure of enzyme*** ***3. Comprehend metabolic pathways of selected biomolecules*** ***4. Get a good grasp of the structure and biochemical role of vitamins and co-enzymes***

UNIT I [15 Lectures]

Introduction to Biochemistry: A historical prospective, Concept of bio-molecules - Building blocks of life, Small molecules and macromolecules.

Carbohydrates: Structure, function and properties of monosaccharides, Stereo isomerism of monosaccharides, Furanose and pyranose forms, Haworth projection formulae, Disaccharides and polysaccharides. Homo & hetero polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions.

Amino acids & Proteins: Amino acids- the building blocks of proteins, Structure, classification and properties of amino acids. Proteins: Types of proteins and their classification, Forces stabilizing protein structure and shape. Primary, secondary, tertiary and quaternary structures, Denaturation and renaturation of proteins. Fibrous and globular proteins.

UNIT II [15 Lectures]

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, prostaglandins, cholesterol. Lipids: Definition and major classes of storage and structural lipids.

Nucleic acids: Structure and functions: Physical & chemical properties of nucleic acids, nucleosides & nucleotides, purines & pyrimidines, Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, Denaturation and renaturation of DNA

UNIT III [15 Lectures]

Enzymes: Nomenclature and classification of enzymes. Holoenzyme, apoenzyme, cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, Activation energy and transition state, Enzyme activity, Specific activity, Common features of active sites, Enzyme specificity: types & theories- Lock and key hypothesis, and Induced Fit hypothesis., Biocatalysts from extreme thermophilic and hyper thermophilic archaea and bacteria. Effect of pH and temperature on enzyme activity. Enzyme inhibition,

Vitamins: Role of NAD+, NADP+, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate, lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions

UNIT IV **[15 Lectures]**

Metabolism: Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. ß-oxidation of fatty acids.

Recommended Textbooks and References:

1. *Berg, J.M., Tymoczko, J.L., Gatto, G.J., & Stryer, L. Biochemistry. (9th Ed.) New York: W.H. Freeman. 2019.*
2. *Nelson, D.L. & Cox, M.M. Lehninger, A. L. Lehninger Principles of Biochemistry (7th Ed.). New York, NY: W H Freeman & Co. 2017.*
3. *Voet, D. & Voet, J. G. Biochemistry (5th Ed.). Hoboken, NJ: J. Wiley & Sons. 2016.*
4. *Dobson, C. M. Protein Folding and Misfolding. Nature, 426(6968), 884-890. doi:10.1038/nature02261. 2003.*
5. *Richards, F. M. The Protein Folding Problem. Scientific American, 264(1), 54-63. doi:10.1038/scientificamerican0191-54. 1991.*

Generic Elective V	
BPL-201: PHYSICS-II (Heat and Thermodynamics)	**Credits: 4+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objective of this course is to familiarize the students with basic concepts of thermodynamical systems, laws of thermodynamics, thermoelectricity and behaviour of real gases.	***After successful completion of this course, students should be able to: -*** ***1. Have strong foundation and understanding of physical variables associated with systems.*** ***2. Behaviours of systems under different conditions (isothermal, isobaric, isochoric).*** ***3. Understand fundamentals of thermoelectricity and allied applications.*** ***4. Application of thermodynamical understanding and concepts to problem solving aspects of societal significance.***

UNIT- I [15 Lectures]

Zeroth and First Law of Thermodynamics: Extensive and intensive thermodynamic variables, Thermodynamic equilibrium, zeroth law and Concept of Temperature, Work and heat, State functions, First law of thermodynamics, Internal energy, Applications of first law, General relation between Cp and Cv, Work done during isothermal and adiabatic processes.

Second Law of Thermodynamics: Reversible and Irreversible process with examples, Conversion of Work into Heat and Heat into Work, Heat Engines, Carnot's Cycle, Carnot engine &its efficiency, Refrigerator & coefficient of performance, 2ndLaw of Thermodynamics: Kelvin-Planck and Clausius Statements and their equivalence, Carnot's Theorem.

UNIT-II [15 Lectures]

Entropy and Third law of Thermodynamics: Concept of entropy, Clausius theorem, Clausius Inequality, Second Law of Thermodynamics in terms of Entropy, Entropy of a Perfect Gas and Universe, Entropy Changes in Reversible and Irreversible Processes, Principle of Increase of Entropy, Third Law of Thermodynamics, Unattainability of absolute zero, T-S Diagrams, Phase Change, Classification of Phase Changes.

UNIT-III [15 Lectures]

Thermodynamic Potentials: Extensive and Intensive Thermodynamic Variables; Internal Energy; Definition, importance, properties and applications of Chemical Potential, Enthalpy, Gibbs function and Helmholtz function. Maxwell's Thermodynamic Relations**:** Derivations of Maxwell's Relations and their applications: (1) Clausius- Clapeyron equation (2) Cp- Cvvalue, (3) Energy equations (4) Change of temperature during adiabatic process.

UNIT-IV **[15 Lectures]**

Real Gases: Behavior of Real Gases, Deviations from the Ideal Gas Equation. The Virial Equation, Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas, Boyle Temperature, Van-der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves, P-V Diagrams, Joule's Experiment, Free Adiabatic Expansion of a Perfect Gas.

Thermo-electricity: Seeback effect, Paltier effect, Thomson effect and their explanations.

Recommended Textbooks and References:

1. *Meghnad Saha & B.N. Srivastava. A Treatise on Heat, Indian Press*
2. *S. Garg, R. Bansal & Ghosh. Thermal Physics, Tata McGraw-Hill*
3. *S.J. Blundell & K.M. Concepts in Thermal Physics. Blundell, Oxford University Press*
4. *M. W. Zemansky & R. Dittman. Heat and Thermodynamics: An Intermediate Textbook. McGraw-Hill.*

Generic Elective- VI	
BCL-201: Chemistry-II	**Credits: 4+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The course provides basic knowledge about ionic, covalent bonding and ionic solids, acids and bases, basics of coordination chemistry, chemical kinetics and basics idea of spectroscopy.	***After successful completion of this course, students should be able to: -*** ***1. Examine Lewis structures of atoms and the Octet Rule. Explain covalent and ionic chemical bonds. Point out chemical compounds and their bond angles and lengths.*** ***2. Explain the difference between acids/bases their classifications and calculate the pH of aqueous solutions of strong acids and strong bases given their concentrations*** ***3. Understand the concept of rate of change associated with chemical change. Determine rate law of chemical change based on experimental data. Be able to identify the reaction order for a chemical change. Understand the concept of pseudo-first order kinetics. Explain the functions and purpose of a catalyst.*** ***4. Understand basic principle of spectroscopy, interactions of electromagnetic radiations with matter, different terminologies in UV-vis and IR spectroscopy.***

UNIT-I **[15 Lectures]**

Introduction to Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, polarizing power and polarizability

Introduction to Covalent Bonding: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bi pyramidal and octahedral arrangements.

Ionic Solids: Factors affecting the formation of ionic solids, concept of close packing, radius ratio rule and coordination number. Calculation of limiting radius ratio for tetrahedral and octahedral sites. Structures of some common ionic solids NaCl, ZnS (zinc blende and wurtzite).

UNIT-II **[15 Lectures]**

Acids and Bases: Brönsted–Lowry concept, conjugate acids and bases, relative strengths of acids and bases, effects of substituent and solvent, differentiating and levelling solvents. Lewis acid-base concept, classification of Lewis acids and bases, Lux-Flood concept and solvent system concept. Hard and soft acids and bases (HSAB concept), applications of HSAB process.

Basic Coordination Chemistry: Coordinate Bond. Werner's coordination theory, ligands, chelates. Nomenclature of coordination compounds. Stereochemistry of different coordination numbers,

isomerism. Valence-bond and crystal field theories of bonding in complexes. Explanation of properties such as geometry colour and magnetism.

UNIT-III [15 Lectures]

Chemical Kinetics and Catalysis: Rates of reactions, rate constant, order and molecularity of reactions. Differential rate law and integrated rate expressions for zero, first, second and third order reactions. Half-life time of a reaction. Methods for determining order of reaction. Effect of temperature on reaction rate and the concept of activation energy.

Catalysis: Homogeneous catalysis, Acid-base catalysis and enzyme catalysis. Heterogeneous catalysis.

UNIT-IV [15 Lectures]

Basics of Spectroscopy: Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law. Electromagnetic radiations, Introduction to ultraviolet, visible and infrared spectroscopy, electronic transitions, λ_{max} & ε_{max}, chromophore, auxochrome, bathochromic, hypochromic shifts. Infrared radiation and types of molecular vibrations, functional group and fingerprint region.

Recommended Textbooks and References:

1. *Cotton, F.A., Wilkinson, G., Murillo, C.A. & Bochmann, M. Advanced Inorg. Chemistry (6^{th} Ed.). Pubs: John Wiley & Sons. Inc. 1999.*
2. *Lee, J.D. Concise Inorganic Chemistry. (4^{th} Ed.). Pubs: ELBS, 1991.*
3. *Huheey, J.E., Keiter, E.A. & Keiter, R.L. Inorganic Chemistry: Principles of Structures and Reactivity (4^{th} Ed.). Pubs: Harper Collins, 1993.*
4. *Greenwood, N.N. & Earnshaw, A. Chemistry of the Elements (2^{nd} Ed.), Pubs: Butterworth/Heinemann, 1997.*
5. *Douglas, B., Daniel D. Mc & Alexander, J., Concepts of Models of Inorganic Chemistry, Pubs: John Wiley, 1987.*
6. *Puri, B.R., Sharma L.R. & Pathania, M.S., Principles of Physical Chemistry, Pubs: Vishal Publishing Company. 2003.*

Generic Elective- VII	
BXL-202: Computer Science	**Credits: 2+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are: - ***1. Students should learn basic principles of using Windows operation system.*** ***2. Identify and analyse computer software, and network components.*** ***3. Read the fundamentals and basics of programming languages.***	***After successful completion of this course, students should be able to: -*** ***1. Develop an intuitive sense of how computers work and how they can be used to design programming to make academic and research work more efficient.*** ***2. Students will be able to identify use of computer and information technology in biological sciences.***

UNIT I **[8 Lectures]**

An Overview of Computer System: Anatomy of a digital Computer, Memory UNITs, Main and Auxiliary Storage Devices, Input Devices, Output Devices, Classification of Computers. Radix number system: Decimal, Binary, Octal, Hexadecimal numbers and their inter-conversions; Representation of information inside the computers.

UNIT-II **[7 Lectures]**

Operating System Basics: The user Interface, Running Programmes, managing files, Introduction to PC operating Systems: Unix/Linux, DOS, Windows 2000.

UNIT-III **[7 Lectures]**

Internet Basics: Introduction to the basic concepts of Networks and Data Communications, how Internet works, Major features of internet, Emails, FTP, Using the internet.

UNIT-IV **[8 Lectures]**

Programming Language: Machine-, Assembly-, High Level- Language, Assembler, Compiler, Interpreter, debuggers, Programming fundamentals: problem definition, algorithms, flow charts and their symbols, introduction to compiler, interpreter, assembler, linker and loader and their inter relationship.

Recommended Textbooks and References:

1. *Goel, A., Computer Fundamentals, Pearson Education, 2010.*
2. *Aksoy, P. & DeNardis, L., Introduction to Information Technology, Cengage Learning, 2006.*
3. *Sinha, P.K. & Sinha, P. Fundamentals of Computers, BPB Publishers, 2007.*

Generic Elective Practical -III	
BCP-201: Chemistry Lab-II	**Credits: 0+2**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**4 H**

Course Objectives	Student Learning Outcomes
The objective of this course is to train the students with complexo-metric titrations, paper chromatography, how to find out the rate constant of a reaction and specific refractivity of liquids, determination of conductance and preliminary tests for organic compounds.	***After successful completion of this course, students should be able to: -*** ❖ ***Perform complexometric titrations*** ❖ ***Determine specific refractivity of liquids and determine the rate constant of a reaction.*** ❖ ***Perform preliminary test of organic compounds.***

List of Experiments:

1. Complexo metric titrations: Determination of Mg^{2+}, Zn^{2+} by EDTA.
2. Paper Chromatography: Qualitative Analysis of any one of the following Inorganic cations and anions by paper chromatography (Pb^{2+}, Cu^{2+}, Ca^{2+}, Ni^{2+}, Cl^-, Br^-, I^- and PO_4^{3-} and NO_3^-).
3. To determine the specific refractivity of at least two liquids.
4. Determine rate constant of acid catalysed hydrolysis of methyl acetate.
5. Determination of conductance of electrolytes
6. The preliminary examination of physical and chemical characteristics (physical state, colour, odour and ignition test), extra element detection (N,S,Cl, Br and I).

Recommended Textbooks and References:

1. Vogel, A. I., Tatchel,l A.R., Furnis, B.S., Hannaford & A.J., Smith, P.W.G., Vogel's Text Book of Practical Organic Chemistry (5th Ed.). Pubs: ELBS, 1989.
2. Pavia, D.L., Lampanana, G.M. & Kriz G.S. Jr., Introduction to Organic Laboratory Techniques (3rd Ed.) Pubs: Thomson Brooks/Cole,2005.
3. Mann F.G. & Saunders. P.C., Practical Organic Chemistry. Pubs: Green & Co. Ltd., London. 1978.
4. Svehla, G., Vogel's Qualitative Inorganic Analysis (revised) (7th Ed.). Pubs: Orient Longman. 1996.
5. Bassett, J., Denney, R.C., Jeffery, G.H. & Mendham, J. Vogel's Textbook of Quantitative Inorganic Analysis (revised) (4th Ed.) Pubs: Orient Longman, 1978.
6. Das, R.C. & Behra, B. Experimental Physical Chemistry. McGraw Hill.
7. Shoemaker & Gailand. Experiments in Physical Chemistry, McGraw Hill.
8. Yadav, J.B. Advanced Practical Physical Chemistry.

Generic Elective Practical-IV	
BPP-201: Physics Lab – II	**Credits: 0+2**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**4 H**

Course Objectives	Student Learning Outcomes
The students will perform the basic experiments related to thermal physics, such as- determination of Mechanical Equivalent of Heat (J), coefficient of thermal conductivity of good and bad conductor, temperature coefficient of resistance, variation of thermo-emf of a thermocouple as a function of temperature difference at its two junctions and calibration of a thermocouple.	***Upon the completion of the course, students are expected to have attained a practical understanding of*** ***1. Heat and its mechanical equivalence*** ***2. Determination of coefficient of thermal Conductivity of Cu using various methods*** ***3. Determination of coefficient of thermal Conductivity of a bad conductor*** ***4. Variation of Thermo-Emf of a thermocouple and calibration of thermocouple***

List of Experiments:

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ2 /T law.
2. To investigate the motion of coupled oscillators.
3. To study Lissajous Figures.
4. Familiarization with: Schuster`s focusing; determination of angle of prism.
5. To determine refractive index of the Material of a prism using sodium source.
6. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
7. To determine the wavelength of sodium source using Michelson's interferometer.
8. To determine wavelength of sodium light using Fresnel Biprism.
9. To determine wavelength of sodium light using Newton's Rings.
10. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
11. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
12. To determine dispersive power and resolving power of a plane diffraction grating.

Recommended Textbooks and References:

1. *Flint, B.L. & Worsnop, H.T. Advanced Practical Physics for students. Asia Publishing House. 1971.*
2. *Prakash, I. & Ramakrishna, A. Text Book of Practical Physics (11th Ed.). Kitab Mahal. 2011.*
3. *Nelson, M. & Ogborn, J.M. Advanced level Physics Practicals. (4th Ed.). Heinemann Educational Publishers. 1985.*
4. *Khandelwal, D.P. A Laboratory Manual of Physics for undergraduate classes. Vani Pub. 1985.*

Generic Elective Practical-V	
BXP-201: Computer Science Lab-I	**Credits: 0+2**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**4 H**

Course Objectives	Student Learning Outcomes
The course is designed to provide basic knowledge of C language. Students will be able to develop logics which will help them to create programs, applications in C. By learning the basic programming constructs, they can easily switch over to any other language in future.	***After successful completion of this course, students should be able to use the language C to design a computer programming and system software.***

List of Experiments:

C Programming language: C fundamentals, formatted input/ output, expressions, selection statements, loops and their applications; Basic types, arrays, functions, including recursive functions, program organization: local and external variables and scope; pointers & arrays

Representative programming in C

1. Write a program to find the largest of three numbers. (if-then-else)
2. Write a program to find the largest number out of ten numbers (for-statement)
3. Write a program to find the average mail height & average female heights in the class (input is in form of sex code, height).
4. Write a program to find roots of quadratic equation using functions and switch statements.
5. Write a program to multiply two matrices

Recommended Textbooks and References:

1. *Kanetkar, Y. Let Us C. BPB publication*

Core Course –III	
BBL-301: Mammalian Physiology	**Credits: 4+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objective of this course is to provide an insight into the physiology of different systems of the body. It also gives an account of the mechanism of digestion, breathing blood circulation and nervous system.	***After successful completion of this course, the students will be able to: -*** ***1. Understand the mammalian physiology at cellular and system levels.*** ***2. Understand different physiological parameters as well as mechanism of action of different hormones, which will help in identifying outliers.***

UNIT- I [15 Lectures]

Digestion and Respiration: Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice Respiration: Exchange of gases, Transport of O_2 and CO_2, Oxygen dissociation curve, Chloride shift.

