BANGALORE UNIVERSITY
DEPARTMENT OF LIFE SCIENCE
JNANABHARATHI CAMPUS
BENGALURU – 560 056.

Syllabus for

I & II Semester for Five Year Integrated M.Sc. in

B I O L O G I C A L S C I E N C E S

Framed according to the National Education Policy (NEP 2020)

SEPTEMBER - 2021

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, credit accumulation, 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 Honors degree
7 Post-graduate Diplomas in respective disciplines.

I am delighted to present curriculum structure and syllabus of Integrated Master Degree in Biological Sciences with multiple exist entry with skills and job opportunities in point of exit system. 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.

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P R E M A B L E

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 Five Year 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. These course eves as a plethora of opportunities in different fields right from classical to applied Biological Sciences.

I N T R O D U C T I O N

Five Year Integrated 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. (Hons.)- M.Sc. Program in Biological Sciences also includes the industry relevant, advanced life science topics like Genomics, Proteomics, Metabolomics, Nano biology, 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.

O B J E C T I V E S

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.

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 Five Year Integrated 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 144 credits.
- Fourth year exit option includes Bachelor of Science Honours (B.Sc. Hons.) Degree in Biological Sciences with 186 credits.
- The student will be awarded with 5 years Integrated B.Sc. (Hons.)- M.Sc. Degree in Biological Sciences with 228 credits.

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
- Ethical awareness
- National and international perspective
- Lifelong learning streak

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

FIVE YEAR INTEGRATED MASTER DEGREE IN

B I O L O G I C A L S C I E N C E S

Programme 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 courses 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 courses 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 Programmes shall extend over Five academic years (Ten Semesters) with exit options with Regular Bachelor Degree after successful completion of Three academic years (Six Semesters) of study and Bachelor Degree with Honors in a discipline/ subject at the end of Four academic years (Eight Semesters). Completion of five years of integrated Master's Degree Programme 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 Honours 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.

Course Pattern and Scheme of Examination for Integrated M.Sc. Biological Sciences
As per NEP (2021-22 onwards)
SUBJECT: BIOLOGICAL SCIENCES

Sl. No	Semester	Title of the Paper	Teaching Hours	Hours / week		Examination Pattern Max. & Min. Marks / Paper						Duration of Exam (Hours)		Total Marks/ Paper	Credits	
						Theory			Practical							
				Theory	Practical	Max.	Min.	IA	Max.	Min.	IA	Theory	Practical		Theory	Practical
1	I	**BS-1T:** Plant Systematics	**56**	**4**	**4**	**60**	**22**	**40**	**25**	**09**	**25**	**3**	**4**	**150**	**4**	**2**
		BSOE-1T: Biodiversity and Conservation	**42**	**3**	**-**	**60**	**22**	**40**	**-**	**-**	**-**	**3**	**-**	**100**	**3**	**-**
2	II	**BS-2T:** Animal Systematics	**56**	**4**	**4**	**60**	**22**	**40**	**25**	**09**	**25**	**3**	**4**	**150**	**4**	**2**
		BSOE-2T: Biophysics	**42**	**3**	**-**	**60**	**22**	**40**	**-**	**-**	**-**	**3**	**-**	**100**	**3**	**-**

Scheme of Internal Assessment marks: Theory

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**

Scheme of Internal Assessment marks: Practicals

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

PROPOSED CURRICULUM STRUCTURE FOR INTEGRATED M.Sc., BIOLOGICAL SCIENCES DEGREE PROGRAMME

II A. Model Programme structure for Bachelor of Science (Basic/Hons.) with practicals with one major and one minor

Semester	Discipline Core (DSC) (Credits) (L+T+P)	Discipline Specific Elective (DSE) /Open Elective (OE) (Credits) (L+T+P)	Ability Enhancement Compulsory Course (AECC) (L+T+P)		Skill Enhancement Course (SEC)			Total Credits
					SKILLBASED (Credits) (L+T+P)	VALUE BASED (credits) (L+T+P)		
I	BS-1 A1 (4+2) BSM-1 B1 (4+2)	BSOE-1 (3)	BS-KL1 (3) BS-EL1 (3)	-	BSSE-01T (2) (1+0+2)	Physical Education for fitness (1) (0+0+2)	Health &Wellness (1) (0+0+2)	**25**
II	BS-2 A2 (4+2) BSM-2 B2 (4+2)	BSOE-2 (3)	BS-KL2 (3) BS-EL3 (3)	Environmental Studies (2)		Physical Education yoga (1) (0+0+2)	NCC/NSS/R &R(S&G)/C ultural (1) (0+0+1)	**25**
Exit Option with Certificate in Biological Sciences (50 Credits)								
III	BS-3 A3 (4+2) BSM-3 B3 (4+2)	BSOE-3 (3)	BS-KL3 (3) BS-EL3 (3)	-	BSSE-02T (2) (1+0+2)	Physical Education sports skills (1) (0+0+2)	NCC/NSS/R &R(S&G)/C ultural (1) (0+0+1)	**25**

