Bangalore University
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Syllabus for

Semester III & IV for Integrated B.Sc. - M.Sc. Program in Biological Sciences

Framed according to the National Education Policy (NEP 2020)

August 2022

Submitted by

Department of Life Science

Jnana Bharathi Campus

Bangalore University

Bangalore

S. No	Table of Content	Page No.
1.	Preamble of the Programme - "**Integrated B.Sc - M.Sc Biological Sciences**"	4
2.	Introduction to the Programme	5
3.	Flexibility of the Programme and Student attributes in Biological Sciences	6
4.	Programme Objectives	7
5.	Syllabus and Regulation governing the choice-based credit system (CBCS)	8-10
5.	Proposed year wise Curriculum Structure for III and IV Semester Integrated B.Sc.- M.Sc. Biological Science	11
7.	Syllabus for III and IV Semester for Integrated B.Sc. - M.Sc. Biological Science	12-47
8.	Minutes of BOS meeting	

F O R E W O R D

National Education Policy (NEP) 2020 seeks to transform the Higher Education system in India by introducing the exit and entry option to the students. Selecting courses of choice will improve the education quality of the students. A creative combination of disciplines like Core, Open Elective, Vocational and Elective courses with multi-disciplinary nature is one key recommendation of NEP - 2020.

The multiple exit and entry options in the Higher Education System would remove rigid boundaries and create new possibilities for students to choose and learn the courses of their choice anywhere in India can pave the wave for improving student progress. A formal system of credit recognition, creditaccumulation, credit transfers and credit redemption is a praiseworthy recommendation in the education system. Karnataka is the first state in the country to implement NEP in higher education. The state come up with the NEP framework for all the UG-PG programmes starting from the academic year 2021.

The prominent features of the NEP framework are:

1 Flexibility in choosing subjects and even disciplines for the graduate programmes.
2 Vertical and horizontal mobility across subjects throughout the programme.
3 Multiple entry and exit points
4 Main streaming of skill-based courses.
5 Credit based evaluation system.
6 Integration of research into IV year of the programme leading to Honours degree
7 Post-graduate Diplomas in respective disciplines.

In continuation of the previous year curriculum structure and syllabus of Integrated master's degree in Biological Sciences with multiple exist entry with skills and job opportunities in point of exit system, I hereby present the syllabus for III and IV Semesters. I hope that the curriculum structure and syllabus will pave the way for overall development of the student community. I ensure that, students' community will procure the benefits at large in higher education.

Prof. M. SHIVASHANKAR. Ph.D.

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Preamble

The NEP-2020 offers an opportunity to effect paradigm shift from a teacher-centric to student-centric higher education system in India. It caters skill-based education where the graduate attributes are first kept in mind to reverse-design the programs courses and supplementary activities to attain the graduate attributes and learning attributes. The objective of any program at Higher Education Institute is to prepare their students for the society enormously. University education is directed by distinct objectives. To acquire knowledge and skills based on the forefront of science in the subject areas of their studies; capability to identify, formulate and handle scientifically complex problems, as well as to critically evaluate information and to formulate possible solutions; skills to communicate knowledge at theoretical as well as at applied scientific levels, and ability to co-operate and to develop management/professional skills. Teaching must stimulate students to learn, to seek information and to critically synthesize information and knowledge, and also offer possibilities for applying their acquired skills. This means that a variety of teaching methods needs to be applied.

The learning outcomes-based curriculum framework (LOCF) for a degree in Integrated B.Sc.-M.Sc. Program in Biological Sciences is intended to provide a comprehensive foundation to the subject and to help students develop the ability to successfully continue with further studies and research in the field of Biological Sciences and allied subjects. The course ensures that students are equipped with required skills at various stages. Effort has been made to integrate use of recent technology to assist teaching-learning process among students. The framework is designed to equip students with valuable cognitive abilities and skills so that they are successful in meeting diverse needs of professional careers in a developing and knowledge-based society. The curriculum framework takes into account the need to maintain globally competitive standards in terms of the knowledge and skills in Biological Sciences and allied courses, as well develop scientific orientation, problem solving skills and human and professional values which foster rational and critical thinking in the students. This course serves as a plethora of opportunities in different fields right from classical to applied Biological Sciences.

Introduction

Integrated B.Sc.- M.Sc. Program in Biological Sciences commenced under the Department of Life Sciences, Bangalore University from the academic year 2007-08, to impart higher quality integrated education in a vibrant academic ambiance with distinguished teachers and infrastructure available from various P. G department of the University.

Biological Sciences is one of the thrust areas of the 21st Century. Biological Sciences is essentially a subject that unifies multi-disciplinary themes for understanding the basic functions of life process that in turn facilitate the objective of benefiting mankind and has impacts on health and diseases across species, agriculture and environment. The purpose of the course is primarily to prepare the students with in – depth integrated knowledge of various branches of biology together with applications using modern tools and techniques. In addition to theory and laboratory classes the students will have research projects supervised by the faculty which in turn prepares them for teaching and research level carriers in bio-industries, Government, and academia.

Study of Biological Sciences is central to the fundamental understanding of living systems. It relates to other subjects, including Animal and Plant biology, Genetics, Biochemistry, Microbiology, as well as contemporary subjects like Molecular Biology, Bioinformatics, Immunology, Biotechnology, Neurobiology, Cancer Biology, Toxicology, Forensic Science and Biomedical sciences to foster comprehensive understanding about various aspects of living world. Integrated B.Sc.- M.Sc. Program in Biological Sciences also includes the industry relevant, advanced life science topics like Genomics, Proteomics, Metabolomics, Nanobiology, Advanced computational biology. The vocational skill sets in the course provided are Bioinstrumentation, Seri-biotechnology, Assisted Reproductive Technology and Science Communication. The applied topics also include visits to Industries, Medical institutes and laboratories and fields to get in-depth knowledge of the subject and to explore employment opportunities in the field.

Flexibility of the Programme

Course is adapted as per NEP 2020 guidelines with holistic and multidisciplinary education approach. The course allows students with a flexibility to combine multi-disciplinary subjects along with vocational courses in Biological Sciences. There are 'multiple exit options' & appropriate 'certification' at the end of every year. Overall emphasis is on conceptual understanding of Biological Sciences with skill enhancement papers on latest advances in the field.

The programme in Integrated B.Sc.- M.Sc. Program in Biological Sciences provides students with a flexibility to combine multi-disciplinary subjects along with integration of vocational courses.

- First year exit option includes Certificate in Biological Sciences with 50 credits.
- Second year exit option includes Diploma Certificate in Biological Sciences with 100 credits.
- Third year exit option includes Bachelor of Science (B.Sc.) Degree in Biological Sciences with 142 credits.
- Fourth year exit option includes Bachelor of Science Honours (B.Sc. Hons.) Degree in Biological Sciences with 184 credits.
- The student will be awarded with 5 years Integrated B.Sc. - M.Sc. Degree in Biological Sciences with 232 credits.

Student attributes in Biological Sciences

Some of the characteristic attributes a graduate in Biological Sciences should possess are:

- Disciplinary knowledge and skills
- Skilled communication
- Biological aptitude
- Biosafety awareness
- Critical thinking and problem-solving capacity
- Sense of enquiry and reasoning
- Team player/worker
- Project Management Skills
- Digital Literacy and lifelong learning streak
- Ethical awareness
- National and international perspective

Program Objectives

Defining objectives for the whole educational programme and for each individual course is essential and the objectives given should be used actively by teachers, as well as by students. The objectives should not only focus on subject knowledge, but also on the skills to be acquired. Students must become aware of what they need to learn to succeed, and teachers should reflect upon what and how to teach to best stimulate the learning process, and how to evaluate it. It is essential to evaluate how well the objectives have been fulfilled. Their students and in this endeavour; it offers a new vision to all its Under-Graduate courses. Imbibes a Learning Outcome - based Curriculum Framework (LOCF) for all its Undergraduate programs.