UNIT -II [15 Lectures]

Circulation: Composition of blood, Plasma proteins & their role, blood cells, Haemopoiesis, Mechanism of coagulation of blood. Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heartbeat.

UNIT- III [15 Lectures]

Muscle Physiology and Osmoregulation: Structure of cardiac, smooth and skeletal muscle, threshold stimulus, All or None Rule, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical and electrical events of mechanism of muscle contraction. Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation.

UNIT- IV [15 Lectures]

Nervous and Endocrine Coordination: Mechanism of generation and propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters Mechanism of action of hormones (insulin and steroids) Different endocrine glands– hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo and hyper-secretions.

Recommended Textbooks and References:

1. *Hall, J.E. & Hall, M.E. Textbook of Medical Physiology (14th Ed.). Elsevier. 2020.*
2. *Tortora, G.J. & Derrickson, B.H. Principles of Anatomy & Physiology (15th Ed.). John wiley & sons, Inc. 2016.*
3. *Marieb, E.N. & Hoehn, K.N. Human Anatomy and Physiology (10th Ed.). Pearson. 2016.*

Core Course –IV	
BBL-302: Plant Anatomy and Physiology	**Credits: 4+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objective of this course is to familiarize the students with the fundamental concepts of plant anatomy. This course will also give an insight into basic physiology and metabolism of plants.	***After successful completion of this course, students should be able to: -*** ***1. Evaluate the structural organization of plant tissues.*** ***2. Understand the anatomical features of leaves, stems, and roots as well as flowers and fruits.*** ***3. Understand the role of growth hormones and water relation of plants with respect to various physiological processes.*** ***4. Explain the significance of carbon and nitrogen metabolism.***

UNIT- I **[15 Lectures]**

Anatomy: The shoot and root apical meristem and its histological organization, Simple and complex permanent tissues, Primary structure of shoot and root, Secondary growth, Growth rings, Leaf anatomy (dorsi-ventral and isobilateral leaf)

UNIT- II **[15 Lectures]**

Plant Water Relations: Importance of water to plant life, Diffusion, Osmosis, Plasmolysis, Imbibition, Guttation, Transpiration, Stomata and their mechanism of opening and closing.

Micro and Macro Nutrients: Criteria for identification of essentiality of nutrients, Roles and deficiency systems of nutrients, Mechanism of uptake of nutrients, Mechanism of food transport

UNIT- III **[15 Lectures]**

Carbon Metabolism: Photosynthesis- Photosynthesis pigments, Concept of two photo systems, photophosphorylation, Calvin cycle, CAM plants, Photorespiration, Compensation point

Nitrogen metabolism: Nitrogen fixation, Inorganic and molecular nitrogen fixation, Nitrate reduction and ammonium assimilation in plants.

UNIT- IV **[15 Lectures]**

Growth and Development: Definitions, Phases of growth, Growth curve, Growth hormones (auxins, gibberellins, cytokines, abscisic acid, ethylene)

Physiological role and mode of action, Seed dormancy and seed germination, Concept of photo-periodic and vernalization.

Recommended Textbooks and References:

1. *Dickinson, W.C. Integrative Plant Anatomy. Harcourt Academic Press, USA. 2000.*
2. *Esau, K. Anatomy of Seed Plants. Wiley Publishers. 1977.*
3. *Fahn, A. Plant Anatomy (4th Ed.). Butterworth-Heinemann Ltd. 1995.*
4. *Hopkins, W.G. & Huner, P.A. Introduction to Plant Physiology (4th Ed.). John Wiley and Sons. 2008.*
5. *Mauseth, J.D. Plant Anatomy. Blackburn Press, USA. 2008.*
6. *Nelson, D.L. & Cox, M.M. Lehninger, A. L. Lehninger Principles of Biochemistry (7th Ed.). New York, NY: W H Freeman & Co. 2017.*
7. *Salisbury, F.B. & Ross, C.W. Plant Physiology (4th Ed.), Wadsworth Publishing Co. Ltd. 2005.*
8. *Taiz, L. & Zeiger, E. Plant Physiology (6th Ed.), Oxford University Press. 2018.*

Core Course-V	
BBL-303/ BCL-301: INORGANIC CHEMISTRY-I (Atomic Structure & Chemical Bonding)	**Credits:4+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The course reviews the structure of the atom, which is a necessary pre-requisite in understanding the nature of chemical bonding in compounds. It discusses the periodicity in properties with reference to the s, p, d and f block, which is necessary in understanding their group chemistry. It provides basic knowledge about ionic, covalent and metallic bonding and explains non covalent interactions.	***After successful completion of this course, students should be able to: -*** ***1. Solve the conceptual questions using the knowledge gained by studying the quantum mechanical model of the atom, quantum numbers, electronic configuration, radial and angular distribution curves, shapes of s, p, and d orbitals, and periodicity in atomic radii, ionic radii, ionization energy and electron affinity of elements.*** ***2. Draw the plausible structures and geometries of molecules using Radius Ratio Rules, VSEPR theory and MO diagrams (homo- & hetero-nuclear diatomic molecules).*** ***3. Rationalize the conductivity of metals, semiconductors and insulators based on the Band theory.*** ***4. Understand the importance and application of chemical bonds, inter-molecular and intramolecular weak chemical forces and their effect on different structures.***

UNIT- I [15 Lectures]

Atomic Structure: Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrodinger's wave equation, significance of ψ and ψ^2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, *p, d* and *f* orbitals. Contour boundary and probability diagrams.

Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

UNIT -II [15 Lectures]

Periodicity of Elements: *s, p, d, f* block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to *s* and p-block.

(a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.

(b) Atomic radii (van der Waals)
(c) Ionic and crystal radii.
(d) Covalent radii (octahedral and tetrahedral)
(e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.
(f) Electron gain enthalpy, trends of electron gain enthalpy.
(g) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffe's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sanderson's electron density ratio.

UNIT- III **[15 Lectures]**

Chemical Bonding-I

Ionic Bond: Types of ions, size effects, radius ratio rule and its Limitations. Packing of ions in crystals. Born-Lande equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its applications, Solvation energy.

Covalent Bond I: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl, BeF_2, CO_2, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (o and n bond approach) and bond lengths.

UNIT- IV **[15 Lectures]**

Chemical Bonding-II

Covalent Bond II: Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization.

Ionic character in covalent compounds: Bond moment and dipole moment, percentage ionic character from dipole moment and electronegativity difference.

Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.

Weak Chemical Forces: Van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions.

Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.

Recommended Textbooks and References:

1. *Lee, J.D. Concise Inorganic Chemistry. ELBS. 1991.*
2. *Douglas, B.E. & McDaniel, D.H. Concepts & Models of Inorganic Chemistry. Oxford 1970.*
3. *Atkins, P.W. & Paula, J. Physical Chemistry (10^{th} Ed.) Oxford University Press. 2014.*
4. *Day, M.C. & Selbin, J. Theoretical Inorganic Chemistry. ACS Publications. 1962.*
5. *Rodger, G.E. Inorganic and Solid State Chemistry. Cengage Learning India Edition. 2002.*

Core Course-VI	
BBL-304/ BCL-302: ORGANIC CHEMISTRY (Hydrocarbons)	**Credits: 4+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The course is designed with the recapitulation of fundamentals of organic chemistry and the introduction of a new concept of visualizing the organic molecules in a three-dimensional space. The preparation and important reactions of alkanes, alkenes, alkynes, aromatic hydrocarbons, alkyl and aryl halides are also introduced.	***After successful completion of this course, students should be able to: -*** ***1. Understand and explain the different nature and behaviour of organic compounds based on fundamental concepts learnt.*** ***2. Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.*** ***3. Learn and identify organic reaction mechanism. Explain the preparation and important reactions of alkanes, alkenes, alkynes, aromatic hydrocarbons, alkyl and aryl halides.***

UNITI **[15 Lectures]**

Basics of Organic Chemistry

Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties of Organic Compounds.

Dipole moment; Organic acids and bases; their relative strength, Curly arrow rules, formal charges; Nucleophlicity and basicity.

Aromaticity: Benzenoids and Hückel's rule.

Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

Chemistry of Aliphatic Hydrocarbons-I

Carbon-Carbon sigma bonds

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

UNIT- II **[15 Lectures]**

Chemistry of Aliphatic Hydrocarbons-II

Carbon-Carbon pi Bonds: Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ AntiMarkownikoff addition), mechanism of oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition

reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene.

Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

UNIT- III **[15 Lectures]**

Chemistry of Aliphatic Hydrocarbons-III

Cycloalkanes and Conformational Analysis

Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of cycloalkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.

Aromatic Hydrocarbons

Aromaticity: Huckel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

UNIT-IV **[15 Lectures]**

Chemistry of Halogenated Hydrocarbons

Alkyl halides: Methods of preparation, nucleophilic substitution reactions - S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.

Aryl halides: Preparation, including preparation from diazonium salts. nucleophilic aromatic substitution; S_NAr, Benzyne mechanism.

Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.

Organometallic compounds of Mg and Li - Use in synthesis of organic compounds.

Recommended Textbooks and References:

1. *Morrison, R. N., Boyd, R. N. & Bhattacharjee S. K. Organic Chemistry (7^{th}Ed.). Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).*
2. *Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).*
3. *McMurry, J.E. Fundamentals of Organic Chemistry (7^{th} Ed.). Cengage Learning India Edition. 2013.*

Core Course-VII	
BBL-305: Interactions with Entrepreneurs in Biotechnology and Start-ups	**Credits: 2+0**

Internal Marks	**100**
Total Marks	**100**

Note: Three Teachers of the department will evaluate the short report/documentary submission by the student after industry visit and award marks based on submitted report/document.

Course Objectives	Student Learning Outcomes
The objectives of this course are: - ***1. To give industry orientation to students for raising industry ready skills.*** ***2. To help raise awareness on the importance of entrepreneurship for biotechnology specialists and to provide them with an entrepreneurial knowledge stock.***	***After successful completion of this course, students should be able to: -*** ***1. Develop a very good understanding of areas where biotechnology has the potential for possible commercialization.*** ***2. Develop a preliminary understanding of how a certain biotechnological technique may be further developed for initiating start-up and developing it into a commercial enterprise.*** ***3. Conceive an idea of planning of establishing a biotechnology industry in India.***

After interaction with experts from biotechnology related industries /enterprises/ start-ups, the students would submit a short report and bring out innovations, novel ideas or the further improvements related to products being produced by such organizations.

Elective Course –I	
BBL-306: Plant Cell, Tissue and Organ Culture	**Credits: 2+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are to introduce students with the basic concepts of plant cell, tissue and organ culture. This course will also aware the students about practical applications of plant tissue culture	***After successful completion of this course, students should be able to: -*** ***1. Understand the importance of plant tissue culture in various aspects like aseptic culture conditions, culture media, organogenesis, somatic embryogenesis, micro-propagation.*** ***2. Gain in-depth knowledge of haploid production, artificial seeds, production of virus free plants, somaclonal variations somatic hybrids and cybrids.***

UNIT- I [8 Lectures]

Introduction: Historical background**,** Concepts and basic techniques in tissue culture, Media preparation, Cell, Tissue and organ culture, Concept of cellular totipotency, Organogenesis, Regeneration of plants, somatic embryogenesis, embryo culture and artificial seeds.

Callus Culture: Induction, Maintenance, Growth characteristics. Single cell culture, Cell suspension culture methodology, kinetics of growth and, nutrient optimization.

UNIT-II [8 Lectures]

Protoplast Culture: Protoplast isolation, Fusion and culture, Somatic hybridization, Selection systems for hybrids, Asymmetric hybrids, Production of hybrids and organellic recombinants, Role of protoplast culture and somatic hybridization in the improvement of crop plants.

Haploid Production: Haploid production and its significance, Anther and pollen culture, Monoploid production through chromosome elimination, Production of triploids through endosperm culture, Role of haploids, Monoploids and triploids in agriculture.

UNIT- III [7 Lectures]

Micropropagation: Techniques, Clonal propagation of elite germplasm, Factors affecting morphogenesis and proliferation rate, Technical problem in micropropagation, Meristem culture for the production of pathogen free plants, Applications of micropropagation.

Variability in Plant Systems: Somaclonal variations and *in-vitro* selection for biotic and abiotic stresses, Isolation of useful mutants at cellular level (disease resistant, herbicide resistant and salt tolerant) Practical applications of variability in tissue cultures.

UNIT- IV [7 Lectures]

Practical Application of Plant Tissue Culture: Role of tissue culture in the improvement of crop plants, Production of secondary metabolites by plant suspension cultures-pigments, perfumes, flavours and pharmacologically important compounds, Hairy root culture. Automation in plant tissue culture for its commercial application.

Recommended Textbooks and References:

1. *Bhojwani, S.S. & Razdan, M.K. Plant Tissue Culture and Practice. Elsevier. 2004.*
2. *Reinert, J. & Bajaj, Y.P.S. Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House. 1997.*
3. *Plant Biotechnology- The genetic manipulation of plants, 2nd Edition by A Slater, N.W. Scott M.R. Fowler, Oxford Univ Press (2008)*
4. *Plant Biotechnology by H. S. Chawla, Oxford and IBH, 2009.*
5. *Plant Biotechnology by B D Singh. Kalyani publisher, 2003*
6. *Agricultural Biotechnology by Arie Altman. Marcel Dekker, Inc. (2001).*
7. *Biochemistry and Molecular Biology of Plants: Edited by Buchanan B.B., Gruissem W, and Jones RL. 2000*

Elective Course – I	
BBL-307: Economic Botany	**Credits: 2+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are to introduce students about some economically important plants; evolution of their species (for cereals only); plant part used; cultivation, harvesting and processing practices.	***After successful completion of this course, students will be able to: -*** ***1. Understand core concepts of economic botany and relate with environment, populations, communities, and ecosystems.*** ***2. Increase the awareness and appreciation of plants and plant products encountered in everyday life.*** ***3. Appreciate the diversity of plants and the plant products in human use.***

UNIT- I [8 Lectures]

Fibres: Classification of fibres – bast fibres, Structural fibres, Surface fibres; Classification according to their use – textile fibres, brush fibres, Plaiting and rough weaving fibres, Filling fibres, Paper-making fibres. Cotton, Jute and Flax: History and origin of species, their distribution, botanical description, agroclimatic conditions and cultivation practices, harvesting, post-harvest processing and utilisation.

Cereals (Rice and Wheat): Origin of major cultivated species. Their national and international distribution, botanical description, cultivation and harvesting practices, Post-harvest processing.

UNIT- II [7 Lectures]

Sugar (Sugarcane): Types of sugars, history and origin, botanical description, Brief idea of cultivation, Harvesting and sugar production.

Pulses (Pigeon pea and Chickpea): Origin of cultivated species, botanical description and cultivation practices.

UNIT- III [7 Lectures]

Oils (Groundnut and Mustard): Distribution, botanical description, cultivation practice, nutritional value and uses, plant parts used.

Spices (Coriander, Ginger and Turmeric): History and origin, distribution, botanical description, cultivation practices, plant part used, key constituents.

UNIT- IV [8 Lectures]

Medicinal Plants (Atropa, Cinchona and Opium): History, distribution, botanical description, cultivation and harvesting practices, plant part used, active constituents and usages.

Rubber (Hevea): Characteristics of rubber, history and origin, distribution, botanical description, ecology and propagation, tapping and processing for controlling characteristics of rubber.

Recommended Textbooks and References:

1. *Kocchar, S.L. Economic Botany in Tropics (4th Ed.), Laxmi Publications. 2012.*
2. *Sambammurthy, A.V.S.S. & Subramanyam, N.S. A Textbook of Economic Botany, Asiatech Publishers Inc. 2000.*
3. *Sharma, O.P. Hills Economic Botany (Late Dr. A.F. Hill adapted by O.P. Sharma), Tata McGraw Hill Co. Ltd., New Delhi. 1996.*
4. *Simpson, B.B. and Conner-Ogorzaly, M. Economic Botany- Plants in our World, McGraw Hill, New York. 1986.*

Skill Enhancement Course-I	
BBL-308: Agri-Biotechnology Products	**Credits: 2+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are to introduce students to fundamental concepts of agri-biotechnology products and their field applications. The course will also cover various processes associated with molecular farming, peptide hormone and edible vaccine	***After successful completion of this course, students should be able to: -*** ***1. Design and deliver useful modern biotechnology products to the Society*** ***2. Develop skill in the area of biotechnology with emphasis on bulk production of commercially important agri- biotechnology products.*** ***3. To learn processes involved in the mass production of bioproducts and their field applications***

UNIT -I [8 Lectures]

Biofertilizers: General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers. Symbiotic N_2 fixers: Rhizobium - Isolation, characteristics, types, inoculum production and field application, Legume/pulses plants Frankia - Isolation, characteristics, Alder, Casurina plants, Non-leguminous crop symbiosis. Mycorrhizal bio-fertilizers and Cyanobacteria as bio-fertilizers.

