FACULTY OF SCIENCES
DEPARTMENT OF LIFE SCIENCES

B.Sc. Life Sciences

w.e.f. 2021-22

J. C. BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY

J. C. BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY

VISION

J. C. Bose University of Science and Technology aspires to be a nationally and internationally acclaimed leader in technical and higher education in all spheres which transforms the life of students through integration of teaching, research and character building.

MISSION

- To contribute to the development of science and technology by synthesizing teaching, research and creative activities.
- To provide an enviable research environment and state-of-the art technological exposure to its scholars.
- To develop human potential to its fullest extent and make them emerge as world class leaders in their professions and enthuse them towards their social responsibilities

DEPARTMENT OF LIFE SCIENCES

VISION

A department that can effectively harness its multidisciplinary strengths to create an academically stimulating atmosphere; evolving into a well-integrated system that synergizes the efforts of its competent faculty towards imparting intellectual confidence that aids comprehension and complements the spirit of inquiry.

MISSION

- To create well-rounded individuals ready to comprehend scientific and technical challenges offered in the area of specialization.
- To counsel the students so that the roadmap becomes clearer to them and they have the zest to turn the blueprint of their careers into a material reality.
- To encourage critical thinking and develop their research acumen by aiding the nascent spirit for scientific exploration.
- Help them take economic, social, legal and political considerations when visualizing the role of technology in improving quality of life.
- To infuse intellectual audacity that makes them take bold initiatives to venture into alternative methods and modes to achieve technological breakthroughs.

B.Sc. Life Sciences

The 'Department of Life Sciences (DLS)', the youngest departments in the J. C. Bose University of Sciences and Technology came into existence in 2020. DLS is an inter-disciplinary department with a holistic approach towards the study of Biological Science. Though still in the fledgling years of its inception, it is paving roads for an exciting way of teaching science.

The B.Sc. program in Life Sciences has been designed in such a way that students will have the opportunity of learning a multitude of inter-disciplinary subjects by the completion of their studies. In the curriculum, there two semesters each academic year and thus a student enrolled in the Bachelor of Science program will leave with a Bachelor's Degree in Life Sciences after completion of six semesters. The course module will help students of the department graduate with a holistic idea about the entire gamut of disciplines comprising life sciences- diversity, evolution, cell and molecular biology, microbiology, genetics, structural biology, developmental biology, biotechnology, bioinformatics, biophysics, environmental biology and neurosciences. In addition, the well-equipped teaching and research laboratories will facilitate the students to develop experimental, analytical and conceptual skills and build their interest in the field of research.

PROGRAM OBJECTIVES

- Producing graduates who are well grounded in the fundamentals and principal concepts and recent development of biological sciences.
- The students are expected to use techniques, skills, and modern instrumental tools necessary for Research practices.
- To enhance student sense of enthusiasm for science and to involve them in an intellectually stimulating experience of course in a supportive environment.
- It is expected to inspire and boost interest of the students in advanced Biological science.
- To develop the power of appreciations, the achievements in science and role in nature and society.

PROGRAM OUTCOMES

After completion of the program, the students will:

PO1. Have sufficient understanding of the basic concepts in biological processes.

PO2. Be able to learn subjects like Green Chemistry/ Pesticide Chemistry/Floriculture etc. as elective or skill enhancement subjects in addition to the core subjects of Botany, Zoology and Chemistry.

PO3. Develop the ability to work with a multidisciplinary approach.

PO4. To use the techniques, skills, and modern instrumental tools necessary for future Research practices

PO5. Be able to stand at par and compete with candidates from renowned universities in any competitive examinations

PO6. Identify their area of interest in academia, research and development

PO7. The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research, if so desired.

PROGRAM SPECIFIC OUTCOMES

PSO1. To develop deep understanding about the classical and applied areas of Zoology, Botany and Chemistry.

PSO2. To inspire the student to pursue post-graduation and further academic studies in different fields of Life Sciences.

PSO3. Knowledge gained through theoretical and lab-based experiments will help them become fundamentally and technically self -sufficient in various fields of Life Sciences

J. C. BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, FARIDABAD
DEPARTMENT OF LIFE SCIENCES

STRUCTURE AND SYLLABI OF B.Sc. Life Sciences (SIX SEMESTER COURSE)

SEMESTER I

Subject Code	Title	L	T	P	Internal Assessment	End- semester Examination	Total Marks	Total Credits
Discipline Core Course (DCC) – Compulsory								
BLS 101	Botany I: Plant Diversity	4	0	0	25	75	100	4
BLS 102	Zoology I: Animal Diversity	4	0	0	25	75	100	4
BLS 103	Chemistry I: Conceptual Organic Chemistry	4	0	0	25	75	100	4
BLS 104	Lab Course I: Botany I	0	0	4	15	35	50	2
BLS 105	Lab Course II: Zoology I	0	0	4	15	35	50	2
BLS 106	Lab Course III: Chemistry I	0	0	4	15	35	50	2
Ability Enhancement Course (AEC) – Compulsory								
BENG 101	English	2	0	0	15	35	100	2
Massive Open Online Course (MOOC)- Compulsory Course in any one semester from Sem-I to Sem-V**								
XXX	MOOC	4/6	0	0	25	75	100	4/6
Total Credits								**20**

**The students have to pass at least one mandatory MOOC course with 4-6 credits (12-16 weeks) from the list given on the SWAYAM portal or the list given by the department/ university from Ist semester to IIIrd semester as notified by the university. (Instructions to students overleaf)

L – Lecture; T - Tutorial; P– Practical

SEMESTER II

Subject Code	Title	L	T	P	Internal Assessment	End semester Examination	Total Marks	Total Credits
Discipline Core Course (DCC) – Compulsory								
BLS 201	Botany II: Plant Ecology and Taxonomy	4	0	0	25	75	100	4
BLS 202	Zoology II: Anatomyand Developmental Biology	4	0	0	25	75	100	4
BLS 203	Chemistry II: Chemistry of Biomolecules	4	0	0	25	75	100	4
BLS 204	Lab Course I: Botany II	0	0	4	15	35	50	2
BLS 205	Lab Course II: Zoology II	0	0	4	15	35	50	2
BLS 206	Lab Course III: Chemistry II	0	0	4	15	35	50	2
Ability Enhancement Course (AEC) – Compulsory								
BEVS 101	Environmental Studies (EVS)	2	0	0	15	35	100	2
Massive Open Online Course (MOOC)- Compulsory Course in any one semester from Sem-I to Sem-V**								
XXX	MOOC	4/6	0	0	25	75	100	4/6
Mandatory Audit Course (MAC)								
XXX	Audit Course #	2	0	0	25	75	100	0
Total Credits								**20**

 # As per the list provided by University Website

SEMESTER III

Subject Code	Title	L	T	P	Internal Assessment	End- semester Examination	Total Marks	Total Credits
Discipline Core Course (DCC) – Compulsory								
BLS 301	Botany III: Plant Anatomy and Embryology	4	0	0	25	75	100	4
BLS 302	Zoology III: Animal Physiology	4	0	0	25	75	100	4
BLS 303	Chemistry III: Chemical Bonding	4	0	0	25	75	100	4
BLS 304	Lab Course I: Botany III	0	0	4	15	35	50	2
BLS 305	Lab Course II: Zoology III	0	0	4	15	35	50	2
BLS 306	Lab Course III: Chemistry III:	0	0	4	15	35	50	2
Skill Enhancement Course (SEC) – Select 1-paper out of the following								
SEC 01	Floriculture	2	0	0	25	75	100	2
SEC 02	Apiculture	2	0	0	25	75	100	2
SEC 03	Biofertilizers and Biopesticides	2	0	0	25	75	100	2
Open Elective Course (OEC-1) * - Select 1-paper of the following 3 given courses								
OCSC-101A	Introduction to Programming	4	0	0	25	75	100	4
OMTH-101A	Calculus	4	0	0	25	75	100	4
OPHY 101A	Electricity and Magnetism	4	0	0	25	75	100	4
Massive Open Elective Course (MOOC)- Online Compulsory Course in any one semester from Sem-I to Sem-V**								
XXX	MOOC	4/6	0	0	25	75	100	4/6
Total Credits								**24**

*OEC- student has to choose one subject out of given disciplines and will be continue from Sem-I to Sem-IV.

SEMESTER IV

Subject Code	Title	L	T	P	Internal Assessment	End- semester Examination	Total Marks	Total Credits
Discipline Core Course (DCC) – Compulsory								
BLS 401	Botany IV: Cell and Molecular Biology	4	0	0	25	75	100	4
BLS 402	Zoology IV: Genetics	4	0	0	25	75	100	4
BLS 403	Chemistry IV: Physical Chemistry for the Biosciences	4	0	0	25	75	100	4
BLS 404	Lab Course I: Botany IV	0	0	4	15	35	50	2
BLS 405	Lab Course II: Zoology IV	0	0	4	15	35	50	2
BLS 406	Lab Course III: Chemistry IV	0	0	4	15	35	50	2
Skill Enhancement Course (SEC) – Select 1-paper out of the following (not opted in Sem-III)								
SEC 04	Mushroom Culture Technology	2	0	0	25	75	100	2
SEC 05	Sericulture	2	0	0	25	75	100	2
Open Elective Course (OEC-2) * - Select 1-paper of the following 3-disciplines								
OMTH 201A	Linear Algebra	4	0	0	25	75	100	4
OCSC 201A	Introduction to Database Systems	4	0	0	25	75	100	4
OELC 201A	Instrumentation	4	0	0	25	75	100	4
Total Credits								**24**

SEMESTER V

Subject Code	Title	L	T	P	Internal Assessment	End- semester Examination	Total Marks	Total Credits
Discipline Core Course (DCC) – Compulsory								
BLS 501	Botany V: PlantPhysiology	4	0	0	25	75	100	4
BLS 502	Zoology V: Immunology	4	0	0	25	75	100	4
BLS 503	Chemistry V: Cheminformatics	4	0	0	25	75	100	4
BLS 504	Lab Course I: Botany V	0	0	4	15	35	50	2
BLS 505	Lab Course II: Zoology V	0	0	4	15	35	50	2
BLS 506	Lab Course III: Chemistry V	0	0	4	15	35	50	2
Discipline Elective Course (DEC) select any1-paper out of the following papers								
DEC 01	EvolutionaryBiology	4	0	0	25	75	100	4
DEC 02	Fundamental of Neuroscience	4	0	0	25	75	100	4
DEC 03	Analytical methodsin Chemistry	4	0	0	25	75	100	4
DEC 04	Bioinformatics	4	0	0	25	75	100	4
DEC 05	Basics of Nanotechnology	4	0	0	25	75	100	4
DEC 06	Omics Technology	4	0	0	25	75	100	4
DEC 07	IPR and Innovation	4	0	0	25	75	100	4
DEC 08	Biostatistics	4	0	0	25	75	100	4
Open Elective Course (OEC-3) * - Select 1-paper out of the following 2-disciplines								
OCSC 301A	Computer Networks and Internet Technology	4	0	0	25	75	100	4
OPHY 301A	Wave and Optics	4	0	0	25	75	100	4
Total Credits								**26**

SEMESTER VI

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total Marks	Total Credits
Discipline Core Course (DCC) – Compulsory								
BLS 601	Botany VI: Plant Biotechnology & Microbiology	4	0	0	25	75	100	4
BLS 602	Zoology VI: Animal Biotechnology	4	0	0	25	75	100	4
BLS 603	Chemistry VI: Bioinorganic & Env. Chemistry	4	0	0	25	75	100	4
BLS 604	Lab Course I: Botany VI	0	0	4	15	35	50	2
BLS 605	Lab Course II: Zoology VI	0	0	4	15	35	50	2
BLS 606	Lab Course III: Chemistry VI	0	0	4	15	35	50	2
Discipline Elective Course (DEC) select any 1-paper out of the following papers (not opted in Sem-V)								
DEC 01	EvolutionaryBiology	4	0	0	25	75	100	4
DEC 02	Fundamental of Neuroscience	4	0	0	25	75	100	4
DEC 03	Analytical methodsin Chemistry	4	0	0	25	75	100	4
DEC 04	Bioinformatics	4	0	0	25	75	100	4
DEC 05	Basics of Nanotechnology	4	0	0	25	75	100	4
DEC 06	Omics Technology	4	0	0	25	75	100	4
DEC 07	IPR and Innovation	4	0	0	25	75	100	4
DEC 08	Biostatistics	4	0	0	25	75	100	4
Open Elective Course (OEC-4) * - Select 1-paper out of the following 2-disciplines								
OCSC 401A	Information Security	4	0	0	25	75	100	4
OPHY 401A	Thermal Physics and Statistical Mechanics	4	0	0	25	75	100	4
Total Credits								**26**

Grand Total Credits: 144/146 [140 + 4/6 (for MOOC Course)]

NOTE:

1. Discipline Elective Course (DEC) papers may be added or deleted as per UGC guidelines.

2. Skill Enhancement Course (SEC) papers may be added or deleted as per UGC guidelines.

Instructions to the students regarding MOOC

1. Two types of courses will be circulated: branch specific and general courses from the website https://swayam.gov.in in the month of June and November every year for the forthcoming semester.

2. The department coordinators will be the course coordinators of their respective departments.

3. Every student has to pass a selected MOOC course within the duration as specified below:

Programme	**Duration**
B. Tech.	Sem. I to Sem. VII
M.Sc./M.Tech./MA/MBA	Sem. I to Sem. III
B.Sc./MCA	Sem. I to Sem. V

The passing of a MOOC course is mandatory for the fulfilment of the award of the degree of concerned programme.

4. A student has to register for the course for which he is interested and eligible which is approved by the department with the help of course coordinator of the concerned department.

5. A student may register in the MOOC course of any programme. However, a UG student will register only in UG MOOC courses and a PG student will register in only PG MOOC courses.

6. The students must read all the instructions for the selected course on the website, get updated with all key dates of the concerned course and must inform his/her progress to their course coordinator.

7. The student has to pass the exam (online or pen-paper mode as the case may be) with at least 25% marks.

8. The students should note that there will be a weightage of Assessment/quiz etc. and final examination appropriately as mentioned in the instructions for a particular course.

9. A student must claim the credits earned in the MOOC course in his/her marksheet in the examination branch by forwarding his/her application through course coordinator and chairperson.

Grading Scheme

*Percentage	Grade	Grade Points	Category
90	O	10	Outstanding
80 to < 90	A+	9	Excellent
70 to < 80	A	8	Very Good
60 to < 70	B+	7	Good
50 to < 60	B	6	Above average
45 to < 50	C	5	Average
40 to < 45	P	4	Pass
< 40	F	0	Fail
	AB	0	Absent

***Lower limit included, upper limit excluded**

The multiplication factor for CGPA is 10

1. Automatic Rounding

2. Average difference between actual percentage and CGPA percentage ± 2.5%

3. Worst case difference between actual percentage and CGPA percentage ± 5% if somebody in all the 8 semesters in all the exams (around 75 in numbers) consistently scores at the bottom of the range, say 55 of 55-65 which is a very remote possibility.

SEMESTER- I

No. of credits: 4
L: 4
P: 0

DCC-Botany I (BLS101): Plant Biodiversity

Course objective: To introduce students fundamental concepts related to microbes, algae, fungi and lower archegoniate. To gain knowledge of diversity, life forms, life cycles, morphology and importance of microorganisms. To create a knowledge base in understanding diversity, morphology, anatomy, reproduction, economic and ecological importance of lower group of plants

Unit 1

Microbes: Viruses; Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

Algae: General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: *Nostoc*, *Chlamydomonas, Oedogonium*, *Vaucheria, Fucus, Polysiphonia*. Economic importance of algae

Unit 2

Fungi: Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of *Rhizopus* (Zygomycota) *Penicillium, Alternaria* (Ascomycota), *Puccinia, Agaricus* (Basidiomycota)

Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhizae & endomycorrhizae and their significance

Unit 3

Introduction to Archegoniate: Unifying features of archegoniate, Transition to land habit, Alternation of generations.

Bryophytes: General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Marchantia* and *Funaria*. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of *Sphagnum*.

Unit4

Pteridophytes: General characteristics, classification, Early land plants (*Cooksonia* and *Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris*. (Developmental details not to be included). Heterospory and seed habit, stelar evolution. Ecological and economical importance of Pteridophytes.

Gymnosperms: General characteristics, classification. Classification (up to family), morphology,

anatomy and reproduction of *Cycas* and *Pinus*. (Developmental details not to be included). Ecological and economical importance.