- Comprehensive and detailed understanding of Plant and Animal Sciences
- Understanding of interdisciplinary relationship between cellular, molecular and biochemical aspects of Life Sciences
- Understanding of how biological sciences affect broad societal issues including health and disease, food and natural resources, environmental sustainability, etc.
- The knowledge required to design, execute, and analyze the results of multidisciplinary biological experimentations in animal and plant model systems.
- To apply statistical and computational knowledge for the analysis high dimensional Genomics, Proteomics and Metabolomics data
- Honing of Communication skills required in the discipline including oral presentations of research data, published research articles, grant proposals, and poster presentations at conferences.
- Holistic approach to learning involving Teamwork and leadership skills, including group analysis of data, working together in the research laboratory, joint compositions of written reports and substantive participation in research group meetings.

SYLLABUS AND REGULATION GOVERNING THE CHOICE-BASED CREDIT SYSTEMM (CBCS)

FIVE YEAR- INTEGRATED B.SC. - M.SC. PROGRAM

IN BIOLOGICAL SCIENCES

Program Structure

Discipline Specific Core (DSC) Courses:

First, second, third and fourth semesters will have one DSC course each. Every DSC course has 6 credits and a practical component (4 credits for theory and 2 credits for practical). Fifth and sixth semesters will have two Discipline Specific Core (DSC) courses each. Every DSC course has 5 credits and has practical components (3 credits for theory and 2 credits for practical).

Seventh and eighth semesters will have three Discipline Specific Core (DSC) courses each. In seventh semester, two DSC courses have 5 credits each (3 credits for theory and 2 credits for practical) and one course has 3 credits with no practical component. Whereas, in eighth semester, one DSC course has 5 credits and a practical component (3 credits for theory and 2 credits for practical). Remaining two DSC courses have 3 credits each with no practical component. Totally, the program has 18 DSC courses.

Open Elective (OE) Courses:

First, second, third and fourth semesters will have one OE course each. Every OE course has 3 credits and with no practical component. OE courses are for other disciplines and the candidate has to choose one OE from the pool in each semester. The OE courses enhance the geographical knowledge and help students in preparation for the competitive examinations. There are totally 4 OE subjects in the program.

Vocational Courses:

Fifth and Sixth semester will have two vocational courses each for 3 credits. The candidate has to choose one vocational course from the pool. There is 2 credits internship course which have to be selected by the candidate. These courses can enable students to obtain the required technical knowledge along with artistic or practical skills.

Discipline Specific Elective (DSE) courses:

Seventh and eighth semesters will have DSE courses. All the DSE courses have 3 credits and with non-practical skills. The seventh semester will have research

methodology for 3 credits and the eighth semester will either be a research project or Internship for 6 credits. If candidate is not interested to opt for the Research Methodology in the seventh semester the candidate can opt one more DSE course from the given pool. However, the candidates willing to pursue a PhD program in future can select a Research Project in the eighth semester. The candidate should have opted for the Research Methodology course in the seventh semester itself. If candidate is not interested to opt for the Research project in the eighth semester, the candidate can opt two more DSE courses from the given pool. The DSE courses enhance the geographical knowledge and help students in preparation for the competitive examinations.

The Integrated Master's Degree Programs shall extend over Five academic years (Ten Semesters) with exit options with Regular bachelor's degree after successful completion of Three academic years (Six Semesters) of study and bachelor's degree with Honours in a discipline/ subject at the end of Four academic years (Eight Semesters). Completion of five years of integrated master's degree Program would lead to master's degree in a subject.

Eligibility for Admission:

Candidates who have passed any PUC Science examinations in Karnataka state or any other States in India with equal qualifications are eligible for admission to the course, provided they have secured 50% marks (45% for SC/ST/ Category-1 Candidates).

Medium of instruction: The medium of instruction shall be Kannada/ English

Attendance: The course shall be treated as an independent unit for the purpose of attendance. A student shall attend a minimum of 75% of the total instruction hours in a course including assignments and seminars in each semester. There shall be no provision for condonation of shortage of attendance and a student who fails to secure 75% attendance in a course shall be required to repeat that semester.

Internal Assessment: Marks for internal assessment shall be awarded on the basis of Attendance, Test, Case Studies and Assignments/ Seminars and other co- curricular activities. The internal assessment marks shall be notified on the department/ college notice board for the information of the students, and it shall be communicated to the Registrar (Evaluation) within 10 days before the commencement of the University examinations, and the Registrar (Evaluation) shall have access to the records of such internal assessment evaluations.

Board of Examiners (BOE): Board of examiners constituted by the University shall consist of a Chairman, internal and external members out of which at least one shall be from the Department / College offering the course and at least two external members from other universities. The board shall scrutinize the question papers and shall forward for the approval of University.

Results: A candidate should obtain a minimum of 40% marks in each of the papers in the University examination and 50% marks including internal assessment marks. A candidate should obtain a minimum of 50 % of marks in all Semesters). The candidates who have passed in all the semester examinations are eligible for the B.Sc. Degree Honors in Biological Sciences.

Carry Over: A candidate who fails in a lower semester examination may go to the higher semester, however, the result of the candidates who have passed the VIII semester examination but not passed the lower semester examinations shall be declared as NCL (not completed lower semester examinations). Such candidates shall be eligible for the degree only after completion of all the lower semester examinations.

Question Paper Pattern: The Theory exam will be conducting for 60 Marks and it consists of 3 Parts namely Short, Medium and Long answer questions.

Part - A: Each question carries 2 marks and student has to answer 5 questions.

Part - B: Each question carries 5 marks and student has to answer 4 questions.

Part - C: Each question carries 15 marks and student has to answer 2 questions.

INTEGRATED B.Sc.- M.Sc., in BIOLOGICAL SCIENCES (NEP Scheme)

Proposed III and IV Semester structure of (Annexure II A) model programme with titles for theory and practical papers

Semester III								
Code	Subjects	Paper Theory/ Practical	Instruction Hrs/week	Duration of Exam (Hrs)	Marks			Credits
					IA	Exam	Total	
BS-03T	Plant Anatomy and Physiology	Theory	4	2.5	40	60	100	4
BS-03P	Plant Anatomy and Physiology	Practical	4	4	25	25	50	2
BSM-03T	Biological Chemistry	Theory	4	2.5	40	60	100	4
BSM-03P	Biological Chemistry	Practical	4	4	25	25	50	2
BSOE-03T	Vermiculture	Theory	3	2.5	40	60	100	3
BS-KL3	Kannada/Hindi	Theory	4	2.5	40	60	100	3
BS-EL3	English	Theory	4	2.5	40	60	100	3
BSSE-02T	Clinical Biochemistry	Practical	3	4	20	30	50	2
BSVC	Physical education for fitness	Practical						1
BSVC	Health and Wellness	Practical						1
Total Credits								**25**

Semester IV								
Code	Subjects	Paper Theory/ Practical	Instruction Hrs/week	Duration of Exam (Hrs)	Marks			Credits
					IA	Exam	Total	
BS-04T	Animal Anatomy and Physiology	Theory	4	2.5	40	60	100	4
BS-04P	Animal Anatomy and Physiology	Practical	4	4	25	25	50	2
BSM-04T	Genetics and Breeding	Theory	4	2.5	40	60	100	4
BSM-04P	Genetics and Breeding	Practical	4	4	25	25	50	2
BSOE-04T	Ecology and Evolutionary Biology	Theory	3	2.5	40	60	100	3
BS-KL4	Kannada/Hindi	Theory	4	2.5	40	60	100	3
BS-EL4	English	Theory	4	2.5	40	60	100	3
BSAE	Constitution of India	Theory	3	1.5	20	30	50	2
BSVC	Physical education for fitness	Practical						1
BSVC	Health and Wellness	Practical						1
Total Credits								**25**

Semester III - Biological Sciences

Core Course Content

Course Title/Code: **PLANT ANATOMY AND PHYSIOLOGY**	Course Credits: **4**
Course Code: **BS-03T**	L-T-P per week: 4-0-0
Total Contact Hours: **56**	Duration of ESA: 3 Hours
Formative Assessment Marks: **40**	Summative Assessment Marks: **60**

Core Course prerequisite: To study Biological Science in undergraduate, student must havestudied Biology or equivalent subject in Class 12 and must have studied BS-01T Core course paper on Plant Systematics.