UNIT- II [7 Lectures]

Phosphate Solubilizers: Phosphate solubilizing microbes - Isolation, characterization, mass inoculum production, field application. PGPR – isolation and characterization; mass production and application.

UNIT- III [7 Lectures]

Bioinsecticides: General account of microbes used as bioinsecticides and their advantages over synthetic pesticides, Bacillus thuringiensis, Production, Field applications, Viruses – cultivation and field applications.

UNIT- IV [8 Lectures]

Molecular Farming: Introduction-carbohydrates and lipids production-molecular farming of proteins-economic considerations for molecular farming.

Transgenic crops for production of antibodies, Viral antigens and peptide hormones in plants, Edible vaccine: Benefits, Limitation, Production, Current status and future prospects. Nutraceuticals, Biofuels.

Recommended Textbooks and References:

1. *Eldor, A.P. Soil Microbiology: Ecology and Biochemistry (6th Ed.). Academic Press. 2007.*
2. *Madsen, E.L. Environmental Microbiology: From Genomes to Biogeochemistry (2nd Ed.), Wiley Blackwell Publishing. 2015.*
3. *Agrios, G.N. Plant Pathology (5th Ed.). Academic Press. 2005.*
4. *Buchanan, B.B., Gruissem, W. & Jones, R.L. Biochemistry and Molecular Biology of Plants (2nd Ed.). Wiley Publisher. 2015.*
5. *Mehrotra, R.S. & Ashok Agrawal, A. Plant Pathology (3rd Ed.). Tata McGraw Hill. 2017.*
6. *Bilgrami, K.S & Dube, H.C. A textbook of modern pathology (6th Ed.) S.Chand (G/L) & Company Ltd. 1998.*
7. *Suri, S. Biofertilizer and Biopesticide. Aph Publishing Corporation. 2011.*

Skill Enhancement Course-I	
BBL-309: Basics of Forensic Science	**Credits: 2+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are to introduce the student to forensic science, its history, methods and the application to human DNA typing techniques and instrumentation.	***After successful completion of this course, students should be able to: -*** ***1. Acquire in-depth knowledge of working of a forensics lab.*** ***2. Understand collection, analysis and drawing valid inference from different evidences at the crime scene.*** ***3. Understand the process of fingerprinting which is widely used throughout world in diagnosis of forensic cases.***

UNIT- I [8 Lectures]

Basics of Forensic Science: Introduction and principles of forensic science, Forensic science laboratory and its organization and service, Tools and techniques in forensic science, Branches of forensic science, Causes of crime, Role of modus operandi in criminal investigation. Classification of injuries and their medico-legal aspects, Method of assessing various types of deaths.

UNIT- II [7 Lectures]

Arms and Handwriting Comparison: Classification of fire arms and explosives, Introduction to internal, external and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of handwriting, Examination and comparison of handwritings and analysis of ink various samples.

UNIT- III [7 Lectures]

Fingerprinting: Role of the toxicologist, Significance of toxicological findings, Fundamental principles of fingerprinting, Classification of fingerprints, Development of finger print as science for personal identification.

UNIT-IV [8 Lectures]

DNA Fingerprinting: Principle of DNA fingerprinting, Application of DNA profiling in forensic medicine, Investigation Tools, eDiscovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security.

Recommended Textbooks and References:

1. *Glick, B.R. & Patten, C.L. Molecular Biotechnology- Principles and Applications of recombinant DNA (5th Ed.) ASM Press, Washington. 2017.*
2. *Nanda, B.B. & Tiwari, R.K. Forensic Science in India: A Vision for the Twenty First Century, Select Publishers, New Delhi. 2001.*
3. *Bhasin M.K. & S. Nath, S. Role of Forensic Science in the New Millennium, University of Delhi, Delhi. 2002.*

4. *James S.H. & Nordby, J.J. Forensic Science: An Introduction to Scientific and Investigative Techniques (3rd Ed.). CRC Press, Boca Raton. 2009.*
5. *Eckert, W.G. Introduction to Forensic Sciences (2nd Ed.). CRC Press, Boca Raton. 1996.*
6. *Saferstein, R. Criminalistics (8th Ed.) Prentice Hall, New Jersey. 2004.*
7. *Tilstone, W.J., Hastrup M.L. & Hald, C. Fisher's Techniques of Crime Scene Investigation, CRC Press, Boca Raton. 2013.*
8. *Lincoln, P.J. & Thomson, J. Forensic DNA Profiling Protocols. Humana Press. 1998.*
9. *Rudin, N. & Inman, K. An Introduction to Forensic DNA Analysis (2nd Ed.). CRC Press, Boca Raton. 2002.*

BBL-310: SEC-I MOOC Course through SWAYAM/ NPTEL

External Marks	**100**
Total Marks	**100**

Core Course Practical-III	
BBP-311: Animal and Plant Physiology Lab - III	**Credits:0+2**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**4 H**

Course Objectives	Student Learning Outcomes
The objectives of this course are: - **1.** ***To learn the concept of how to conduct experiments in plant physiology for studying membrane permeability, ascent of sap, seed germination, photosynthesis etc.*** **2.** ***To learn the concept of how to conduct experiments in animal physiology for qualitative and quantitative study of blood, serum and biomolecules associate with animal system etc.***	***After successful completion of this course, students should be able to: -*** ***1. Think critically to understand common research techniques used in plant and animal physiology.*** ***2. Design and execute an experiment of plant and animal physiology.***

List of Experiments:

Section A: Plant Physiology

1. To study the permeability of plasma membrane using different concentrations of organic solvents.
2. To study the effect of temperature on permeability of plasma membrane.
3. Determining the osmotic potential of vacuolar sap by plasmolytic method.
4. Determining the water potential of any tuber (Potato tuber).
5. To demonstrate the ascent of sap using a dye.
6. Comparison of loss of water from two surfaces of leaf by $CoCl_2$ method/ four leaf method.
7. Demonstration of imbibition pressure by plaster of Paris method
8. Determination of rate of respiration in germinating seeds under aerobic and anaerobic conditions.
9. Effect of phytohormones on plant growth
10. Separation of chloroplast pigments by chromatography
11. To study the effect of different concentration of CO_2 on rate of photosynthesis
12. To demonstrate the occurrence of transfer cells and tracheary element (PAS toluidine Blue O)
13. To demonstrate the process of 'anaerobic' respiration.
14. To study the R. Q. of different respiratory substrates by Ganong's respirometer.
15. To localize polysaccharides in a tissue.
16. To demonstrate the process of phototropism.

Section B: Animal Physiology

1. Collection of blood sample, isolation of serum and plasma.
2. Estimation of Differential Leucocyte Count (DLC).
3. Estimation of haemoglobin in the given blood sample.
4. Determination of blood groups.
5. Counting of mammalian RBCs

6. Determination of Haemoglobin.
7. Determination of urea in blood.
8. Qualitative estimation of proteins in the given sample.
9. Quantitative estimation of proteins by Lowry's method in the given sample.
10. Qualitative estimation of carbohydrates in the given samples.
11. Quantitative estimation of carbohydrates by anthrone method in the given samples.
12. Qualitative and quantitative estimation of nitrogenous wastes viz. Ammonia, Urea and Uric acid,
13. Analysing CO_2 content of exhaled air with the Müller's method.

Recommended Textbooks and References:

1. *General and Comparative physiology - Hoar, W.S. Prentice Hall of India, New Delhi. 1975*
2. *Comparative animal physiology - Professor C.L. and Brown, F.A W.B. Sounders, Philadelphia.*
3. *Animal physiology Cambridge university press. Cambridge - Schmidt – Nielsen K.*
4. *A handbook of Animal physiology - Pantelouris. EMA; W.B. Sounders Co. Philadelphia.*
5. *An Introduction to general and comparative animal physiology - Floray, E. W.B.Sounders Co., Philadelphia.*
6. *Practicals in Plant Physiology and Biochemistry – Manju Bala , Sunita Gupta, N K Gupta.2012*
7. *Practical text book of Plant Physiology- Daniel Trembly Macdouga.2018*
8. *Akhtar Inam. A Laboratory Manual of Plant, Physiology, Biochemistry and Ecology. Agriobios Publication. 2012*
9. *Guyton, A.C. & Hall, J.E. Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.2006*
10. *Tortora, G.J. & Grabowski, S. Principles of Anatomy & Physiology. XI Edition. John Wiley & Sons, Inc.2006.*

Core Course Practical-IV	
BBP-312/BCP-301: Inorganic Chemistry Lab-IV	**Credits: 0+2**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**4 H**

Course Objectives	Student Learning Outcomes
The objectives of this course are: - ***1. To make the students learn about calibration of apparatus and preparation of solution of different concentration.*** ***2. To learn about acid-base titrations as well as oxidation-reduction titrations.***	***After successful completion of this course, students should be able to: -*** ***1. Prepare standard solutions.*** ***2. Perform acid base titrations*** ***3. Perform oxidation-reduction titrations for estimation of Fe (II), oxalic acid, etc.***

List of Experiments:

(A) Titrimetric Analysis
(i) Calibration and use of apparatus
(ii) Preparation of solutions of different Molarity/Normality of titrants

(B) Acid-Base Titrations
(i) Estimation of carbonate and hydroxide present together in mixture. (ii) Estimation of carbonate and bicarbonate present together in a mixture. (iii) Estimation of free alkali present in different soaps/detergents

(C) Oxidation-Reduction Titrimetry
(i) Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution.
(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.
(iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

Recommended Textbooks and References:

1. *Mendham, J., A. I. Vogel's Quantitative Chemical Analysis (6th Ed.). Pearson. 2009*

Core Course-VIII	
BBL-401: Basic Microbiology	**Credits: 4+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
This course is designed to cover fundamental aspects of the microbial world, historical developments, classification of microorganisms with special emphasis on how microbes grow, divide, methods of culturing and their economic importance.	***After successful completion of this course, students will be able to: -*** ***1. Develop a good knowledge of the development of the discipline of microbiology and the contributions made by prominent scientists in this field.*** ***2. Develop a very good understanding of the characteristics of different types of microorganisms, methods to organize/classify these into and basic tools to study these in the laboratory.*** ***3. Explain the useful and harmful activities of the microorganisms.*** ***4. Perform basic experiments to grow and study microorganisms in the laboratory.***

UNIT-I [15 Lectures]

Origin of Microbiology: History of microbiology and introduction to the microbial world. Germ theory of disease, Development of various microbiological techniques and golden era of microbiology. Contributions of Antony von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman, Paul Ehrlich, Elie Metchnikoff and Edward Jenner.

UNIT-II [15 Lectures]

Classification: Physiochemical and biological characteristics of microorganisms (including viruses); Baltimore classification of viruses. Binomial Nomenclature, Whittaker's five kingdom and Carl Woese three domain classification systems and their utility. General characteristics of Cellular microorganisms, wall-less forms (mycoplasma and spheroplasts) with emphasis on distribution and occurrence, morphology, Mode of reproduction and economic importance.

UNIT-III [15 Lectures]

Eukaryotic Microorganisms: General concept of phytoplanktons and zooplanktons. General characteristics, structure, mode of reproduction and economic importance of fungi with special reference to their application in medicine and industry. General characteristics, occurrence, structure, reproduction and importance of protozoa.

UNIT-IV [15 Lectures]

Microbial Methods: Methods of studying microorganism; Staining techniques: simple staining, Gram staining, negative staining and acid-fast staining. Sterilization techniques (physical & chemical

sterilization). Culture media and conditions for microbial growth. Pure culture isolation: Streaking, serial dilution and plating methods; Cultivation, Maintenance and preservation of pure cultures.
Beneficial and harmful microorganisms and their role in daily life. Concept of disease in plant and animal caused by microorganism.

Recommended Textbooks and References:

1. *Madigan, MT, Bender, K.S., Buckley, D.H., Sattley, W.M. & Stahl, D.A. Brock Biology of Microorganisms (15th Ed.). Pearson/ Benjamin Cummings. 2018.*
2. *Stainer, R.Y. Adelberg, E.A. & Ingrham J.L. General Microbiology (5th Ed.) Macmillan. 1987.*
3. *Davis, B.D. Dulbecco, R.Eisen, H.N. & Ginsberg H.S. Microbiology. Harper & Row publishers. 1980.*
4. *Pelczar, M.L., Chan, E.C.S. & Krieg, N.R. Microbiology (5th Ed.). Mc Graw-Hill Book Company. 2001.*
5. *Freeman, W., Burrows, W. & Freeman B.A. Text book of Microbiology. WB Saunders Company. 1985.*
6. *Joklik, W.K., Willet, H.P., Amos, D.B. & Wilfert, C.M. Zinssers Microbiology (19th Ed.) Prentice Hall International Inc. 1988.*
7. *Vandemark, P.J. & Batzing, B.L. The microbes. The Benjamin/ Cummings publishing company, Inc. 1987.*
8. *Willey, J.M., Sherwood, L., Woolverton, C.J., Prescott, L.M. & Willey, J.M. Prescott's Microbiology (8th Ed.). New York: McGraw-Hill. 2011.*
9. *Sequeira, M., Kapoor, K.K., Yadav, K.S., & Tauro, P. Introduction to Microbiology (3rd Ed.). New Age Pub., New Delhi. 2019.*

Core Course-IX	
BBL-402: Microbial Physiology and Metabolism	**Credits: 4+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The major objective of this course is to develop clear understanding of various aspects of microbial physiology along with diverse metabolic pathways existing in bacteria in relation to its survival and propagation.,	***After successful completion of this course, students should be able to: -*** ***1. Describe the growth characteristics of the microorganisms capable of growing under unusual environmental condition of temperature, oxygen, and solute and water activity.*** ***2. Describe the growth characteristics of the microorganisms which require different nutrient for growth and the associated mechanisms of energy generation for their survival like autotrophs, heterotrophs, chemolithotrophs etc.*** ***3. Differentiate concepts of aerobic and anaerobic respiration and how these are manifested in the form of different metabolic pathways in microorganisms.***

UNIT- I [15 Lectures]

General Account of Microbial Growth: Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, Synchronous growth, Diauxic growth curve. Microbial growth in response to environment -temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), Solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe), Barophilic.

UNIT- II [15 Lectures]

Microbial Growth in Response to Nutrition and Energy: Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph. Passive and facilitated diffusion. Primary and secondary active transport, concept of uniport, symport and antiport Group Translocation Iron uptake.

UNIT- III [15 Lectures]

Bacterial Respiration: Concept of aerobic respiration, anaerobic respiration and fermentation, Sugar degradation pathways *i.e.* EMP, ED, Pentose phosphate pathway, TCA cycle. Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, Electron transport phosphorylation, uncouplers and inhibitors. Fermentation - Alcohol fermentation and

Pasteur Effect; Lactate fermentation (homofermentative and heterofermentative pathways), Concept of linear and branched fermentation pathways.

UNIT- IV [15 Lectures]

Microbial Metabolism: Introduction to aerobic and anaerobic chemolithotrophy. Hydrogen oxidation and methanogenesis. Phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic *vs*. oxygenic. Photosynthesis: photosynthesis in green, purple bacteria and Cyanobacteria.

Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate/nitrite and nitrate/ammonia respiration; fermentative nitrate reduction).

Introduction to biological nitrogen fixation Ammonia assimilation. Assimilatory nitrate reduction, Dissimilatory nitrate reduction, Denitrification.