IV	BS-4 A4 (4+2) BSM-4 B4 (4+2)	BSOE-4 (3)	BS-KL4 (3) BS-EL4 (3)	Constitution of India (2)	-	Physical Education games (1) (0+0+2)	NCC/NSS/R &R(S&G)/C ultural (1) (0+0+1)	**25**
Exit Options with Diploma in Biological Sciences (100 Credits) or Choose any one of the core subjects as major and other as minor								

V	BS-5 A5 (3+2) BS-6 A6 (3+2) BSM-5 B5 (3+2)	Vocational-1 (3)	-	-	BSSE-03T (2) (1+0+2)	-	-	**20**
VI	BS-7 A7 (3+2) BS-8 A8 (3+2) BSM-6 B6 (3+2)	Vocational-2 (3)	-	-	BSSE-04T (2) (1+0+2)	-	-	**22**
Exit option with Bachelor of Science B.Sc. Degree in Biological Sciences (142 credits) Or continue studies with Major in the fourth year								
VII	BS-9 A9 (3+2) BS-10 A10 (3+2) BS-11 A11 (3)	BSDS-01T (3) BSDS-02T (3) Research Methodology(3)	-	-	-	-	-	**22**

VIII	BS-12 A12 (3+2) BS-13 A13 (3) BS-14 A14 (3)	BSDS-03T (3) Research project (6)*	-	-	-	-	-	**20**
Exit option with Award of Bachelor of Science Honors Degree B.Sc. (Hons.) Degree in Biological Sciences (184 credits)								
IX	BS-15 A15 (4+2) BS-16 A16 (4+2) BS-17 A17 (4)	BSDS-04T (4) BSDS-05T (4)	-	-	-	-	-	**24**
X	BS-18		-	-	-	-	-	**24**
Award of Master Degree in Biological Sciences (232 credits)								

*BS: Biological Sciences

Year wise structure of (Annexure II A) Model Program with titles for Theory and Practical papers

Core Courses – BS (18)

FIVE YEAR INTEGRATED M.Sc. IN BIOLOGICAL SCIENCES (NEP SCHEME)

I - SEMESTER								
Code	Subjects	Paper Theory/ Practical	Instruction Hrs/week	Duration of Exam (Hrs)	Marks			Credits
					IA	Exam	Total	
BS-01T	Plant Systematics	Theory	4	3	40	60	100	4
BS-01P	Plant Systematics	Practical	4	4	25	25	50	2
BSM-01T	Biomolecules	Theory	4	3	40	60	100	4
BSM-01P	Biomolecules	Practical	4	4	25	25	50	2
BSOE-01T	Biodiversity and Conservation	Theory	3	3	40	60	100	3
BS-KL1	Kannada/Hindi	Theory	4	3	40	60	100	3
BS-EL1	English	Theory	4	3	40	60	100	3
BSSE-01T	Bioinstrumentation	Theory/ Practical	4	4	25	25	50	2
BSVC	Physical education for fitness	Practical						1
BSVC	Health and Wellness	Practical						1
							Total Credits	**25**

II - SEMESTER								
Code	Subjects	Paper Theory/ Practical	Instruction Hrs/week	Duration of Exam (Hrs)	Marks			Credits
					IA	Exam	Total	
BS-02T	Animal Systematics	Theory	4	3	40	60	100	4
BS-02P	Animal Systematics	Practical	4	4	25	25	50	2
BSM-02T	Cell Biology	Theory	4	3	40	60	100	4
BSM-02P	Cell Biology	Practical	4	4	25	25	50	2
BSOE-02T	Biophysics	Theory	3	3	40	60	100	3
BS-KL2	Kannada/Hindi	Theory	4	3	40	60	100	3
BS-EL2	English	Theory	4	3	40	60	100	3
BSAE	Environmental Studies	Theory	2	2	25	25	50	2
BSVC	Physical education for Yoga	Practical						1
BSVC	NCC/NSS/R&R (S&G/Cultural)	Practical						1
							Total Credits	**25**

Job Opportunities for Students after completion of one year Certificate in Biological Sciences

- The **Certificate** awarded after successful completion of II semester provides students with core skills in basic laboratory techniques specializing in 'Bioinstrumentation'
  - ✓ Lab technicians
  - ✓ Higher Education/pursuing Diploma or Bachelors

III - SEMESTER								
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	3	40	60	100	4
BS-03P	Plant Anatomy and Physiology	Practical	4	4	25	25	50	2
BSM-03T	Biological Chemistry	Theory	4	3	40	60	100	4
BSM-03P	Biological Chemistry	Practical	4	4	25	25	50	2
BSOE-03T	Vermiculture	Theory	3	3	40	60	100	3
BS-KL3	Kannada/Hindi	Theory	4	3	40	60	100	3
BS-EL3	English	Theory	4	3	40	60	100	3
BSSE-02T	Clinical Biochemistry	Theory/ Practical	4	4	25	25	50	2
BSVC	Physical education for fitness	Practical						1
BSVC	Health and Wellness	Practical						1
						Total Credits		**25**