Suggested Readings

- Aneja, K.R. and Mehrotra, R.S. (2015) An Introduction to Mycology. New Age International Publ.New Delhi
- Kumar, H.D. (1999) Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi
- Lee, R.E. (2018) Phycology, Cambridge University Press, Cambridge
- Prescott, L.M., Harley J.P., Klein D. A. (2019) Microbiology, McGraw Hill, India
- Tortora, G.J., Funke, B.R., Case, C.L. (2010) Microbiology: An Introduction, Pearson BenjaminCummings, U.S.A.
- Sethi, I.K. and Walia, S.K. (2018) Text book of Fungi & Their Allies, MacMillan Publishers Pvt.Ltd., Delhi.
- Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996) Introductory Mycology, John Wiley and Sons(Asia), Singapore
- Webster, J. and Weber, R. (2007) Introduction to Fungi, Cambridge University Press, Cambridge (3rd Ed).
- Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2016) Biology. Tata McGraw Hill, Delhi, India (11th Ed).
- Vashishta, P.C., Sinha, A.K., Kumar, A. (2010) Pteridophyta, S. Chand. Delhi, India.
- Bhatnagar, S.P. and Moitra, A. (1996) Gymnosperms. New Age International (P) Ltd Publishers, NewDelhi, India.
- Parihar, N.S. (2019) An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad
- Pelczar, M.J. Microbiology, (2009) Tata McGraw-Hill Co, New Delhi.

Course outcomes

After completion of the course the learners will be able to:

CO1. Understand the economic and pathological importance of fungi, bacteria and viruses and identify common plant diseases and their control measures.

CO2. Compare fungi, lichens and mycorrhiza.

CO3. The classification, morphology, anatomy, reproduction, ecological and economic importance of archegoniates.

CO4. Study and understand the classification, morphology, anatomy, reproduction, ecological and economic importance of Pteridophytes and Gymnosperms

Mapping of CO and PO for BLS101:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1	2	3	3	3	3	3	3	3
CO2	3	1	3	3	3	3	2	3	2	3
CO3	3	1	2	3	3	3	2	3	3	3
CO4	3	1	3	3	2	3	3	3	3	2

No. of credits: 4
L: 4
P: 0

DCC-Zoology I (BLS102): Animal Diversity

Course Objective

The main purpose of introducing this course is to teach the students the Morpho-taxonomy, and evolutionary relationships among and between non-chordates and chordates along with creating awareness and concern towards the importance of animal diversity for human survival and its socio-economic significance.

Unit 1
General characters and classification of Protozoa, Porifera and Cnidaria up to order level; Life cycle of *Plasmodium and sycon* in brief, Canal system and spicules in sponges, Corals and coral reef, Nematocysts, Nerve Net and Body Structure in Cnidarians, Life cycle of *Obelia*.

Unit 2
General characters and classification of Helminthes, Annelida and Arthropoda up to classes; Life cycle of *Fasciola hepatica* and *Pheretima* (Earthworm) in brief, General features of Earthworm and Vermicomposting, Metamorphosis in Insects and its hormonal control, Types of respiratory systems in insects

Unit 3
General characters and classification of Mollusca and Echinodermata up to classes; Life History of Pila, Podium in Mollusca, Torsion in Gastropoda, Shell in Mollusca, Larval forms in Echinodermata in brief, Ambulacral System; General characteristics of Hemichordata, Urochordata, Cephalochordata (Brief life cycle of *Amphioxus*), Retrogressive metamorphosis in Urochordata

Unit 4
General characters and classification of fishes, amphibians, reptiles, aves and mammals up to order level; Structural and Functional Adaptations of Fishes, Osmoregulation and parental care in fishes, Origin of *Tetrapoda* and Parental care in Amphibians, Characteristics of Reptiles that Distinguish them from Amphibians, Poison apparatus and Biting mechanism in snakes, *Archaeopteryx*-- a connecting link, Flight adaptations and migration in birds, Structural and Functional Adaptations of Mammals, Dentition in Mammals

Suggested readings

- Barnes, R.S.K, Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2009) The Invertebrates:A New Synthesis. Blackwell Science
- Kotpal R.L, (2019) Modern Textbook of Zoology: Invertebrates. Rastogi Publication
- Kotpal R.L, (2015) Modern Textbook of Zoology: Vertebrates. Rastogi Publication
- Dhami J K. (1979) Invertebrate Zoology, S Chand Publication
- Pough, H. (2012) Vertebrate life. Pearson International
- Ruppert, E.E. and Barnes, R.D. (2006) Invertebrate Zoology. Holt Saunders International edition.
- Young, J. Z. (2004) The Life of Vertebrates. Oxford university press.

Course outcomes

After completion of the course the learners will be able to explain:

CO1. Morpho-taxonomy and structural organization of non-chordata and chordate groups.
CO2. Acquire knowledge of diversity of non-chordata and chordate groups.
CO3. Learn evolutionary relationships and phylogeny of non-chordates and chordates through functional and structural similarities.
CO4. General characteristics of various organisms from non-chordates and chordates

Mapping of CO and PO for BLS102

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1	3	3	3	3	3	2	3	3
CO2	3	1	3	3	3	3	2	3	3	3
CO3	3	1	3	2	3	3	3	3	3	3
CO4	3	1	3	3	3	3	2	3	3	3

No. of credits: 4
L: 4
P: 0

DCC-Chemistry I (BLS103): Conceptual Organic Chemistry

Course objective

To predict and explain patterns in shape, structure, bonding, hybridization, formal charge, stability, acidity, basicity, solubility, and reactivity for hydrocarbons, halocarbons, alkenes, dienes, and arenes, by understanding and applying concepts of organic chemical structure and bonding and stability.

Unit 1

Stereochemistry: Writing of Fischer projection, Newman and Sawhorse projection and Wedge formulae. Interconversion of one type of structural representation into another type. Conformations: Restricted rotation about single bonds, Various conformations of ethane, butane, ethane-1,2-diol and cyclohexane. Relative stability of different conformations in terms of energy difference is to be discussed for all these compounds. Geometrical Isomerism: Requirements for a molecule to show geometrical isomerism, Cis-Trans and E/ Z notation along with CIP rules for geometrical isomers. Optical Isomerism: Optical activity, specific and molar rotation, chirality, enantiomerism, diastereo-isomerism, racemic mixtures and their resolution by salt formation method. Relative and absolute configuration: D / L nomenclature system for configuration of carbohydrates (difference between d/l and D/L notations). Threo and Erythro designation. R-and S- configuration (upto two chiral centres).

Unit 2

Addition Reactions: Alkenes and Alkynes: Hydrogenation, addition of halogens, Hydrohalogenation (Markovnikov's and anti-Markovnikov's addition), hydration, hydroxylation (cis and trans), oxymercuration-demercuration, hydroboration-oxidation, ozonolysis. Reactivity of alkenes vs alkynes. Aldehydes and ketones: (formaldehyde, acetaldehyde, benzaldehyde, acetone) Addition of sodium bisulphite, hydrogen cyanide and alcohols. Addition- elimination reactions with ammonia and its derivatives Name reactions: Aldol, cross Aldol, Claisen, Cannizzaro, cross Cannizzaro.

Unit 3

Substitution Reactions: Free radical substitution reactions: Halogenation of alkanes, allylic compounds and alkyl benzenes. Nucleophilic substitution reactions: Alkyl, allyl and benzyl halides – substitution of halogen by some common nucleophiles. Mechanism of SN1 and SN2 reactions (stereochemistry, nature of substrate, nucleophile and leaving group).Alcohols, amines and phenols: Substitution of active hydrogen, replacement of hydroxyl group in alcohols. Electrophilic Substitution Reactions (aromatic compounds): General mechanism of electrophilic substitution reactions (nitration, halogenation, sulphonation, Friedel Crafts alkylation and acylation), directive influence of substituents.

Unit-4

Elimination Reactions: Alkyl halides (dehydrohalogenation, Saytzeff's rule), vicinal dihalides (dehalogenation), alcohols (dehydration), Quaternary ammonium salts (Hofmann's elimination). Mechanism of E1 and E2 reactions (nature of substrate and base), elimination vs substitution. Alcohols: Oxidation with potassium permanganate, potassium dichromate, catalytic dehydrogenation and Oppenauer oxidation. Oxidation of 1,2–diols with periodic acid and lead tetraacetate. Aldehydes: Oxidation with potassium permanganate, chromic acid and Tollens's reagent Ketones: Oxidation withpotassium permanganate, sodium hypoiodite (iodoform reaction) and Baeyer–Villiger oxidation. Reductions -Aldehydes and Ketones: Catalytic hydrogenation, reduction with sodium borohydride, lithium aluminium hydride, Clemmensen, Wolff-Kishner. Carboxylic acids and their derivatives: Lithium aluminium hydride, sodium-ethanol and Rosenmund reduction. Nitro compounds: Acidic, alkaline and neutral reducing agents, lithium aluminium hydride and electrolytic reduction.

Suggested Readings

- Bahl, A. and Bahl. B.S. (2012) Advanced Organic Chemistry, S. Chand
- Eliel, E. L. and Wilen, S. H. (2008) Stereochemistry of Organic Compounds; Wiley: London.
- Finar, I.L. Organic Chemistry, E. L. B. S.
- Kalsi, P.S. (2015) Stereochemistry, Conformation and Mechanism. John Wiley and Sons.
- Morrison, R.T. and Boyd., R. N. (2010) Organic Chemistry, Pearson Education
- Nasipuri, D. (2020) Stereochemistry of Organic Compounds, New Age International Publishers
- Solomon's, T.W.G. (2017) Organic Chemistry. John Wiley and Sons
- Sykes, P. (2003) A Guide Book to Mechanism in Organic Chemistry. Orient Longman

Course outcomes

After completion of the course the learners will be able to explain:

CO1. The fundamental principles of organic chemistry that include chemical bonding, nomenclature, structural isomerism, stereochemistry, chemical reactions and mechanism.
CO2. Name the functional groups and different classes of organic compounds.
CO3. The basic practical skills for the synthesis and analysis of organic compound
CO4. Different kinds of reactions and their applications in research

Mapping of CO and PO for BLS103

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	1	3	3	3	3	3	3	2	3
CO2	1	1	3	3	3	3	3	3	3	3
CO3	1	1	3	3	2	3	3	2	3	3
CO4	1	1	2	3	2	3	3	3	2	2

No. of credits: 2
L: 0
P: 4

DCC-Lab Course I (BLS104): Botany I

- EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph/Virtual lab of Lytic and LysogenicCycle.
- Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Gram staining.
- Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas* (electron micrographs), *Oedogonium, Vaucheria, Fucus* and Polysiphonia* through temporary preparations and permanent slides. (* *Fucus* - Specimen and permanent slides)
- *Rhizopus and Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.
- *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.
- Lichens: Study of growth forms of lichens (crustose, foliose and fruticose).
- *Marchantia*- morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup, w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides).
- *Funaria*- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.
- *Selaginella*- morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus, w.m. microsporophyll and megasporophyll (temporary slides), l.s. strobilus (permanent slide).
- *Equisetum*- morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m. sporangiophore, w.m. spores (wet and dry) (temporary slides); t.s rhizome (permanent slide).
- *Pteris*- morphology, t.s. rachis, v.s. sporophyll, w.m. sporangium, w.m. spores (temporary slides), t.s. rhizome, w.m. prothallus with sex organs and young sporophyte (permanent slide).
- *Cycas*- morphology (coralloid roots, bulbil, leaf), t.s. coralloid root, t.s. rachis, v.s. leaflet, v.s. microsporophyll, w.m. spores (temporary slides), l.s. ovule, t.s. root (permanent slide).
- *Pinus*- morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), w.m. dwarf shoot, t.s. needle, t.s. stem, l.s./t.s. male cone, w.m. microsporophyll, w.m. microspores (temporary slides), L.S. female cone, t.l.s. & r.l.s. stem (permanent slide).

**** Minimum seven experiments will be done in each course and at least one experiment from each unit should be done.***

*****Addition or deletion of the lab experiments can be done as per the availability of resources in lab.***

Course outcomes:

After the completion of the course the students will be able to:

CO1: Distinguish between Gram positive and negative bacteria and will also be able to identify other kinds of bacteria

CO2: Understand the vegetative and reproductive structures of *Oedogonium*, *Nostoc*, *Rhizopus* etc. through the temporary or permanent mounts

CO3: Understand the morphology and organization of thalli of *Funaria*, *Pteris*, *Cycas*, *Pinus* etc. using photographs, permanent and temporary slides.

Mapping of CO and PO of BLS104

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1	2	3	3	3	3	2	3	3
CO2	3	1	3	3	2	3	3	3	2	3
CO3	3	1	3	2	3	3	3	3	3	3

No. of credits: 2
L: 0
P: 4

DCC- Lab Course II (BLS105): Zoology I

- Study of the following specimens: *Amoeba, Euglena, Plasmodium, Paramecium, Sycon, Hyalonema, and Euplectella, Obelia, Physalia, Aurelia, Tubipora, Metridium, Taenia solium, Male and female Ascaris lumbricoides, Aphrodite, Nereis, Pheretima, Hirudinaria, Palaemon, Cancer, Limulus, Palamnaeus, Scolopendra, Julus, Periplaneta, Apis, Chiton, Dentalium, Pila, Unio, Loligo, Sepia, Octopus, Pentaceros, Ophiura, Echinus, Cucumaria and Antedon, Balanoglossus, Herdmania, Branchiostoma, Petromyzon, Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis,* Any six common birds from different orders, *Sorex*, Bat, *Funambulus, Loris*
- Study of the following permanent slides- T.S. and L.S. of *Sycon,*
- Study of life history stages of *Taenia*
- T.S. of Male and female *Ascaris*
- Key for Identification of poisonous and non-poisonous snakes
- An "animal album" containing photographs, cut outs, with appropriate write up about the above-mentioned taxa. Different taxa/ topics may be given to different sets of students for this purpose.
- Preparation of temporary and permanent mounts of few key specimens

**** Minimum seven experiments will be done in each course and at least one experiment from each unit should be done.***

*****Addition or deletion of the lab experiments can be done as per the availability of resources in lab.***

Course outcomes:

After the completion of the course the students will be able to:

CO1. Identify various distinguishing features of different organisms shown through specimen.

CO2. Understand the life cycle of *Taenia* and also be able to distinguish between poisonous and non-poisonous snakes.

CO3. Prepare permanent and temporary slides of different organisms

Mapping of CO and PO of BLS 105

Course Outcomes	P O1	P O2	P O3	P O4	P O5	P O6	P O7	PS O1	PS O2	PS O3
CO1	3	1	2	3	3	2	3	3	3	3
CO2	3	1	3	3	3	3	2	3	3	3
CO3	3	1	3	3	2	3	3	3	2	3

No. of credits: 2

L: 0
P: 4

DCC Lab Course III (BLS 106):

Chemistry I

- Purification of organic compounds by crystallization using the following solvents: a. Water b. Alcohol
- Determination of the melting points of organic compounds (by Kjeldahl method and electrically heated melting point apparatus).
- Determination of optical activity by using polarimeter Organic preparations:
- To prepare acetanilide by the acetylation of aniline.
- Benzoylation of aniline or β-naphthol by Schotten-Baumann reaction
- Hydrolysis of benzamide or ethyl benzoate.
- Semicarbazone derivative of one the following compounds: acetone, ethyl methyl ketone, diethylketone, cyclohexanone, benzaldehyde.
- Nitration of nitrobenzene.
- Oxidation of benzaldehyde by using alkaline potassium permanganate.

**** Minimum seven experiments will be done in each course and at least one experiment from each unit should be done.***

*****Addition or deletion of the lab experiments can be done as per the availability of resources in lab.***

Course outcomes:

After the completion of the course the students will be able to:

CO1. Purify certain organic compounds by crystallization using polar solvent like water and non-polar solvent like ethanol/methanol and determine m.p. or organic compounds using Kjeldahl method

CO2. Carry out reactions like acetylation, benzoylation, nitration and oxidation of various compounds

CO3. Determine optical activity using polarimeter

Mapping of CO and PO of BLS 105

Course Outcomes	P O1	P O2	P O3	P O4	P O5	P O6	P O7	PS O1	PS O2	PS O3
CO1	1	1	2	3	3	2	3	3	3	3
CO2	1	1	3	3	3	3	2	3	3	3
CO3	1	1	3	3	2	3	3	3	2	3

SEMESTER II

No. of credits: 4
L: 4
P: 0

DCC Botany II (BLS 201): Plant Ecology and Taxonomy

Course objective: To make students understand ecology and basic ecological concepts. Detailed understanding between the living world and environment. To make them aware about identification, nomenclature and classification.

Unit 1

Introduction to Ecology: Relevance of studying ecology, Autecology and synecology, levels of organization. Laws of limiting factors (Leibigs law of minimum, Shelford's law of tolerance), ecological range (Eury, Steno).

Population Ecology: Unitary and Modular populations, metapopulation; density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, population dynamics, r and K selection, density-dependent and independent population regulation; Competition, Niche concept, Phenotypic and genotypic plasticity, Species interactions.

Unit 2

Ecosystem ecology: Concept, components, types of ecosystems with one example of ecosystem in detail (abiotic and biotic components, BOD, eutrophication). Energy flow (Grazing and Detritus food chain), energy flow models, food web. Ecological pyramids and Ecological efficiencies. Nutrient cycle with one example of Nitrogen cycle.