Recommended Textbooks and References:

1. *Gottschalk, G. Bacterial Metabolism (2nd Ed.). Springer Verlag, New York. 1986.*
2. *Madigan, MT, Bender, K.S., Buckley, D.H., Sattley, W.M. & Stahl, D.A. Brock Biology of Microorganisms (15th Ed.). Pearson/ Benjamin Cummings. 2018.*
3. *Moat, A.G. & Foster, J.W. Microbial Physiology (4th Ed.). John Wiley & Sons. 2002.*
4. *Reddy, S.R. & Reddy, S.M. Microbial Physiology. Scientific Publishers India. 2005.*
5. *Stanier, R.Y., Ingrahm, J.I., Wheelis, M.L. & Painter, P.R. General Microbiology (5thEd.). McMillan Press. 1987.*
6. *Willey, J.M., Sherwood, L., Woolverton, C.J., Prescott, L.M. & Willey, J.M. Prescott's Microbiology. New York: McGraw-Hill. 2011.*
7. *Tortora, G.J., Funke, B.R. & Case, C.L. Microbiology: An Introduction (12th Ed.). Pearson. 2014.*
8. *Alcomo, I.E. Fundamentals of Microbiology (9th Ed.). Jones and Bartlett Publishers. Sudbury. Massachusetts. 2010.*
9. *Black JG. & Black, L.J. Microbiology-Principles and Explorations (10th Ed.) John Wiley & Sons Inc New York. 2017.*
10. *Pelczar, M.L., Chan, E.C.S. & Krieg, N.R. Microbiology (5th Ed.). Mc Graw-Hill Book Company. 2001.*
11. *Besty, T.D.C. & Koegh, J.R.N. Microbiology Demystified (2nd Ed.). McGRAW-HILL. 2012.*
12. *Caldwell, D.R. Microbial Physiology and Metabolism. Star Pub Co. 1999.*

Core Course-X	
BBL-403/BCL-401: INORGANIC CHEMISTRY-II (Periodic Properties of Elements)	**Credits: 4+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
This inorganic chemistry course reviews the s-, p-block elements, transition elements, lanthanides, actinides and noble gases. It further discusses the patterns and trends exhibited by s-, p-block elements, transition elements, lanthanides, actinides and noble gases and their compounds with emphasis on synthesis, structure, bonding and uses.	***After successful completion of this course, students should be able to: -*** ***1. Learn the basic chemistry of s-, p-block elements and their complexes.*** ***2. Understand the structure, bonding, properties and uses of compounds of p-block elements.*** ***3. Understand the group trends with respect to different properties of transition elements, lanthanides, actinides and noble gases and their compounds.***

UNIT-I **[15 Lectures]**

Chemistry of *s* and *p* Block Elements : Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of *s* and *p* block elements.

Hydrides and their classification ionic, covalent and interstitial. Basic beryllium acetate and nitrate.

UNIT-II **[15 Lectures]**

Chemistry of *p* Block Elements: Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudo halogens and basic properties of halogens.

UNIT-III **[15 Lectures]**

Transition Elements: General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, and ability to form complexes.

Stability of various oxidation states and e.m.f. (Latimer & Bsworth diagrams). Difference between the first, second and third transition series.

Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy)

UNIT-IV **[15 Lectures]**

Lanthanides and Actinides: Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).

Noble Gases: Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF_2, XeF_4 and XeF_6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF_2). Molecular shapes of noble gas compounds (VSEPR theory).

Recommended Textbooks and References:

1. *Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.*
2. *Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry (3rd Ed.). John Wiley Sons, N.Y. 1994.*
3. *Greenwood, N.N. & Earnshaw. Chemistry of the Elements, Butterworth-Heinemann. 1997.*
4. *Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH, 1999.*
5. *Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India, Edition, 2002.*
6. *Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry (4th Ed.). Pearson, 2010.*
7. *Atkin, P. Shriver & Atkins' Inorganic Chemistry (5th Ed.). Oxford University Press. 2010.*

Core Course-XI	
BBL-404/BCL-402: ORGANIC CHEMISTRY-II (Functional Group Chemistry)	**Credits: 4+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The core course Organic Chemistry II is designed in a manner that it gives a better understanding of oxygen, nitrogen and sulphur containing functional groups and their reactivity patterns. The detailed reactions mechanistic pathways for each functional group will be discussed to unravel the spectrum of organic chemistry and the extent of organic transformations.	***After successful completion of this course, students should be able to: -*** ***1. Understand preparation, properties and reactions of alcohols, phenols, ethers and epoxides, carbonyl, nitro and sulphur containing compounds.*** ***2. Use the synthetic chemistry learnt in this course to do functional group transformations.*** ***3. To propose plausible mechanisms for the important reactions of Alcohols, Phenols, Ethers and Epoxides, carbonyl, nitro and sulphur containing compounds.***

UNIT-I **[15 Lectures]**

Alcohols: Preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement.

Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer-Tiemann and Kolbe's-Schmidt Reactions, Fries and Claisen rearrangements with mechanism.

Ethers and Epoxides: Preparation and reactions with acids. Reactions of epoxides with alcohols, Ammonia derivatives and $LiAlH_4$

UNIT-II **[15 Lectures]**

Carbonyl Compounds: Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of aldol and benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, n MPV, PDC and PGC); Addition reactions of unsaturated carbonyl compounds: Michael addition.

Active methylene compounds: Keto-enoltautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

UNIT-III **[15 Lectures]**

Carboxylic Acids and their Derivatives: Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids. Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic substitution at acyl group- Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann-bromamide degradation and Curtius rearrangement.

Sulphur Containing Compounds: Preparation and reactions of thiols, thioethers and sulphonic acids.

UNIT-IV [15 Lectures]

Nitrogen Containing Functional Groups: Preparation and important reactions of nitro and compounds, nitriles and isonitriles Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2° and 3° amines with Hinsberg reagent and nitrous acid.

Diazonium Salts: Preparation and their synthetic applications.

Recommended Textbooks and References:

1. *Morrison, R.T., Boyd, R.N. & Bhattacharjee S.K. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).*
2. *Finar, I.L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).*
3. *Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.*
4. *McMurry, J.E. Fundamentals of Organic Chemistry (7th Ed.). Cengage Learning India Edition, 2013.*
5. *Carey, F.A. & Sundberg R.J. Advanced Organic Chemistry, Part A: Structure and Mechanism, Springer.*
6. *Carey, F.A. & Sundberg R.J. Advanced Organic Chemistry, Part B: Reactions and Synthesis, Springer*.

Elective Courses-II	
BBL-405: DNA Barcoding	**Credits: 2+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
This course focuses on the introduction to DNA Barcoding that will provide students with a basic understanding of DNA-based approaches for species identification and discovery. Students will have the opportunity to explore the historical framework for species identification. The fields of taxonomy, ecology, and evolution will be explored	***After successfully completing this course, students should be able to: -*** ***1. Comprehend the concepts of evolution, taxonomy and biodiversity.*** ***2. Understand modern DNA-based approaches for species identification and discovery*** ***3. Utilize various strategies for the conservation of biodiversity***

UNIT-I [8 Lectures]

Evolution: Basics, Darwin's evidence and mechanism of evolution, geological succession, natural selection, adaptation, evolutionary genetics, Hardy- Weinberg; recombination; gene duplication, genetic drift, migration, selection, mutation, gene flow, speciation, DNA barcoding and its relevance from an evolutionary perspective.

UNIT-II [7 Lectures]

Taxonomy: Molecular taxonomy; phylogenetic trees; Delimitation and identification of taxa; Molecular data, Integrated Taxonomy Cryptic, and Nominal Species, Type Specimens.

UNIT-III [8 Lectures]

Biodiversity: Introduction to the concept of biodiversity: definition, qualitative and quantitative assessment. Biodiversity in the world's megatrends: threats identification. Management, conservation, preservation as approaches to biodiversity. Biodiversity indicators, sustainable management, DNA barcoding in ecology and conservation biology.

UNIT-IV [7 Lectures]

DNA Barcoding: Introduction, history, conventional morphological identification against molecular identification using DNA barcode, Metabarcoding, DNA sequencing, DNA barcode regions in plants, animals and microbes, sequence variations, data analysis, phylogenetic tree, character-based tree, haplotype, network; use in conservation and forensics, BLAST, BOLD, I Barcode, Applied DNA barcoding.

Recommended Textbooks and References:

1. *Baum, D.A., & Smith, S.D. Tree thinking: an introduction to phylogenetic biology. Greenwood Village, CO: Roberts. 2013.*
2. *Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F., & Donoghue, M.J. Plant systematics. Sunderland, Massachusetts, USA: Sinauer. 2002.*
3. *Moritz, C., & Cicero, C. DNA barcoding: promise and pitfalls. PLoS biology, 2(10), e354. 2004.*
4. *Lopez, I. & Erickson, D.L. DNA Barcodes: Methods and Protocols. Humana Press. 2012.*
5. *Wheeler, Q.D. The New Taxonomy. CRC Press. 2008.*

Elective Courses-II	
BBL-406: Evolutionary Biology	**Credits: 2+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are to introduce students about early evolution of earth and life on earth along with phenomena of extinction and mass extinctions, and about methods of studying them.	***After successful completing this course, students should be able to: -*** ***1. Understand creation of earth followed by its transformation to the current form, along with change in conditions on it.*** ***2. Acquire in-depth knowledge about theories of evolution, evidences of evolution, concept of species, creation of species, extinction and mass extinctions.*** ***3. Learn about tools and methods for studying evolution.***

UNIT-I [8 Lectures]

Origin of Life and Evidences of Evolution: Life's Beginnings: Evolution of prokaryotes and eukaryotes; Theory of Lamarckism, Darwinism, Neo-Darwinism. Evidences of Evolution: evolution of horse, Neutral theory of molecular evolution, molecular clock, Sources of variations: Heritable variations and their role in evolution

UNIT-II [7 Lectures]

Evolution Law and Forces: Hardy-Weinberg Law, Evolutionary forces upsetting H-W equilibrium; Natural selection, Genetic Drift -mechanism, founder's effect, bottleneck phenomenon; Role of Migration and Mutation in changing allele frequencies

UNIT-III [7 Lectures]

Products of Evolution: speciation mechanisms: Micro evolutionary changes, inter-population variations, clines, races, Species concept, Isolating mechanisms, modes of speciation—allopatric, sympatric, Adaptive radiation, macroevolution

UNIT-IV [8 Lectures]

Origin and Evolution of Man: Origin and evolution of man, Unique hominin characteristics contrasted with primate characteristics, Primate phylogeny from Dryopithecus leading to Homo sapiens, Molecular analysis of human origin; Phylogenetic trees, Multiple sequence alignment, Construction of phylogenetic trees, interpretation of trees.

Recommended Textbooks and References:

1. *Ridley, M. Evolution (2nd Ed.). Blackwell Publishing. 2004.*
2. *Barton, N.H., Briggs, D.E.G., Eisen, J.A., Goldstein, D.B. and Patel, N.H. Evolution. Cold Spring Harbour Laboratory Press. 2007.*
3. *Hall, B.K. & Hallgrimsson, B. Evolution (4th Ed.). 2008.*
4. *Pevsner, J. Bioinformatics and functional genomics (2nd Ed.). Wiley-Blackwell. 2009.*

Skill Enhancement Course-II	
BBL-407: Mushroom Cultivation and Trading	**Credits: 2+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are to demonstrate various types of mushroom cultivating technologies and related trading and entrepreneurship.	***After successfully completing this course, students should be able to: -*** ***1. Understand various types of mushrooms and technologies associated with mushroom industry.*** ***2. Develop a very good understanding of nutritional aspects and commercial use of mushrooms for human consumption.*** ***3. Acquire in-depth knowledge of cultivation, factors affecting production and storage of mushrooms*** ***4. Learn about mushroom trading, cost benefit ratio and marketing strategies for setting mushroom-based Start-up***

UNIT- I [7 lectures]

Introduction and History: Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in India - *Volvariella volvacea, Pleurotus citrinopileatus, Agaricus bisporus*.

UNIT- II [8 lectures]

Cultivation Technology: Infrastructure: substrates (locally available) Polythene bag, vessels, inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparations of spawn, multiplication. Mushroom bed preparation – paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation- low cost technology; composting technology in mushroom production.

UNIT- III [8 lectures]

Harvest and Post-harvest Technology: Storage and nutrition: Short-term storage (Refrigeration – up to 24 hours) Long term Storage (canning, pickles, papads), drying, storage in salt solutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins.

UNIT- IV [7 lectures]

Trading and Entrepreneurship: Types of foods prepared from mushroom. Research Centres – National level and Regional level. Cost benefit ratio - Marketing in India and abroad, Export Value. Entrepreneurship.

Recommended Textbooks and References:

1. *Bahl, N. Handbook on Mushrooms (4th Ed.) Oxford & Ibh Publishing Co. Pvt Ltd. 2000.*
2. *Hirst, B. Mushrooms: A Beginners Guide to Home Cultivation. Createspace Independent Publishing Platform. 2015.*
3. *Pathak, V.N. Mushroom Production and Processing Technology (1st Ed.) Agro-bios. 2011.*
4. *Eiri Staff, E. Hand Book of Mushroom Cultivation, Processing and Packaging. Engineers India Research Institute. 2007.*
5. *Tewari, P. and Kapoor, S.C. Mushroom cultivation. Mittal Publications, Delhi. 2018.*

Skill Enhancement Course-II	
BBL-408: Herbal Technology	**Credits: 2+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are: - ***1. To familiarize the budding biotechnologist with how plant products can be exploited for the wellbeing of mankind.*** ***2. To introduce the students about the use of Herbal Technology as a tool to cure Indian population deprived of costly medicine.***	***After successful completion of this course, students should be able to: -*** ***1. Define and describe the principle of cultivation of herbal products.*** ***2. Gain in-depth knowledge of major herbs, their botanical name, chemical constituents and medicinal uses.*** ***3. Evaluate the drug adulteration through the biological testing.*** ***4. Formulate the value-added processing / storage / quality control for the better use of herbal medicine.***

UNIT- I [8 LECTURES]

Herbal Technology: Definition and scope; Herbal medicines: history and scope; Traditional systems of medicine, A brief overview of AYUSH (Traditional Indian Systems of Medicine); Cultivation, harvesting, processing and storage of herbs and herbal products.

UNIT- II [7 LECTURES]

Value-added Plant Products: Herbs and herbal products recognized in India; Major herbs used as herbal medicines, nutraceuticals, cosmeticals and biopesticides, their botanical names, plant parts used, major chemical constituents.

UNIT- III [7 LECTURES]

Pharmacognosy: Systematic position, botany and medicinal properties of the plant part used and active principles of the following herbs: Tulsi, Ginger, Curcuma, Fenugreek, Indian Gooseberry, *Catharanthus roseus*, *Withania somnifera*, *Centella asiatica*, *Achyranthes aspera*, Kalmegh, Giloe (*Tinospora*), Satavar. Herbal foods, Future of pharmacognosy.

UNIT- IV [8 LECTURES]

Analytical Pharmacognosy: Morphological and microscopic examination of herbs, Evaluation of drug adulteration - types, methods of drug evaluation, Biological testing of herbal drugs, phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds). Plant gene banks, Cultivation of plants and their value-added processing / storage / quality control for use in herbal formulations, introductory knowledge of tissue culture and micro propagation of some medicinal plants (*Withania somnifera*, neem and tulsi).

Recommended Textbooks and References:

1. *Agarwal, P., Alok, S., Fatima, A. & Verma, A. Current scenario of Herbal Technology worldwide: An overview. Int J Pharm Sci Res; 4(11): 4105-17. 2013.*
2. *Agnes, A. Herbal Plants and Drugs. Mangal Deep Publications, Jaipur. 2010.*
3. *Varzakas, T., Zakynthinos, G, & Francis Verpoort, F. Plant Food Residues as a Source of Nutraceuticals and Functional Foods. Foods. 5: 88. 2016.*
4. *Aburjai, T. and Natsheh, F.M. Plants Used in Cosmetics. Phytotherapy Research 17 :987-1000. 2003.*
5. *AYUSH (www.indianmedicine.nic.in). About the systems—An overview of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy. New Delhi: Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH), Ministry and Family Welfare, Government of India.*
6. *Evans, W.C. Trease and Evans PHARMACOGNOSY. 16th Edition, SAUNDERS / Elsevier. 2009.*
7. *Sivarajan, V.V. & India, B. Ayurvedic Drugs and Their Plant Sources. Oxford & IBH Publishing Company. 1994.*
8. *Miller, L. and Miller, B. Ayurveda & Aromatherapy: The Earth Essential Guide to Ancient Wisdom and Modern Healing (4th Ed.). Motilal Banarsidass. 2017.*

Skill Enhancement Course-II	
BBL-409: Clinical Biochemistry	**Credits: 2+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are: - ***1. To introduce students about the normal constituents of urine, blood and their significance in maintaining good health.*** ***2. To develop understanding of the current concepts related to biochemical basis of disease.*** ***3. Exposure to the mechanisms of causation of diseases of liver and kidney.***	***After successfully completing this course, students should be able to: -*** ***1. Students will learn about the normal constituents of urine, blood and their significance in maintaining good health.*** ***2. The mechanisms of causation of diseases of liver, kidney and of Cancer will be explained.*** ***3. Students will become aware with the variations in the levels of triglycerides and lipoproteins and their relationship with various diseases.*** ***4. Students will get acquainted with the role of enzymes in diagnosis of various diseases.***

UNIT- I [8 Lectures]

Urine: Normal composition of urine – volume, pH, colour, specific gravity. Constituents-urea, uric acid, creatinine, pigment. Abnormal constituents – glucose, albumin, ketone bodies, variations in urea, creatinine, pigments and their clinical significance in brief.