IV - SEMESTER								
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	3	40	60	100	4
BS-04P	Animal Anatomy and Physiology	Practical	4	4	25	25	50	2
BSM-04T	Genetics and Breeding	Theory	4	3	40	60	100	4
BSM-04P	Genetics and Breeding	Practical	4	4	25	25	50	2
BSOE-04T	Ecology and Evolutionary Biology	Theory	3	3	40	60	100	3
BS-KL4	Kannada/Hindi	Theory	4	3	40	60	100	3
BS-EL4	English	Theory	4	3	40	60	100	3
BSAE	Constitution of India	Theory	3	2	25	25	50	2
BSVC	Physical education for fitness	Practical						1
BSVC	Health and Wellness	Practical						1
						Total Credits		**25**

Job Opportunities for Students after completion of two year Diploma in Biological Sciences

- The **Certificate** awarded after successful completion of IV semester provides students with core skills in basic laboratory techniques specializing in 'Bioinstrumentation' and 'Clinical Biochemistry
  - ✓ Lab technicians
  - ✓ Basic and Advanced Diagnostic Laboratories
  - ✓ Higher Education/pursuing Bachelors

V - SEMESTER								
Code	Subjects	Paper Theory/ Practical	Instruction Hrs/week	Duration of Exam (Hrs)	Marks			Credits
					IA	Exam	Total	
BS-05T	Reproduction and Developmental Biology	Theory	3	3	40	60	100	3
BS-05P	Reproduction and Developmental Biology	Practical	4	4	25	25	50	2
BS-06T	Molecular Biology	Theory	3	3	40	60	100	3
BS-06P	Molecular Biology	Practical	4	4	25	25	50	2
BSM-05T	Microbiology	Theory	3	3	40	60	100	3
BSM-05P	Microbiology	Practical	4	4	25	25	50	2
Vocational 1	Forensic Biology	Theory	3	3	40	60	100	3
BSSE-03T	Assisted Reproductive Technology	Theory/ Practical	4	4	25	25	50	2
							Total Credits	**20**

VI - SEMESTER								
Code	Subjects	Paper Theory/ Practical	Instruction Hrs/week	Duration of Exam (Hrs)	Marks			Credits
					IA	Exam	Total	
BS-07T	Genetic Engineering	Theory	3	3	40	60	100	3
BS-07P	Genetic Engineering	Practical	4	4	25	25	50	2
BS-08T	Immunology	Theory	3	3	40	60	100	3
BS-08P	Immunology	Practical	4	4	25	25	50	2
BSM-06T	Biomedical Science	Theory	3	3	40	60	100	3
BSM-06P	Biomedical Science	Practical	4	4	25	25	50	2
Vocational 2	Seri-Biotechnology	Theory	3	3	40	60	100	3
Internship								2
BSSE-04T	Immunological Techniques	Theory/ Practical	4	4	25	25	50	2
Exit Options with B.Sc. Degree in Biological Sciences (142 Credits) or Continue with the Major							**Total Credits**	**22**

Job opportunities for the Exit option with Bachelor of Science Degree in Biological Sciences

- Degree in Integrated B.Sc. - M.Sc. Program in Biological Sciences is intended to provide a comprehensive foundation to the core subjects of Plant and Animal Sciences along with Biological Chemistry.

Opportunities for Students after completion of three years B.Sc. degree in Biological Sciences

- The **B.Sc. degree** awarded after successful completion of VI semester provides students with core skills in basic laboratory techniques specializing in 'Bioinstrumentation', 'Clinical Biochemistry' and 'Assisted Reproductive Technology' along with optional Vocational course in 'Forensic Biology'.
  - ✓ Assistants in Central and State Silk Board /Pollution Control Boards
  - ✓ Assistants in Forensic Labs
  - ✓ Basic and Advanced Diagnostic Laboratories
  - ✓ IVF- Centres
  - ✓ Higher Education/pursuing Masters at IITs/IISERs/IISc/NCBS

VII - SEMESTER								
Code	Subjects	Paper Theory/ Practical	Instruction Hrs/week	Duration of Exam (Hrs)	Marks			Credits
					IA	Exam	Total	
BS-09T	Plant and Animal Biotechnology	Theory	3	3	40	60	100	3
BS-09P	Plant and Animal Biotechnology	Practical	4	4	25	25	50	2
BS-10T	Applied Biology	Theory	3	3	40	60	100	3
BS-10P	Applied Biology	Practical	4	4	25	25	50	2
BS-11T	Biostatistics and Bioinformatics	Theory	3	3	40	60	100	3
BSDS-01T	Solid Waste Management	Theory	3	3	40	60	100	3
BSDS-02T	Nanobiology	Theory	3	3	40	60	100	3
	Research Methodology	Theory	4	3	40	60	100	3
							Total Credits	**22**