Course Articulation Matrix: Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Course outcomes (COs)/program Outcomes (Pos)	CC T1	CC 2	CC 3	CC 4	CC 5	CC 6	CC 7	CC 8	CC 9	CC 10	CC 11
I Core competency	✓										
II Critical thinking	✓										
III Analytical reasoning	✓										
IV Research skills	✓										
V Team work	✓										

Note:

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark = '✓' in the intersection cell if a course outcome addresses a particular program outcome.

Semester III - Biological Sciences

BS-03T: PLANT ANATOMY AND PHYSIOLOGY

No of credits: 4 **No of hours: 56**

Aim and Objectives: ✓ To understand the general account of Plant anatomy ✓ To provide an overview of the fundamental aspects of physiology in Plants ✓ To understand the process of mineral metabolism in plants	
UNIT I	**14 hrs**
PLANT ANATOMY • Cell wall-Structure and development of the cell wall (light microscopic and ultramicroscopic structure studies), composition of the cell wall. • Plant Body-Organization of primary plant body, apical meristems. The role of auxin in the development of the vascular system. • Meristems - Definition, classification of meristems, Apical meristems of Shoot and Root apex, relevant theories pertaining to structure and organization of root apex and shoot apex. Shoot Apex: Apical Cell Theory, Tunica Corpus Theory, and Zonation Theory. Root Apex: Histogenic boundaries; Quiescent centre Formation of leaf primordial, Transitional tissue regions, the primary peripheral thickening meristem of Monocotyledons.	
UNIT II	**14 hrs**
VASCULAR SYSTEMS • Vascular system of the stem and root. Xylem- types of xylem and composition, Structure and development of secondary xylem, Secondary xylem of gymnosperms and dicotyledons. Role of the vascular cambium, Patterns of distribution of xylary elements and rays, Tyloses, Evolutionary perspectives of secondary Xylem. • Phloem – types of phloem and composition. Secondary phloem: Gross and Ultra structure, development of the phloem. Cell wall of sieve elements. Nature of protoplast of sieve elements, Distinctive features of phloem: of Gymnosperms, the nature and function of companion cells and Strasburger cells. Nature and function of P-protein, • Nodal anatomy: A general account- (*Aristolochia, Boerhaavia, Dracaena*) • Periderm: Structure and development of rhytidome, Lenticels, • Secretary tissues in plants: Internal secretory structures and External secretory structures.	

• Anatomical modifications pertaining to habitat, Ecological adaptations: Xerophytes, Mesophytes, Hydrophytes, Epiphytes, Parasites and Mangroves.	
UNIT III	**14 hrs**
PLANT PHYSIOLOGY • Plant water relation: Water potential, osmotic potential, pressure potential, membrane and their permeability mechanism of water absorption, SPAC concept. • Ascent of sap: Vital and physical force theories. • Solutes and ion transportation Passive and active transport of solutes across the membranes, ion transport in roots, mechanism of translocation, sources and sink concept. • Mineral nutrition: Importance of nutrients, major and minor elements and their deficiency, disorders and treatments. • Nitrogen metabolism: Introduction, nitrogen fixation, biochemistry of nitrogen fixation role of *nif* genes and Leghaemoglobin.	
UNIT IV	**14 hrs**
PHOTOSYNTHESIS • Photosynthesis: General concepts and historical backgrounds, photosynthetic apparatus, mechanism of absorption of light, Absorption spectrum, Emerson's enhancement effect, two pigment system-PS-I and PS–II. Noncyclic and cyclic electron transport system. Photophosphorylation, carbon assimilation-the Calvin cycle, C4 cycle and the CAM pathway. Photorespiration and its significance. • Respiration: Types of respiration, mechanism of respiration, Glycolysis, Krebs cycle, Electron transport system. Oxidative phosphorylation, Energetics of biological oxidation, respiratory inhibitors. • Growth, metabolism and growth hormones: Definition, Kinetics, growth hormones, biosynthesis, transport and physiological effects of Auxins, Cytokinins, Gibberellins, Abscissic acid and ethylene, mechanism of hormone action.	

Suggested Reading:

1. Charles, B. Beck (2010) An Introduction to Plant Structure and Development
2. Cutter, D.G. 1971. Plant anatomy- Part-1. Cell and Tissues. Edward Arnold, London.

3. Inam,A.(2012). A Laboratory Manual of Plant Physiology, Biochemistry and Ecology.Agrobios(India),Jodhpur.
4. Jain,V.K.(2016). Fundamentals of Plant Physiology.S.Chand & Co.,Pvt.,Ltd,New Delhi.
5. Katherine Esau, (1996). Anatomy of seed plants, First Wiley prints, New Delhi.
6. Malik,C.P.(2014).Plant Physiology Kalyani Publishers, New Delhi.
7. Metcalf C.R and L. Chalk,(1950), Anatomy of Dicotyledons. Leaves, Stems and wood in relation to taxonomy with Notes on Economic users II Vols. Clerodendron press, Oxford.
8. Oxlade,E.(2010).Plant Physiology.The Structure of Plants Explained.Viva Books,New Delhi.
9. Pandey,S.N. & Sinha,B.K.(2016).Plant Physiology,Vikas Publishing House Pvt.Ltd,New Delhi.
10. Roy, P. (2010). Plant Anatomy. New Central book Agency, New Delhi. 20.Pandey, B.P. (2001). Plant Anatomy. S.Chand & Company Ltd. New Delhi.
11. Stiles,W.(2016).Principles of Plant Physiology. Discovery Publishing House, New Delhi.
12. Verma, S.K.& Verma,M.(2012).Plant Physiology,Biochemistry and Biotechnology.S.Chand & Company, Ltd.,New Delhi.

Pedagogy:

Formative Assessment	
Assessment Occasion	**Weightage in marks**
House Examination/ Test	15
Written assignment/ Presentation/ Project/ Term Papers/Field Visits/Seminars	15
Class performance/ Participation/Attendance	10
Total	**40**

Semester III - Biological Sciences

Course content

Course Title/Code: **PLANT ANATOMY AND PHYSIOLOGY**	Course Credits: **2**
Course Code: **BS-03P**	L-T-P per week: 0-0-4
Total Contact Hours: **56**	Duration of ESA : 3 Hours
Formative Assessment Marks: **25**	Summative Assessment Marks: **25**

Core Course prerequisite: To have successfully completed BS-01T/BS-01P (Plant Systematics) Ist Sem Biological Science

Course Articulation Matrix: Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Course outcomes (COs)/ program Outcomes (Pos)	CC T1	CC 2	CC 3	CC 4	CC 5	CC 6	CC 7	CC 8	CC 9	CC 10	CC 11
I Core competency	✓										
II Critical thinking	✓										
III Analytical reasoning	✓										
IV Research skills	✓										
V Team work	✓										

Note:

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark = '✓' in the intersection cell if a course outcome addresses a particular program outcome.

Semester III - Biological Sciences

BS-03P: PLANT ANATOMY AND PHYSIOLOGY

No. of Credits: 2 **No. of hours: 56**

PLANT ANATOMY PRACTICALS	**28 hrs**
Stem anatomy: • Free hand section of Dicot Stem: (*Helianthus /Tridax*), *Cucurbita* and *Peperomia* (Special features). Monocots stem (Maize/ Grass/ Wheat) • Study of anomalous secondary growth of stem: *Boerrhavia*, *Aristolochia*, *Nyctanthus* and *Draceana*. • Nodal anatomy of *Cocculus*, *Polyscias, Helianthus* • Study of leaf anatomy of Isobilateral view of *Nerium* and Dorsiventral view of *Ficus* stomatal ontogeny • Study of stomata: Paracytic, anisocytic, anamocytic, Tetracytic, Diacytic types. • Study of root anatomy: Dicot - Aerial root (*Ficus*), Monocot – Areal root of • Orchid. Wood anatomy subjected to availability of slides • Wood anatomy-TS, TLS & RLS of Gymnosperms wood (*Pinus/Araucaria*) & Angiosperms wood (*Michelia*) • Plant Microtechnique - Microtomy, Maceration. Anatomical modifications • Study of Ecological adaptation – Xerophyte (*Opuntia, Euphorbia*), Hydrophytes; (*Nymphaea, Hydrilla*)	
PLANT PHYSIOLOGY PRACTICALS	**28 hrs**
• Determination of water potentials by following drops methods. • Hydrophonics study of deficiency symptoms (chlorosis, necrosis) • Separation of chlorophylls and carotenoids by Ascending paper chromatography • Bioassay of Phyto hormones – Auxins, Cytokinins, Gibberllins, Abssisic acid, Ethylene • Determination of lipid activity.	