Community ecology: Community structure; Dominance, diversity, species richness, abundance, stratification; Diversity indices; Ecotone and edge effect; Community dynamics (succession): Primary and secondary succession, Climax; monoclimax and polyclimax concepts, Concept of keystone, indicator, umbrella and flagship species.

Unit 3

Introduction to plant taxonomy: Plant identification, Classification, Nomenclature; Biosystematics.

Identification: Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access

Classification: Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prant (upto series), Brief reference of Angiosperm Phylogeny Group (APG III) classification.

Botanical nomenclature: Principles and rules (ICN); ranks and names; binomial system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.

Unit 4

Taxonomic hierarchy: Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary), Taxonomic evidence from palynology, cytology, phytochemistry and molecular data.

Biometrics, numerical taxonomy and cladistics: Characters; variations, OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definitions and differences).

Suggested readings

- Kormondy, E.J. (1995) Concepts of Ecology. Prentice Hall, U.S.A
- Sharma, P.D. (2019), Ecology and Environment. Rastogi Publications, Meerut, India
- Simpson, M.G. (2019) Plant Systematics. Elsevier Academic Press, San Diego, CA, U.S.A
- Singh, G. (2018) *Plant Systematics:* Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi
- Odum, E.P. (2005) Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi
- Singh, J.S., Singh, S.P., Gupta, S. (2017) Ecology, Environment and Resource Conservation.Anamaya Publications, New Delhi, India.
- Wilkinson, D.M. (2006) Fundamental Processes in Ecology: An Earth Systems Approach. OxfordUniversity Press. U.S.A.
- Singh, G. (2018) Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi
- Jeffrey, C. (1982) An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge
- Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2007) Plant Systematics-A PhylogeneticApproach. Sinauer Associates Inc., U.S.A

Course outcomes

After completion of the course the learners will be able to explain:

CO1. The interactions and interdependence of abiotic and biotic factors in nature.

CO2. They will also learn about the impact of anthropogenic activities on the environment and need for conservation.

CO3. An understanding of the ecological principles that link individuals at populations, community and ecosystem levels.

CO4. Analyse the implications of biometrics, numerical taxonomy and cladistics

Mapping of CO and PO for BLS201

Course Outcome s	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1	3	2	3	3	3	3	3	3
CO2	3	1	3	3	3	3	2	3	2	3
CO3	3	1	2	3	3	3	3	3	3	3
CO4	3	1	3	2	3	3	3	3	3	2

No. of credits: 4
L: 4
P: 0

DCC Zoology II (BLS 202): Anatomy and Developmental Biology

Course objective: The course offers a complete understanding about anatomy of vertebrate animals. It educates the students regarding derivatives of integuments, skeletal system and visceral arches, anatomy of digestive system and associated glands, different respiratory organs, urogenital organs, components of nervous system and receptors in vertebrates.

Unit 1

Integumentary System- Derivatives of integument w.r.t. glands and digital tips.

Skeletal System- Evolution of visceral arches.

Digestive System- Brief account of alimentary canal and digestive glands,

Circulatory System - Evolution of heart and aortic arches.

Unit 2

Respiratory System - Brief account of Gills, lungs, air sacs and swim bladder.

Urinogenital System- Succession of kidney, Evolution of urinogenital ducts,

Nervous System- Comparative account of brain,

Sense Organs-Types of receptors.

Unit 3

Early Embryonic Development -Gametogenesis: Spermatogenesis and oogenesis w.r.t. mammals, vitellogenesis in birds; Fertilization: external (amphibians), internal (mammals), blocks to polyspermy; Early development of frog and humans (structure of mature egg and its membranes, patterns of cleavage, fate map, up to formation of gastrula); types of morphogenetic movements; Fate of germ layers; Neurulation in frog embryo.

Unit 4

Late Embryonic Development - Implantation of embryo in humans, Formation of human placenta and functions, other types of placenta on the basis of histology; Metamorphic events in frog life cycle and its hormonal regulation. Control of Development -Fundamental processes in development (brief idea) – Gene activation, determination, induction, Differentiation, morphogenesis, intercellular communication, cell movements and cell death.

Suggested Readings

- Balinsky, B.I. (2012) An introduction to Embryology, International Thomson Computer Press
- Kumar Veera, Prasanna A. (2021) Human Anatomy, IP Innovative publication Pvt. Ltd
- Kotpal, Shastri. Shukla. (2019) Comparative anatomy and developmental Biology, Rastogi publication
- Carlson, B. M.Patten's (2014) Foundations of Embryology, McGraw Hill

- Gilbert, S.F. (2014) Developmental Biology. Sinauer Associates, Inc. Publishers, USA
- Hilderbrand, M. and Gaslow, G.E. (2001) Analysis of vertebrate structure, John Wiley and Sons
- Kardong, K.V. Vertebrates' (2005) Comparative Anatomy, Function and Evolution. McGraw-Hill Higher Education
- Kent, G.C. and Carr, R.K. (2000) Comparative Anatomy of the Vertebrates. The McGraw- HillCompanies
- Walter, H.E. and Sayles, L.P. (1949) Biology of Vertebrates, Khosla Publishing House.

Course outcomes

After completion of the course the learners will be able to:

CO1. Explain comparative account of different vertebrate systems and understand the pattern of vertebrate evolution, organization and functions of various systems.

CO2. Understand the pattern of vertebrate evolution, organization and functions of various systems.

CO3. Understand the events that lead to formation of a multicellular organism from a single fertilized egg, the zygote

CO4. Describe the general patterns and sequential developmental stages during embryogenesis; and understand how the developmental processes lead to establishment of body plan of multicellular organisms.

Mapping of CO and PO for BLS202

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1	3	3	3	3	3	3	2	3
CO2	3	1	3	3	3	3	3	3	3	3
CO3	3	1	3	2	3	3	3	3	3	3
CO4	3	1	3	3	3	3	2	3	2	3

No. of credits: 4
L: 4
P: 0

DCC Chemistry II (BLS 203):
Chemistry of Biomolecules

Course Objective: The cells of living organisms contain thousands of biomolecules. From this course the students will know the structure-function relationship of these molecules, and their importance with regard to maintenance and perpetuation of the living systems.

Unit I

Carbohydrates: Classification of carbohydrates, reducing and non-reducing sugars, General properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers. Determination of configuration of glucose (Fischer proof). Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Linkage between monosaccharides, structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.

Unit 2

Amino Acids, Peptides and Proteins: Classification of Amino Acids, Zwitterion structure and Isoelectric point. Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C–terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme).Enzymes and correlation with drug action-Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (including stereospecificity), Enzyme inhibitors and their importance, phenomenon of inhibition (competitive and non-competitive inhibition including allosteric inhibition).

Unit 3

Nucleic Acids: Components of Nucleic acids: Adenine, guanine, thymine and cytosine (structure only), other components of nucleic acids, Nucleosides and nucleotides (nomenclature), Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (types of RNA), Genetic code, biological roles of DNA and RNA:

Lipids-Introduction to lipids, classification. Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats, Hydrogenation, Saponification value, Iodine number. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).

Unit 4

Concept of Energy in Biosystems: Calorific value of food. Standard caloric content of carbohydrates, proteins and fats. Oxidation of foodstuff (organic molecules) as a source of energy for cells. Introduction to metabolism (catabolism, anabolism), ATP: the universal currency of cellular energy, ATP hydrolysis and free energy change. Conversion of food into

energy. Outline of catabolic pathways of Carbohydrates - Glycolysis, Krebs Cycle. Overview of catabolic pathways of fats and proteins.

Suggested Readings

- Nelson, D.L. and Cox, M.M. (2017) Lehninger's Principles of Biochemistry. W. H. Freeman
- Satyanarayana. U. (2013) Biochemistry, Elsevier Books and Allied Pvt. Ltd
- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2015) Biochemistry. W.H. Freeman
- Murray, R. K., Granner, D. K. and Rodwell V. W., (2018). Harper's Illustrated Biochemistry, McGraw Hill, NewYork, USA
- Voet D. and Voet C. W. (2010), Biochemistry, John Wiley
- Jain, J.L., Jain, S., Jain, N., (2016) Fundamentals of Biochemistry. S Chand publication
- Morrison, R.T. and Boyd, R.N. (2010) Organic Chemistry, Dorling Kindersley (India) Pvt.Ltd. Pearson Education
- Ahluwalia, V.K. and Aggarwal, R. (2004) Comprehensive practical organic chemistry,universities press.
- Finar, I.L. (2002) Organic Chemistry. Dorling Kindersley (India) Pvt. Ltd.Pearson Education
- Furniss, B.S., Hannaford, A.J., Rogers, V., Smith, P.W.G. and Tatchell, A.R.V. (2003) Textbook of practical organic chemistry, ELBS

Course outcomes

After completion of the course the learners will be able to:

CO1. Comprehend the importance of chemical foundation in living organisms
CO2. Analyse the various types of weak interactions between the biomolecules and water.
CO3. Correlate how the large biomolecules such as proteins, carbohydrates, lipids, nucleic acids are made from the simple precursors.
CO4. Explain how the metabolism of biomolecules leads ultimately to the generation of energy and to understand essentials of the metabolic pathways along with their regulation.

Mapping of CO and PO for BLS203

Course Outcome s	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	1	3	3	3	3	3	3	2	3
CO2	1	1	3	3	3	3	3	3	3	3
CO3	1	1	3	3	2	3	3	2	3	3
CO4	1	1	2	3	2	3	3	3	2	2

No. of credits: 2
L: 0
P: 4

DCC Lab Course I (BLS 204):
Botany II

- Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and luxmeter.
- Determination of pH, and analysis of two soil samples for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency by rapid field test.
- Comparison of bulk density, porosity and rate of infiltration of water in soil of three habitats.
- (a) Study of morphological adaptations of hydrophytes and xerophytes (four each). (b)Study of biotic interactions of the following: Stem parasite (*Cuscuta),* Root parasite (Orobanche), Epiphytes, Predation (Insectivorous plants)
- Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (Species to be listed)
- Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law
- Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification): Brassicaceae -*Brassica, Alyssum / Iberis;* Asteraceae - *Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax;* Solanaceae -*Solanum nigrum, Withania;* Lamiaceae -*Salvia, Ocimum*; Liliaceae - *Asphodelus / Lilium / Allium.*
- Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

**** Minimum seven experiments will be done in each course and at least one experiment from each unit should be done.***
*****Addition or deletion of the lab experiments can be done as per the availability of resources in lab.***

Course outcomes:

After the completion of the course the students will be able to:

CO1: Understand different methods of studying the physical features of the environment and the structure of populations, communities and ecosystems.

CO2: Interpret taxonomic information and use it to evaluate and formulate a position of plant in taxonomy

CO3: Learn about the method and importance of preparing herbarium.

Mapping of CO and PO of BLS204

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2	PSO 3
CO1	3	1	3	3	2	3	3	2	3	3
CO2	2	1	3	3	3	3	3	3	3	3
CO3	3	1	3	3	3	3	3	3	2	3

No. of credits: 2
L: 0
P: 4

DCC Lab Course II (BLS 205): Zoology II

- Osteology: a) Disarticulated skeleton of fowl and rabbit
  b) Carapace and plastron of turtle /tortoise
  c) Mammalian skulls: One herbivorous and one carnivorous animal.
- Frog - Study of developmental stages - whole mounts and sections through permanent slides – cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole external and internal gill stages.
- Study of the different types of placentas- histological sections through permanent slides orphotomicrographs.
- Study of placental development in humans by ultrasound scans.
- Examination of gametes - frog/rat - sperm and ova through permanent slides or photomicrographs
- Museum specimens of Vertebrate embryos/ slides of different stages of chick embryo.
- Preparation of whole mount of chick embryo

**** Minimum seven experiments will be done in each course and at least one experiment from each unit should be done.***

*****Addition or deletion of the lab experiments can be done as per the availability of resources in lab.***

Course outcomes:

After the completion of the course the students will be able to:

CO1. Identify anatomical features of different groups of vertebrates and understand their similarities and differences

CO2. Gain in depth knowledge of osteology – axial and appendicular skeleton.

CO3. Learn about embryology of animals (developmental stages of animals and complete examination of sperm and ova)

Mapping of CO and PO of BLS 205

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1	3	3	3	3	3	3	2	3
CO2	3	1	3	3	3	3	3	3	3	2
CO3	2	1	3	3	2	3	3	2	3	3

No. of credits: 2
L: 0
P: 4

DCC Lab Course III (BLS 206): Chemistry II

- Separation of amino acids by paper chromatography
- To determine the concentration of glycine solution by formulation method.
- Study of titration curve of glycine
- Action of salivary amylase on starch
- Effect of temperature on the action of salivary amylase on starch.
- To determine the saponification value of an oil/fat.
- To determine the iodine value of an oil/fat
- Differentiate between a reducing/non reducing sugar.
- Extraction of DNA from onion/ cauliflower

**** Minimum seven experiments will be done in each course and at least one experiment from each unit should be done.***

*****Addition or deletion of the lab experiments can be done as per the availability of resources in lab.***

Course outcomes:

After the completion of the course the students will be able to:

CO1. Learn various techniques adopted for separation of biomolecules (carbohydrates, amino acids, DNA) from biological samples

CO2. Isolate and purify biomolecules from samples

CO3. Learn about methods of isolation and estimation of amount of biomolecules

Mapping of CO and PO of BLS 105

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	1	2	3	2	3	3	3	2	3
CO2	1	1	3	3	3	3	2	3	3	3
CO3	2	1	3	3	3	3	3	3	3	3

No. of credits: 4
L: 4
P: 0

SEMESTER III

DCC Botany III (BLS 301): Botany III: Plant Anatomy and Embryology

Course objective: Main objective of the course is to provide basic knowledge of plant internal architecture, acquaint students with plant cell composition and reproduction. To understand how different plant tissue structures evolve and modify their functions with respect to their environment.

Unit 1

Meristematic and permanent tissues: Root and shoot apical meristems; Simple and complex tissues. cytodifferentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Wall ingrowths and transfer cells, adcrustation and incrustation, Ergastic substances.

Organs: Organization of root and shoot apex; Structure of dicot and monocot root, stem and leaf.

Unit 4

Secondary Growth: Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood).

Adaptive and protective systems: Epidermal tissue system, cuticle, epicuticular waxes, trichomes (uni-and multicellular, glandular and non-glandular, two examples of each), stomata (classification); Adcrustation and incrustation; Anatomical adaptations of xerophytes and hydrophytes.

Unit 3

Reproductive development: Induction of flowering; flower as a modified determinate shoot. **Structural organization of flower**: Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac.

Pollination and fertilization: Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.

Unit 4

Embryo, Endosperm and Seed: Structure and types; General pattern of development of dicot and monocot embryo and endosperm; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo; Unusual features; Embryo development in Paeonia. Seed structure, importance and dispersal mechanisms

Apomixis and polyembryony: Definition, types and practical applications.

Suggested readings

- Panchanan Maheshwari (1950). An introduction to the embryology of angiosperms. McGraw Hill.
- Bhojwani, S.S. & Bhatnagar, S.P (2014). Embryology of Angiosperms. Vikas Publication House Pvt.Ltd. New Delhi.
- Mauseth, J.D (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.
- Dickison, W.C (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
- Fahn, A (1990). Plant Anatomy. Pergamon Press, USA.
- Esau, K (2006). Anatomy of Seed Plants. John Wiley & Sons, Inc., Delhi Esau, K. Anatomy of Seed Plants. John Wiley & Sons, Inc., Delhi.
- Raghavan, V (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
- Johri, B.M (2015). Embryology of Angiosperms, Springer-Verlag, Netherlands

Course outcomes

After completion of the course the learners will be able to:

CO1. Identify different types of tissues and make them able to correlate their physiology in a better way.
CO2. Understand how different plant tissues evolve and modify their structure and functions with respect to their environment.
CO3. Understand how reproduction plays a significant role in defining population structure, natural diversity and sustainability of the ecosystem in a better way.
CO4. To provide basic knowledge of plant architecture

Mapping of CO and PO for BLS 301:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1	2	3	2	3	3	3	3	3
CO2	3	1	3	3	3	3	3	3	2	3
CO3	2	1	2	3	3	3	3	3	3	3
CO4	3	1	3	3	2	3	3	3	3	2

No. of credits:
4L: 4
P: 0

CC Zoology III (BLS 302): Animal Physiology

Course outcome: The study of physiology is the study of the internal working of organisms; how organs and systems within the body work, communicate and integrate their efforts to make conditions favorable for survival. The study of biochemistry explains how inanimate constituents of living organisms i.e., the biomolecules interact to maintain and perpetuate life.

Unit 1

Blood and Cardiovascular system - Composition of blood, structure and functions of its constituents. Blood coagulation and anticoagulants, Hemostasis, Hemoglobin and its polymorphism. Concept of arteries, veins and capillaries. Blood Groups. Double circulatorysystem. Structure of Heart, Origin and conduction of the cardiac impulse, Cardiac cycle.