VIII - SEMESTER								
Code	Subjects	Paper Theory/ Practical	Instruction Hrs/week	Duration of Exam (Hrs)	Marks			Credits
					IA	Exam	Total	
BS-12T	Genomics	Theory	3	3	40	60	100	3
BS-12P	Genomics	Practical	4	4	25	25	50	2
BS-13T	Enzymology	Theory	3	3	40	60	100	3
BS-14T	Bioethics and Biosafety	Theory	3	3	40	60	100	3
BSDS-03T	Toxicology	Theory	3	3	40	60	100	3
	Research Project*							6
Award of Bachelor of Science Honours Degree in Biological Sciences (184 Credits) of Continue with Major for M.Sc. Degree						**Total Credits**		**20**

*** In lieu of the Research Project, two additional elective papers /internship may be offered**

Job opportunities for Students after completion B.Sc. (Hons.) degree in Biological Sciences

- The B.Sc. (Hons.) degree awarded after successful completion of VIII semesters provides students with advanced skills in laboratory techniques with specialization in 'Immunological techniques' and 'Seri-Biotechnology' as vocational skill. In addition, 'Research Project' is expected to provide advanced hands-on training.
  - ✓ Quality Analyst (QA) in Pharma Companies/Labs
  - ✓ Research Assistant/Staff
  - ✓ R&D Lab Assistant
  - ✓ NGOs/Consultancy firms
  - ✓ Teachers in Schools/PUC Colleges
  - ✓ Content Developer for EdTech Companies like Byjus
  - ✓ Higher Education/pursuing Masters at IITs/IISERs/IISc/NCBS

IX - SEMESTER								
Code	Subjects	Paper Theory/ Practical	Instruction Hrs/week	Duration of Exam (Hrs)	Marks			Credits
					IA	Exam	Total	
BS-15T	Proteomics and Metabolomics	Theory	3	3	40	60	100	4
BS-15P	Proteomics and Metabolomics	Practical	4	4	25	25	50	2
BS-16T	Cancer Biology	Theory	3	3	40	60	100	4
BS-16P	Cancer Biology	Practical	4	4	25	25	50	2
BS-17T	Computational Biology	Theory	3	3	40	60	100	4
BSDS-04T	Science Communication	Theory	3	3	40	60	100	4
BSDS-05T	Genetic Counselling	Theory	3	3	40	60	100	4
							Total Credits	**24**

X - SEMESTER								
Code	Subjects	Paper Theory/ Practical	Instruction Hrs/week	Duration of Exam (Hrs)	Marks			Credits
					IA	Exam	Total	
BS-18	Major Research Project	Theory/ Practical			150	450	600	24
Award of Master Degree of Science in Biological Sciences (232 Credits)						**Total Credits**		**24**

Job opportunities for Students after completion of five years integrated M.Sc. degree in biological Sciences

- The IX and X semester for M.Sc. degree provide in depth knowledge of advanced inter disciplinary fields with subjects covering state of art translational research to help students develop the ability to not only successfully continue with further studies and research in the field of Biological Sciences and allied subjects but also contribute to Life Science Industries and Start-Ups.
- The course ensures that students are equipped with required skills that caters to the broad areas of Life Sciences i.e., Healthcare (Med Tech& Pharma/Biopharma), Agriculture, Food/ Nutrition, Industrial Biotechnology and Environmental Biotechnology.
- Subjects like 'Science Communication' introduced under NEP2020 provide students opportunity to work in the areas of Science Journalism/ Content Developer.
  - ✓ Assistants in Central and State Silk Board /Pollution Control Boards
  - ✓ Basic and Advanced Diagnostic Laboratories like SRL, Religare, Thyrocare etc.
  - ✓ IVF- Centers
  - ✓ Life Science wing of MNCs like Accenture/Infosys/TCS/Molecular Connections/Biocon/Syngene etc. that form the base of Bangalore city
  - ✓ Clinical Data Analyst/Scientist
  - ✓ Assistants in Contract Research Organization (CROs)
  - ✓ Science Journalism
  - ✓ Content Developer for Ed Tech Companies like Byjus

- ✓ Quality Analyst (QA) in Pharma Companies/Labs
- ✓ Research Assistant/Staff
- ✓ R&D Lab Assistant
- ✓ NGOs/Consultancy firms
- ✓ Teachers in PUC and degree colleges across Bangalore
- ✓ Coaching Institutes for Medical entrance exams like Akash/FIITJEE etc.
- ✓ Self-employment/ Bio-Entrepreneurship
- ✓ Higher Education/pursuing Ph.D. Degree at esteemed Institutes like NCBS / NIMHANS / CCMB / CDFD / IISERs etc.