Pedagogy:

Formative Assessment	
Assessment Occasion	**Weightage in marks**
House Examination/ Test	15
Written assignment/ Presentation/ Project/ Term Papers/Field Visits/ExperimentalDocumentation	05
Class performance/ Participation/Attendance	05
Total	**25**

Semester III - Biological Sciences

Course Content

Course Title/Code: **BIOLOGICAL CHEMISTRY**	Course Credits: **4**
Course Code: **BSM-03T**	L-T-P per week: 4-0-0
Total Contact Hours: **56**	Duration of ESA: 3 Hours
Formative Assessment Marks: **40**	Summative Assessment Marks: **60**
Model Syllabus Authors:	

Core Course prerequisite: The student must have studied BSM-01T Core course paper on Biomolecules.

Course Articulation Matrix: Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Course outcomes (COs)/ program Outcomes (Pos)	CC T1	CC 2	CC 3	CC 4	CC 5	CC 6	CC 7	CC 8	CC 9	CC 10	CC 11
I Core competency	✓										
II Critical thinking	✓										
III Analytical reasoning	✓										
IV Research skills	✓										
V Team work	✓										

Note:

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark = '✓' in the intersection cell if a course outcome addresses a particular program outcome.

Semester III - Biological Sciences

BSM-03T: BIOLOGICAL CHEMISTRY

No of credits: 4 **No of hours: 56**

Aim and objectives ✓ To introduce the student to reactions of biomolecules that constitute metabolic pathways ✓ To understand the biosynthesis and breakdown of biomolecules ✓ To give an overview of the integration of metabolism	
UNIT 1	**14 hrs**
INTRODUCTION • Definition of metabolism, anabolism and catabolism General features of metabolic pathways • **carbohydrate metabolism** Glycolysis, important checkpoints in glycolysis, energy generation in glycolysis Glycolysis under anaerobic conditions: formation of lactate, types of lactate dehydrogenases and Cori's cycle Pyruvate dehydrogenase complex and the Krebs' cycle, regulation of and energy generation from Krebs cycle • **Pentose phosphate pathway** and its significance • **Gluconeogenesis** and its regulation • **Glycogen metabolism:** synthesis of glycogen and glycogenolysis Disorders of Carbohydrate metabolism: (Lactose intolerance, Essential fructosuria, Galactosemia and Von-Gierke's disease, Diabetes Mellitus)	
UNIT 2	**14 hrs**
LIPID METABOLISM • **Breakdown of triglycerides:** Fate of glycerol and β-oxidation of fatty acids • **Ketone body metabolism:** Synthesis of acetoacetate and β-hydroxybutyrate, acetone formation from acetoacetate. Acetone as a precursor for gluconeogenesis • **Fatty acid biosynthesis:** Fatty acid synthase reactions and inhibitors Mitochondrial export of acetyl CoA via citrate and acetoacetate Elongation and desaturation of fatty acids, The glyoxylate bypass Disorders of fatty acid metabolism [Carnitine-acylcarnitine translocase deficiency (CACT), Medium Chain acyl-coenzyme A dehydrogenase deficiency (MCAD), Long chain 3-hydroxyacyl coenzyme A dehydrogenase deficiency (LCHAD), Carnitine Transport Defect (CTD)]	

• **Cholesterol metabolism:** HMG- CoA reductase and biosynthesis of cholesterol, steroid hormones and vitamin D, Regulation of sterol metabolism, Transport of cholesterol between the liver and peripheral tissues, Bile acid metabolism and transport, Cholesterol and atherosclerosis, inhibitors of HMG-CoA reductase. Disorders of lipid metabolism-(Familial hypercholesterolemia, Tangier disease, Tay Sachs disease, Wolman's disease)	
UNIT 3	**14 hrs**
AMINO ACID METABOLISM • Biosynthesis of essential amino acids – shikimate pathway in plants and microbes; lysine and histidine biosynthesis. • Biosynthesis of non-essential amino acids. Transamination, deamination and decarboxylation. • The urea cycle and its regulation. • Disorders related to amino acid metabolism (Phenylketonuria, Alkaptonuria) **NUCLEIC ACID METABOLISM** • **Purine metabolism:** Biosynthesis of purines and its regulation. Salvage pathways. Degradation of purines and derived metabolites. • Formation of uric acid and allantoin in various species. • **Pyrimidine metabolism:** Biosynthesis and degradation of pyrimidines • Disorders in nucleic acid metabolism: SCID, Lesch-Nyhan syndrome, gout.	
UNIT 4	**14 hrs**
ELECTRON TRANSPORT CHAIN (ETC) AND OXIDATIVE PHOSPHORYLATION (OXPHOS) • The ETC as the final pathway for the generation of ATP in aerobes • Complexes I to IV in the electron transport chain. Redox reactions of various cofactors in the different complexes • Inhibitors of the ETC, CO and cyanide poisoning • Coupling of the ETC to oxidative phosphorylation – the proton gradient and the F1F0 ATP synthase complex. • Uncoupling of ETC and OXPHOS – proton gradient driven thermogenesis, active transport, flagellar rotation, generation of electric potential and formation of NADPH from NADH. **INTEGRATION OF METABOLISM** • **Hormonal regulation of metabolism:** Hormonal regulation of carbohydrate metabolism – role of insulin and glucagon. Hyperglycemia, hypoglycemia, diabetes mellitus	

Action of glucocorticoids and thyroxine & their receptors Action of epinephrine and its receptor • **The central role of Krebs cycle in the integration of metabolism** - anaplerotic reactions	

Suggested Reading:

1. Lehninger AL. 2013 **Principles of Biochemistry**. 6th edition. 2013. WH Freeman & Co, USA.
2. Berg, J, Stryer L, Tymoczko J, Gatto G. 2019. **Biochemistry**. 9th edition. WH Freeman & Co, USA
3. Voet D, Pratt C and Voet J.2012. **Principles of Biochemistry**. 4th edition. International Student Version. Wiley Publishers, USA.
4. Satyanarayana U and Chakrapani U. 2013. **Biochemistry**. 4th edition. Elsevier Publications, India.
5. Rodwell V, Bender D, Botham K, Kennelly P and Weil PA. 2018. **Harper's Illustrated Biochemistry**. 31st edition. McGraw-Hill Publications, India.
6. Devlin TM.Text Book of Biochemistry with Clinical correlations. 7th edition, 2010. Wiley Publishers, USA.

Learning outcomes:

- Understanding the generation of energy from the breakdown of biomolecules
- Understanding the biosynthesis of biomolecules from smaller precursors
- Understanding the importance of hormonal regulation of anabolic and catabolic pathways
- Relating metabolic pathways in different cell types to the organism as a whole
- Associating diseases/disorders with deficiencies in metabolic pathways

Pedagogy:

Formative Assessment	
Assessment Occasion	**Weightage in marks**
House Examination/ Test	15
Written assignment/ Presentation/ Project/ Term Papers/Field Visits/Seminars	15
Class performance/ Participation/Attendance	10
Total	**40**

Semester III - Biological Sciences

Course Content

Course Title/Code: **BIOLOGICAL CHEMISTRY**	Course Credits: **2**
Course Code: **BSM-03P**	L-T-P per week: 0-0-4
Total Contact Hours: **56**	Duration of ESA: 3 Hours
Formative Assessment Marks: **25**	Summative Assessment Marks: **25**
Model Syllabus Authors:	

Core Course prerequisite: The student must have studied BSM-01T and BSM-01P Core course paper on Biomolecules.