Unit 2

Digestion - Physiology of digestion in the alimentary canal; Absorption of carbohydrates, proteins, lipids.

Respiration- inhalation and exhalation, internal intercostal muscles, external intercostal muscles, roles of accessory muscles in forceful inspiration and expiration. Regulation of respiration Respiratory volumes and capacities, Transport of Oxygen and carbon dioxide in blood.

Reproduction and Endocrine System - Physiology of male reproduction: hormonal control of spermatogenesis; Physiology of female reproduction, hormonal control of menstrual cycle Structure and function of pituitary, thyroid, Parathyroid, pancreas and adrenal glands.

Unit 3

Excretion- Structure of nephron, Mechanism of Urine formation, Counter-current Mechanism, Glomerular Filtration rate. Renin-angiotensin aldosterone system.

Muscle physiology- Molecular basis of Muscle contraction, Sarcomere, role of calcium ion in muscle contraction. Z disc, M line. Motor end plate. Rigor mortis.

Unit 4

Nervous system- Structure of a neuron, Resting membrane potential, Graded potential, Origin of Action potential and its propagation in myelinated and unmyelinated nerve fibers. Different types of Nerve fibers. Peripheral nervous system, somatic nervous system, autonomic nervous system. Concept of ganglia, presynaptic nerve fiber and post synaptic nerve fiber. Synapse and neurotransmitters.

Sensory physiology- Structure of eye, mechanism of vision, Auditory physiology.

Suggested Readings

- Sembulingam K (2019). Essentials of Medical Physiology, Jaypee Brothers Medical Publication.
- Guyton, A.C. and Hall, J.E (2015). Textbook of Medical Physiology. Harcourt Asia Pvt. Ltd/ W.B. Saunders Company.

- Barret Kim (2019). Ganong's review of medical Physiology, McGraw Hill Publication
- Tortora, G.J. and Derrickson, B.H (2018). Principles of Anatomy and Physiology. John Wiley &Sons, Inc.
- Verma P S, Tyagi (2017). Animal Physiology. S Chand Publication
- Widmeyer, E.P., Raff, H. and Strang, K.T (2019). Vander's Human Physiology. McGraw Hill.

Course outcomes

After completion of the course the learners will be able to:

CO1. Understand the functions of major physiological systems in the body.
CO2. Recognize and identify principal tissue structures.
CO3. Relate how biochemical systems interact to yield integrated physiological responses
CO4. Understanding physiology and biochemistry of the living organisms

Mapping of CO and PO for BLS 302:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1	2	3	3	3	3	3	2	3
CO2	2	1	2	3	2	3	2	3	2	3
CO3	3	1	2	3	3	3	2	3	3	3
CO4	3	1	3	3	3	3	3	2	3	2

No. of credits:
4L: 4
P: 0

DCC Chemistry III (BLS 303): Chemical Bonding

Course Objective: To understand the shapes of different orbitals, different principles for filling electrons and to understand how to draw energy diagrams. Also understand how to calculate bond order and how to calculate lattice energy through Born Haber Cycle.

Unit 1

The covalent bond and the structure of molecules: Valence bond approach, Concept of resonance in various organic and inorganic compounds, Hybridization and structure, equivalent and non-equivalent hybrid orbitals, Bent's rule and its applications, VSEPR model for predicting shapes of molecules and ions containing lone pairs, sigma and pi bonds. Molecular Orbital Approach: LCAO method, symmetry and overlap for s-s, s-p and p-p combinations, MO treatment of homonuclear diatomic molecules of 2nd period (B2, C2, N2, O2, F2) and heteronuclear di-atomic molecules (CO, NO) and their ions.

Unit 2

Intermolecular forces: van der Waals forces, Hydrogen bonding and its applications, effects of these forces on melting point, boiling point and solubility. Transition Elements (3d series)
– General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu. Lanthanoids and actinoids: Electronic configurations, oxidation states, color, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only).

Unit 3

Coordination Chemistry: Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT. IUPAC system of nomenclature. Coordination compounds in biological systems: Fe, Cu, Co, Mn, Ni, Zn and heavy metal ions.

Unit 4

Crystal Field Theory: Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for Oh and Td complexes, Tetragonal distortion of octahedral geometry. Jahn-Teller distortion, Square planar coordination.

Suggested Readings

- Alan, G.S. Inorganic Chemistry (2013). University of Cambridge.
- Douglas, B., McDaniel, D.H. and Alexander, J.J. Concepts and Models of Inorganic Chemistry (2014). John Wiley and Sons.
- Grey, L.M. and Donald A.T (2015). Inorganic Chemistry. Prentice Hall.
- James, E.H (2006). Inorganic Chemistry: Principles of structure and reactivity. Prentice Hall.
- Lee, J.D (2008). A New concise inorganic chemistry. ELBS
- Rodgers, G.E (2008). Inorganic and Solid-State Chemistry. Cengage Learning India Ltd.
- Shriver, D.S. and Atkins, P.A (2009). Inorganic Chemistry. Oxford University Press.
- Vogel., A.I (1989). A Textbook of quantitative inorganic analysis, ELBS. Harris, D.C. &Freeman

Course outcomes

After completion of the course the learners will be able to:

CO1. Able to write electronic configuration of given atomic numbers.
CO2. Able to Identify several natural and technological occurrences of coordination compounds
CO3. Able to tell the name of orbitals by recognizing shapes of orbitals.
CO4. Understanding orbital theory and related principles

Mapping of CO and PO for BLS 303:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	1	2	3	3	3	3	3	3	3
CO2	1	1	3	3	3	3	2	3	2	3
CO3	1	1	2	2	3	3	2	3	3	3
CO4	1	1	3	3	2	3	3	3	3	3

No. of credits: 2
L: 0
P: 4

DCC Lab III -Botany (BLS 304): Plant Anatomy and Embryology

- Study of meristems through permanent slides and photographs.
- Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
- Stem: Monocot: *Zea mays;* Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
- Root: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
- Leaf: Dicot and Monocot leaf (only Permanent slides).
- Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem).
- Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).
- Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous.
- Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs).
- Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).
- Dissection of embryo/endosperm from developing seeds.
- Calculation of percentage of germinated pollen in a given medium.

**** Addition or deletion of the practical's may be done as per the convenience***

Course Outcome

After completion the course the learners will be able to explain:

CO1. Sectioning of different plant parts tissue.
CO2. Dissection of embryo from developing seeds and different plant parts
CO3. Understand the types of embryos and development of permanent slides

Mapping of CO and PO for BLS 304:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1	2	3	3	3	3	3	3	3
CO2	3	1	3	3	2	3	2	3	2	3
CO3	3	1	2	2	3	3	2	3	3	3

No. of credits:
2L: 0
P: 4

DCC Lab III: Zoology (BLS 305)- Animal Physiology

- Preparation of hemin and hemochromogen crystals
- Blood group identification
- Determination of Protein content
- Counting the different kinds of blood cells using hemocytometer
- Study of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland
- Study of permanent slides of spinal cord, duodenum, liver, lung, kidney, bone, cartilage
- Study of activity of salivary amylase under optimum conditions
- Study of graphical ECG with different waves and their diversion pattern in heart diseases.
- Measurement of statics lung volumes and lung capacities
- Buffy coat representation in blood sample.
- Hematocrit calculation

* ***Blood sample collection would be performed under a lab attendant of a health center or doctor.***

****Addition or deletion of the practical's may be done as per the convenience***

Course Outcome

After completion the course the learners will be able to explain:

CO1. Understanding blood group identification and preparation of blood protein crystals

CO2. Calculation of Hematocrit and graphical analysis of the different ECG waves

CO3. Permanent histological sections of different samples

Mapping of CO and PO for BLS 305:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1	2	3	3	3	3	3	3	3
CO2	3	1	3	2	3	3	2	3	2	3
CO3	3	1	2	3	3	3	2	3	3	3

No. of credits: 2
L: 0
P: 4

DCC Lab III: Chemistry (BLS306)- Chemical Bonding

- Titrimetric Analysis: Preparations of standard solutions (concept of primary and secondary standards), Different units of concentration (molarity, molality, normality and formality)

Titrations involving Acids-Bases:

- Principles of acid-base titrations, Principle behind selection of an appropriate indicator.
- Standardization of NaOH solution (standard solution of oxalic acid to be prepared)
- Determination of concentration of carbonate and hydroxide present in a mixture.
- Determination of concentration of carbonate and bicarbonate present in a mixture.
- Determination of concentration of free alkali present in soaps/detergents/shampoos.

Titrations involving redox reactions:

- Concept of electrode potential, principle behind selection of an appropriate indicator.
- Standardization of KMnO4 solution (standard solution of Mohr's salt to be prepared).
- Determination of concentration of Fe (II) in Mohr's salt and/or K2Cr2O7 using diphenylamine/ N-phenyl anthranilic acid as internal indicator (standard solution of K2Cr2O7 and /or Mohr's salt to be prepared).
- Determination of iron content in ores / alloys using appropriate redox titration.

Complexometric Titrations

- Principles of complexometric titrations
- Determination of concentration of Mg (II) & Zn (II) by titrimetric method using EDTA.
- Determination of concentration of Ca/Mg in drugs or in food samples.
- Determination of concentration of total hardness of a given sample of water by complexometric titration.

Addition or deletion of the practical's may be done as per the convenience

Course Outcome

After completion the course the learners will be able to explain:

CO1. Preparations of standard solutions for titrimetric analysis

CO2. Principles of acid-base titrations involving redox reactions.

CO3. Principle of Complexometric Titrations

Mapping of CO and PO for BLS 306:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	1	2	3	3	3	3	3	2	3
CO2	1	1	3	3	3	2	2	3	3	3
CO3	1	1	2	3	3	3	2	3	3	3

Skill Enhancement Course (SEC)

No. of credits-2
T-2
P-0

SEC 01: Floriculture

Course objective: The Floriculture course is designed to teach technical knowledge and skills in the production, processing, and distribution of flowers, foliage, and related plant materials including best management practices in field and greenhouse production of flowers and related plant materials and the arrangement of plant materials for ornamental purposes.

Unit 1

Introduction to floriculture: History, definitions, scope and importance of floriculture, aesthetic values, Floriculture industry, area and production, industrial importance of ornamental plants and flowers. Classification of floricultural plants, design values and general cultivation aspects for ornamental plants.

Unit 2

Designing and cultivation: Design and establishment of garden features/components viz. important gardens of India, types of gardens, Styles of Gardens, miniature and Special Types of gardens, the Landscaping features of a Garden, art of making bonsai, bonsai styles, culture of bonsai and maintenance.

Unit 3

Nursery management: Nursery Management and Routine Garden Operations: Types of nurseries, selection of nursery sites, media for nursery or potting media, nursery beds, Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary, Role of plant growth regulators.

Unit 4

Commercial floriculture: Scope and importance of commercial floriculture in India, production techniques of commercial flower crops like rose, marigold, chrysanthemum and orchid under protected environments such as glass houses. Postharvest technology of cut flowers in respect of commercial flower crops, Techniques of flower drying, production techniques for bulbous crops.

Suggested Readings

- Randhawa, G.S. Mukhopadyay A.N.Mukhopadhyay. A (1998). Floriculture in India. AlliedPublishers Pvt Ltd.
- Singh, A.K., Sisodhia A (2020). Textbook of Floriculture and Landscaping. New India PublishingAgency.
- Tyagi.S. (2019). Protected Cultivation of Flowers. New India Publishing Agency- Nipa.
- Edmond, J.B., Senn, T.L., Andrews, F.S. and Halfacre, R.G (1975). Fundamentals of Horticulture.McGraw-Hill, Inc.
- Sagawa, Y. and Kunisaki, J.T (1990). Micropropagation of Floriculture Crops. Handbook of PlantCell Culture.

Course Outcomes

After completion the course the learners will be able to explain:

CO1. Identify and select different commercial flowers.

CO2. Understanding different cultivation practices used for Identify floral plants

CO3. Understanding aesthetic and commercial importance of ornamental plants

CO4. Understanding commercial importance of ornamental plants

Mapping of CO and PO for SEC 01:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	3	3	3	3	3
CO2	3	3	2	3	3	3	3	3	3	3
CO3	3	3	2	3	3	3	3	3	3	3
CO4	3	3	3	3	2	3	3	3	3	3

No. of credits: 2

L: 2
P: 0

SEC 02: Apiculture

Course objective: The course will offer detailed understandings and methodologies in extracting, preservation and marketing of honey and other products of honey bees. It will also provide an Inclination for taking up bee keeping or bee rearing as a self-employment activity.

Apiculture

Course objective: The course will offer detailed understandings and methodologies in extracting, preservation and marketing of honey and other products of honey bees. It will also provide an Inclination for taking up bee keeping or bee rearing as a self-employment activity.

Unit 1

Basics of Bee rearing: Introduction to honey bee; Origin, systematics and distribution; history of beekeeping, types of honey bees, social organization in honey bees, colony life and social organization – Queen, drone, worker communications in honey bee, adaptations in honey bee.

Unit2

Bee keeping techniques: Basic requirements for starting bee keeping, general management practices in bee keeping, bee pasturage and pollination, Seasonal management of honey bees, Queen rearing and colony multiplication, Bee enemies and diseases.

Unit 3

Diseases and Enemies: Bee Diseases and Enemies, control and Preventive measures to minimize bee losses, Economic loss due to bee diseases, Low-cost nursery raising techniques and construction of artificial bee hives.

Unit 4

Bee products and economics: Bee products –honey, pollen, royal jelly, bees wax, propolis & venom, Significance of bee products. Value added honey products, Nutrients and composition of honey, Acid content and flavor effects, Economic Value of Commercial Beekeeping.

Suggested Readings

- Caron, D.M (2013). Honey Bee Biology and Beekeeping. Wicwas Press, Kalamazoo.
- Jabde, P.V (2016). Text Book of Applied Zoology: Vermiculture, Apiculture, Sericulture, LacCulture, Agricultural Pests and their Controls. Discovery Publishing House, New Delhi.
- Crane, E (1999). The World History of Beekeeping and Honey Hunting. Routledge, India.
- Hooper. T (2010). Guide to Bees & Honey: The World's Best-Selling Guide to Beekeeping. NorthernBee Books, Oxford.
- Pezza. K (2013). Backyard Farming: Keeping Honey Bees: From Hive Management to Honey Harvesting andMore. Hatherleigh Press, U.S

Course outcome

After completion the course the learners will be able to explain:

CO1. Various activities of bee rearing and its economic importance.

CO2. Provide insights into the different methods by which bees communicate socially.

CO3. Value added products obtained from honey bees

CO4. Provide entrepreneurial opportunities in bee rearing.

Mapping of CO and PO for SEC 02:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	3	3	2	3	3
CO2	3	3	3	3	3	3	2	3	2	3
CO3	3	3	2	3	3	3	2	3	3	3
CO4	3	3	2	3	2	3	3	3	3	3

No. of credits: 2

L: 2
P: 0

SEC 03: Biofertilizers and Biopesticides

Course objective: This course has immense employment potential, as organic biofertilizers and biopesticides are proving farm effectiveness in lab as well as field conditions. Also, students will come across diverse mechanisms by which microbes work for enhancing plant growth and decreasing disease incidence.

Unit 1
Biofertilizers: Introduction, types and importance of biofertilizers History of biofertilizers production, Classification of biofertilizers microorganisms used in biofertilizers production. Strategies of Mass multiplication and packing, Registration of biofertilizers and applications of using biofertilizers. Vermicomposting.

Unit 2
Mycorrhiza: Concept of Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants. Brief account of biofertilizers like Azospirillum, Rhizobium, cyanobacteria.

Unit 3
Mechanisms and applications: Nitrogen, phosphorus and potassium mechanisms for enhancing plant growth, process of nodule formation, role of Nif and Nod gene in Biological Nitrogen fixation, Methods used for the studying selection of efficient strain of Rhizobium. Quality standard for biofertilizers different methods of application of biofertilizers (solid and liquid biofertilizers).

Unit 4
Biopesticides: Introduction to biological agents and biopesticides**,** Importance of Trichoderma spp., Pseudomonas spp. and Bacillus spp. as a biocontrol agent. Mechanism of disease control by these organisms bioagents. Types of diseases controlled bioagents formulations, Effectiveness of bioagents against seed borne and soil borne plant pathogens.

Suggested readings

- Subba, R (2020). Biofertilizers in Agriculture and Forestry. International Science Publisher.
- Panda, H (2011). Manufacture of Biofertilizer and Organic Farming. Asia Pacific Business Press Inc.
- Rai, M.K (2008). Handbook of Microbial Biofertilizers. CRC Press.

Course outcome

After completion the course the learners will be able to explain:

CO1. Gain the knowledge of cultivation of different types of biofertilizer and biopesticides.

CO2. Mechanisms of enhancing plant growth through biological means.

CO3. Learn the basis of biofertilizer and biopesticides and generate employment opportunities.