Abnormalities in Nitrogen Metabolism: Uremia, Hyperuricemia, Porphyria and factors affecting nitrogen balance.

UNIT- II [7 Lectures]

Blood: Normal constituents of blood and their variation in pathological conditions - urea, uric acid, creatinine, glucose, bilirubin, total protein, albumin/globulin ratio. Lipid profile - cholesterol, triglycerides, lipoproteins - HDL and LDL.

Blood Clotting: Disturbances in blood clotting mechanisms – haemorrhagic disorders – haemophilia, von Willebrand's disease, purpura, Rendu-Osler-Werber disease, thrombotic thrombocytopenic purpura, disseminated intravascular coagulation, acquired prothrombin complex disorders, circulating anticoagulants.

UNIT -III [7 Lectures]

Diagnostic Enzymes: Enzymes in health and diseases. Biochemical diagnosis of diseases by enzyme assays – SGOT, SGPT, alkaline phosphatase, CPK, cholinesterase, LDH

Disorders of Liver and Kidney: Jaundice, fatty liver, normal and abnormal functions of liver and kidney. Inulin and urea clearance.

UNIT- IV [8 Lectures]

Electrolytes and Acid-base Balance: Regulation of electrolyte content of body fluids and maintenance of pH, Reabsorption of electrolytes.

Cancer: Biochemistry of cancer, Cellular differentiation in cancer.

Inborn Errors of Metabolism: Sickle cell anaemia, Phenyl ketonuria, Niemann – Pick disease and Gaucher's disease.

Recommended Textbooks and References:

1. *Choudhary, S.K. Concise Medical Physiology. New Central Book Agency, Calcutta. 2016.*
2. *Hall, J.E. Guyton and Hall Text Book of Medical Physiology (13th Ed.). Saunders. 2015.*
3. *Murray, R.K., Granner, D.K., Mayes, P.A. & Rodwell V.W. Harper's Biochemistry (30th Ed.). McGraw-Hill Education / Medical. 2015.*
4. *Hall, J.E. & Hall, M.E. Textbook of Medical Physiology (14th Ed.). Elsevier. 2020.*
5. *Delvin, T.M. Text Book of Biochemistry with Clinical Correlation (7th Ed.). John Wiley & Sons Inc. USA. 2010.*

Core Course Practical-V	
BBP-410/ BCP-402: Organic Chemistry – LAB V	**Credits: 0+2**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**4 H**

Course Objectives	Student Learning Outcomes
The objectives of this course are: - **1. To make the students learn about different chemical tests for detection of extra elements** **2. To learn about how to perform tests for nitro, amine and amides.** **3. To know how to perform tests for alcohols, carboxylic acids, phenol and carbonyl compounds**	**After successful completion of this course, students should be able to: -** **1. Explain and perform tests for extra element detection in organic compounds.** **2. Explain and perform tests for nitro, amine and amide groups in organic compounds.** **3. Find alcohol, carboxylic acid, phenol and carbonyl groups in a given sample.**

List of Experiments:

1. Detection of extra elements (N, S, Halogens).
2. Functional group test for nitro, amine and amide groups.
3. Qualitative analysis of unknown organic compounds containing following functional groups: alcohol, carboxylic acid, phenol and carbonyl groups.

Recommended Textbooks and References:

1. *Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education. 2009.*
2. *Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry (5th Ed.) Pearson. 2012.*
3. *Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press. 2000.*
4. *Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press. 2000.*

Core Course Practical-VI	
BBP- 411: Microbiology – Lab VI	**Credits: 0+2**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**4 H**

Course Objectives	Student Learning Outcomes
The objective of this course is to educate and train students about microbiological techniques and to expand the knowledge of this scientific field through hands-on training.	***After successful completion of this course, students should be able to: -*** ***1. Develop a good knowledge of the organization of basic microbiology laboratory and precautions taken while dealing with the microorganisms.*** ***2. Develop a very good understanding of nutritional requirement and in vitro cultivation of microbes.*** ***3. Differentiate various types of microorganisms and perform basic experiments to grow and study microorganisms in the laboratory.***

List of Experiments:

1. Good Laboratory Practices and Bio-safety in Microbiology laboratory.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter etc.) used in the microbiology laboratory.
3. Preparation of microbiological media and different sterilization methods.
4. Demonstration of the presence of microflora in the environment by exposing media plates to air.
5. Microscopic observation of microorganisms - bacteria, cyanobacteria, protozoa, fungi, yeasts, and algae from natural habitats.
6. Microscopic examination of common fungi, algae and protozoan using temporary / permanent mounts.
7. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
8. Determination of bacterial cell size by micrometry.
9. Enumeration of microorganism - total and viable count.
10. Isolation and maintenance of organisms by plating, streaking and serial dilution methods.
11. Isolation of pure; cultures from soil and water and their biochemical characterization.
12. Growth curve, Measurement of bacterial population by turbidometry and serial dilution methods.
13. Direct microscopes counting of bacteria.
14. Assay of antibiotics and demonstration of antibiotic resistance.

Recommended Textbooks and References:

1. *Alexopoulos, C.J., Mims, C.W. & Blackwell, M. Introductory Mycology (4th Ed.). John and Sons, Inc. 1996.*
2. *Jay, J.M., Loessner, M.J. & Golden, D.A. Modern Food Microbiology (7th Ed.). CBS Publishers and Distributors, Delhi, India. 2005.*
3. *Kumar, H.D. Introductory Phycology (2nd Ed.). Affiliated East Western Press. 1999.*

4. *Madigan, MT, Bender, K.S., Buckley, D.H., Sattley, W.M. & Stahl, D.A. Brock Biology of Microorganisms (15th Ed.). Pearson/ Benjamin Cummings. 2018.*
5. *Stanier, R.Y., Ingrahm, J.I., Wheelis, M.L. & Painter, P.R. General Microbiology (5thEd.). McMillan Press. 1987.*
6. *Tortora, G.J., Funke, B.R. & Case, C.L. Microbiology: An Introduction (12th Ed.). Pearson. 2014.*
7. *Pelczar, M.L., Chan, E.C.S. & Krieg, N.R. Microbiology (5th Ed.). Mc Graw-Hill Book Company. 2001.*
8. *Willey, J.M., Sherwood, L., Woolverton, C.J., Prescott, L.M. & Willey, J.M. Prescott's Microbiology. New York: McGraw-Hill. 2011.*

Core course –XII	
BBL-501: Genetics	**Credits: 4+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objective of this course is to provide students with an understanding of both classical and modern concepts in genetics with special emphasis on the areas of transmission genetics, molecular and developmental genetics, mapping techniques and chromosomal aberrations.	***After successful completion of this course, students should be able to: -*** ***1. Develop good understanding of fundamentals of genetics.*** ***2. Gain basic knowledge of mendelian and non-mendelian traits.*** ***3. Understand genome organisation in prokaryotes and chromosome structure in eukaryotes.*** ***4. Gain knowledge about concept and mechanism of mutations and variations. They will also understand the mechanism of crossing over and genetic mapping.***

UNIT-I [15 Lectures]

Basic Genetics: Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance.

Mendel's principles, Applications of Mendel's principles, Chromosome Theory of Heredity (Sutton-Boveri), Inheritance patterns- incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple alleles, pseudo-allele, essential and lethal genes, penetrance and expressivity. Inheritance patterns in Human (Sex linked & Autosomal). Non allelic interactions: interaction producing new phenotype complementary genes and epistasis (dominant & recessive).

UNIT - II [15 Lectures]

Chromosome and Genomic Organization: Eukaryotic nuclear genome, Nucleotide sequence composition –unique and repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, middle repetitive sequences- VNTRs and dinucleotide repeats, repetitive transposed sequences- SINEs & LINEs, middle repetitive multiple copy genes, noncoding DNA, Transposons.

Genetic organization of prokaryotic and viral genome, chromosome morphology, concept of euchromatin and heterochromatin. Packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function.

UNIT -III [15 Lectures]

Gene Mutations: Definition and types of mutations, Causes of mutations, Ames test for mutagenic agents, Screening procedures for isolation of mutants and uses of mutants, Variations in chromosomes structure - deletion, duplication, inversion and translocation (reciprocal and Robertsonian), Position effects of gene expression, Chromosomal aberrations in human beings, Abnormalities – Aneuploidy

and Euploidy. Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, Fragile-X-syndrome.

Genetic Disorders: Down, Turner and Klinefelter syndromes, chronic myeloid leukemia, cri-du-chat syndrome, cystic fibrosis.

UNIT –V [15 Lectures]

Genetic Linkage, Crossing Over and Chromosome Mapping: Linkage and Recombination of genes in a chromosome crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Genetic mapping.

Extra Chromosomal Inheritance: Chloroplast inheritance, mitochondria inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting.

Recommended Textbooks and References:

1. *Hartl, D.L. & Jones, E.W. Genetics: Principles and Analysis. Sudbury, MA: Jones and Bartlett. 1998.*
2. *Pierce, B.A. Genetics: a Conceptual Approach. New York: W.H. Freeman. 2005.*
3. *Tamarin, R.H. & Leavitt, R.W. Principles of Genetics. Dubuque, IA: Wm. C. Brown. 1991.*
4. *Klug, W.S., Cummings, M.R., Spencer, C.A., Palladino, M.A. & Killian, D. Concepts of Genetics (12th Ed.). Pearson Education Limited: London. 2019.*

Core course –XIII	
BBL-502: Developmental Biology	**Credits: 4+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are: - ***1. To provide the students a comprehensive understanding of the concepts of early animal development.*** ***2. To familiarize the students with the events that led up to and comprise the process of fertilization, cleavage, blastulation, gastrulation, cell commitment and determination and development of different body structure.***	***After successful completion of this course, students should be able to: -*** ***1. List the types of characteristics that make an organism ideal for the study of developmental biology.*** ***2. Compare and contrast spermatogenesis and oogenesis and meiosis and mitosis and fertilization process in mammals.*** ***3. Describe the organogenesis in different animals and the fate of the embryo.*** ***4. Conclusively explain the development of the life starting from the first day to the formation of different organs and cellular and genetic control of the development.***

UNIT- I [15 Lectures]

Gametogenesis and Fertilization: Definition, scope and historical perspective of developmental biology; Gametogenesis: spermatogenesis, oogenesis, Generalized structure of mammalian ovum and sperm; Fertilization: Definition, mechanism and types of fertilization; Different types of eggs on the basis of yolk.

UNIT- II [15 Lectures]

Early Embryonic Development: Definition, types, patterns & mechanism; Blastulation: Process, types & mechanism; Morphogenetic movements- epiboly, emboly, extension, invagination, convergence, delamination; Formation & differentiation of primary germ layers; Fate Maps in early embryos. Early development of mammals up to gastrulation. Embryonic induction and organizers.

UNIT- III [15 Lectures]

Embryonic Differentiation: Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation, control of differentiation at the level of genome, transcription and post-translation level; Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.

UNIT-IV [15 Lectures]

Organogenesis: Neurulation, Notogenesis, Development of vertebrate eye. Development of behaviour: constancy & plasticity; Extra embryonic membranes, Placentation in Mammals: Definition, types and functions of placenta.

Recommended Textbooks and References:

1. *Gilbert, S.F. Developmental Biology (8th Ed.). Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA. 2010.*
2. *Balinsky, B.I. An introduction to Embryology. International Thomson Computer Press. 2008.*
3. *Kalthoff, K. Analysis of Biological Development (2nd Ed.). McGraw-Hill Professional. 2000.*
4. *Slack, J.M.W. Essential of Developmental Biology (3rd Ed.). Blackwell Publishing. 2012.*

Core course –XIV	
BBL-503/BCL-501: INORGANIC CHEMISTRY-III (Coordination Chemistry)	**Credits: 4+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The course introduces the students to coordination compounds which find manifold applications in diverse areas like qualitative and quantitative analysis, metallurgy, as catalysts in industrial processes as medicines, paints and pigments as well as in life. This course will provide an insight into inorganic reaction mechanism and metal ions present in biological systems along with their role.	***After successful completion of this course, students should be able to: -*** ***1. Understand the terms, ligand, density of ligands, chelate, coordination number and use standard rules to name coordination compounds.*** ***2. Use Valence Bond Theory to predict the structure and magnetic behaviour of metal complexes and understand the terms inner and outer orbital complexes. Explain magnetic properties and colour of complexes on basis of Crystal Field Theory*** ***3. Understand the important properties of transition metals and use Latimer diagrams to predict and identify species which are reducing, oxidizing, etc.*** ***4. Understand inorganic reaction mechanisms and differentiate between kinetic and thermodynamic stability.***

UNIT- I [15 Lectures]

Coordination Chemistry-I : Werner's theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of 10 Dq (Δo), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq (Δo, Δt). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory.

UNIT- II [15 Lectures]

Coordination Chemistry-II: IUPAC nomenclature of coordination compounds, Isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, Polynuclear complexes, Labile and inert complexes- Thermodynamic & Kinetic stability.

UNIT- III [15 Lectures]

Reaction Kinetics and Mechanism: Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans- effect, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes, Thermodynamic and kinetic stability, Kinetics of octahedral substitution, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes.

UNIT- IV **[15 Lectures]**

Bioinorganic Chemistry: Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium / K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine. Iron and its application in bio-systems, Haemoglobin; Storage and transfer of iron.

Recommended Textbooks and References:

1. *Purcell, K.F & Kotz, J.C. Inorganic Chemistry W.B. Saunders Co. 1977.*
2. *Huheey, J.E. Inorganic Chemistry, Prentice Hall. 1993.*
3. *Lippard, S.J. & Berg, J.M. Principles of Bioinorganic Chemistry Panima Publishing Company. 1994.*
4. *Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry Wiley-VCH. 1999.*
5. *Basolo, F, & Pearson, R.C. Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY. 1967.*
6. *Greenwood, N.N. & Earnshaw A. Chemistry of the Elements, Butterworth-Heinemann. 1997.*

Core course –XV	
BBL-504/BCL-504: Pharmaceutical Chemistry	**Credits: 4+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objective of this paper is to develop basic understanding of drugs discovery, design, development and their side effects. The course will cover synthesis of major drug classes. An overview of fermentation process and production of certain dietary supplements and certain common antibiotics will be discussed.	***After successful completion of this course, students should be able to: -*** ***1. Gain insight into retro-synthesis approach in relation to drug design and drug discovery.*** ***2. Learn synthetic pathways/ therapeutic uses of major drug classes including-analgesics, antipyretics, anti- inflammatory agents, antibacterial and antifungal agents, antiviral agents, central nervous system agents and drugs for HIV--AIDS.*** ***3. Understand the fermentation process and production of ethanol, citric acids, antibiotics and some classes of vitamins.***

UNIT- I [15 Lectures]

Drug Action: Physiochemical aspects of Drug action- Stereochemical aspects of drug action (Optical, geometric and bioisosterism of drug molecules with biological action), conformational isomerism, solubility and partition coefficient, chemical bonding. Drug receptor, Drug receptor interactions, receptor- effector theories, types of receptor and their action including transduction mechanism and G proteins. Principles of drug design (Theoretical aspects).

UNIT- II [15 Lectures]

Pharmaceuticals: Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarials: Chloroquine (with synthesis). An elementary treatment of antibiotics and detailed study of chloramphenicol and antacid (ranitidine). Antibacterial and antifungal agents (Sulphonamides, Sulphanethoxazole, Sulphacetamide, Trimethoprim). Medicinal values of curcumin (haldi), azadirachtin (neem).

UNIT -III [15 Lectures]

Drug Synthesis: Synthesis of the representative drugs of the following classes: Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular (Glyceryl trinitrate), anti-leprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine), antiviral agents (Acyclovir).

UNIT- IV [15 Lectures]

Fermentation: Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.

Recommended Textbooks and References:

1. *Patrick, G. L. Introduction to Medicinal Chemistry, Oxford University Press, UK. 2013.*
2. *Singh, H. & Kapoor, V.K. Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi. 2012.*
3. *Foye, W.O., Lemke, T.L. & William, D.A. Principles of Medicinal Chemistry (4th Ed.) B.I. Waverly Pvt. Ltd. New Delhi*

Discipline Specific Elective-I	
BBL-505: Plant Diversity	**Credits: 2+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are:- ***1. To introduce students with the basic concept of plant diversity.*** ***2. To provide students with informed perspectives on economic importance of various groups of the plants like Algae, Fungi, Lichens, Bryophyta, Pteridophyta, Gymnosperms and Angiosperms.***	***After successful completion of this course, students should be able to: -*** ***1. Know the distribution, structure, pigmentation, food reserves and reproduction of Algae, Fungi, Lichens, Bryophyta, Pteridophyta, Gymnosperms and Angiosperms.*** ***2. Know the economic importance of these plant groups and their role to mankind.*** *3.* ***Perform basic laboratory experiments to study the vegetative and reproductive parts of plants belonging to these groups.***

UNIT -I [8 Lectures]

Give general characteristics, classification, brief life history and economic importance of the following:

Algae: *Nostoc*, *Volvox*, *Vancheria*, *Ectocarpus* and *Polysiphonia*

Fungi: Mucor, Yeast, Agaricus and Colletotrichiom.