Course Articulation Matrix: Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Course outcomes (COs)/ program Outcomes (Pos)	CC T1	CC 2	CC 3	CC 4	CC 5	CC 6	CC 7	CC 8	CC 9	CC 10	CC 11
I Core competency	✓										
II Critical thinking	✓										
III Analytical reasoning	✓										
IV Research skills	✓										
V Team work	✓										

Note:

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark = '✓' in the intersection cell if a course outcome addresses a particular program outcome.

Semester III - Biological Sciences

BSM-03P: BIOLOGICAL CHEMISTRY

No. of Credits: 2 **No. of hours: 56**

PRACTICAL	
• Extraction and assay of invertase from yeast by DNS method. • Assay of salivary amylase using starch as a substrate by DNS method. • Study on the effect of pH, temperature and ionic strength on enzyme activity (Salivary amylase) • Estimation of ethanol from yeast (sucrose fermentation method). • Estimation of NADH conversion by lactic acid dehydrogenase activity. • Estimation of urea, uric acid and ammonia from ureotelic (goat blood), uricotelic (chicken blood) and ammoniotelic (aquarium fish) organisms • Estimation of free fatty acids from triglycerides.	

Suggested Reading:

1) Practical Clinical Biochemistry by Harold Varley. Fourth Edition, Interscience Publishers, 1954.

Pedagogy:

Formative Assessment	
Assessment Occasion	**Weightage in marks**
House Examination/ Test	15
Written assignment/ Presentation/ Project/ Term Papers/Field Visits/ExperimentalDocumentation	05
Class performance/ Participation/Attendance	05
Total	**25**

Semester III - Biological Sciences

Course Content

Course Title/Code: **VERMICULTURE (Open Elective)**	Course Credits: **3**
Course Code: **BSOE-03T**	L-T-P per week: 3-0-0
Total Contact Hours: **42**	Duration of ESA : 3 Hours
Formative Assessment Marks: **40**	Summative Assessment Marks: **60**
Model Syllabus Authors:	

Core Course prerequisite: To study Biological Science in undergraduate, student must havestudied Biology or equivalent subject in Class 12.

Course Articulation Matrix: Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Course outcomes (COs)/ program Outcomes (Pos)	CC T1	CC 2	CC 3	CC 4	CC 5	CC 6	CC 7	CC 8	CC 9	CC 10	CC 11
I Core competency	✓										
II Critical thinking	✓										
III Analytical reasoning	✓										
IV Research skills	✓										
V Team work	✓										

Note:

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark = '✓' in the intersection cell if a course outcome addresses a particular program outcome.

Semester III - Biological Sciences

BSOE-03T: VERMICULTURE

No. of Credits: 3 **No. of hours: 42**

Aim and Objectives: ✓ To understand about the earthworm, the major component of vermicomposting. ✓ To provide an overview of the process of using earthworms to decompose organic waste. ✓ To familiarize the students regarding problems and prospects of vermicomposting.	
UNIT I	**14 hrs**
INTRODUCTION TO VERMICULTURE • Definition, classification, history, economic importance, their value in maintenance of soil structure, bio transformation of the residues generated by human activity and production of organic fertilizers. • Choosing the suitable worm: Useful species of earthworms, local species of earthworms, exotic species of earthworms. • Biology of earthworm: Classification, biology, anatomy, physiology and reproduction.	
UNIT II	**14 hrs**
CONVENTIONAL AND COMMERCIAL COMPOSTING • Earthworm Farming: Vermiculturing, harvest. • Methods of Vermicomposting: Small- and large-scale Bed method, Pit method, Small Scale Earthworm farming for home gardens, earthworm composting in large scale. Harvesting, packaging, transport and storage of vermicompost. • Nutritional composition of Vermicompost: Nutritional composition of vermicompost for plants, comparison with other fertilizers. • Vermiwash: Extraction and processing. Benefits of vermiwash.	
UNIT III	**14 hrs**
ECONOMICS, PROBLEM AND PROSPECTS OF VERMICOMPOSTING • Physiochemical parameters: moisture, pH, temperature, aeration, pH value, ammonia and salt content. • Pests, predators and diseases of earthworms • Applications of vermiculture • Potentials and constraints for vermiculture in India.	

• Marketing the products of vermiculture – quality control, market research, marketing techniques – creating the demand by awareness and demonstration, advertisements, packaging and transport, direct marketing.	

Suggested Reading:

1. Aravind Kumar. 2005.Verms & Vermitechnology, A.P.H. Publishing Corporation, New Delhi.
2. Bhatnagar and Patla. 2007. Earthworm vermiculture and vermin-composting, Kalyani Publishers, New Delhi.
3. Jordan and Verma,2009. Invertebrate Zoology , Chand & Company Ltd.
4. Mary Violet Christy. 2008. Vermitechnology. MJP Publishers, Chennai.
5. Sultan Ahmed Ismail. 2005. The Earthworm Book. Other India Press, Goa, India. 2nd revised edition.

Pedagogy:

Formative Assessment	
Assessment Occasion	**Weightage in marks**
House Examination/ Test	15
Written assignment/ Presentation/ Project/ Term Papers/Field Visits/Seminars	15
Class performance/ Participation/Attendance	10
Total	**40**

Semester III - Biological Sciences

Course Content

Course Title/Code: **CLINICAL BIOCHEMISTRY**	Course Credits: **2**
Course Code: **BSSE-02T**	L-T-P per week: 1-0-0
Total Contact Hours: **14**	Duration of ESA: 3 Hours
Formative Assessment Marks: **25**	Summative Assessment Marks: **25**
Model Syllabus Authors:	

Core Course prerequisite: To study Biological Science in undergraduate, student must have studied Biology or equivalent subject in Class 12 and must have studied Biochemistry/Biomolecules related core course paper.

Course Articulation Matrix: Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Course outcomes (COs)/ program Outcomes (Pos)	CC T1	CC 2	CC 3	CC 4	CC 5	CC 6	CC 7	CC 8	CC 9	CC 10	CC 11
I Core competency	✓										
II Critical thinking	✓										
III Analytical reasoning	✓										
IV Research skills	✓										
V Team work	✓										

Note:

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark = '✓' in the intersection cell if a course outcome addresses a particular program outcome.

Semester III - Biological Sciences

BSSE-02T: CLINICAL BIOCHEMISTRY

No of credits: 2 **No of hours: 28**

Aim and objective ✓ To extend the concepts of metabolism to understanding of diseases, disorders and deficiencies ✓ To familiarize students with the principles and instrumentation in current diagnostic techniques as well as the interpretation of results	
UNIT 1	**7 hrs**
INTRODUCTION TO CLINICAL BIOCHEMISTRY • Homeostasis and its relation to the health of normal individuals. • Physical aspects of homeostasis: pH: The pH scale, buffers, physiological buffers and their importance • Ionic strength: Hypertonic, isotonic and hypotonic solutions. Importance of Ca^{++}, Na^{+}. K^{+}, Cl^{-} and PO_4^{---} ions. Osmolality and oncotic pressure • Dissolution of gases: Partial pressure and the concentration of O_2 and CO_2 in body fluids. Arterial Blood Gas (ABG) analysis and relevance in metabolic acidosis. • Changes in homeostasis brought about by diseases (infectious, contagious, zoonotic and nosocomial infections). • Homeostatic changes due to nutritional deficiencies (Malabsorption and Cachexia in cancer) • Congenital homeostatic changes due to genetic disorders	
UNIT 2	**7 hrs**
BIOCHEMICAL TESTS AS DIAGNOSTIC TOOLS • *Types of screening:* Population screening, selective screening, individual screening • *Determination of reference ranges:* Accuracy, specificity, sensitivity and precision. • Body fluids analyzed in clinical biochemistry: blood, urine, ascites, CSF, amniotic fluid, faeces, mucus, synovial fluid, pleural/pericardial fluid, saliva.	