CO4. Understanding the basics and detailed applications of bioformulations.

Mapping of CO and PO for SEC 03:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	3	3	3	3	3
CO2	3	3	3	2	3	3	2	3	3	3
CO3	3	3	2	3	3	3	2	3	3	3
CO4	2	3	3	3	2	3	3	3	3	2

No. of credits: 2

L: 2
P: 0

SEC 04: Mushroom Culture Technology

Course objective: To teach to the students knowledge, understanding and skills, which allow them to establish a mushroom cultivation enterprise, or to cultivate mushrooms in a form of extra-earnings, or simply as a hobby.

Unit 1
Introduction to mushroom: History and Scope of mushroom cultivation - Edible and Poisonous Mushrooms, morphology of mushrooms, of Button mushroom (*Agaricus bisporus*), Milky mushroom (*Calocybe indica*), Oyster mushroom (*Pleurotus sajor caju*) and paddy straw mushroom (*Volvariella volvacea*).

Unit 2
Cultivation Technology: Cultivation of white button mushroom (*Agaricus bisporus*), Spawn production technology, Pure culture preparation: culture and isolation, preservation and maintenance of cultures,media preparation production of pure culture, mother spawn, and multiplication of spawn. Composting technology, mushroom bed preparation. Spawning, harvesting. Diseases, pests and nematodes, moulds and their management strategies of white button mushroom.

Unit 3
Storage and nutrition: Nutritional and medicinal values of mushrooms. Therapeutic aspects-antitumor effect, Preservation of mushrooms - freezing, packaging, chemicals used for preservation, preservation by gamma radiation, dry freezing, drying, canning, quality assurance and entrepreneurship. Value added products of mushrooms.

Unit 4
Marketing of Mushrooms: Food preparation, Types of food prepared from mushrooms. Research centres-- National level and regional level, Cost benefit ratio-- Marketing in India and abroad, Export value.

Suggested Readings

- Krishnendu, A.J.S., and Marimuthu, A.R (2020). Mushroom Cultivation Technology. Technoworld book.
- Bhal, N. (2000). Handbook on Mushrooms. Oxford and IBH Publishing, New Delhi.
- Pandey, R.K. and Ghosh, S.K (1999). A Hand Book on Mushroom Cultivation. Emkey Publications.
- Pathak, V.N. and Yadav, N (2010). Mushroom Production and Processing Technology. Agrobios,Jodhpur, India.

Course outcome

After completion the course the learners will be able to explain:

CO1. Identify edible types of mushrooms, manage the diseases and pests of mushrooms

CO2. Gain the knowledge of cultivation of different types of edible mushrooms and spawn production.

CO3. Learn a means of self-employment and income generation

CO4. Manage the diseases and pests of mushrooms

Mapping of CO and PO for SEC 04:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	2	3	2	3
CO3	3	3	2	3	3	3	2	3	3	3
CO4	3	3	3	3	2	3	3	3	3	2

No. of credits:
2L: 2
P: 0

SEC 05: Sericulture

Course objective: This course will provide detailed insight into technology of young and late age silkworm for raising assured cocoon crops. Also, it will highlight how to use this appropriate and affordable technology for sustainable rural development.

Unit 1

Introduction to sericulture: History, development and status of mulberry and non-mulberry sericulture in India; Silk production in India and other countries; export and import. Introduction to textile fibres: types- natural/synthetic and their properties; importance of silk fibre.

Unit 2

Rearing of silk worms Life cycle of Bombyx mori, rearing houses and equipment, disinfection and hygiene, silkworm rearing, moulting, mounting, spinning, cocoon harvesting and marketing, physical and commercial characteristics of cocoons; cocoon sorting. cocoon stifling, cocoon cooking, Silk reeling

Unit 3

Entrepreneurship: Sericulture Organization in India: extension systems- Central Silk Board, State sericulture Departments, Universities and voluntary organizations, biomedical importance of silk. Characteristic features and advantages of sericulture; scope of sericulture in India employment potential and income generation.

Unit 4

Organizational setup: Different Sericulture Organization in India: extension systems- Central Silk Board, State sericulture Departments, Universities and voluntary organizations**.**

Suggested Readings

- Charsley, S.R. (1982). Culture and Sericulture. Academic Press Inc. New York, U.S.A.
- FAO Manuals (2016)- I Mulberry Cultivation. FAO Rome.
- Foth, H.D. (1991). Fundamentals of Soil Science. John Wiley & Sons, New York.
- Ganga, G. and Chetty, J.S. (2020). An Introduction to Sericulture. Oxford & IBH PublishingCompany.

Course Outcome

After completion the course the learners will be able to explain:

CO1. Historical perspective of sericulture, its scope and significance.

CO2. Economic advantages of sericulture and its role towards rural development.

CO3. Organizational set up of sericulture in India

CO4. Various activities of sericulture and importance of sericulture by products.

Mapping of CO and PO for SEC 05:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	2	3	2	3
CO3	3	3	2	3	3	3	2	3	3	3
CO4	3	3	3	3	2	3	3	3	3	2

No. of credits: 4
L: 4
P: 0

SEMESTER IV

DCC Botany IV (BLS 401): Cell and Molecular Biology

Course objective: To make students gain knowledge on the activities in which the giant molecules and minuscule structures that inhabit the cellular world of life are engaged. To provide insight into the organization of cells, its features and regulation at different levels. Through the study of biomolecules and cell organelles, they will be able to understand the various metabolic processes such as respiration, photosynthesis etc. which are important for life.

Unit 1

Tools and techniques in cell biology: Principles of microscopy; Light Microscopy, (EM)- Scanning EM and Transmission EM (TEM).
Cell as a unit of Life: Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory).
Cell wall and plasma membrane: Chemistry, structure and function of Plant cell wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis.

Unit 2

Cell Organelles: Nucleus; Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus.
Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filaments.
Chloroplast, mitochondria and peroxisomes: Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast. Endomembrane system: Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing; Smooth ER and lipid synthesis, export of proteins and lipids; Golgi Apparatus – organization, protein glycosylation, protein sorting and export from Golgi Apparatus; Lysosomes
Cell Cycle: Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle-checkpoints, role of protein kinases.

Unit 3

Nucleic acids: Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty, Fraenkel-Conrat's experiment.
Replication of DNA: Chemistry of DNA synthesis (Kornberg's discovery); Mechanism of replication in prokaryotes and eukaryotes, Enzymes involved in DNA replication.
Central dogma and genetic code: The Central Dogma (Adaptor hypothesis and discovery of mRNA template), Genetic code (deciphering & salient features)

Unit 4

Transcription: Mechanism of Transcription in prokaryotes and eukaryotes

Processing and modification of RNA: Split genes-concept of introns and exons, removal of introns,spliceosome machinery, splicing pathways, group I & group II intron splicing, alternative splicing eukaryotic mRNA processing; Ribozymes, exon shuffling; RNA editing and mRNA transport.

Translation: Translation in Prokaryotes and eukaryotes; Ribosome structure and assembly, mRNA;Charging of tRNA, aminoacyl tRNA synthetases; Fidelity of translation; Inhibitors of protein synthesis; post-translational modifications of proteins.

Regulation of transcription in prokaryotes and eukaryotes: Principles of transcriptional regulationin prokaryotes and Eukaryotes

Suggested Readings

- Karp, G. (2 0 0 9) . Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. Inc.
- De Robertis, E.D.P. and De Robertis, E.M.F (2006). Cell and Molecular Biology. Lippincott Williamsand Wilkins, Philadelphia.
- Cooper, G.M. and Hausman, R.E. (2007). The Cell: A Molecular Approach. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2006). The World of the Cell. PearsonBenjamin Cummings Publishing, San Francisco.
- Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2004). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. Snustad, D.P. and Simmons, M.J. Principles of Genetics. John Wiley and Sons Inc., U.S.A.
- Klug, W.S., Cummings, M.R., Spencer, C.A. Concepts of Genetics. Benjamin Cummings. U.S.A.
- Russell, P. J. (2006). iGenetics- A Molecular Approach. Benjamin Cummings, U.S.A.
- Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2012). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A.

Course outcome

After completion of the course the learners will be able to explain:

CO1. Relationship between the properties of macromolecules, their cellular activities and biological responses.

CO2. Cell metabolism, chemical composition, physicochemical functions of the cell

CO3. Organization of cell organelles and cell cycle

CO4. Foundational knowledge in understanding of nucleic acid, organization of DNA in prokaryotes and eukaryotes, DNA replication mechanism, genetic code and transcription process.

Mapping of CO and PO for BLS 401:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1	2	3	3	3	3	3	2	3
CO2	3	1	3	2	3	3	2	3	2	3
CO3	3	1	2	3	3	3	2	3	3	3
CO4	3	1	3	3	2	3	2	3	3	2

No. of credits: 4
L: 4
P: 0

DCC Zoology IV (BLS 402):
Genetics

Course objectives: This course is to familiarize students with basic principles of genetics and its application in understanding of real-life hereditary conditions

Unit 1

Introduction to Genetics- Concept of alleles, Genes, Homologous, non-homologous chromosomes. And homoeologous chromosomes. Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information, Principles of Inheritance, Chromosome theory of inheritance. Monohybrid cross, Dihybrid cross. Law of segregation. law of independent assortment. Nondisjunction. Human genetic disorders. Polygenic inheritance with examples. Sex linked genes, Sex limited gene, Sex influenced genes.

Unit 2

Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, intergenic gene interaction- complementary gene action, Epistasis (Dominant and recessive), , Collaboratory genes, Duplicate genes, sex linked inheritance, Extra- chromosomal inheritance, Pedigree analysis and probability.

Unit 3

Linkage, Crossing Over and Chromosomal Mapping, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence. Centromere mapping by Tetrad analysis. Ordered tetrad analysis and unordered tetrad analysis with relevant numericals.

Difference between genetic map and physical map.

Microbial genetics- Gene transfer mechanism- Transformation, Conjugation, Transduction

Unit 4

Mutations- Point mutation and its types, Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy, Euploidy and Polyploidy. Transposable elements. Determination, dosage compensation. Barr bodies, Polytene chromosome, lamp brush chromosome.

Suggested Readings

- Gardner, E.J., Simmons, M.J. and Snustad, D.P. (2006). Principles of Genetics. Wiley India.
- Singh B.D. (2009). Fundamental of Genetics, Kalyani Publisher
- Lewis Ricky, (2020). Human Genetics: Concepts and application, McGraw Hill publication
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. (2007). Introduction to GeneticAnalysis. W. H. Freeman and Co.

- Klug W. S, Cummings M.R, Spencer C.A, Palladino M.A, Killian D. (2019). Concepts of Genetics. Benjamin Cummings.
- Russell, P. J. (2009). Genetics- A Molecular Approach. Benjamin Cummings.
- Snustad, D.P. Simmons, M.J. (2014). Principles of Genetics. John Wiley and Sons

Course outcome

After completion of the course the learners will be able to explain:

CO1. Basic principles of pedigree analysis and will be able to construct and analyze pedigree related problems for inherited traits.

CO2. Gene interaction (Dominant and Recessive) and chromosomal inheritance

CO3. Gene and allele frequency using Hardy-Weinberg law and analyses population genetics problem

CO4. Chromosomal sex-determination mechanisms and dosage compensation.

Mapping of CO and PO for BLS 402:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1	2	3	3	3	3	2	3	3
CO2	3	1	2	3	3	3	2	3	2	3
CO3	3	1	2	3	3	3	2	3	3	3
CO4	3	1	3	3	2	3	3	2	3	2

No. of credits: 4
L: 4
P: 0

DCC Chemistry IV (BLS 403):
Physical Chemistry for the Biosciences

Course objectives: Develop an understanding of physical chemistry, structural chemical biology, and thermodynamics. Familiarize with modern experimental methods used to study thermodynamic and kinetic mechanisms.

Unit 1

Chemical Energetics: Review of the Laws of Thermodynamics. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formation, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.Chemical Equilibrium - Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^o, Le Chatelier's principle. Relationships between K_p, K_c and K_x for reactions involving ideal gases

Unit 2

Ionic Equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product ofsparingly soluble salts – applications of solubility product principle. Chemical Kinetics: The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero and first order reactions. Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation. Enzyme kinetics.

Unit 3

Electrochemistry: Redox reactions, EMF of a cell, standard electrode potential, Nernst equation and its application to chemical cells, Relation between Gibbs energy change and EMF of a cell, conductance in electrolytic solutions, specific and molar conductivity, variations of conductivity with concentration, Kohlrausch's Law, electrolysis

Unit 4

Photochemistry: Laws of photochemistry. Fluorescence and phosphorescence. Quantum efficiency and reasons for high and low quantum yields. Primary and secondary processes in photochemical reactions. Photochemical and thermal reactions.

Suggested Readings

- Atkins, P. W. & Paula, J. de. (2017). Atkin's Physical Chemistry 11th Ed., Oxford UniversityPress
- Ball, D. W. (2017). Physical Chemistry Thomson Press, India
- Castellan, G. W. (2004). Physical Chemistry 4th Ed. Narosa
- Mortimer, R. G. (2008). Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP
- Chang, R. (2005). Physical Chemistry for the Biosciences. University Science Books

Course outcome

After completion of the course the learners will be able to explain:

CO1. The critical state, apply the critical state equation to the problems.

CO2. The condensed phases, expresses and uses the vapor pressure.

CO3. Express the stability of the phases in the pure substance.

CO4. Basics of the photochemistry including photochemical and thermal reactions.

Mapping of CO and PO for BLS 403:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	1	2	3	3	3	3	3	3	3
CO2	1	1	3	3	3	3	2	3	2	3
CO3	1	1	2	3	2	3	2	3	3	2
CO4	1	1	3	3	2	3	3	3	3	2

No. of credits: 2

L: 0
P: 4

DCC Lab IV: Botany (BLS 404)- Cell and Molecular Biology

- Study of the of cell organelles virtually
- To study the structure of plant cells and animal cells through temporary mounts.
- To prepare temporary stained preparation of mitochondria from striated muscle cells /cheek epithelial cells using vital stain Janus green.
- Study of mitosis and meiosis (temporary mounts and permanent slides).
- Study the effect of temperature, organic solvent on semi permeable membranes.
- Study of plasmolysis and deplasmolysis in *Rhoeo* leaf.
- Cytochemical staining of DNA- Feulgen and cell wall in the epidermal peel of onion using Periodic Schiff's (PAS) staining technique.
- Estimation of DNA by DPA method.
- Estimation of RNA by Orcinol method
- Extraction of total nucleic acids from plant tissue/animal cells/ yeast. And checking its purity by A260/A280 Ratio.

**** Addition or deletion of the practical's may be done as per the convenience***

Course Outcomes:

After completion of the course the learners will be able to explain:

CO1. Structure of cell organelles, Plant and animal cells.

CO2. To prepare temporary stained preparation of mitochondria, stages of mitosis & meiosis, also effect of temperature and organic solvents on semi-permeable membranes.

CO3. Cytochemical staining of DNA, estimation of DNA & RNA by different methods and extraction of DNA from different samples.

Mapping of CO and PO for BLS 404:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1	2	3	3	3	2	3	2	3
CO2	3	1	3	2	3	3	2	3	2	3
CO3	3	1	2	3	3	3	2	3	2	3

No. of credits: 2

L: 0
P: 4

DCC Lab IV: Zoology
(BLS 405)-Genetics

- Study of Mendelian Inheritance and gene interactions using suitable examples/ seeds
- Study of Linkage, recombination, gene mapping using the data
- Centromere mapping by tetrad analysis
- Study of Human Karyotypes (normal and abnormal)
- Pattern of inheritance of given pedigree.
- Calculation of recombination frequency
- Bacterial gene mapping by interrupted conjugation method
- Calculation of co-transformation and co-transduction frequency
- Calculation of deviation in phenotypic ratios of different intergenic gene interactions
- Comparison of ploidy level with respect to given example.
- Mounting of Barr Body from Buccal epithelium
- Temporary squash perpetrations of onion root tip/ grasshopper testis for the study of mitosis/ Meiosis using acetocarmine staining

Addition or deletion of the practical's may be done as per the convenience

Course Outcomes:

After completion of the course the learners will be able to explain:

CO1. Mendelian inheritance, gene interaction via suitable examples and linkage, gene mapping using the data.

CO2. Centromere mapping, Human karyotyping and pattern of inheritance by pedigree analysis.

CO3. The bacterial gene mapping by different methods, comparison of ploidy level and Barr Body mounting from the sample.