Lichens: General account of Crustose, Foliose and Fruiticose Lichens

UNIT- II [7 Lectures]

Give general characteristics, classification (up to classes), brief life history and economic importance of the following:

Bryophyta: *Marchantia* and *Funaria*

Pteridophyta: *Pteris* and *Equisetum*

(Structural and developmental details are not required)

UNIT- III [7 Lectures]

Give general characteristics, classification (up to classes), brief life history and economic importance of the following:

Gymnosperms: *Pinus* and *Cycas*

(Structural and developmental details are not required)

UNIT- IV [8 Lectures]

Salient features, vegetative, floral characteristics and economic importance of the following families including floral structure of given flowers:

Angiosperms: Brassicaceae: *Brassica,* **Leguminoseae:** *Lathyrus,* **Solanceae:** *Solanum,***Malvaceae :** *Hibiscus rosa-sinensis,* **Asteraceae:** *Helianthus,* **Poaceae:** *Triticum.*

Recommended Textbooks and References:

1. *Agrios, G.N. Plant Pathology (4th Ed.) Academic Press, U.K. 1997.*
2. *Alexopoulos, C.J., Mims, C.W. & Blackwell, M. Introductory Mycology (4th Ed.). John Wiley and Sons (Asia) Singapore. 1996.*
3. *Bold, H.C. & Wayne, M.J. Introduction to Algae (2nd Ed.) Pearson. 1996.*
4. *Lee, R.E. Phycology (4th Ed.). Cambridge University Press, USA. 2008.*
5. *Sambamurty, A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany.IK International Publishers. 2008.*
6. *Shaw, A.J. & Goffinet, B. Bryophyte Biology. Cambridge University Press.2000.*
7. *Vander-Poorteri, Introduction to Bryophytes. COP. 2009.*
8. *Webster, J. & Weber, R. Introduction to Fungi (3rd Ed.). Cambridge University Press, Cambridge. 2007.*

Discipline Specific Elective-I	
BBL-506: Plant Biotechnology	**Credits: 2+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
This course is envisaged to introduce the students about the basic principles of plant biotechnology. It will also provide an insight into modern biotechnology tools and their applications in crop improvement & plant-based product development.	***After the completion of this course, the students will be able to: –*** ***1. Understand the importance of transgenic plants, its commercial status and public acceptance.*** ***2. Understand the molecular mechanism of nitrogen fixation, photosynthesis, biotic and abiotic stress.*** 3. ***Exploit plants for the production of valuable secondary metabolites and biofuel.***

UNIT- I [8 Lectures]

Genetic Transformation: Basis of tumour formation, hairy roots, features of Ti and Ri plasmids, Mechanisms of transformation, binary vectors, use of 35S and other promoters, Genetic markers, Use of reporter genes, Transformation of monocots, Transgene stability and gene silencing, Herbicide and insect resistance, Plant genetic engineering: Transgenic plants, Genetically modified (GM) plants (Bt cotton, Bt Brinjal).

UNIT-II [8 Lectures]

Transgenic Plants and the Society: Transgenic plants, commercial status and public acceptance. Bio-safety guidelines for research involving GMO's, Benefits and risks, Socio-economic impact and ecological considerations of GMO's. Gene flow, National biosafety policies and law, WTO and other international agreements related to biosafety, Cross border movement of germplasm; Risk management issues – containment.

Agricultural Biotechnology: An overview, Concept of Sustainable Agriculture, Role of biofertilizers and bio-pesticides in sustainable agriculture.

UNIT- III [7 Lectures]

Plant Metabolism: Photoregulation and phytochrome regulation of nuclear and chloroplast genes expression, Molecular biology of light and dark reactions of photosynthesis, Molecular mechanism of nitrogen fixation, Genetics of *nif* genes.

UNIT- IV [7 Lectures]

Plant Secondary Metabolites: Plant secondary metabolites, Control mechanisms and manipulation, Metabolic pathways of production of alkaloids and industrial enzymes, Biodegradable plastics, Therapeutic proteins, Edible vaccines, Green house technology.

Molecular genetics of biotic and abiotic stress

Recommended Textbooks and References:

1. *Bhojwani, S.S. & Razdan, M.K. Plant Tissue Culture and Practice. Elsevier. 2004.*
2. *Brown, T. A. Gene cloning and DNA analysis: An Introduction (7th Ed.). Wiley-Blackwell. 2016.*
3. *Gardner, E.J., Simmonns, M.J. & Snustad, D.P. Principles of Genetics (8th Ed.). Wiley India. 2008.*
4. *Raven, P., Johnson, G., Mason, K., Losos, J. & Duncan, T. Biology (12th Ed.) Tata McGraw Hill Publications, New York. US. 2020.*
5. *Reinert, J. & Bajaj, Y.P.S. Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House. 1997.*
6. *Russell, P.J. Genetics – A Molecular Approach (3rd Ed.). Benjamin Co. 2009.*
7. *Sambrook, J. & Green, M.R. Molecular Cloning: A laboratory manual (4th Ed.). CSHL Press. 2012.*
8. *Slater, A., Scott, N.W. & Fowler, M.R. Plant Biotechnology: The Genetic Manipulation of Plants. Oxford University Press. 2008.*

Discipline Specific Elective-I	
BBL-507: Plant Breeding	**Credits: 2+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are: - ***1. To familiarize the students with the basic concepts of plant breeding and plant genetic resources*** ***2. To equip the students with the conventional and modern approaches of crop improvement***	***After successful completion of this course, students should be able to: -*** ***1. Develop conceptual understanding of plant genetic resources, plant breeding, gene bank and gene pool.*** ***2. Reflect upon the role of various non-conventional and modern approaches used in crop improvement.*** ***3. Understand the socio-economic benefits of transgenic plants and associated biosafety and ethical issues.***

UNIT-I [7 Lectures]

Nature and Scope of Plant Breeding : Introduction and objectives of Plant Breeding, Ideotype Concept, Major International and National Plant Breeding Institutes / Centres, Some reputed Indian and International Plant Breeders, Significant achievements of plant breeding (Semi-dwarf wheat and rice, Nobilization of Indian Canes, Hybrid Millets, Hybrid Cotton, Disease resistance and Transgenic varieties), Undesirable consequences of Plant Breeding (Genetic erosion, Narrow Genetic base, Increased susceptibility to minor diseases).

UNIT- II [8 Lectures]

Methods of Crop Improvement: Breeding, Hybridization, backcross breeding, recombinant inbred lines, Molecular breeding- marker assisted selection (MAS), foreground and background selection, QTLs- cisQTLs, eQTLs, trait introgression, Genome wide association studies. Cytoplasmic male sterility and principles of hybrid seed production, TGMS and PGMS, applications of male sterility in hybrid seed production. Transgenic male sterility, clonal propagation, grafting and their uses, Plant tissue culture, Hormones and their uses, Double haploids development mechanisms and its application in crop improvement.

UNIT -III [7 Lectures]

Biotechnological Advances in Crop Improvement: Genetic engineering methods to improve stress tolerance. Binary vectors, Overexpression, Gene silencing, Gene editing, Plant transformation, Transgenic plants few examples (Bt-cotton, Bt-brinjal). Socio-economic benefits of transgenic plants, Biosafety -ethical issues associated with GM crops. Procedure for Release of transgenic varieties and IPR rights.

UNIT- IV **[8 Lectures]**

Genetic Resources: Crop Genetic Resources and Centres of Diversity, Basics of Gene Banks, Gene Pool: Primary, Secondary and Tertiary Gene Pools, Gene conversion, Gene duplication and divergent evolution, Collecting, maintenance, evaluation, storage and documentation, Genetic diversity within crops, Tools for drawing phylogenetic inferences and its importance.

Recommended Textbooks and References:

1. *Chaudhari, H.K. Elementary Principles of Plant Breeding (2nd Ed.). Oxford – IBH. 1984.*
2. *Das, L.D.V. Plant Breeding. New Age International Publishers, New Delhi. 2006.*
3. *Sharma, J.R. Principles and practices of Plant Breeding. Tata McGraw-Hill Publishing Company Ltd., New Delhi. 1994.*
4. *Singh, B.D. Plant Breeding: Principles and Methods (9th Ed.). Kalyani Publishers. 2012.*
5. *Phundan, S. Essentials of Plant Breeding. Kalyani Publishers, New Delhi. 1996.*

Discipline Specific Elective-II	
BBL-508: Bioinformatics	**Credits: 2+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are to introduce students about the bioinformatics tools of analysing biological data and testing hypotheses using computer science algorithms. The course will provide a basic overview of various information repositories widely used in biological sciences; and tools for searching or querying those databases. This will build the foundation of sequence alignment techniques and finding evolutionary connections.	***After successful completion of this course, students should be able to: -*** ***1. Perform computational analyses of biological sequences.*** ***2. Browse or retrieve gene, protein sequences and related information from biological databases.*** ***3. Learn to align sequences using various approaches.*** ***4. Understand the notion of similarity, identity, and gaps in the context of sequence alignment and deduce evolutionary relationships among sequences.***

UNIT- I [8 Lectures]

General Introduction: Basics of computer and information technology in context to bioinformatics, History of Bioinformatics. Goal, Scope and application of Bioinformatics, The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web.

UNIT- II [7 Lectures]

Protein Information Sources: PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry.

UNIT III [8 Lectures]

Sequence and Phylogeny Analysis: Detecting Open Reading Frames, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Introduction to molecular phylogeny and Phylogenetic Analysis.

UNIT- IV [7 Lectures]

Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, online sequence/Data Submission.
Genome Annotation: Pattern, repeat finding and motif finding, Gene identification tools.

Recommended Textbooks and References:

1. *Ghosh, Z. & Bibekanand, M. Bioinformatics: Principles and Applications. Oxford University Press. 2008.*
2. *Xiong, J. Essential Bioinformatics. (1st Ed.). Cambridge University Press. 2006.*
3. *Rastogi, S.C. Bioinformatics: methods and applications (4th Ed.). PHI learning. 2013.*
4. *Pevsner, J. Bioinformatics and Functional Genomics (2nd Ed.). Wiley-Blackwell. 2009.*
5. *Campbell, A.M., & Heyer, L.J. Discovering Genomics, Proteomics and Bioinformatics (2nd Ed.). Benjamin Cummings. 2006.*

Discipline Specific Elective-II	
BBL-509: Biostatistics	**Credits: 2+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are: - ***1. To provide the required skill to apply the statistical tools in biotechnology problems.*** ***2. To introduce the basic concepts of probability and random variables.*** ***3. To acquaint the knowledge of testing of hypothesis for small and large samples this plays an important role in real life problems.***	***After successful completion of this course, students should be able to: -*** ***1. Develop the basic concepts of statistics and their importance*** ***2. Understand the fundamental knowledge of the concepts of probability and have knowledge of standard distributions which can describe real life phenomenon.*** ***3. Apply the concept of testing of hypothesis for small and large samples in real life problems.*** ***4. Apply the basic concepts of classifications of design of experiments in the field of agriculture and statistical quality control.***

UNIT- I [8 Lectures]

Data Types: Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.

UNIT- II [7 Lectures]

Probability: Probability classical & axiomatic definition of probability, Elementary ideas of Binomial, Poisson and Normal distributions.

UNIT- III [7 Lectures]

Test of Significance: Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, Z, t-test, chi-square test for goodness of fit.

UNIT- IV [8 Lectures]

ANOVA: Introduction to sample survey methods for crop, livestock and their products. Bioassay - meaning and uses. Experimental designs: Completely Randomized Design (CRD.) and Randomized Block Design (R.B.D). Analysis of variance. Correlation and Regression. Emphasis on examples from Biological Sciences.

Recommended Textbooks and References:

1. *Le, C.T. Introductory Biostatistics (1st Ed.). John Wiley, USA. 2003.*
2. *Glaser, A.N. High Yield Biostatistics. Lippincott Williams and Wilkins. USA. 2001.*
3. *Edmondson, A. & Druce, D. Advanced Biology Statistics. Oxford University Press. 1996.*
4. *Danial, W. Biostatistics: A foundation for Analysis in Health Sciences. John Wiley and Sons Inc. 2004.*
5. *Daniel, W.W. Biostatistics: A Foundation for Analysis in the Health Sciences. John Wiley & Sons. 1987.*
6. *Dutta, N.K. Fundamentals of Bio-Statistics. Kanishka Publication. 2002.*

Discipline Specific Elective-II	
BBL-510: Genomics and Proteomics	**Credits: 2+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are to provide the students a broader knowledge on the structure and function of genomes, the technologies developed for genomics, functional genomics, proteomics and metabolomics	***After successful completion of this course, students would have: -*** ***1. Gained a better understanding of the organization of genomes in multiple levels of taxa, and the methodologies and approaches used for the study of structural and functional genomics.*** ***2. Acquired knowledge on various genome mapping and sequencing methods, genomic markers, microarray technology and methods for proteomics and metabolomics.***

UNIT-I **[8 Lectures]**

Introduction to Omics: Introduction to genome, transcriptome, proteome and metabolome; Overview of genomes of bacteria, archae, and eukaryote; Genomes of organelles.

UNIT-II **[7 Lectures]**

Genome Mapping and Sequencing: Genetic and physical mapping, Linkage analysis, RFLP, SNP, SSLP, Restriction mapping, STS mapping, FISH, Top-down and bottom-up sequencing strategies, Whole genome sequencing, Gap closure, Pooling strategies.

UNIT-III **[7 Lectures]**

Functional Genomics: Genome annotation, ORF and functional prediction, Gene finding, Subtractive DNA library screening, Differential display and representational difference analysis, SAGE, TOGA, Introduction to DNA microarray.

UNIT-IV **[8 Lectures]**

Proteomics: Basics of mass spectrometry, Tandem MS/MS spectrometry, MALDI TOF and ESI, and their application in proteomics, Peptide sequencing by tandem mass spectrometry. Protein microarrays, Yeast two hybrid system, Clinical and biomedical application of proteomics

Metabolomics: Metabolomics: Definition, History, Tools, Databases and the Applications

Recommended Textbooks and References:

1. *Sandor, S. Genomics and Proteomics: Functional and Computational Aspects. Springer. 2009.*
2. *Devarajan, T. & Jeyabalan, S. Genomics and Proteomics: Principles, Technologies, and Applications. Apple Academic Press. 2015.*

3. *Rudolph, M. Genomics and Proteomics: Functional and Computational Aspects. Syrawood Publishing House. 2019.*
4. *Cullis, C.A. Plant Genomics and Proteomics, Wiley-Blackwell. 2004.*
5. *Bagchi, D., Swaroop, A. & Bagchi, M. Genomics, Proteomics and Metabolomics in Nutraceuticals and Functional Foods. John Wiley & Sons, Ltd. 2015.*
6. *John, P. Genomics and Proteomics: Functional and Computational Aspects. Westbury Publishing Ltd. 2020.*
7. *Primrose, S.B. & Twyman. Principles of Genome Analysis and Genomics (7th Ed.). Blackwell Publishing. 2006.*
8. *Edward. C. Genomics. Apple Academics. 2010.*

Core Course Practical-VII	
BBP-511: Genetics and Developmental Biology - Lab VII	**Credits: 0+2**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**4 H**

Course Objectives	Student Learning Outcomes
The objectives of this course are: - ***1. To develop skill in the graduates that understand fundamental genetic principles, comprehensive understanding of concept of early animal development and apply key models and techniques used to study animal and plant development; to enable them to develop practical skills in the field of biology integrating concepts from genetics, molecular biology, cell biology, physiology, ecology and evolution.*** ***2. To give them the opportunity to combine background knowledge and independent research to interpret experimental results and solve problems.***	***After successful completion of this course, students should be able to: -*** ***1. Demonstrate a basic understanding of developmental terms and mechanisms.*** ***2. Utilize laboratory techniques to design and carry-out experimental studies.*** ***3. Demonstrate proficiency in quantitative reasoning and analytical skills*** ***4. Display a broad understanding of core molecular genetics concepts including molecular biology, genetics, cell biology, physiology, and evolution***

List of Experiments:

1. Permanent and temporary mount of mitosis.
2. Permanent and temporary mount of meiosis.
3. Mendelian deviations in dihybrid crosses.
4. Demonstration of - Barr Body-Rhoeotranslocation.
5. Demonstration of chromosomal (structural and numerical) aberrations
6. Study of polytene chromosomes (lamp brush chromosomes and giant chromosomes).
7. Karyotypic with the help of photographs.
8. Effect of colchicine on chromosomes
9. Demonstration of Mendelian laws using colour marbles or beads
10. Evaluation of segregation and random assortment using Chi square test or test of fitness.
11. Construction of genetic maps based on Problems in two and three factor crosses
12. Estimation of acid phosphatase levels in Tad pole tails
13. Pedigree charts of some common characters like blood group, colour blindness and PTC tasting
14. Study of polyploidy in onion root tip by colchicine treatment
15. Identification of developmental stages of chick and frog embryo using permanent mounts.
16. Preparation of a temporary stained mount of chick embryo.
17. Study of developmental stages of Anopheles.
18. Study of the developmental stages of Drosophila from stock culture/ photographs.
19. Study of different types of placenta

Recommended Textbooks and References:

1. *Cooper, G.M. The Cell: A Molecular Approach (8th Ed.) Oxford University Press. 2018.*
2. *Karp, G., Iwasa, J. & Marshall, W. Karp's Cell and Molecular Biology (9th Ed.). John Wiley & Sons. 2020.*

3. *Gardner, E.J., Simmonns, M.J. & Snustad, D.P. Principles of Genetics (8th Ed.). Wiley India. 2008.*
4. *De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology (8th Ed.). Lippincott Williams and Wilkins, Philadelphia. 2017.*
5. *Snustad, D.P., Simmons, M.J. Principles of Genetics. V Edition. John Wiley and Sons Inc. 2009.*
6. *Klug, W.S., Cummings, M.R., Spencer, C.A. Concepts of Genetics. XI Edition. Benjamin Cummings. 2009.*
7. *Russell, P.J. Genetics – A Molecular Approach (3rd Ed.). Benjamin Co. 2009.*
8. *Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. & Carroll, S.B. Introduction to Genetic Analysis (9th Ed.). W. H. Freeman & Co. 2017.*
9. *Gilbert, S. F. Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA. 2006*
10. *Balinsky, B.I. An introduction to Embryology, International Thomson Computer Press. 2008*
11. *Kalthoff . Analysis of Biological Development, II Edition, McGraw-Hill Professional.2000*

Core Course Practical-VIII	
BBP-512/BCP-501: Inorganic Chemistry – Lab VIII	**Credits: 0+2**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**4 H**

Course Objectives	Student Learning Outcomes
The objectives of this course are: - ***1. To make the students learn about gravimetric analysis.*** ***2. To learn about preparation of some common inorganic complexes.***	***After successful completion of this course, students should be able to: -*** ***1. Learn about estimation of different metals gravimetrically.*** ***2. Prepare various metal complexes in the laboratory.***

List of Experiments:

Gravimetric Analysis:

1. Estimation of nickel (II) using Dimethylglyoxime (DMG).
2. Estimation of copper as CuSCN
3. Estimation of iron as Fe_2O_3 by precipitating iron as $Fe(OH)_3$.
4. Estimation of Al (III) by precipitating with oxine and weighing as $Al(oxine)_3$ (aluminium oxinate).

Inorganic Preparations:

1. Tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$
2. *Cis*and *trans* $K[Cr(C_2O_4)_2.(H_2O)_2]$ Potassium dioxalatodiaquachromate (III)
3. Tetraamminecarbonatocobalt (III) ion
4. Potassium tris(oxalate)ferrate(III)

Recommended Textbooks and References:

1. *Mendham, J., A. I. Vogel's Quantitative Chemical Analysis (6th Ed.)Pearson, 2009.*
2. *Vogel's Qualitative Inorganic Analysis, Revised by G. Svehla. Pearson Education. 2002.*
3. *Marr & Rockett Practical Inorganic Chemistry. John Wiley & Sons. 1972.*
4. *Synthesis and characterization of inorganic compounds by W. L. Jolly, Prentice Hall.*

Core Course -XVI	
BBL-601: Bioanalytical Tools	**Credits: 4+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objective of this course is to teach the students about fundamentals of basic trends and techniques that are utilized in different domains of biotechnology for studying different objects, analyzing data and interpretation of results.	***After completing this course, students should be able to develop skills towards basic understanding and practical utility of different biophysical and biochemical techniques that are employed in numerous fields of biotechnological processes ranging from academics, R&D and industries.***

UNIT- I [15 Lectures]

Microscopy: Principle and working of pH meter, autoclave, laminar air flow. Fundamentals of optical microscopy: dark filed, bright field, phase contrast microscopy, fluorescence microscopy, production and applications of X rays, Limitations of optical microscopy, Electron microscopes- introduction, types and applications. Importance of vacuum in electron microscopy.

UNIT- II [15 Lectures]

Spectroscopy: Characteristics and applications, Principle and applications of atomic absorption and atomic emission spectroscopy, UV-visible spectroscopy, Fluorescence spectroscopy, Raman spectroscopy.

Centrifugation: Principle and applications of centrifugation, Analytical and preparative centrifugation, Fixed angle and swinging bucket rotors. RCF and sedimentation coefficient, Differential centrifugation, Density gradient centrifugation and ultracentrifugation.

UNIT- III [15 Lectures]

Analytical Techniques: Chromatography-introduction, types and principle. Paper chromatography, Thin layer chromatography, Column chromatography, Gel filtration chromatography, Ion exchange chromatography, Affinity chromatography, Gas chromatography, High performance liquid chromatography (HPLC).

UNIT- IV [15 Lectures]

Electrophoresis: Introduction to electrophoresis. Agarose-gel electrophoresis, Polyacrylamide gel (native and SDS-PAGE), Pulse field gel electrophoresis, Northern Blotting, Southern Blotting, Western blotting. ELISA, RIA.

Radioisotope Techniques: Introduction to Radioisotopes and their biological applications, Radioactive Decay – Types and Measurement. Principles and Applications of GM Counter, Solid and Liquid Scintillation Counter, Autoradiography, Radiation Dosimetry.

Introduction to Biosensors and their applications

Recommended Textbooks and References:

1. *Plummer, D. An Introduction to Practical Biochemistry. 2006.*
2. *Wilson & Walker. Principles and Techniques in Practical Biochemistry (5th Ed.). Cambridge University Press. 2000.*
3. *Hofmann, A., Wilson and Walker Principles and Techniques in Biochemistry and Molecular Biology, 8th Edition Cambridge University Press. 2018.*
4. *Karp, G.. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. JohnWiley & Sons.Inc. 2010*
5. *De Robertis, E.D.P. and De Robertis, E.M.F.Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.2006*
6. *Cooper, G.M. and Hausman, R.E. The Cell: A Molecular Approach. 5th edition.ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.2009.*
7. *Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. The World of the Cell.7thedition. Pearson Benjamin Cummings Publishing, San Francisco.2009*
8. *Textbook of Biophysical Chemistry by U N Dash Macmillan Publishers India 2006.*

Core Course –XVII	
BBL- 602: Recombinant DNA Technology	**Credits: 4+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objective of the course is to familiarize the students with the basic concepts in recombinant DNA technology; to acquaint the students to versatile tools and techniques employed in genetic engineering and to appraise them about applications of recombinant DNA technology.	***After successful completion of this course, students: -*** ***1. Will be able to understand and develop the concept of recombinant DNA technique.*** ***2. Will have knowledge of tools and strategies used in genetic engineering*** ***3. Will understand applications of recombinant DNA technology from academic and industrial perspective*** ***4. Can use and apply knowledge of genetic engineering in problem solving and in practice***

UNIT- I **[15 Lectures]**

Introduction to rDNA Technology: Recombinant DNA Technology: introduction and milestone, DNA manipulative enzymes: restriction enzymes, ligases, polymerases, polynucleotide kinase, alkaline phosphatase, Cloning: cutting of DNA molecules, joining of DNA molecules, homopolymer tails, linkers, adapters. Gene cloning vectors: salient features, plasmids, properties, types, pBR322 and pUC18, bacteriophage vectors, cosmids, Artificial chromosomes: BAC, YAC, MAC. Steps for cloning a gene in *E. coli*.

UNIT- II **[15 Lectures]**

Transformation: Transformation of r-DNA into target host organisms: calcium chloride mediated gene transfer, Agrobacterium mediated DNA transfer, Electroporation, Microinjection, Liposome fusion, Particle gun bombardment. Screening and selection of recombinant host cells: blue/white screening. Construction of gene libraries: genomic and cDNA libraries, Blotting techniques, Genome mapping, DNA fingerprinting.

UNIT- III **[15 Lectures]**

Polymerase Chain Reaction: Polymerase Chain Reaction (PCR) and its applications, Reverse transcription, Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, Production of chimeric proteins, Protein engineering concepts and examples.

UNIT- IV **[15 Lectures]**

Applications of rDNA Technology: Applications of rDNA technology in animals, plants/agriculture, industry and medicine/pharmacy. Risks and ethical issues in recombinant DNA technology. Social impact of recombinant DNA technology.

Recommended Textbooks and References:

1. *Brown, T. A. Gene cloning and DNA analysis: An Introduction (7th Ed.). Wiley-Blackwell. 2016.*
2. *Sambrook, J. & Green, M.R. Molecular Cloning: A laboratory manual (4th Ed.). CSHL Press. 2012.*
3. *Clark, D.P. & Pazdernik, N.J. Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA. 2009.*
4. *Primrose, S.B. & Twyman R.M. Principles of Gene Manipulation and Genomics (7th Ed.). Blackwell Publishing, Oxford, U.K. 2006.*

Core Course –XVIII	
BBL-603: Molecular Biology	**Credits: 4+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are to know about the genetic material, its replication, damages, repair, translation and regulation.	***After successful completion of this course, students should be able to: -*** ***1. Understand the structure of DNA and RNA.*** ***2. Learn how DNA replication takes place and its significance.*** ***3. Know what are the causes of DNA damage, and mechanism of its correction.*** ***4. Understand the mechanism of translation in prokaryotes and eukaryotes and how they differ?*** ***5. Comprehend the different mechanisms of gene regulation in prokaryotes.***

UNIT -I [15 Lectures]

DNA Structure: DNA as genetic material: Experiments of Griffith; Avery, McCleod and McCarthy, and Hershey and Chase. RNA as genetic material: Experiment of Frankel and Singer; Nucleic acids: structure of DNA, RNA, and Proteins

Replication: DNA Replication in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, and the replication complex: Pre-primming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

UNIT- II [15 Lectures]

DNA Damage and Repair: Damage, repair and homologous recombination, DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photo reactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion DNA synthesis, recombinational repair, non-homologous end joining. Homologous recombination: models and mechanism.

UNIT -III [15 Lectures]

Transcription: Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, initiation, elongation and termination of RNA chains, Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation,

RNA Splicing and Processing: Processing of pre-mRNA: 5'Cap formation, Polyadenylation, Splicing, rRNA and tRNA splicing.

UNIT -IV [15 Lectures]

Translation: Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation,

elongation and termination of polypeptides, Fidelity of translation, Posttranslational modifications of proteins.

Regulation of Gene Expression: Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Positive and negative control, lac, trp and arb operon,

Recommended Textbooks and References:

1. *Karp, G., Iwasa, J. & Marshall, W. Karp's Cell and Molecular Biology (9th Ed.). John Wiley & Sons. 2020.*
2. *De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology (8th Ed.). Lippincott Williams and Wilkins, Philadelphia. 2017.*
3. *Becker, W. M., Kleinsmith, L. J., Hardin. J. & Bertoni, G. P. The World of the Cell (8th Ed.). Pearson Benjamin Cummings Publishing, San Francisco. 2016.*
4. *Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., & Losick, R. Molecular Biology of the Gene (7th Ed.). Pearson Pub. 2013.*

Core Course –XIX	
BBL- 604/BCL-604: Polymer Chemistry	**Credits: 4+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are: - ***1. To help the student to know about the polymerization, mechanism and kinetics of polymerization.*** ***2. To know the important applications of some common polymers.***	***After successful completion of this course, students should be able to: -*** ***1. Learn about history of polymeric materials and their classification, kinetics of polymerization.*** ***2. Differentiate between glass transition temperature (Tg) and crystalline melting point (Tm), Determine Tg and Tm.*** ***3. Explain solid and solution properties of polymers*** ***4. Learn properties and applications of various useful polymers in our daily life.***

UNIT- I [15 Lectures]

Functionality and its Importance: Criteria for synthetic polymer formation, Polymerisation reactions -Addition and condensation -Mechanism of cationic, anionic and free radical addition polymerization; Metallocene-based Ziegler-Natta polymerisation of alkenes; Relationships between functionality, extent of reaction and degree of polymerization. Bi-functional systems, Poly-functional systems.

UNIT- II [15 Lectures]

Kinetics of Polymerization: Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

Crystallization and Crystallinity: Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

Nature and structure of Polymers: Structure Property relationships.

UNIT -III [15 Lectures]

Molecular Weight of Polymers: Determination of molecular weight of polymers (Mn, Mw etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.

Glass Transition: Glass transition temperature (Tg) and determination of Tg, Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg).

Polymer Solution: Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory-Huggins theory, Lower and Upper critical solution temperatures.

UNIT- IV **[15 Lectures]**

Properties of Polymers: Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly (vinyl chloride) and related polymers, poly (vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes,

Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly (p-phenylene sulphide polypyrrole, polythiophene)].

Recommended Textbooks and References:

1. *Seymour R.B. & Carraher C.E. Polymer Chemistry: An Introduction, Marcel Dekker, Inc. New York. 1981.*
2. *Odian G. Principles of Polymerization (4th Ed.). Wiley. 2004.*
3. *Billmeyer F.W. Textbook of Polymer Science (2nd Ed.). Wiley Interscience, 1971.*
4. *Ghosh P. Polymer Science & Technology, Tata McGraw-Hill Education, 1991.*
5. *Lenz R.W. Organic Chemistry of Synthetic High Polymers. Interscience Publishers, New York, 1967.*

Discipline Specific Elective-III	
BBL-605: Animal Diversity	**Credits: 2+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objective of this course is to gives insight into the development of non-chordate and chordate. The study of non-chordate and chordate highlight general characters and clarification up to level of an Order.	***After successful completion of this course, students should be able to: -*** ***1. Acquire an in-depth knowledge on the classification and relationships in animal world.*** ***2. Develop a holistic appreciation on the anatomy of animals.*** ***3. Enable the students to understand the non-chordate and chordate.*** ***4. Develop an interest in the debate and discussion taking place in the field of animal science.***

UNIT-I [7 Lectures]

Concept of Non-Chordate: General Characters and classification up to order of phylum protista, porifera, coelenterate, Platyhelminthes, Annelida; locomotory organelles, canal system in sycon, Coral reefs, polymorphism in hydrozoa, life history and parasitic adaptation of *Taenia solium* & *Ascaris lumbricoides.*

UNIT-II [8 Lectures]

Origin of Non-Chordate: General Characters and classification upto order of phylum Annelida, Mollusca, Arthropoda and Echinodermata; Metamerism in Annelida, vermicomposting, apiculture, sericulture, vision in arthropods, metamorphosis in Insect, Social Insect & Insect vectors of diseases, torsion in gastropoda, water vascular system in echinodermata, phylogeny of protochordata.

UNIT-III [8 Lectures]

Origin of Chordate: General Characters and classification of phylum chordate upto order; types of scales and migration in Pisces, osmoregulation in Pisces and Amphibian, parental cares, poisonous and non-poisonous snakes, biting mechanism in snakes, flight adaptation, migration and perching mechanism in birds, origin of mammals.

UNIT- IV [8 Lectures]

Anatomy of Vertebrate: Comparative anatomy of various system of vertebrate; integumentary, digestive system, respiratory system, cardiovascular system, urinogenital system, and nervous system.

Recommended Textbooks and References:

1. *Hall, B.K. and Hallgrimsson, B. Strickberger's Evolution (5th Ed.). Jones and Bartlett Publishers. 2014.*
2. *Kardong, K.V. Vertebrates Comparative Anatomy, Function and evolution (4th Ed.). McGraw-Hill Higher Education. 2005.*
3. *Kent, G.C. & Carr, R.K. Comparative Anatomy of the Vertebrates (9th Ed.). The McGraw-Hill. 2000.*
4. *Weichert, C.K. Anatomy of Chordate. McGraw Hill. 1970.*
5. *Young, J.Z. The life of vertebrates (3rd Ed.). Oxford university press. 2004.*

Discipline Specific Elective-III	
BBL-606: Animal Biotechnology	**Credits: 2+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are: - ***1. To familiarize the students about the fundamentals of animal cell culture, gene therapy and IPR*** ***2. To provide the students a comprehensive understanding of the modern biotechnology tools for genetic improvement of farm animal.***	***After successful completion of this course, students should be able to: -*** ***1. Know the requirements of basic animal tissue culture lab, its maintenance and sterilization.*** ***2. Understand the significance of AI, sexing, embryo transfer and embryo cloning for genetic livestock improvement.*** 3. ***Know the role of transgenic technology and maintenance of animal diversity for enhancing production***.