• *Samples analyzed in clinical biochemistry:* swabs, FNAC samples, solid tissue from tumors, Routine procedures followed for Sample collection, storage and transport, Sample processing, Testing of samples, Quality check. • *Interpretation:* Assessment of disease severity and progression, Declaration of disease prognosis based on the result. •	
UNIT 3	**10 hrs**
COMMON BIOCHEMICAL TESTS IN CLINICAL DIAGNOSIS • **Liver function tests:** Determination of Total protein and albumin, Estimation of Bilirubin (conjugated, unconjugated and total), Assay of Alkaline phosphatase (ALP), Alanine aminotransferase (ALT) and Aspartate aminotransferase (AST) and Gamma glutamyl transpeptidase (GGT). • **Renal function tests:** Estimation of Blood urea, BUN, Serum creatinine, Glomerular Filtration Rate, Analysis of H^+, PCO_2 and PO_2 (blood gases), • **Cardiac function tests:** Assay of Lactate dehydrogenase, Creatine kinase. Determination of Troponin T and Troponin I. • **Tests related to carbohydrate, lipid and mineral metabolism:** • *Carbohydrate metabolism*: Glucose Tolerance Test (GTT), Determination of Blood Glucose (fasting, post prandial and random), Glycosylated hemoglobin, Glucose analysis in urine, Assay of amylase • *Lipid metabolism:* Estimation of cholesterol, triglycerides, HDL, LDL and VLDL, Apolipoproteins. • *Mineral metabolism:* Estimation of calcium and phosphate. Estimation of Serum electrolytes (Sodium, potassium and chloride). • *Specialized Tests* Estimation of Hormones (TSH, T3 and T4, cortisol, beta hCG), Specific proteins (PSA, AFP) Trace elements (copper, zinc, selenium), Vitamins (Vitamin D, B 12).	
UNIT 4	**4 hrs**
GOOD LABORATORY PRACTICES • Design of a clinical laboratory. Importance of calibration of instruments. Accuracy and precision in preparation of reagents, Safety and handling of samples; Interpretation of results and reporting, Disposal of medical waste.	

• Basic equipment's required for a clinical diagnostic laboratory. Principle of colorimetry and spectrophotometry. Autoanalyzer's and their significance in a clinical laboratory.	

Suggested reading:

1. Clinical Biochemistry by Nanda Maheshwari. JayPee brothers Medical Publishers, India. 1st edition (2008).
2. Clinical Biochemistry Lecture Notes. Beckett G, Walker S, Rae P and Ashby P. John Wiley & Sons, UK. 8th edition (2010).
3. Biochemistry of Clinical Medicine by W.S.Hoffman, January 1, 1966, Year Book Medical Publishers, Chicago.
4. Clinical Chemistry in Diagnosis and Treatment by Zilva JF, Pannall PR, Mayne PD, Year Book Medical Publishers, 1988.
5. Text Book of Biochemistry for Medical Students by Vasudevan DM. Jaypee Brothers Medical Publishers, New Delhi.

Learning outcomes:

- Ability to read, interpret and explain a laboratory diagnostic report to a patient.
- Ability to understand the clinical basis of diseases.
- Appreciate the importance of precise diagnosis for planning therapeutic regimes.
- Acquire basic knowledge of a diagnostic laboratory and the routine tests conducted therein

Pedagogy:

Formative Assessment	
Assessment Occasion	**Weightage in marks**
House Examination/ Test	15
Written assignment/ Presentation/ Project/ Term Papers/Field Visits/Seminars	15
Class performance/ Participation/Attendance	10
Total	**40**

Semester III - Biological Sciences

CLINICAL BIOCHEMISTRY

No of credits: 2 **No of hours: 28**

PRACTICAL	
• Assay of Aspartate transaminase (AST) and Alanine transaminase (ALT). • Assay of Lactate dehydrogenase (LDH). • Estimation of Glucose (Glucose Oxidase method). • Estimation of Bilirubin (Diazo method) • Estimation of Creatinine (Jaffe's method) • Assay of Alkaline phosphatase	
• All the above tests are to be done using human serum and results should be compared with the correct reference ranges • A final diagnostic report may be generated and affixed in the practical record book	

Pedagogy:

Formative Assessment	
Assessment Occasion	**Weightage in marks**
House Examination/ Test	15
Written assignment/ Presentation/ Project/ Term Papers/Field Visits/ExperimentalDocumentation	05
Class performance/ Participation/Attendance	05
Total	**25**

Suggested Reading:

1. Bergmeyer H.U., Bernst E. Glutamate-oxaloacetate transaminase: UV-assay manual method, in. In: Bergmeyer H.U., editor. Methods of Enzymatic Analysis. 2nd English Ed. Academic Press; New York: 1963. pp. 727–733.
2. Bergmeyer H.U., Bernst E. lutamate-pyruvate transaminase: UV-assay manual method, in. In: Bergmeyer H.U., editor. Methods of Enzymatic Analysis. 2nd English Ed. Academic Press; New York: 1963. pp. 752–758.
3. Practical Clinical Biochemistry by Harold Varley. Fourth Edition, Insterscience Publishers, 1954.

Semester IV - Biological Sciences

Core Course Content

Course Title/Code: **ANIMAL ANATOMY AND PHYSIOLOGY**	Course Credits: **4**
Course Code: **BS-04T**	L-T-P per week: 4-0-0
Total Contact Hours: **56**	Duration of ESA: 3 Hours
Formative Assessment Marks: **40**	Summative Assessment Marks: **60**
Model Syllabus Authors:	

Core Course prerequisite: The student must have studied BS-02T Animal Systematics paper.

Course Articulation Matrix: Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Course outcomes (COs)/ program Outcomes (Pos)	CC T1	CC 2	CC 3	CC 4	CC 5	CC 6	CC 7	CC 8	CC 9	CC 10	CC 11
I Core competency	✓										
II Critical thinking	✓										
III Analytical reasoning	✓										
IV Research skills	✓										
V Team work	✓										

Note:

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark = '✓' in the intersection cell if a course outcome addresses a particular program outcome.

Semester IV - Biological Sciences

BS-04T: ANIMAL ANATOMY AND PHYSIOLOGY

No. of Credits: 4 **No. of hours: 56**

Aim and Objectives: ✓ To understand the general account of animal anatomy ✓ To provide an overview of the basic physiology in animals ✓ To understand the concepts of homeostasis in physiological regulation	
Unit I	**14 hrs**
INTEGUMENTARY AND ENDOCRINE SYSTEM • Structure and functions of skin • Accessory structures of skin: hair, nail and skin gland. • Anatomy of endocrine glands and role of their hormones: Pituitary, Pineal, Thyroid, Parathyroid, Adrenal, Pancreas, Ovaries and Testes.	
Unit II	**14 hrs**
CIRCULATORY AND RESPIRATORY SYSTEM • The blood- composition of blood and its function, systemic and pulmonary circulations. • Heart; Cardiac conduction system, Contraction of contractile fibres, ATP production in cardiac muscle, cardiac cycle, ECG, cardiac output, myocardial ischemia and infarction, Control of blood pressure and blood flow, hormonal regulation and autoregulation of blood pressure. • Lymphatic system and its functions. • Respiratory System and Pulmonary ventilation: external and internal respiration. Factors affecting Pulmonary ventilation: pressure changes, surface tension of alveolar fluid, compliance of the lungs, airway resistance. Lung volume and capacities, transport of oxygen and carbon dioxide, neural and chemical regulation of respiration.	
UNIT III	**14 hrs**
DIGESTIVE AND EXCRETORY SYSTEM • Organs of the Digestive System, Mechanical and chemical digestion, deglutition, secretion of gastric acid, pepsin, role of intestinal juice and brush border enzymes (maltase, nucleosidase, enterokinase, amylopsin, steapsin, nuclease, erepsin), absorption in small intestine,	

absorption and faeces formation in large intestine. Digestion of carbohydrates, lipids and proteins. • Kidney, nephron, urine formation: glomerular filtration, tubular reabsorption and secretion, production of dilute and concentrated urine, urine transportation, storage and elimination. Regulation of water balance, electrolyte balance and acid-base balance.	
UNIT IV	**14 hrs**
NERVOUS SYSTEM AND MUSCULAR SYSTEM • Neurons, Electrical signals in neurons: generation and propagation of action potential. Signal transmission at synapse: electrical synapse, chemical synapse. Neurotransmitters: acetylcholine, biogenic amines, nitric oxide and neuropeptides. Autonomic nervous system: Sympathetic and parasympathetic response, cholinergic neurons, adrenergic neurons. • Sense organs – Visual, auditory, gustatory and olfactory response. • Structure, functions and properties of muscular tissue. Contraction and relaxation of skeletal muscle fibres: sliding filament mechanism, neuromuscular junction. Control of muscle tension: twitch contraction, muscular atrophy and hypertrophy.	