I SEMESTER - BIOLOGICAL SCIENCES
Core Course Content

Course Title/Code: **PLANT SYSTEMATICS**	Course Credits: **4**
Course Code: **BS-01T**	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.

I SEMESTER - BIOLOGICAL SCIENCES

BS-01T: PLANT SYSTEMATICS

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

Aim and Objectives: ✓ To enable students to understand and appreciate relevance of Microbes and Plants to environment and human well-being ✓ To gain knowledge of diversity, life forms, life cycles, morphology and importance of microorganisms ✓ To provide the students with an opportunity to develop basic knowledge in non-vascular plants. ✓ To create an understanding by observation and table study of representative members of phylogenetically important groups to make students learn the process of plant evolution in a broad sense. ✓ Study of morphology, anatomy, reproduction and developmental changes therein through typological study should create a knowledge base in understanding plant diversity and economic values ✓ To understand the basic concept of binomial nomenclature ✓ To gain knowledge on taxonomy and phylogeny of flowering plants	
Unit I	**14 hrs**
Microbes: • **Viruses:** General characteristics, DNA virus (T4 bacteriophage), RNA virus (TMV), Lytic and Lysogenic cycles, Viroids and Prions. • **Bacteria:** General characteristics and classification of bacteria, Cell structure, Reproduction and Genetic recombination in bacteria, Economic importance of bacteria. • **Cyanobacteria:** General characteristics, morphology, structure, reproduction and economic importance. • **Mycoplasma:** General characteristics and economic importance. • **Fungi:** General characteristics and classification. Morphology, cell structure and reproduction in *Rhizopus*, *Aspergillus*, *Agaricus* and *Cercospora*, economic importance. Mycorrhiza.	
Unit II	**14 hrs**
Algae and Byrophytes: • **Algae:** General characteristics, morphology, structure and reproduction of Chlorophyceae (*Spirogyra*), Charophyceae (*Chara*), Bacillariophyceae (*Diatoms*), Phaeophyceae (*Ectocarpus*), Rhodophyceae (*Polysiphonia*) and Xanthophyceae (*Botrydium*). Economic importance of algae. • **Bryophytes:** General characteristics, morphology, anatomy and reproduction in Marchantiaceae (*Marchantia*), Anthocerataceae (*Anthoceros*), Sphagnaceae (*Sphagnum*), Mosses (*Funaria*), Porellaceae (*Porella*). Economic importance of bryophytes.	
Unit III	**14 hrs**
Pteridophytes and Gymnosperms: • **Pteridophytes:** General characteristics and classification. Morphology, anatomy and reproduction in Lycopodiaceae (*Lycopodium*), Selaginellaceae (*Selaginella*), Equisetaceae	

(*Equisetum*), Polypodiaceae (*Pteris*) and Marsileaceae (*Marsilea*). • A brief account on stellar evolution, heterospory and seed habit. Economic importance of Pteridophytes. • **Gymnosperms:** General characteristics and classification. Morphology, anatomy and reproduction in Cycadaceae (*Zamia*), Pinaceae (*Pinus*), Ginkgoaceae (*Ginkgo*), Taxaceae (*Taxus*) and Gnetaceae (*Gnetum*). • Economic importance of Gymnosperms.	
Unit IV	**14 hrs**
Angiosperms • **Botanical Nomenclature:** Principles of nomenclature and a brief account of ICBN. Monographs and role of computer in taxonomy • **Systematics:** Bentham and Hooker's system of classification, Engler and Prantl's system of classification, Cronquist's system of classification and APG IV system. • Salient features and economic importance of • **Monocots:** Arecaceae, Cannaceae, Poaceae, Liliaceae, Musaceae, Orchidaceae and Zingiberaceae. • **Dicots:** Asteraceae, Asclepiadaceae, Brassicaceae, Cucurbitaceae, Fabaceae, Malvaceae, Magnoliaceae, Rubiaceae and Solanaceae. • **Herbarium**: Wet and dry herbaria, maintenance and importance of herbaria. • **Botanical Gardens**: Importance of botanical gardens.	

Suggested Readings:

Non-Vascular Plants

1. Alexopoulus C.J. & Mims C.W. 1990. Introductory mycology, 5th edn Wiley Eastern Limited, New Delhi.
2. Bhatia, K.N. 1984. A treatise on Algae. S. Chand and Company, New Delhi.
3. Bold, H.C. and Wyhne, M.J. 1978. Introduction to Algae: Structure and reproduction. Prentice Hall, Engle Wood Cliffs, New Jersey.
4. Chopra, R.N & Kumar, P.K. 1988. Biology of Bryophytes. New Age International Publisher, New Delhi.
5. Contract, F. H., Kimball, P.C. and Jay, L. 1998. Virology. Prentice Hall, Englewood Cliff, New Jersey.
6. Fritsch, F.E. 1961. Structure and reproduction in algae, Vol. I, II. Cambridge University Press, London.
7. Fritsch, F.E. 1961. Structure and Reproduction in Algae. Vol. I and II. Cambridge University Press. Cambridge, U.K.
8. Kumar, H.D. 1999. Introductory Phycology (2nd edition). Affiliated East West Pvt. Ltd. Bangalore.
9. Pandey, B.P. 1994. Fungi. S. Chand and Company Ltd, New Delhi.
10. Sethi, I.K. and Walia, S.K. 2011. Text book of Fungi and Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
11. Parihar, N.S. 1970. An Introduction to Embryophyta, Vol. I Bryophyta. Central Book. Dept. Allahabad, India.
12. Tortora, G.J., Funke, B.R., Case, C.L. 2010. Microbiology: An Introduction (10th edition). Pearson Benjamin Cummings, U.S.A.

Pteridophytes and Gymnosperms

1. Andrew. H.N. 1961. Studies in Paleobotany. John Wiley, New York.
2. Bhatnagar and Moitra. A. 1996. Gymnosperms. Poplei. New Age International Ltd. New Delhi. fossilization, fossilization,
3. Bower F.O. 1884. On the comparative morphology of the vascular cryptogams and gymnosperm. Phil. Trans. Roy. Society. London.

4. Chamberlain. C.J. 1986. Gymnosperms, structure and evolution. CBS Publications, New Delhi.
5. Chopra. G.L and Verma. V. 1988. Gymnosperm. Pradeep Publications, Jalandar, India
6. Eames A.J. 1936. Morphology of vascular plants (lower groups). Mc. Graw Hill Publications, NewYork
7. Parihar. N.S. 1977. The morphology of Pteridophytes, Central book Dept, Allahabad, India.
8. Singh, Pande and Jain. 2018. A Textbook of Botany (6th Revised Edition). S. Chand Publications, Meerut.

Angiosperms

1. Cronquist. A. 1981. An integrated system of classification of flowering plants. Columbia University Press, New York.
2. Davis. P.H. and Heywood. V.H. 1973. Principles of Angiosperm taxonomy, Robert and E. Kriegen Publications, New York.
3. Heywood. V.H and Moore. D.M. 1984. Current concept in plant taxonomy, Academic Press, London.
4. Lawrence. G.H.M. 1951. Taxonomy of vascular plants, Mac Milan, New York.

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**

I SEMESTER - BIOLOGICAL SCIENCES
Core Course Content

Course Title/Code: **PLANT SYSTEMATICS**	Course Credits: **2**
Course Code: **BS-01P**	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: 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.

I SEMESTER - BIOLOGICAL SCIENCES

BS-01P: PLANT SYSTEMATICS

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

PRACTICALS	
Systematics of Non-Vascular Plants	**28 hrs**
• **Algae (Microalgae and Macroalgae):** Study of morphology and micro-preparation of the following specimens: Cyanophyceae: *Oscillatoria*, *Nostoc* Chlorophyceae: *Hydrodictyon*, *Spirogyra*, Charophyceae: *Chara*, Xanthophyceae: *Botrydium*, Phaeophyceae: *Sargassum*, Rhodophyceae: *Polysiphonia* • **Fungi:** Study of morphology and micro-preparation of the following specimens: *Phytophthora*, *Rhizopus*, *Penicillium*, *Puccinia* and *Cercospora*. • **Bryophyta:** Study of morphology and anatomy of vegetative and reproductive structures of *Marchantia*, *Porella*, *Anthoceros*, *Sphagnum* and *Funaria*. • Gram- staining of bacteria. • Study of viruses and bacteria using electron photo micrographs (TMV, Bacteriophage, HIV, Cocci, Bacillus, Spirillum bacteria). • Measurement of microscopic structures. • Field visits to study and to collect non-vascular plants.	
Systematics of Vascular Plants	**28 hrs**
1. **Pteridophytes:** Study of morphology, anatomy of vegetative and reproductive structures of *Psilotum*, *Selaginella*, *Lycopodium*, *Equisetum*, *Ophioglossum*, *Osmunda*, *Pteris*, *Marsilia* and fossil pteridophytes subjected to the availability of materials / slides. 2. **Gymnosperms:** Study of morphology, anatomy of vegetative and reproductive structures of *Zamia*, *Pinus*, *Podocarpus*, *Ephedra*, *Gnetum* and fossil Gymnosperms subjected to the availability of materials/slides. 3. **Angiosperms:** Herbarium preparation, Description of a taxon using technical terms. Derivation of a taxon to respective family using Floras. 4. Study of local flora and field visits to various Botanical gardens to study the vegetation.	

Pedagogy:

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

I SEMESTER - BIOLOGICAL SCIENCES
Course Content

Course Title/Code: **BIOMOLECULES**	Course Credits: **4**
Course Code: **BSM-01T**	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.