UNIT-I **[8 Lectures]**

Cell and Tissue Culture: Animal biotechnology: overview. Animal cell culture: laboratory facilities, culture media, culture procedures, sterilization, primary culture, cell lines, their maintenance, large scale cell culture production. Stem cell, its various types, stem cell banks, stem cell therapy. Embryo culture, tissue and organ culture, tissue engineering.

UNIT-II **[7 Lectures]**

Reproductive Biotechnology: Artificial insemination, its advantages disadvantages, semen collection, preservation, various methods of sexing semen, AI in farm animals, *In vitro* fertilization, Embryo transfer, its applications and limitations, MOET, embryo sexing. Animal cloning, research application of cloning, examples in different species of farm animals.

UNIT- III **[7 Lectures]**

Transgenic Animals: Objectives of gene transfer, vectors used in gene transfer, reporter genes, various transfection methods, viz; retroviral infection, microinjection, electroporation, etc. Embryonic stem cell transfer, gene targeting/genome editing, identification of transgenic animals, examples in different species of farm animals and their importance, bioethics.

UNIT- IV **[8 Lectures]**

Gene Therapy and IPR: Vectors and delivery systems for gene therapy, Ex vivo and in vivo gene therapy. Gene therapy for genetic diseases, success rates, Animal diversity and animal genetic resources, National biodiversity authority (NBA), Global biodiversity information facility (GBIF),

IPR, patents, trade secrets, copyright, trademarks, patenting of life forms/products, IPR and animal genetic resources.

Recommended Textbooks and References:

1. *Brown, T.A. Molecular biology Labfax II: Gene analysis (2nd Ed.). Academic Press, California, USA. 1998.*
2. *Butler, M. Animal cell culture and technology: The basics (2nd Ed.). Bios scientific publishers. 2004.*
3. *Glick, B.R. & Pasternak, J.J. Molecular biotechnology- Principles and applications of recombinant DNA (4th Ed.). ASM press, Washington, USA. 2009.*
4. *Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. & Carroll, S.B. Introduction to Genetic Analysis (9th Ed.). W. H. Freeman & Co. 2017.*
5. *Watson, J.D., Myers, R.M., Caudy, A. & Witkowski, J.K. Recombinant DNA-genes and genomes- A short course. Freeman and Co., N.Y., USA. 2007.*

Discipline Specific Elective-III	
BBL-607: Immunology	**Credits: 2+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
This course is envisaged to introduce the students about the cell and organ of the immune system, cell adhesion molecule, antigen and types of antibodies. It will also provide an insight into MHC, hybridoma technology and various new immunological techniques	***After successful completion of this course, students should be able to: -*** ***1. Understand general aspects of immune system like different components of the immune system, generation and functions of these components.*** ***2. Understand the concepts of MHC, and Hybridoma technology.*** ***3. Gain in-depth knowledge of important immunological techniques.***

UNIT -I [8 Lectures]

Introduction: Introduction i) Overviews of immune system – Historical perspectives ii) Innate and acquired immunity iii) Clonal nature of immune response. Cells of the immune system: Haematopoiesis and differentiation, lymphocyte trafficking, B-lymphocytes, T-lymphocytes, macrophages, dendritic cells, Natural killer cells and lymphocyte activated killer cells, eosinophil, neutrophils & mast cells.

UNIT- II [7 Lectures]

Organs of the Immune System: Primary and secondary lymphoid organs, systemic function of immune system. 4. Lymphocyte Trafficking: Cell surface proteins, Cell Adhesion molecules (Integrin, Selectin, Cadherin family and Ig Superfamily). Antigen – Immunogenicity Vs. antigenicity, factors effecting immunogenicity, nature of immunogen, epitopes, haptens and antigenicity,

UNIT- III [7 Lectures]

Immunoglobulins: Structure of antibody, antibody effector function, antibody classes and biological activities, antigenic determinants on Immunoglobulins, Immunoglobulins superfamilies. Major histocompatibility complex: General organization and inheritance, MHC molecules and genes, genetic map, cellular distribution, regulation of MHC expression and disease susceptibility.

UNIT- IV [8 Lectures]

Hybridoma Technology: Production of Monoclonal Antibodies, applications of polyclonal and monoclonal antibodies. Antigen–Antibody interactions: Strength of interaction, cross reactivity, antibody affinity, avidity. Antigen-antibody interactions as tools for research and diagnosis: precipitation and agglutination reactions, immunodiffusion, immunoelectrophoresis, immunoassays, Enzyme linked immunosorbent assay (ELISA), Radioimmunoassay (RIA), western blot, Immunofluorescence.

Recommended Textbooks and References:

1. *Punt, J., Stranford, S., Jones, P. & Owen, J.A. Kuby Immunology (8th Ed.). Macmillan International Higher Education. 2018.*
2. *Delves, P.J., Martin, S.J., Burton, D.R. & Roitt, I.M. Roitt's Essential Immunology (13th Ed.). Wiley-Blackwell. 2017.*
3. *Kenneth, M. & Weaver, C. Janeway's Immunobiology (9th Ed.). Garland Science. 2016.*
4. *Abbas, A.K., Lichtman, A.H. & Pillai, S. Cellular and Molecular Immunology (9th Ed.). Saunders Publication, Philadelphia. 2017.*

Discipline Specific Elective-IV	
BBL- 608: Food Biotechnology	**Credits: 2+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are: - ***1. To equip students with theoretical understanding related to different aspects of food biotechnology.*** ***2. To encourage students to learn involvement of microorganisms in foods and exploitation of microorganisms in food industries in addition to use of biotechnological tools for production of useful products including food diagnostics.***	***After successfully completing this course, students should be able to: -*** ***1. Describe the association of microorganisms with food and methods to control.*** ***2. Discover useful microorganisms and their role in food fermentations.*** ***3. Understand various biotechnological approaches for food ingredients.*** ***4. Evaluate new and rapid molecular techniques used in food diagnostics.***

UNIT- I [8 Lectures]

Introduction: Scope and Importance, Microorganisms associated with food, its sources, types and factors affecting growth of microorganisms in foods. Contamination of foods - chemical contaminants. Principles under lying food spoilage: chemical, physical and physiological changes caused by microorganisms, Spoilage of milk and meat products, Spoilage of Canned foods.

UNIT- II [7 Lectures]

Food Preservation: Heat processing, Low temperature storage, Control of Water activity, Modified atmosphere packaging, Irradiations, Chemical preservatives, Bio-preservatives. Fermented Food Products: Microbiology of food fermentation, Dairy fermented products, Fermented beverages: Beer wine, vinegar; Meat fermentation; Fermented vegetable and Cereal products (Tempeh, Soy sauce, Sauerkraut and Kimchi). Important Food Borne illness- Bacterial, Algal toxins and Mycotoxins- A brief account.

UNIT- III [7 Lectures]

Fermentation Biotechnology: Biotechnology & Functional Foods, Nutraceuticals & Nano-nutraceuticals, Single cell protein, Baker's yeast production, Biotechnology routes to food flavour production, Fumaric acid, malic acid, fat substitutes, Natural and artificial sweeteners, Bio-gums etc HACCP & Quality control.

UNIT- IV [8 Lectures]

Food Engineering: Protein Engineering in Food Technology- Objectives, methods, applications in food technology and limitations; Impact of Biotechnology on Microbial testing of foods- Physical & Chemical methods, New approaches in Food diagnostics- Real time PCR, BAX system, Immunological methods, Riboprinter, Biotracing etc.
Nanotechnology in Food industry for value addition and quality control.

Recommended Textbooks and References:

1. *Shetty, K. & Sarkar, D. Functional Foods and Biotechnology: Biotransformation and Analysis of Functional Foods and Ingredients. CRC press. 2020.*
2. *Adams, M.R., Moss M.O. & McClure. P.J. Food Microbiology (4th Ed.). Royal Society of Chemistry, UK. 2016.*
3. *Matthews, K.R.,* Kniel, *K.E. &* Montville, T.J. *Food Microbiology: An Introduction (4th Ed.). ASM Press, Washington, DC. 2019.*
4. *Goldberg, I., Williams, R.A. & Williams. R. Biotechnology and Food Ingredients. Van Nostrand Reinhold, New York. 1991.*
5. *Ricke, S., Donaldson, J.R. & Phillips, C.A.. Food Safety: Emerging Issues, Technologies and Systems. Academic Press. 2015.*

Discipline Specific Elective-IV	
BBL-609: Medical Microbiology	**Credits: 2+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objective of this course is to familiarize the students with the normal *microflora of human body.* The course will also provide the basic concepts of *common diseases caused by bacteria, viruses and other microbes*	***After successful completion of this course, students should be able to: -*** ***1. Acquire a fairly good understanding of normal microflora of human body, common diseases caused by bacteria, viruses and other microbes.*** ***2. Understand the basic components of the immune system and how this system serves to protect the host against disease-causing microbes.*** ***3. Acquire skills of handling microorganisms in the laboratory and study their characteristics.***

UNIT -I [8 Lectures]

Bacterial Pathogenicity & Gram-positive Bacterial Pathogens: Normal microflora of human body. Mechanism of bacterial pathogenicity, colonization and growth, Virulence factors – exotoxins, enterotoxins, endotoxins, neurotoxins. – Avoidance of host defence mechanisms. Host factors responsible for infection and innate resistance to infection. Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of Gram positive bacterial infections: *S. aureus, S. pyogenes, B. anthracis, C. tetani, C. diphtheriae, M. tuberculosis,* and *M. leprae.*

UNIT- II [7 Lectures]

Gram-negative Bacterial Pathogens: Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of diseases caused by Gram negative bacteria: *E. coli, N. gonorrhoea, N. meningitidis, P. aeruginosa, S. typhi, S. dysenteriae, Y. pestis, B. abortus, H. influenzae, V. cholerae, M. pneumoniae, T. pallidum, Rickettsiae,* and *Chlamydiae*.

UNIT III [7 Lectures]

Viral Diseases: Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses, Corona virus family- Covid-19. Other emerging viral diseases.

UNIT- IV [8 Lectures]

Fungal and Protozoan Pathogens: Dermatophytosis (*Trichophyton, Microsporun* and *Epidermophyton*) Subcutaneous infection (*Sporothrix, Cryptococcus*), systemic infection (*Histoplasma, Coccidoides*) and opportunistic fungal infections (Candidiasis, Aspergillosis), gastrointestinal infections (Amoebiasis, Giardiasis), Blood-borne infections (Leishmaniasis, Malaria)

Recommended Textbooks and References:

1. *Carroll, K.C., Morse, S.A., Butel, J.S. & Mietzner, T.A. Jawetz, Melnick and Adelberg's Medical Microbiology (27th Ed.). McGraw Hill Publication. 2017.*
2. *Goering, R., Dockrell, H., Zuckerman, M. & Chiodini, P. Mims' Medical Microbiology (6th Ed.). Elsevier. 2018.*
3. *Willey, J.M., Sherwood, L., Woolverton, C.J., Prescott, L.M. & Willey, J.M. Prescott's Microbiology. New York: McGraw-Hill. 2011.*

Discipline Specific Elective-IV	
BBL-610: Industrial Biotechnology	**Credits: 2+0**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**3 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
***The objectives of this course are to prepare the students for the bulk production of commercially important fermented products, industrial enzymes,* vaccines and diagnostics.**	***After successfully completing this course, students should be able: -*** ***1. To explain the steps involved in the bulk production of biotechnology products.*** ***2. To acquire broad grounding in industrial biotechnology, the innovation opportunities in the global bio-economy and the governance of the technology as well as expertise in the area.*** ***3. To design and deliver useful modern biotechnology products to the society.***

UNIT - I [8 Lectures]

Introduction: Introduction, scope and historical development; isolation, screening and genetic improvement of industrially important microorganisms. Principles of Microbial growth – ways of growing microorganisms, ways to increase yield of microbes, Batch, fed-batch and continuous cultures (definition and kinetics).

UNIT-II [7 Lectures]

Fermentation: Introduction, historical perspective of development of bioprocessing technology. Emerging new technologies for processing and production of recombinant products, isolation and preservation. Media designs, sterilization, downstream processing, important fermentation process.

UNIT-III [7 Lectures]

Immobilization: Immobilization of enzymes and cells, and their application, growth rate analysis, Estimation of biomass, Batch and plug flow cultures, chemostate cultures. Production of vaccines and diagnostics.

UNIT-IV [8 Lectures]

Microbial Technology: Fermented beverages, production of single cell protein, steroid transformation,
silage production, waste water treatment. Industrial application of nanobiotechnology. Computer simulations, Energy requirement and product formation in microbial culture, fed-batch and mixed cultures, scale-up principles.

Recommended Textbooks and References:

1. *Alberghina, L. Protein Engineering for Industrial Biotechnology. Routledge. 2000.*
2. *Kun, L.Y. Microbial Biotechnology. World Scientific Publisher. 2006.*
3. *Singh, R. & Ghosh, S.K. Industrial Biotechnology. Global Vision Publ. House. 2004.*
4. *Thomson, J. Your Guide to Industrial Biotechnology. Abhishek Publication. 2006.*

Core Course Practical IX	
BBP- 611: Plant Biotechnology Lab- IX	**Credits: 0+2**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**4 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Course Objectives	Student Learning Outcomes
The objectives of this course are: - ***1. To train students in plant tissue culture and micro-propagation techniques.*** ***2. To acquire the basic skills of recombinant DNA Technology.***	***After successfully completing this course, students should be able to: -*** ***1. Establish plant cell culture of important plant species.*** ***2. Perform independent genetic engineering experimentations including cloning, transformation and screening of transformants.***

List of Experiments:

1. Plant tissue culture and molecular biology laboratory set up.
2. Preparation of MS stock and culture media.
3. Production of callus and suspension culture.
4. Plant micro-propagation through tissue culture (shoot tip and Nodal culture).
5. Isolation of vector/plasmid DNA.
6. Qualitative and quantitative analysis of DNA using spectrophotometer.
7. Removal of RNA from isolated plasmid/vector DNA.
8. DNA separation by agarose gel electrophoresis.
9. Restriction digestion of vector DNA/gene.
10. Designing the primers for PCR.
11. Demonstration of PCR.
12. Ligation of foreign gene to linearized vector.
13. Preparation of competent cells using chemical methods.
14. Transformation of competent cells.
15. Blue white screening of transformants.

Recommended Textbooks and References:

1. *Bhojwani S.S. and Rajdan M.K. Plant Tissue Culture: Theory and Practice: A Revised Edition, Reed Elsevier, India, New Delhi. 2004.*
2. Chawla Plant Biotechnology: Laboratory Manual For Plant Biotechnology Oxford and IBH Publishing,2004
3. *Sambrook, J. & Green, M.R. Molecular Cloning: A laboratory manual (4th Ed.). CSHL Press 2012.*

Core Course Practical X	
BBP- 612/BCP-601: Inorganic Chemistry Lab-X	**Credits: 0+2**

Maximum Marks	**70**
Internal Marks	**30**
Total Marks	**100**
Time	**4 H**

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

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Course Objectives	Student Learning Outcomes
The objectives of this course are: - ***1. To train students to find qualitatively different cations and anions from given mixture including their chemical reactions.*** ***2. To acquaint students with chromatographic separations of different cations using paper chromatography.***	***After successfully completing this course, students should be able to: -*** ***1. To perform different chemical tests for analysis of various cations and anions from given mixture including their chemical reactions.*** ***2. Students will be able to perform chromatographic separations of different cations using paper chromatography.***

List of Experiments:

1. Qualitative semi-micro analysis of mixtures containing 2 anions and 2 cations. Emphasis should be given to the understanding of the chemistry of different reactions.

The following radicals are suggested:CO_3^{2-}, NO_2^-, S^{2-}, SO_3^{2-},$S_2O_3^{2-}$, CH_3COO^-, F^-,Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, $C_2O_4^{2-}$, PO_4^{3-}, NH_4^+, K^+,Pb^{2+}, Cu^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}. Mixtures should preferably contain one interfering anion, **or** combination of anions e.g. $CO_3^{2-}$and SO_3^{2-}, NO_2^- and NO_3^-,Cl^- and Br^-, Cl^- and I^-, $Br^-$and I^-, NO^{3-} and Br^-, NO_3^- and I^-.

Spot tests should be done whenever possible.

Chromatography of metal ions

2. Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:

i. Ni (II) and Co (II)

ii. Fe (III) and Al (III)

(e.g. bidentate ligands like acetylacetone, DMG, glycine) by substitution method.

Recommended Textbooks and References:

1. *Vogel's Qualitative Inorganic Analysis, Revised by G. Svehla. Pearson Education, 2002.*
2. *Marr & Rockett. Practical Inorganic Chemistry. John Wiley & Sons. 1972.*
3. *Synthesis and characterization of inorganic compounds by W. L. Jolly, Prentice Hall*