Suggested Reading:

1) Guyton C. and Hall J. E. 2015. Text book of Medical physiology. W. B. Saunders publication. 13th edition.
2) Hill R. H. 2016, Animal physiology. CBS publication. 4th edition.
3) Kent G. C. and Carr R. K. 2001. Comparative anatomy of vertebrates. McGraw Hill publication. 9th edition.
4) Reddy P.B. 2015. Text book of Animal Physiology. Ratna Prasad multidisciplinary research and education society publication.
5) Ruth L. and Otaqo P. 2015. Anatomy and physiology of animals. Klickibooks publication. (open text book library).
6) Sembulingam K. and Sembulingam P. 2012. Essentials of medical physiology. Jaypee brothers medical publications. 6th edition.
7) Tortora G. J. and Derrickson B. J. 2017. Principles of Anatomy and Physiology. Hoboken NJ. 15th Edition.
8) Victor P. Eroschenko.2017. Atlas of Histology with Functional Correlations. Wolters Kluwer Health. 13th Edition.

Pedagogy:

Formative Assessment	
Assessment Occasion	**Weightage in marks**
House Examination/ Test	15
Written assignment/ Presentation/ Project/ Term Papers/Field Visits/Seminars	15
Class performance/ Participation/Attendance	10
Total	**40**

Semester IV - Biological Sciences

Course Content

Course Title/Code: **ANIMAL ANATOMY AND PHYSIOLOGY**	Course Credits: **2**
Course Code: **BS-04P**	L-T-P per week: 0-0-4
Total Contact Hours: **56**	Duration of ESA : 3 Hours
Formative Assessment Marks: **25**	Summative Assessment Marks: **25**
Model Syllabus Authors:	

Core Course prerequisite: The student must have studied BS-02T and BS-02 P Animal Systematics paper.

Course Articulation Matrix: Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Course outcomes (COs)/ program Outcomes (Pos)	CC T1	CC 2	CC 3	CC 4	CC 5	CC 6	CC 7	CC 8	CC 9	CC 10	CC 11
I Core competency	✓										
II Critical thinking	✓										
III Analytical reasoning	✓										
IV Research skills	✓										
V Team work	✓										

Note:

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark = '✓' in the intersection cell if a course outcome addresses a particular program outcome.

Semester IV - Biological Sciences

BS-04P: ANIMAL ANATOMY AND PHYSIOLOGY

No. of Credits: 2 **No. of hours: 56**

PRACTICAL	
• Determination of oxygen consumption and metabolic rate in fish. • Determination of ATPase activity in tissues. • Determination of Acetylcholine esterase activity in tissues. • Determine the nitrogenous end products (ammonia, urea and uric acid) in body fluid and excreta of aquatic and uricotelic organisms. • Effect of isotonic, hypotonic and hypertonic salines on erythrocytes. • Estimation of RBC count and total WBC count using haemocytometer. • Measurement of heartbeat rate in Invertebrates. Influence of excitatory and inhibitory neurotransmitter on the rate. • Identification and functions of nails, hairs, skin glands. • Study of Histology sections of Testis, Ovary, Liver, Pancreas, Thyroid gland, Adrenal gland, kidney, Spleen, Stomach, Intestine. • Microtomy – Organ fixing, Block making, Sectioning and staining of any one organ (rat).	

Pedagogy:

Formative Assessment	
Assessment Occasion	**Weightage in marks**
House Examination/ Test	15
Written assignment/ Presentation/ Project/ Term Papers/Field Visits/ExperimentalDocumentation	05
Class performance/ Participation/Attendance	05
Total	**25**

Semester IV - Biological Sciences

Course Content

Course Title/Code: **GENETICS AND BREEDING**	Course Credits: **4**
Course Code: **BSM-04T**	L-T-P per week: 4-0-0
Total Contact Hours: **56**	Duration of ESA: 3 Hours
Formative Assessment Marks: **40**	Summative Assessment Marks: **60**
Model Syllabus Authors:	

Core Course prerequisite: To study Biological Science in undergraduate, student must have studied Biology or equivalent subject in Class 12.

Course Articulation Matrix: Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Course outcomes (COs)/ program Outcomes (Pos)	CC T1	CC 2	CC 3	CC 4	CC 5	CC 6	CC 7	CC 8	CC 9	CC 10	CC 11
I Core competency	✓										
II Critical thinking	✓										
III Analytical reasoning	✓										
IV Research skills	✓										
V Team work	✓										

Note:

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark = '✓' in the intersection cell if a course outcome addresses a particular program outcome.

Semester IV - Biological Sciences

BSM-04T: GENETICS AND BREEDING

No. of Credits: 4 **No. of hours: 56**

Aim and Objectives: ✓ To learn and apply concepts of transmission genetics. ✓ To familiarize the students with mutations and their impacts on human. ✓ To understand the concepts and prospects of animal and plant breeding.	
UNIT 1	**14 hrs**
TRANSMISSION GENETICS • Introduction, Historical account, brief overview of Mendel's principles (Dominance, segregation, independent assortment). • Extension of Mendelian principles: Co-dominance, incomplete dominance, gene interactions, pleiotropy, Penetrance and Expressivity, Polygenic Inheritance. Concept of gene – Allele, Multiple alleles, Pseudoalleles. • Extra chromosomal inheritance -Mitochondrial and cytoplasmic inheritance, maternal inheritance. Examples: Paramecium and Yeast. • Linkage, crossing over and recombination, Chromosomal mapping, Interference and Coincidence.	
UNIT II	**14 hrs**
HUMAN GENETICS • Sex limited and sex influenced characters, X linked inheritance. • Gene Mutations: Types and molecular mechanism – Missense, Nonsense, Frame shift. • Chromosomal aberrations- Deletions, Duplications, Inversions, Translocations. Numerical variations in chromosomes: Euploidy and Aneuploidy — causes and consequences. • Chromosome banding techniques- Quinacrine dihydrochloride (Q), Giemsa(G), reverse (R), centromere (C) and Fluorescence in situ hybridization (FISH). • Pedigree analysis, karyotypes and idiogram. Genome imprinting Syndromes (Prader-Willi and Angelman syndromes, Beckwith-Wiedemann syndrome).	

UNIT III	14 hrs
PLANT BREEDING • Concept and scope of plant breeding, a brief historical account of plant breeding, objectives, significance, problems and prospects of plant breeding. • Methods of Plant breeding: Plant introduction and acclimatisation, germplasm maintenance, Selection (pure line, mass, pedigree analysis, single seed descent, clonal selection). • Hybridisation: Definition, methods of hybridization (self-pollinated crops – rice and wheat, cross pollinated crops – maize, asexually propagated crops- sugarcane, potato), Polyploidization and breeding- its significance. • Mutation breeding: Methods of mutation breeding (chemical and physical), merits and demerits of mutation breeding, significance. • Heterosis: definition, types, theories of Heterosis, heterosis in self- and cross-pollinating plants and its application. • Inbreeding depression: Inbreeding depression, genetic basis of inbreeding depression, degree of inbreeding depression, outbreeding and significance of inbreeding and outbreeding. • Back cross breeding: Methods, merit and demerits, markers assisted breeding.	
UNIT IV	**14 hrs**
ANIMAL BREEDING • Concepts, development and applications of breeds and breed structure. • Basic breeding methods; Silkworm, sheep, poultry and cattle; genetic principles in animal breeding, heredity and environment, Heritability, repeatability, methods of their estimations; genotypic, phenotypic and environmental correlations. Traits for selection, breeding efficiency in inbreeding, outbreeding, top crossing, grading, cross breeding, crisscrossing, triple crossing system. • Artificial insemination, infertility and assisted reproduction. Cryopreservation of embryos.	