I SEMESTER - BIOLOGICAL SCIENCES

BSM-01T: BIOMOLECULES

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

Aims and objectives: ✓ To introduce the students to the different types of biomolecules ✓ To familiarise the students with the structures of the basic building blocks biomolecules ✓ To lay the foundation for a better understanding of metabolism	
Unit I	**14 hrs**
Carbohydrates • Nomenclature, classification and properties of sugars • Monosaccharides: Glucose, fructose; ascending and descending monosaccharide series • Derived monosaccharides: structure and biological importance of amino sugars, sugar phosphates, sugaracids and deoxy-sugars. • Disaccharides: glycosidic linkage. Structure and biological importance of sucrose, maltose, lactose, isomaltose, cellobiose and trehalose. Unusual sugars: inositol and muramic acid.Metabolic functions of carbohydrates: Fuel molecules (glucose, fructose etc.); Storage polysaccharides (starch and glycogen); Structural polysaccharides (cellulose, chitin, pectin, glycosaminoglycans);Cell wall components (peptidoglycan and teichoic acid).	
Unit II	**14 hrs**
Lipid • Nomenclature, classification and properties of lipids • Fatty acids; classification based on structure and properties. • Acyl glycerols: Hydrolysis, rancidity, acid, saponification and iodine values. • Phosphoglycerides: structures and biological roles • Sphingolipids: phosphosphingolipids – sphingomyelins; glycosphingolipids - gangliosides and cerebrosides. • Prostaglandins; An overview of biological roles, structure of PGE2 and PGF2a. • Sterols: Basic ring system (ergosterol, cholesterol, sitosterol, campesterol) • Steroids: Testosterone and estradiol • Waxes of biological importance • Metabolic functions of fatty acids, lipids, sterols and steroids.	
Unit III	**14 hrs**
Amino acids, Proteins and Nucleic acids • Nomenclature, classification and properties of amino acids • Protein and non-protein amino acids • Unusual amino acids – selenocysteine and pyrrollysine • Metabolic functions of amino acids: Importance of amino acid neurotransmitters • Peptides: Important features of the peptide bond. Biologically important peptides (glutathione, peptide hormones, antimicrobial peptides) • Proteins: Classification based on composition, shape and function, color reaction. Structural	

organization – primary, secondary, tertiary and quaternary structures. • Native structure and denaturation. • Glycoproteins • Lipoproteins (HDL, LDL and VLDL)	
Unit IV	**14 hrs**
Nucleic Acids • Nomenclature and classification of nucleic acids, Dinucleotides and the phosphodiester bond, Polynucleotides: DNA and RNA types, structure and functions. Metabolic function of nucleotides: Importance of ATP as a currency of energy, GTP in signalling, CTP and UDP as activators	

Suggested readings:

1. Bhutani SP. 2019. Chemistry of Biomolecules. 2nd edition, CRC press.
2. Armugam N. 2016. Biomolecules.Saras Publications, India.
3. Ahluwalia VK. 2017. Biomolecules: Chemistry of living systems. Manakin Publications, India.
4. Lehninger AL. 2013 Principles of Biochemistry. 6th edition. 2013. WHFreeman & Co, USA.
5. Berg, J, Stryer L, Tymoczko J, Gatto G. 2019. Biochemistry. 9thedition. WH Freeman & Co, USA

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**

I SEMESTER - BIOLOGICAL SCIENCES
Course Content

Course Title/Code: **BIOMOLECULES**	Course Credits: **2**
Course Code: **BSM-01P**	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: 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.

I SEMESTER - BIOLOGICAL SCIENCES

BSM-01P: BIOMOLECULES

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

PRACTICAL	
• Systematic qualitative analysis of hexoses/pentoses & aldoses/ketoses • Estimation of glucose using 3, 5- dinitrosalicylic acid (DNS reagent) • Estimation of fructose using resorcinol method • Determination of iodine value of common oils • Determination of saponification value of common oils • Estimation of cholesterol by Zak's method • Solubility test for amino acids to study their hydrophobicity/hydrophilicity • Tests for aromatic amino acids: Millon's test for tyrosine; Hopkin's-Cole test for tryptophan • Sakaguchi test for arginine • Lead sulfide test for cysteine • Protein estimation by Bradford method • Colorimetric estimation of DNA by diphenylamine method • Colorimetric estimation of RNA by orcinol method	

Pedagogy:

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

I SEMESTER - BIOLOGICAL SCIENCES
Course Content

Course Title/Code: **BIODIVERSITY AND CONSERVATION**	Course Credits: **3**
Course Code: **BSOE-01T**	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.