Mapping of CO and PO for BLS 405:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1	2	3	3	3	3	2	3	3
CO2	3	1	3	3	2	3	2	3	2	3
CO3	3	1	2	3	3	3	2	2	3	3

No. of credits: 2
L: 0
P: 4

DCC Lab IV: Chemistry (BLS 406)-Physical Chemistry for Biosciences

- Determination of heat capacity of a calorimeter for different volumes.
- Determination of the enthalpy of neutralization of hydrochloric acid with sodium hydroxide. Determination of integral enthalpy of solution of salts (endothermic and exothermic).
- Preparation of sodium acetate-acetic acid buffer solutions and measurement of their pH.
- Potentiometric titrations of (i) strong acid vs strong base (ii) weak acid vs strong base
- Determination of dissociation constant of a weak acid.
- Determination of pK (indicator) for phenolphthalein.
- Study t h e kinetics of interaction of crystal violet with sodium hydroxide calorimetrically.
- Equilibrium potential calculation by Nernst Equation

Addition or deletion of the practical's may be done as per the convenience

Course Outcomes:

After completion of the course the learners will be able to explain:

CO1. Understand the concept of heat capacity and various type of enthalpy.

CO2. To learn the concept of buffer solution and determine the pH of different solutions.

CO3. To investigate the potential of different cell at equilibrium using Nernst equation.

Mapping of CO and PO for BLS 406:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	1	2	3	3	3	2	3	3	3
CO2	1	1	3	3	2	3	2	3	2	3
CO3	1	1	2	3	3	3	2	3	2	3

SEMESTER V

No. of credits: 4
L: 4
P: 0

DCC Botany V (BLS 501):
Plant Physiology and metabolism

Course objective: To make students understand about the mechanism and physiology of life processes in plants. To make them aware about plants function, namely the importance of water, minerals, hormones, and light in plant growth and development. To educate students about photosynthesis, respiration and nitrogen metabolism.

Unit 1

Plant-water relations: Importance of water, water potential and its components; Water transport processes in plants, Water balance of plants. The Soil-Plant-Atmosphere continuum. Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

Mineral nutrition: Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; deficiencies and plant disorders.

Unit 2

Solute transport and photo assimilate translocation: Transport of solutes across membrane barriers, Membrane transport proteins, mechanisms of loading and unloading of photoassimilates, Assimilate allocation and partitioning.

Translocation in phloem: Composition of phloem sap, girdling experiment; Pathways, patterns and mechanism of translocation. Pressure flow model; Phloem loading and unloading.

Unit 3

Concept of metabolism: Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric , covalent modulation and Isozymes).

Photosynthesis: Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation; Photorespiration.

Respiration: Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway.

Enzymes: Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.

Nitrogen metabolism: Biological nitrogen fixation; Nitrate and ammonia assimilation.

Unit 4

Plant growth regulators; Discovery, physiological roles, cellular and molecular modes of action of auxins, gibberellins, cytokinins, ABA, ethylene. Strigolactone and other plant growth regulators- Physiological role in plant development. Plant response to light and temperature: Photoperiodism (SDP, LDP, Day neutral plants); Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins, red and far red light responses on photomorphogenesis; Vernalization

Suggested Readings

- Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2015). Plant physiology and development. Sinauer Associates Inc.: Sunderland, MA, USA.
- Hopkins, W. G., & Hüner, N. P. (2003). Introduction to Plant Physiology 3 rd ed. John Willey and Sons. *Inc. USA*, 731.
- Bajracharya, D. (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa PublishingHouse, New Delhi.
- Harborne, A. J. (1998). *Phytochemical methods a guide to modern techniques of plant analysis*. springer science & business media.

Course outcome

After completion of the course the learners will be able to:

CO1. Develop a deep insight in understanding the importance of water and minerals for plants

CO2. Gain knowledge about the uptake and transport mechanisms in plants

CO3. Understand the role of various hormones, signaling compounds,thermodynamics and enzyme kinetics

CO4. Correlate morphology, anatomy, cell structure and biochemistry with plant functioning.

Mapping of CO and PO for BLS-501

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1	3	2	3	3	3	3	3	3
CO2	3	1	3	2	3	3	3	3	3	3
CO3	3	1	3	2	3	3	3	3	3	3
CO4	3	1	3	2	3	3	3	3	3	3

No. of credits: 4

L: 4

P: 0

DCC Zoology V (BLS 502): Immunology

Course objectives: Immunology is a broad discipline that encompasses specialties as diverse as biochemistry, clinical biology, medicine, ecology and evolutionary biology. Basic knowledge of Immunology can be applied to understand and treat a wide range of diseases and infections. This branch has expanded into newer avenues of prophylaxis and immunotherapy thus providing new therapeutic approaches to immunodeficiency diseases, cancer therapy and autoimmune disorders.

Unit 1

Introduction to basic concepts in immunology, components of immune system, principles of innate and adaptive immune system. Hematopoiesis, Cells of immune system and organs (primary and secondary lymphoid organs) of the immune system

Unit 2

Antigens-Basic properties of antigens, B and T cell epitopes, haptens and adjuvants. Antibodies Structure, classes and function of antibodies, monoclonal antibodies,
antigen antibody interactions as tools for research and diagnosis.

Unit 3

Structure and functions of MHC, exogenous and endogenous pathways of antigen presentation and processing, Basic properties and functions of cytokines, Complement system: Components and pathways.

Unit 4

Various types of hypersensitivities, Introduction to concepts of autoimmunity and immunodeficiency. Vaccines-General introduction to vaccines, Various types of vaccines. Application of Vaccination.

Suggested Readings

- Roitt, I. M. (2013). Leitfaden der Immunologie. Springer-Verlag.
- Gupta S K. (2017) Essentials of Immunology, Arya Publication.
- Frank. C Hay. (2002). Practical Immunology, John Wiley and sons ltd.
- Khan, F. H. (2009). The elements of immunology. Pearson Education India.

- Owen, J. A., Punt, J., & Stranford, S. A. (2013). Kuby immunology (p. 574). New York, NY, USA:: WH Freeman.
- Delves, P. J., & Roitt, I. M. (1998). Encyclopedia of immunology. Academic Press.
- Chapel, H., Haeney, M., Misbah, S., & Snowden, N. (2013). Essentials of clinical immunology. John Wiley & Sons.
- Hudson, L., Hay, F. C., & Hudson, L. (1989). Practical immunology (Vol. 3). Oxford: Blackwell Scientific Publications.
- Pravash Sen. Gupta, (2003). Clinical Immunology. Oxford University Press
- Detrick, B., Hamilton, R. G., & Schmitz, J. L. (Eds.). (2020). Manual of molecular and clinical laboratory immunology. John Wiley & Sons.

Course outcome

After completion of the course the learners will be able to:

CO1. Learn the concepts of innate and acquired immunity.

CO2. Gain knowledge about the Complement system and how they interact and activate acatalytic cascade to remove immunogens.

CO3. Learn about the importance of major histocompatibility complex and role of complement system combating various infections.

CO4. Develop a deep understanding about various immunological disorders

Mapping of CO and PO for BLS-502

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1	3	2	3	3	3	3	3	3
CO2	3	1	3	2	3	3	3	3	3	3
CO3	3	1	3	2	3	3	3	3	3	3
CO4	3	1	3	2	3	3	3	3	3	3

No. of credits: 4

L: 4
P: 0

DCC Chemistry V (BLS 503): Cheminformatics

Course objectives: The objective of this course is to provide introduction to chemoinformatics, an interdisciplinary area on the interface of chemistry, informatics and biology. The student will be provided with understanding of fundamentals of chemoinformatics and its applications. Through lectures, hands-on exercises and assignments, the student is expected to achieve a good grasp of the concepts and applications of chemoinformatics.

Unit 1

Introduction to Chemoinformatics: History and evolution of chemoinformatics, Use of chemoinformatics, Prospects of chemoinformatics, Molecular modelling and structure elucidation. Representation of molecules and chemical reactions: Nomenclature, Different types of notations, SMILES coding, Matrix representations, Structure of Molfiles and Sdfiles, Libraries and toolkits, Different electronic effects, Reaction classification.

Unit 2

Searching chemical structures: Full structure search, sub-structure search, basic ideas, similarity search, three-dimensional search methods, basics of computation of physical and chemical data and structure descriptors, data visualization.

Unit 3

Applications: Prediction of Properties of Compounds; Linear Free Energy Relations; Quantitative Structure-Property Relations; Descriptor Analysis; Model Building; Modeling Toxicity. Structure-Spectra correlations; Prediction of NMR, IR and Mass spectra; Computer Assisted Structure elucidations; Computer Assisted Synthesis Design

Unit 4

Introduction to drug design; Target Identification and Validation; Lead Finding and Optimization; Analysis of HTS data; Virtual Screening; Design of Combinatorial Libraries; Ligand-Based and Structure Based Drug design; Application of Chemoinformatics in Drug Design.

Suggested Readings

- Mining, W. I. D. (2006). Data mining: Concepts and techniques. Morgan Kaufinann.
- Pieter, A. and Dolf, Z. (1997) Data MiningAddison-Wesley Longman Publishing.
- Pujari, A. K. (2001). Data mining techniques. Universities press.
- BPB Editorial Board.(2004) Data Mining. BPB Publications

Course outcome

After completion of the course the learners will be able to:

CO1. Explain and implement computation of molecular descriptors and chemical similarity.

CO2. Classify small molecules and interpret results from chemo-informatics analysis.

CO3. Strengthen skills in working with computational chemistry andbioinformatics applications and databases

CO4. Develop a deep understanding in computer aided drug designing

Mapping of CO and PO for BLS-503

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1	3	3	3	3	3	3	3	3
CO2	2	1	3	3	3	3	3	3	3	3
CO3	3	1	3	3	3	3	3	3	3	3
CO4	2	1	3	3	3	3	3	3	3	3

No. of credits: 2

L:0

P: 4

DCC Botany V (BLS 504):
Plant Physiology and metabolism (Lab)

- Determination of osmotic potential of plant cell sap by plasmolytic method.
- To study the effect of two environmental factors (light and wind) on transpiration by excised twig.
- Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
- Demonstration of Hill reaction.
- Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.
- To study the effect of light intensity and bicarbonate concentration on O2 evolution in photosynthesis.
- Separation of amino acids by paper chromatography.
- Chemical separation of photosynthetic pigments.

**** Addition or deletion of the practical's may be done as per the convenience***

Course outcome

After completion of the course the learners will be able to:

CO1. Demonstrate the importance of various factors in plant growth

CO2. Perform experiments regarding separation of amino acids and photosynthetic pigments.

CO3. Develop a deep understanding in plant physiology and metabolism

Mapping of CO and PO for BLS-504

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1	2	3	3	3	3	3	3	3
CO2	3	1	2	3	3	3	3	3	3	3
CO3	3	1	2	3	3	3	3	3	3	3

No. of credits: 2

L: 0

P: 4

DCC Zoology V (BLS 505): Immunology (Lab)

- Identification of various immune cells by morphology – Leishman staining, Giemsa staining.
- Differential counts, Total counts.
- Agglutination Reactions
- Hemagglutination Reactions- Blood Grouping
- Rh Typing, Coomb's test
- Serum electrophoresis, PAGE of serum proteins.
- Detection of antigen by ELISA
- Histological study of spleen, thymus and lymph nodes through slides/ photographs

**** Blood sample collection would be performed under lab attendant of health center or doctor***
**** Addition or deletion of the practical's may be done as per the convenience***

Course outcome

After completion of the course the learners will be able to:

CO1. Differentiate immune cells present in the body

CO2. Understand the basis of different types of blood groups in humans

CO3. Demonstrate the principles of antigen-antibody reaction

Mapping of CO and PO for BLS-505

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1	3	3	3	3	3	3	3	3
CO2	3	1	3	3	3	3	3	3	3	3
CO3	3	1	3	3	3	3	3	3	3	3

No. of credits: 2
L:0
P: 4

DCC Chemistry V (BLS 506):
Cheminformatics (Lab)

- Overview of Rational Drug Design, Ligands and Ta rgets
- In silico representation of chemical information
- CIF IUCr Crystallographic Information Framework
- CML Chemical Markup Language
- SMILES -- Simplified Molecular Input Line Entry Specification
- Chemical Databases and Data Mining
- Cambridge Structural Database CCDC CSD

**** Addition or deletion of the practical's may be done as per the convenience***

Course outcome
After completion of the course the learners will be able to:
CO1. Understand the basis of drug designing
CO2. Develop a deep understanding on CIF and CML
CO3. Demonstrate the structure and importance of databases related to chemistry

Mapping of CO and PO for BLS-506

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	1	3	3	3	3	3	3	3	3
CO2	1	1	3	3	3	3	3	3	3	3
CO3	1	1	3	3	3	3	3	3	3	3

No. of credits: 4
L: 4
T: 0

DEC 01: Microbiology

Course objective: Understand the basic microbial structure and function and study the comparative characteristics of prokaryotes and also understand the structural similarities and differences among various physiological groups of bacteria/archaea.

Unit 1

History and scope of microbiology: Introduction to microbiology, history of microbiology, contributions of Anton van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Martinus W. Beijerinck and Sergei N. Winogradsky. Role of microorganisms in fermentation, Germ theory of disease. golden era of microbiology.

Unit 2

Isolation and Preservation techniques: Culture media, Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non-culturable bacteria.

Unit 3

Bacterial cell organization: Cell size, shape and arrangement, capsule, flagella, fimbriae and pili. Structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, Gram and acid fast staining mechanisms, spheroplasts, protoplasts, and L-forms. Inclusion bodies and Endospore, Growth kinetics.

Unit 4

Sterilization methods: Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation. Chemical methods of microbial control: disinfectants, types and mode of action.

Suggested Readings

- Mehrotra, R. S. (2009). *Principles of microbiology*. Tata McGraw-Hill Education.
- Pelczar Jr, M. J., Chan, E. C. S., & Krieg, N. R. (2004). Microbiology. Tata McGraw Hill.
- Willey, J. M., Sherwood, L., & Woolverton, C. J. (2011). *Prescott's microbiology* (Vol. 7). New York: McGraw-Hill.
- Tortora, G. J., Funke, B. R., Case, C. L., Weber, D., & Bair, W. (2004). *Microbiology: an introduction* (Vol. 9). San Francisco, CA: Benjamin Cummings.

Course outcome

After completion of the course the learners will be able to:

CO1. Get an overview about historic development in microbiology

CO2. Know various Culture media and their applications and also understand various physical and chemical means of sterilization

CO3. Know General bacteriology and microbial techniques for isolation of pure cultures of bacteria, fungi and algae

CO4. Master aseptic techniques and be able to perform routine culture handling effectively.

Mapping of CO with PO of DEC01

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	2	2	3	2
CO2	3	3	3	3	3	3	2	2	3	3
CO3	3	3	3	3	3	3	3	2	3	3
CO4	3	3	3	3	3	3	3	2	3	3

No. of credits: 4

L: 4
T: 0

DEC 02: Evolutionary Biology

Course objective: Evolutionary biology is a unifying thread which joins all organisms from prokaryotes to the highest of eukaryotes. This course emphasizes on the development of evolutionary thought by dealing in general with the process and pattern of biological evolution. On one hand, it offers a chance to students to learn about deciphering evidence ranging from fossil records to molecular data and arranges them to establish phylogenetic relationships of species.

Unit 1
Life's beginning: Chemogeny, RNA World, Biogeny, Origin of photosynthesis, Endo-symbiotic theory.

Unit 2
Historical review of evolutionary concepts: Concept of Lamarckism, Darwinism, Neo-Darwinism.

Unit 3
Concept of speciation: Speciation: Micro-evolutionary changes (inter-population variations, clines, Ring species, races), Species concept, Isolating mechanisms, Modes of speciation, Adaptive radiation/macroevolution, Phyletic gradualism and punctuated equilibrium.

Unit 4
Forces of evolution: Qualitative and quantitative traits, Natural selection, Hardy-Weinberg Equilibrium, Natural selection (concept of fitness, selection coefficient), genetic drift (founder's effect, bottleneck phenomenon), migration and mutation (genetic load).

Suggested Readings

- Ridley, M. (1993). Evolution Blackwell Publishing.
- Hall, B., & Strickberger, M. W. (2008). *Strickberger's evolution*. Jones & Bartlett Learning.
- Futuyma, D. J. (1998). Evolutionary Biology, Sinauer Associates. *Inc. Sunderland, MA*.
- Douglas, J. Futuyma (1997).Evolutionary Biology. Sinauer Associates.
- Minkoff, E.C. (1983) Evolutionary biology. Reading, MA: Addison-Wesley Publishing Company.
- Sober, E. (Ed.). (1994). *Conceptual issues in evolutionary biology*. Mit Press.

Course outcome

After completion of the course the learners will be able to:

CO1. Explain the fundamental processes of beginning of life on earth.

CO2. Acquire problem solving and high order analytical skills by attempting numerical problems as well as performing simulation studies of various evolutionary forces in action.

CO3. Apply knowledge gained, on populations in real time, while studying speciation, behaviour

and susceptibility to diseases.

CO4. Gain knowledge about the relationship of the evolution of various species and the environment they live in.