Suggested Reading:

1. Allard, R. W. 1999. Principles of Plant Breeding. John Willey & Sons, New York.
2. Dalton, D.C. 1987. An Introduction to Practical Animal Breeding. English Language Book Society Collins.
3. Gordon, 1. 1983. Controlled breeding in farm animals. Paragon Press, Oxford, NY & Sydney
4. Pierce, B.A., 2012. Genetics- A Conceptual Approach .W.H. Freeman & Co. (New York), ISBN:13:978-1292-7606-1 / ISBN:10:1-4292-7606-1. 4th ed.
5. Singh, p 2001. Essentials of Plant Breeding. Kalyani Publishers, Hyderabad.
6. Snustad, D.P. and Simmons, M.J. 2012. Genetics. John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2 6th ed.

Pedagogy:

Formative Assessment	
Assessment Occasion	**Weightage in marks**
House Examination/ Test	15
Written assignment/ Presentation/ Project/ Term Papers/Field Visits/Seminars	15
Class performance/ Participation/Attendance	10
Total	**40**

Semester IV - Biological Sciences

Course Content

Course Title/Code: **GENETICS AND BREEDING**	Course Credits: **2**
Course Code: **BSM-04P**	L-T-P per week: 0-0-2
Total Contact Hours: **56**	Duration of ESA: 3 Hours
Formative Assessment Marks: **25**	Summative Assessment Marks: **25**
Model Syllabus Authors:	

Core Course prerequisite: To study Biological Science in undergraduate, student must have studied Biology or equivalent subject in Class 12.

Course Articulation Matrix: Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Course outcomes (COs)/ program Outcomes (Pos)	CC T1	CC 2	CC 3	CC 4	CC 5	CC 6	CC 7	CC 8	CC 9	CC 10	CC 11
I Core competency	✓										
II Critical thinking	✓										
III Analytical reasoning	✓										
IV Research skills	✓										
V Team work	✓										

Note:

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark = '✓' in the intersection cell if a course outcome addresses a particular program outcome.

Semester IV - Biological Sciences

BSM-04P: GENETICS AND BREEDING

No. of Credits: 2 **No. of hours: 56**

PRACTICAL	
• Study of Life cycle, culture and maintenance of *Drosophila melanogaster*. • Study of Morphology (wing, sex comb, genital plate and bristles) of *Drosophila melanogaster.* • Study of mutants of *Drosophila melanogaster.* • Dermatoglyphics • Study of Multiple alleles - Blood typing. • Study of abnormal human karyotype and pedigree analysis. • Genetic crosses and analysis of P1, P2, F1, F2 & test cross progeny in Drosophila: (a) Monohybrid (b) Dihybrid (c) Sex-linked inheritance. • Assisted reproductive techniques in animals. • Estimation of heterosis, inbreeding depression and heritability. • Hybrid breeding in plants. • Breeding by emasculation, bagging and artificial cross pollination.	

Pedagogy:

Formative Assessment	
Assessment Occasion	**Weightage in marks**
House Examination/ Test	15
Written assignment/ Presentation/ Project/ Term Papers/Field Visits/ExperimentalDocumentation	05
Class performance/ Participation/Attendance	05
Total	**25**

Semester IV - Biological Sciences

Course Content

Course Title/Code: **ECOLOGY AND EVOLUTIONARY BIOLOGY**	Course Credits: **3**
Course Code: **BSOE-04T**	L-T-P per week: 3-0-0
Total Contact Hours: **42**	Duration of ESA : 3 Hours
Formative Assessment Marks: **40**	Summative Assessment Marks: **60**
Model Syllabus Authors:	

Core Course prerequisite: To study Biological Science in undergraduate, student must have studied Biology or equivalent subject in Class 12.

Course Articulation Matrix: Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Course outcomes (COs)/ program Outcomes (Pos)	CC T1	CC 2	CC 3	CC 4	CC 5	CC 6	CC 7	CC 8	CC 9	CC 10	CC 11
I Core competency	✓										
II Critical thinking	✓										
III Analytical reasoning	✓										
IV Research skills	✓										
V Team work	✓										

Note:

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark = '✓' in the intersection cell if a course outcome addresses a particular program outcome.

Semester IV - Biological Sciences

BSOE-04T: ECOLOGY AND EVOLUTIONARY BIOLOGY (Open Elective)

No. of Credits: 3 **No. of hours: 42**

Aim and Objectives: ✓ To understand the interactions among living organisms and their environment. ✓ To provide an overview of the diversity, distribution, biomes and population of organisms including competition among themselves ✓ To provides a comprehensive understanding of evolutionary principles and major events in the evolution of Homo sapiens.	
UNIT I	**14 hrs**
ECOSYSTEMS AND BIOCHEMICAL CYCLES • Ecosystem: components, structural, and functional. Food webs, Food chain, Ecological pyramids, Energy flow-Laws of thermodynamics. • Bio productivity: Primary & Secondary productivity, primary production process, Estimation of productivity, factors affecting primary production. • Ecosystems Types: Terrestrial, Forest, Grassland, Cropland, Desert, Tundra, Aquatic, Pond, Ocean, Estuarine. • Biogeochemical cycles: water, nitrogen, carbon, sulphur, phosphorus, Homeostatis, Management and optimization of ecosystem, and evolution.	
UNIT II	**14 hrs**
CONVENTIONAL AND COMMERCIAL COMPOSTING • Population and community ecology: Population growth, community-biotic concept, groups of community, classification, composition, structure, theories and characteristics. • Ecological succession (community dynamics), mechanisms of succession, process, Hydrosere, Xerosere. • Biomes of the world – Biomes- classification, Forest biomes, Aquatic biomes, Desert biomes, Grassland biomes, Tundra biomes. • Stress Ecology and Ecological adaptation, plant adaptations-stress, Hydrophyte, Mesophytes, Xerophytes, Halophytes, Ecological adaptation in animals	

UNIT III	14 hrs
CONCEPT OF EVOLUTION AND EVOLUTIONARY MECHANISM • Concept of evolution: origin of life-origin of Basic Biological molecules, concept of Oparin and Haldane, Miller's experiment, Lamarckism, Darwinism, Natural selection, Neo-Darwinism. Evolution time scale- eras, periods and Epoch, major events in evolutionary time scale, evolution of Homo sapiens. • Evolution mechanism – population genetics- populations, gene pool, gene frequency, Hardy-Weinberg Law, adaptive radiation and modification, isolation mechanism, speciation- allopatricity and sympatricity. • Human Origins and cultural evolution: Primate evolution, Chimpanzees and Humans, Earliest Hominids, Australopithecins: the southern apes of Africa, Bipedalism and brain size, origins of Homo, Out of Africa, Humans as hunter-gatherers; Cultural and Social evolution: Instincts and learned behavior, Learning, society and culture, cultural evolution dominating phenotypic evolution, Social Darwinism, inheritance of social behavior.	

Suggested Reading:

1. Ahad, A. M. and Ferdous, A.S.M. 2019. A text book of ecology. Himachal Publications Dhaka.
2. Ambasht, R.S and A.K. Ambasht.2002. A textbook of Plant Ecology. 14th edition C.B.S Publishers and Distributors.
3. Barton, Briggs, Eisen, Goldstein and Patel. 2007. Evolution. CSHL.
4. Kumar, H.D.2000. Modern Concepts of Ecology**,** Prentice Hall India, New Delhi.
5. Muehlenbein M.P. 2010. Human evolutionary biology. Cambridge University press.
6. Riisgard, H. U. 2018. General ecology. The eBook company. 2nd edition
7. Strickberger. 2000. Evolution, prentice Hall of India private limited, New Delhi.

Pedagogy:

Formative Assessment	
Assessment Occasion	**Weightage in marks**
House Examination/ Test	15
Written assignment/ Presentation/ Project/ Term Papers/Field Visits/Seminars	15
Class performance/ Participation/Attendance	10
Total	**40**