Mapping of CO with PO of DEC 02

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	3	3	3	3	2
CO2	3	3	2	3	3	3	3	3	3	3
CO3	3	3	2	2	3	3	3	3	3	3
CO4	3	3	3	2	3	3	3	3	3	3

No. of credits: 4

L: 4
P: 0

DEC 03:
Fundamentals of Neurosciences

Course objective: To provide a systematic introduction to the mammalian nervous system, emphasizing the structural and functional organization of the human brain. To expose students to the field of neuroscience.

Unit 1

Introduction to neuroscience: Origins of Neuroscience; Neuroanatomy, Neurophysiology, and Systems Neurobiology.

Unit 2

The Nervous system: Introduction to the structure and function of the nervous system: Cellular components: Neurons; Neuroglia; Neuron doctrine; The prototypical neuron – axons and dendrites as unique structural components of neurons. The ionic bases of resting membrane potential; The action potential- its generation and properties.

Unit 3

Neurotransmitters: catecholamines, amino acidergic and peptidergic neurotransmitters; Transmitter gated channels; G-protein coupled receptors and effectors, neurotransmitter receptors; Ionotropic and metabotropic receptors.

Unit 4

Synapse: Synaptic transmission, Types of synapses; synaptic function; Principles of chemical synaptic transmission; Principles of synaptic integration; Ion channels, Neural transmission.

Suggested readings

- Dale, P. (2011) Neuroscience. Sinauer Associates.
- Simmons, P., & Young, D. (2010). *Nerve cells and animal behaviour*. Cambridge University Press.
- Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology, XI Edition. John Wiley & Sons

Course outcomes

On successful completion of the course students will be able to:

CO1. Explain the origin of different fields of neuroscience and their application
CO2. Understand the nerve cells in terms of their structure and propagation of nerve impulses.
CO3. How the transfer of information takes place between nerve cells
CO4. The development of nerve cells into the brain and spinal cord

Mapping of CO with PO of DEC 03

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	3	2	1	2	3	2	2	2	3
CO2	3	3	2	1	2	3	2	2	2	3
CO3	3	3	2	2	2	3	2	2	2	3
CO4	3	3	2	2	2	3	2	2	2	3

No. of credits: 4

L: 4
P: 0

DEC 04:
Analytical methods in Chemistry

Course objectives: The aim of this course is to provide students with a broad understanding of the principles of analytical chemistry and their application in the areas of environmental and medicinal/pharmaceutical sciences and advanced materials. Depending on their program, students will have the opportunity to apply analytical chemical methods in different science following areas

Unit 1

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law. UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instruments. Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques. Structural illustration through interpretation of data, Effect and importance of isotopesubstitution. Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal.

Unit 2

Electroanalytical methods: Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values. Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.

Unit 3

Separation techniques: Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media. Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.

Unit 4

Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents. Chiral chromatographic techniques using chiral columns (GC and HPLC). Role of computers in instrumental methods of analysis

Suggested readings

- Vogel, A. I., & Jeffery, G. H. (1989). Vogel's textbook of quantitative chemical analysis. Wiley.
- Willard, H. H., Merritt Jr, L. L., Dean, J. A., & Settle Jr, F. A. (1988). Instrumental methods of analysis. Wadsworth Publishing Company Ltd., Belmont, California, USA
- Christian, G.D; Analytical Chemistry, (2004). John Wiley & Sons, New York
- Harris, D. C. (2012). Exploring chemical analysis. Macmillan.
- Khopkar, S. M. (1998). Basic concepts of analytical chemistry. New Age International.
- Skoog, D. A., Holler, F. J., & Crouch, S. R. (2017). Principles of instrumental analysis. Cengage learning.

Course outcome

After completion the course the learners will be able to explain:

CO1. Explain the fundamentals of analytical chemistry and steps of a characteristicanalysis.

CO2. Expresses the role of analytical chemistry in science.

CO3. Compare qualitative and quantitative analyses.

CO4. analytical techniques for separation and characterization of a target analyte from a given sample

Mapping of CO with PO of DEC 04

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	3	3	3	2	3	3	3	2	3
CO2	2	3	3	3	2	3	3	3	2	3
CO3	1	3	3	3	2	3	3	3	2	3
CO4	2	3	3	3	2	3	3	3	2	3

No. of credits: 4

L: 4
P: 0

DEC-05
Bioinformatics

UNIT I
Introduction to Bioinformatics: Definition, role, scope and limitation of bioinformatics. Different branches of bioinformatics. Terminologies: Internet browser, software, hardware, database, Network, NicNet, Inflibnet, EMBnet, Operating System, algorithm.

UNIT II
Biological Data Banks: An introduction to data mining and data security, Data warehousing, Data capture, Data Analysis, Data Banks, Gene banks, EMBL nucleotide sequence data bank, Sequence data bank, rRNA data Bank, Peptide data bank., Data Bank similarity searches (BLAST, FASTA, PSI-BLAST algorithms multiple), Structural Data Bank

UNIT III
Biodiversity Data Bases: Organizing Biological SPP information, Data sets in Biodiversity informatics ATCC, NCBI Sequence Analysis: Computational methods and significance, homology algorithms (BLAST) for proteins and nucleic acids, open reading frames, annotations of genes, conserved protein motifs related structure / function. Phylogenetic analysis: Introduction and importance, phylogenetic tree, methods of phylogenetic analysis.

UNIT IV
Application of Bioinformatics and Scientific Documentation: Virtual library searching Medline, Science citation indexes, Electronic Journals, Grants and finding information. Research documentation-preparation of research report, settling up of a laboratory, seminar, paper preparation and presentation.

Suggested readings

- Agarwal, B.L. (2003). Basic Statistics. New Age, New Delhi
- Gupta, S.P. (2004). Statistical Methods., S. Chand & Sons, New Delhi
- Dutta, N.K. (2002). Fundamentals of Bio-Statistics., Kanishka Publ., New Delhi
- Przytycka, T.M. and Sagot, M.F. (2011) Algorithms in Bioinformatics, Springer My
- Copy, UK
- Mount, D.W (2002), Bioinformatics: Sequence & Genome Analysis, Cold Spring Harbor
- Laboratory Press.
- Lesk, A.M. (2013), Introduction to Bioinformatics, 4thEdn. Oxford University Press, Oxford.

Course Outcome
After completion of this course, the learner will be able to:

CO1. Understand about overview of bioinformatics scope and their disciplines. Generation of large-scale data in the field of molecular biology.

CO2. To attain knowledge about data storage model/format, retrieval of information and integration. Understanding about different sequence formats. Perform sequence alignment and phylogenetic prediction with different tools/softwares with algorithm.

CO3. Review of database source, database management system, Biological databases and their classification. Sequences databases and specialized databases.
CO4. To write scientific documents, retrieve scientific date from online sources. Guidelines for writing dissertation, thesis and research articles.

Mapping of CO and PO for DEC 05

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1	3	3	2	3	3	2	3	3
CO2	3	1	3	3	2	3	3	2	3	3
CO3	3	1	3	3	2	3	3	2	3	3
CO4	3	1	3	3	2	3	3	2	3	3

No. of credits: 4

L: 4
P: 0

DEC-06
Basic Nanotechnology

Unit-I
Introduction & Background: Introduction to Nanotechnology, Insights and intervention into the Nanoworld, Historical Background, recent advances and future aspects, Applications of Nanotechnology in different fields- Agriculture, medical applications, Environmental applications, Space, Defence, Food processing, consumer durables, textiles, cosmetics etc, Safety, Health & environmental issues, Societal implications of Nanotechnology.

Unit-II
Instrumentation Techniques for Nanotechnology: FTIR, DSC, Scanning Probe Microscopy (SPM), AFM, Scanning Tunneling Microscopy (STM), SEM, TEM, XRD (Powder/Single crystal), Particle size analyzer and Zeta Sizer.

Unit-III
Nanomaterials- Types, Properties and applications; Synthesis methods- Physical, Chemical and Biological methods of synthesis; Carbon Nanotubes – Synthesis methods, Characterization and applications; Nanowires- synthesis methods, physical properties, applications; Smart materials.

Unit-IV
Micro and Nanofabrication Techniques- Concept of MEMS and NEMS, Fabrication techniques- A brief account, applications of Micro and Nanodevices, Micro fluidic devices and their applications; Material aspects for Micro fluidic devices, active and smart passive Micro fluidics devices, Lab-on-a-chip.

Suggested Readings:

- Kulkarni, S, K. (2014). Nanotechnology- Principles and Practices. 3rd Edition, Capital Publishing Company.
- Vajtai, R(2013). Handbook of Nanomaterials, Springer.
- Hari Singh Nalwa 2011. Encyclopedia of Nano Science & Nanotechnology. American Scientific Publishers.
- Balzani, V., Credi, A. & Verturi, M. (2003). Molecular Devices and Machines- A Journey into Nanoworld. Wiley-VCH Verlag.
- Albert Folch (2013) “Introduction to BioMEMS”, CRC Press.
- Bhushan, Bharat. (2004). Handbook of Nanotechnology. Springer.

Course Outcome
After the completion of this course, the learner will be able to:

CO1. An overview of historic development of nanotechnology, applications of nanotechnology in agriculture, food industries, defence, space etc.
CO2. characterise different properties of nanoparticles using modern day instruments.
CO3. Explain the different types of nanomaterials, methods of nanoparticle synthesis and their applications for societal development.

CO4. understand the different fabrication methods used for dressing of nanoparticles in regards to micro and nano devices.

Mapping of CO and PO for DEC 06

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	2	1	3	3	2	3	3	2	3	3
CO2	2	1	3	3	2	3	3	2	3	3
CO3	3	1	3	3	2	3	3	2	3	3
CO4	3	1	3	3	2	3	3	2	3	3

No. of credits: 4

L: 4
P: 0

DEC- 07
Omics Technology

Unit I
Proteomics Mass spectrometry – ionization methods (MALDI, electrospray), mass analysers, fragmentation modes (CID, HCD and ETD), intact protein analysis, protease digestion, peptide mass fingerprinting, tandem mass spectrometry, introduction to Data Independent Analysis (DIA), Basics of chromatography and fractionation strategies; Protein sequence and spectral databases/ libraries, de-novo sequencing, search algorithms- SEQUEST, X!tandem, MS-Amanda; Proteomic data repositories.

Unit II
Metabolomics-an overview, basic sample preparation strategies- extraction, derivatization, Workflow for lipidomics; Introduction to mass spectrometry and modes of data acquisition, data repositories. Targeted Vs Untargeted metabolomics; development of targeted assays for small molecules.

Unit III
Sanger sequencing-principle, methodology and applications, History of genome sequencing, Human Genome sequencing project; Analysis of gene expression- qPCR, northern blot, southern blot; Transcriptome profiling; DNA microarrays; Copy number variation, sequence repeats, SNV, haplotype, and their relevance in diseases. Comparative genomics. Metagenomics

Unit IV
Whole genome - de novo sequencing or resequencing; exome sequencing; RNA sequencing; small RNA sequencing; metagenomics; NGS workflow: DNA/RNA isolation and quantitation; Fragmentation (different methods – Physical / Enzymatic/ Chemical); Library preparation-blunt end and adapter ligation, amplification, index addition; single end and paired end reads; Exome/ gene panel capture; Ribosomal RNA depletion (RNA-Seq) and small RNA enrichment; 16S rRNA based sequencing for metgenomics; Platforms for NGS sequencing; Clonal amplification- Bead-based or Emulsion-based PCR amplification, array-based or bridge amplification; Sequencing technologies-(Clone-by-clone sequencing, Shot-gun sequencing, sequencing by hybridization and sequencing by synthesis),

Suggested Readings:

- Wilson K, Walker J (2010). Principles and techniques of biochemistry and molecular biology, 7th edition. Cambridge University Press.
- Primrose SB, Twyman RM (2006). Principles of gene manipulation and genomics. Blackwell Publishing
- Simpson R (2002). Proteins and proteomics: A laboratory manual. Cold Spring Harbor Laboratory Press.
- Green MR, Sambrook J (2012). Molecular cloning – A laboratory manual. Cold Spring Harbor Laboratory Press.
- Fan TW-M, et al. (2012). The handbook of metabolomics. Humana Press
- Reece RJ (2004). Analysis of genes and genomes. John Wiley & Sons Ltd.

Course Outcome

After the completion of this course, the learner will be able to

CO1. Basic concept of proteomics and different techniques used to identify and characterise the protein sample.

CO2. Importance of metabolites in defining biological processes and identification of target metabolites and data analysis.

CO3. Basic work flow behind different biotechniques used to study DNA, RNA and proteins to solve a biological question.

CO4. Modern day sequencing technologies used for whole genome draft, NGS transcriptome, PacBio and Nanopore platform.

Mapping of CO and PO for DEC07

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	2	3	3	3	2	3	2	2	3	3
CO2	3	3	3	3	2	3	2	2	3	3
CO3	2	3	3	3	2	3	2	2	3	3
CO4	3	3	3	3	2	3	2	2	3	3

No. of credits: 4

L: 4
P: 0

DEC- 08
IPR and Innovation

UNIT I
Understanding and Overview of the IPR Regime: Introduction, types of intellectual property, Industrial properties. Artistic and literary properties, sui generis system. Need for intellectual property rights. Rational for protection of IPR. Impact of IPR on development, health, agriculture and genetic resources. IPR in lndia Genesis and Development. IPR in abroad, Some important examples of IPR, international organizations and agencies and treaties.

UNIT II
Patents-Trips, Definition, kind of inventions protected by patents and patentable and non patentable inventions, Process and product patent, double patent, patent of addition. Legal requirements for patents,- Granting of patent- Right of a patent exclusive right. Patent application process, Searching a patent- Drafting a patent- Filing a patent, types of patent applications- Patent document: Specification and claims. Management of IP assets, and IP portfolio, commercial exploitation of IP-Assignment, Licensing, Infringement. The different layers of the international patent system: National, regional and international options.

UNIT III

Rights of trademark-kind of sign used as trademarks-types, purpose and functions of trademarks, trademark protection, trademark registration, acquisition of trade mark rights, protectable matter, selecting and evaluating trade mark, trade mark registration processes. Trade secrete law, determination of trade secrete status, liabilities for misappropriations of trade secretes, protection for submission, trade secret litigation.

UNIT IV
Right and protection covered by copyright-Law of copyright: Fundamentals of copyright law, originality of material, rights of reproduction, right to perform the work publicity, copyright ownership issue, obtaining copy right registration, notice of copy right, international copy right law, infringement of copyright under copyright Act, academic integrity or plagiarism: An intellectual theft.
Geographical indication of Goods, types why and how GI need protection and GI laws, Indian GI Act

Suggested readings

1. Shrivastava P.S., Narula A. and Shrivastava S.S (2004), Plant Biotechnology and Molecular Markers, Anamaya Publisher, New Delhi.
2. Altman A. (1998), Agricultural Biotechnology, Marcel Dekker.
3. Maria et al. (2002) Plant Biotechnology and Transgenic Plants, Marcel Dekker.
4. Adrianstater et.al. (2004), Plant Biotechnology: The Genetic Manupulation of Plants, Oxford University Press.
5. Brian C. (2004), Legal Aspect of Gene Technology, Thomson Severt Maxwell.
6. Sarad R.P. (2004), The GMO Hand Book: Genetically Modified Animals, Microbes and Plants, Humana Press, New Jersey

Course outcome

After completion of this course, the learner will be able to:

CO1. understand the basic concept of IPR, different types of IP with examples.

CO2. Recognise a patentable process or material and file an international/national patent for it through proper channel.

CO3. Different aspects of trademark and trade secrets and procedures to protect them.

CO4. explain fundamental copyright law, academic integrity or plagiarism, geographical indication of goods.

Mapping of CO and PO of DEC08

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	2	3	2	2	3	2	2	3	3
CO2	3	3	3	3	2	3	2	2	3	3
CO3	2	3	3	3	2	3	2	3	3	3
CO4	2	3	3	3	2	3	2	3	3	3

No. of credits: 4

L: 4
P: 0

DEC- 08
Biostatistics

UNIT I
Types of data, Collection and Graphical representation of data, Measures of central tendency: Mean, Median, Mode, Quartile, and Percentile. Measures of Dispersion: Range, Variance, Standard deviation, Coefficient of Variation, Correlation and Regression.

UNIT II
Probability and its applications: Laws of Addition and Multiplication, Compound Probability, Bayes theorem. Probability distributions: Binomial, Poisson and Normal distributions and their applications.
UNIT III

Testing of hypothesis: Parameter and Statistic, Sampling distribution and Standard error, Null and Alternative hypotheses, Simple and composite hypotheses, Two types of errors, Level of significance and Power of the test, One tailed and two tailed tests.

UNIT IV
Tests of significance: t and Z tests for mean and proportion for one and two samples, Chi square test of goodness of fit and independence. F test, Analysis of variance for one way and two way classification, Elementary ideas of Designs of Experiments Important statistical softwares and their applications

Suggested readings
1. Daniel, Wayne W. (2007) Biostatistics: A Foundation for Analysis in Health Sciences 10th Edition, Wiley Series.
2. Pagano, Marcello and Gauvreau, Kimberlee (2000) Principles of Biostatistics, 2nd Edition, Session: 2020-21 18 CRC Press
3. Chap T. Le, Introductory Biostatistics (2017), Wiley India Pvt Ltd.
4. P.N. Arora and P. K. Malhan, Biostatistics, Himalaya Publishing House
5. B. K. Mahajan, Methods in Biostatistics: For Medical Students and Research Workers, JPB

Course outcome

After the successful completion of the course the learner will get complete idea about the

CQ.1. An ability to apply knowledge of statistics to design and conduct experiments, as well as to analyze and interpret data related to domain of biology

CQ.2. An ability to apply concept of probability

CQ.3. An ability to understand the principle and application different types of tests

CQ.4. An ability to understand basics of sampling

Mapping of CO and PO of DEC08

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	2	3	2	2	3	2	2	3	3
CO2	3	3	3	3	2	3	2	2	3	3
CO3	2	3	3	3	2	3	2	3	3	3
CO4	2	3	3	3	2	3	2	3	3	3

SEMESTER VI

No. of credits:
4L: 4
P: 0

DCC (BLS 601) Botany VI:

Plant Biotechnology and Microbiology

Course objectives: To provide students with knowledge in classical and modern plant biotechnology processes, including breeding of healthy plants, plants with improved characteristics and plants for biomolecule production. To introduce and understand the basic and applied aspects of microbiology, **S**tudy the comparative characteristics of cellular and acellular microorganisms, Infection causing microorganisms and control methods, and Techniques to study various microorganisms.

Unit 1

Plant Tissue culture: Culture media; composition, preparation and sterilization, Totipotency: definition and importance, Dedifferentiation and redifferentiation, Callus and suspension culture, meristem culture, Soma clonal variation, Somatic embryogenesis, Synthetic seeds, Anther culture and production of haploids - protoplast culture – somatic hybrids –cybrids
Androgenesis and gynogenesis. Plant protoplast isolation, culture and fusion, Application of protoplast hybridization, Biotransformation and immobilization of plant cells, Hairy root clones, Production of secondary metabolic compounds using cell and tissue culture. Application of Plant Biotechnology, Development of pest, herbicide and drought resistance varieties of plants.

Unit 2

Plant breeding: Maintenance and conservation of germplasm, Cryopreservation, Mass selection and Pure line selection, Heterosis and hybrid seed production, Male sterility, types and its use in plant breeding. Polyploidy breeding-types of polyploids, origin and effects of auto and allopolyploidy in plants; application of auto and allopolyploidy in plant breeding; limitations. Mutation breeding- types:chemical mutagens, radiation, transposons; handling and release of mutagenic varieties.

Unit 3

Prokaryotic microbes- General characters of Bacteria (sizes, shapes and arrangements of bacteria, structure of cell wall and cell membrane, bacterial growth curve), Eukaryotic microbes- General characters of Fungi, Yeast, and Algae. Acellular microbes-Viruses (Discovery of viruses, General structure, symmetry and classification, Cultivation, chick embryo, T4-Bacteriophages- lytic cycle, Lambda phage- Lysogenic cycle.

Unit 4

General terms & definitions used in microbial control- Sterilization, Microbiostatic, Microbicidal, Disinfectant, Sanitizer, Viricide, Sporicide, Antimetabolite antibiotic, and Germicide etc. Types of culture media- Selective, Differential, Enriched, and Synthetic, Isolation of pure culture by various methods, Preservation of microorganisms, Staining Techniques,
Normal microflora of healthy human host, Study of pathogenic organisms- Morphology, cultural characteristics, biochemical characteristics, pathogenesis, serology, and lab diagnosis of *Escherichia coli*, *Salmonella typhi*, *Mycobacterium tuberculosis*, HIV, Hepatitis, Ebola and Coronavirus

Suggested Readings

- Bhojwani, S. S., & Razdan, M. K. (1996). Plant tissue culture: theory and practice. Elsevier.
- Govil, C. M., Aggarwal, A., & Sharma, J. (2017). Plant biotechnology and genetic engineering. PHI Learning Pvt. Ltd..
- Glick, B. R., & Patten, C. L. (2017). Molecular biotechnology: principles and applications of recombinant DNA (Vol. 34). John Wiley & Sons.
- Snustad, D. P., & Simmons, M. J. (2015). Principles of genetics. John Wiley & Sons.
- Stewart Jr, C. N. (Ed.). (2016). Plant biotechnology and genetics: principles, techniques, and applications. John Wiley & Sons.
- Bhojwani, S. S., & Bhatnagar, S. P. (2014). The Embryology of Angiosperms, Vikas Pub. House Pvt. Ltd., New Delhi.
- edition.
- Murray PR, Rosenthal KS, Kobayashi GS and Pfaller MA (2020) Medical Microbiology. Elsevier. 9th edition.
- Sastry A and Bhat S (2018) Essentials of Medical Microbiology. Jaypee Brothers 2nd edition.
- Aneja KR, Pranay J, and Raman A (2008) A Text-book of Basic and Applied Microbiology. New Age International Publishers. 1st edition.

Course outcome

After completion of the course the learners will be able to explain:

CO1. Genetic variability in plants and importance of plant breeding to our foodsystem, economy, and environment.

CO2. Understand manipulation of genes, transfer techniques, expression systemsand methods of selection for crop improvement

CO3. Understand the characteristics and pathogenesis of the common pathogenic organisms with their diagnostic measures

CO4. Understand the basic microbial techniques, their principles, and applications

Mapping of CO with PO of BLS601

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1	1	3	3	3	2	2	3	3
CO2	3	1	3	3	3	2	2	2	3	3

CO3	3	1	3	3	3	3	2	3	3	3
CO4	3	1	3	3	3	3	2	2	3	3

No. of credits: 4

L: 4
P: 0

DCC (BLS 602) Zoology VI:

Animal Biotechnology

Course objectives: Biotechnology is the advanced branch of biological sciences which mostly deals with technologies that use living organisms or their components to produce products for specific use. The present paper attempts to give a wholesome idea of biotechnology at a basic level.It provides a tool kit in the form of a number of various techniques and processes developed over time to solve problems involving primarily human welfare with focus on health and medicine.

Unit 1

Recombinant DNA technology: Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic and EukaryoticVectors. Gene Cloning (Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR-mediated gene cloning); Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain Gene of interest by genetic selection, colony hybridization; Probes-oligonucleotide, PCR and its types. Methods of gene transfer- by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes.

Unit 2

Structure and organization of animal cell; sources of cell; Techniques of obtaining cells by disaggregation of tissues, Enzymatic disaggregation; EDTA treatment; Types of cell culture, Equipments required for animal cell culture

Medium preparations and its various types Natural, artificial serum protein free media Advantages and disadvantages; sub culturing techniques, viable cell counts with haemocytometer, development of cell lines, types of cell lines, their characteristics; suspension culture advantages & disadvantages, totipotency in animal cell culture.

Unit 3

Blotting Techniques-Southern, Northern and Western blotting. DNA sequencing: Sanger method, Maxam Gilbert method. DNA Finger-Printing. DNA micro array. Basics of electrophoresis. DNA- protein interaction study like EMSA, Super shift assay, DNasefoot printing, ChIP assay. Protein- protein interaction study like Yeast two hybrid system.

Chromosome walking, Chromosome painting, Fluorescence *in situ* hybridization (FISH). Different molecular markers like RFLP, AFLP, RAPD

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Unit 4

Stem cell technology, embryonic stem cell culture, Application of stem cell culture.
Transgenic cells and animals & their application; organ culture, Histotypic & organotypic culture, rearing animal models and advantages, potential of transgenic animals to improve human welfare in Agriculture, medicine and industry, ethical and value issues in animal biotechnology

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Suggested Readings

- Freshney, R. I. (2015). Culture of animal cells: a manual of basic technique and specialized applications. John Wiley & Sons.
- Das, H. K. (2007). Textbook of biotechnology. John Wiley & Sons.
- Singh, B. D., & Singh, B. D. (2007). Biotechnology expanding horizons. Kalyani publishers.
- Gupta, P. K. (2008). Molecular biology and genetic engineering. Deep and Deep Publications.
- Brown, T. A. (2020). Gene cloning and DNA analysis: an introduction. John Wiley & Sons.
- Glick, B. R., & Patten, C. L. (2017). Molecular biotechnology: principles and applications of recombinant DNA (Vol. 34). John Wiley & Sons.
- Suzuki, D. T., Griffiths, A. J., Miller, J. H., & Lewontin, R. C. (2015). An introduction to genetic analysis . WH Freeman and Company.
- Snustad, D. P., & Simmons, M. J. (2015). Principles of genetics. John Wiley & Sons.
- Watson, J. D., Myers, R. M., Caudy, A. A., & Witkowski, J. A. (2007). Recombinant DNA: genes and genomes: a short course. Macmillan.

Course outcome

After completion of the course the learners will be able to:

CO1. Demonstrate the basic techniques of animal cell culture, preparation of general and specific media for maintaining and preserving animal cell lines

CO2. Fundamental biotechnology; like DNA isolation, PCR,transformation, restriction, digestion etc.

CO3. Devise a strategy to manipulate genetic structure of an organism for the improvement inany trait or its well-being based on the techniques.

CO4. Understand the ethical and social issues raised regarding GMOs.

Mapping of CO and PO of DCC (BLS602)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1	2	3	3	3	2	2	3	3
CO2	3	1	2	3	3	3	2	2	3	3

CO3	3	1	2	3	3	3	2	2	3	3
CO4	3	1	2	3	3	3	2	2	3	3

No. of credits: 4
L: 4
P: 0

DCC (BLS 603) Chemistry VI: Bioinorganic, Environmental chemistry and Polymer

Course objectives: The course will provide students with a general overview of the many very fundamental tasks performed by inorganic elements in living organisms as well as the related methods and theories with particular emphasis on enzymatic conversions and electron transfer. Demonstrate knowledge of chemical and biochemical principles of fundamental environmental processes in air, water, and soil.

Unit 1

A brief introduction to bioinorganic chemistry. Role of metal ions present in biological systems with special reference to Na^+, K^+ and Mg^{2+} ions: Na/K pump; Role of Mg^{2+} ions in energy production and chlorophyll. Role of Ca^{2+} in blood clotting, stabilization of protein structures and structural role (bones).

Unit 2

Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in the atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution.

Unit 3

Pollution by SO_2, CO_2, CO, NO_x, H_2S and other foul-smelling gases. Methods of estimation of CO, NO_x, SO_x and control procedures Water Pollution: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems. Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of Sulphur from coal. Control of particulates.

Unit 4

Basic concepts in polymer science. Different ways in classification of polymers depending on- The origin (natural, Semisynthetic, synthetic etc.), The structure (linear, branched, network, hyperbranched, dendrimer.), The type of atom in the main chain (homochain, heterochain), The formation (condensation, addition), Homopolymers, copolymers. The behavior on application of heat and pressure (thermoplastic and Thermosetting). The form and application (plastics, fiber. elastomers and resin). Chemical bonding in polymers – ionic (ionomers), covalent, coordinate, metallic (Metallocene polymers), hydrogen bonding. Stereochemistry of polymers, Introduction to two types of polymerization Reactions viz. condensation and addition polymerization (without detailed mechanism and derivations) Monomer structure and polymerizability

Suggested Readings

- Felder, R.M., Rousseau, R.W. and Bullard, L.G., (2020). Elementary principles of chemical processes. John Wiley & Sons.
- Kent, J. A. (Ed.). (2012). Riegel's handbook of industrial chemistry. Springer Science & Business Media.
- DARA, S. S. (2008). A textbook of engineering chemistry. S. Chand Publishing.
- De, AK (2012). Environmental chemistry. New Age International Ltd. Publisher, New Delhi, 213-219.
- Manahan, S. E. (2017). Environmental Chemistry, CRC Press. Boca Raton, Fla.
- Mishra, A. (2005). Environmental Studies. Selective and Scientiic Books.
- Billmeyer, F.W. (1984). Textbook of polymer science. John Wiley & Sons.
- Seymour, R. B. (1978). Introduction to polymer chemistry. RE Krieger Pub. Co.

Course outcome

After completion of the course the learners will be able to explain:

CO1. Basic concept of bioorganic chemistry and its application in everyday life.

CO2. Composition of atmosphere, biogeochemical cycles, water quality parameters.

CO3. Characterization of polymers, polymerization procedure and Zigler-Natta catalysis.

CO4. Molecular weight and structure property relationship

Mapping of CO with PO of DCC(BLS603)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	1	3	3	3	3	2	1	2	3
CO2	1	1	3	3	3	3	2	1	2	3
CO3	1	1	3	3	3	3	2	1	2	3
CO4	1	1	3	3	3	3	2	1	2	3

No. of credits:2

L: 0
P: 4

DCC (BLS 604) Botany VI:

Plant Biotechnology and Microbiology (Lab)

- Preparation of MS medium.

Demonstration of in vitro sterilization and inoculation methods using leaf and nodalexplants of tobacco, Datura, Brassica etc.

- Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.
- Isolation of protoplasts.
- Study of methods of gene transfer through photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
- Isolation of plasmid DNA.
- Restriction digestion and gel electrophoresis of plasmid DNA
- To perform simple staining technique from the given bacterial sample.
- To perform differential staining technique from the given sample.
- To perform capsule staining from the given sample.
- To perform preparation of nutrient agar media.
- To perform serial dilution from the provided sample.
- To learn and perform spreading technique for the isolation of microbes.
- To learn and perform streaking technique for isolation of pure culture of microbes.
- To perform isolation of microflora from human skin.
- To perform isolation of microflora from human throat.

**** Addition or deletion of the practical's may be done as per the convenience***

Course outcome

After completion of the course the learners will be able to:

CO1. Formulate the media and conditions for plant tissue culture

CO2. Get the basic ideas and methodologies used in transformation of plants at DNA level

CO3. Demonstrate the complete process of plant tissue engineering used for developing new varieties.

Mapping of CO and PO for BLS-604

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3

CO1	3	1	3	3	3	3	3	3	3	3
CO2	3	1	3	3	3	3	3	3	3	3
CO3	3	1	3	3	3	3	3	3	3	3

No. of credits: 2

L: 0
P: 4

DCC (BLS 605) Zoology VI

Animal Biotechnology (Lab)

- Genomic DNA isolation
- Plasmid DNA isolation from *E. coli*
- Restriction digestion of plasmid DNA and observation of bands by performing Agarose Gel Electrophorresis
- To study and practical performanceof following techniques through
    a) Southern Blotting
    b) Northern Blotting
    c) Western Blotting
    d) DNA Sequencing (Sanger's Method)
    e) PCR
    f) EMSA
    g) DNA fingerprinting
- Introduction to the equipment used in animal tissue culture laboratory.
- Cell counting using Neubauer's chamber/hemocytometer.
- Cell viability testing using trypan blue dye.
- Cell cloning by dilution method.
- Sub culturing/splitting of monolayer culture.
- Apoptosis studies using Hoecsht/PI staining method
- Preservation and storage of cell lines using DMSO/FBS.
- Isolation of metagenomic DNA from soil samples/water samples.

Course outcome

After completion of the course the learners will be able to:

CO1. Perform isolation of nucleic acids from various biological samples

CO2. Get familiar with different techniques and equipment used in animal biotechnology

CO3. Develop a better understanding about animal cell culture.

Mapping of CO and PO for BLS-605

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1	3	3	3	3	3	3	3	3
CO2	3	1	3	3	3	3	3	3	3	3
CO3	3	1	3	3	3	3	3	3	3	3

No. of credits:2

L: 0
P: 4

DCC (BLS 606): Bioinorganic & Env. Chemistry and Polymer (Lab)

- Determination of dissolved oxygen in water.
- Determination of Chemical Oxygen Demand (COD)
- Determination of Biological Oxygen Demand (BOD)
- Percentage of available chlorine in bleaching powder.
- Measurement of chloride, sulphate and salinity of water samples by simple titrationmethod ($AgNO_3$ and potassium chromate).
- Estimation of total alkalinity of water samples (CO_3^{2-}, HCO_3^-) using doubletitration method.
- Study of some of the common bio-indicators of pollution.
- To determine acid value of a given polymer
- To determine sap value and % purity of plasticizer
- To determine epoxy content of given polymer by Pyridinium chloride
- Preparation of cellulose sodium carboxymethylcellulose.
- Modification of PS to chloromethylated PS.
- Hydrolysis of PVAC, preparation of PVA.

- ***Addition or deletion of the practical's may be done as per the convenience***

Course outcome

After completion of the course the learners will be able to:

CO1. Evaluate the quality of water sample.

CO2. Evaluate the chemistry of given polymer.

CO3. Chemical modification of PS and PVA.

Mapping of CO with PO of DCC (BLS 606)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	2	1	3	3	3	3	3	3	3	3
CO2	1	1	3	3	3	3	3	3	3	3
CO3	1	1	3	3	3	3	3	3	3	3