I SEMESTER - BIOLOGICAL SCIENCE

BSOE-01T: BIODIVERSITY AND CONSERVATION (Open Elective)

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

Aim and Objectives: ✓ To understand the concept of biodiversity. ✓ To understand the diversity of species. ✓ To comprehend the threats to biodiversity. ✓ To assess the causes of extinction ✓ To study conservation strategies.	
Unit I	**14 hrs**
Concept of Biodiversity: • Introduction to biodiversity • Levels of biodiversity: genetic diversity, species diversity, ecosystem/community diversity. • Measurement of biodiversity: species richness - alpha, beta, and gamma diversity. • Factors promoting high diversity. • Latitudinal and altitudinal gradients of biodiversity • Species evenness biodiversity and food web • Biodiversity values: economic, social, cultural, aesthetic, intrinsic and option values. • Biogeographical classification of India.	
Unit II	**14 hrs**
Threats to Biodiversity: • Habitat destruction, fragmentation, transformation, degradation and loss: causes, patterns and consequences on the biodiversity, • Impacts of water pollution and air pollution on biodiversity. • Climate change and biodiversity, • Threats to biodiversity: habitat loss, poaching of wildlife, human-wildlife conflicts (Elephant, Tiger and Leopard). • Biopiracy, Red Data Book and its significance, IUCN. • Endemic, threatened and endangered species. • Causes and factors of mass extinctions.	
Unit III	**14 hrs**
Conservation Biology: • Principles of conservation. • In-situ conservation - biodiversity hot spots, bioreserves, national parks and wildlife sanctuaries. • Ex-situ conservation - zoos and their significance, modern methods of ex-situ conservation. • Cryopreservation: fundamentals, applications in agriculture and horticulture • *In-vitro* conservation: germplasm or gene bank, tissue culture. • Global and indigenous approaches to biodiversity conservation: Indian case studies on conservation/management strategy (project Tiger, Biosphere reserves);	

Biological Diversity Act in India. • Intellectual property rights and gene patenting. • Ethics of conservation of natural resources, conservation of rare species, long lived species, keystone species and mutualistic species.	

Suggested Readings:

1. Asish Ghosh. 2007, Biodiversity Conservation. APH Publishing Corporation, NewDelhi.
2. Avise J.C., Hubbel S.P., Ayala F.J. 2008. In the Light of Evolution II: Biodiversity and Extinction. Proc Natl Acad Sci, USA. 105:11453.
3. Gaston, K.J and Spicer, J.I. 2004. Biodiversity: An Introduction. BlackwellPublishing Company, USA.
4. Heywood, V.H. 1995. Global Biodiversity, Published for UN EnvironmentalProgramme, Cambridge University Press.
5. Kasthuri Reddy. 2010. Biodiversity and Land Conservation. Pacific Publication,New Delhi.
6. Maiti P.K. and Maiti P. 2011. Biodiversity Perception, Peril and Preservation. PHILearning Private Limited, New Delhi.
7. Negi, S.S. 2002. Handbook of National Parks, Wildlife Sanctuaries and Biosphererereserves in India. Indus Publ., New Delhi.
8. Richard. B. Primack. 1998. Essentials of conservation biology. Sinauer AssociatesInc., USA
9. Stanley, A.H., 2002. Managing our Wildlife Resources, Prentice-Hall, USA.

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**

I SEMESTER - BIOLOGICAL SCIENCES
Course Content

Course Title/Code: **BIOINSTRUMENTATION**	Course Credits: **2**
Course Code: **BSSE-01T**	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.

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.

I SEMESTER - BIOLOGICAL SCIENCES

BSSE-01T: BIOINSTRUMENTATION (Skill Based)

No. of Credits: 2 **No. of hours: 14**

Aim and Objectives: ✓ To familiarise the students about instruments used in biological laboratory ✓ To understand the principle and mechanism of bio-instruments and their applications	
Unit I	**14 hrs**
Bioinstrumentation Instruments: • pH meter and its applications • **Centrifugation:** Principle of sedimentation, centrifugation; General applications of centrifugation, Ultracentrifugation, analytical centrifugation, Density gradient centrifugation • **Electrophoresis:** General principle; Agarose gel electrophoresis; PAGE (Native and SDS); Isoelectric focusing • **Chromatography:** Principle and types; Ion exchange, Molecular exclusion, Affinity chromatography, HPLC, GC • **Spectrophotometry:** Theory and applications of UV-VIS, IR-Raman, Fluorescence, Atomic force, NMR • **PCR:** Types of PCR	

Suggested Readings:

1. Biomolecular crystallography: Principles, practice and application to structuralbiology by B. Rupp. 1st edition. Garland Science (2009).
2. Biophysical chemistry, Part 2: Techniques by C. R. Cantor, P. R. Schimmel. 1st edition. W.H Freeman and Co. (2008).
3. Fundamentals of Molecular Spectroscopy by Colin Banwell. 4th edition. McGrawHill (1994).
4. Harrison, R.G., Todd, P., Rudge, S.R. and Petrides, B.B. Bioseparations: Science and Engineering, Oxford University Press (2006).
5. McHale, J.L., Molecular Spectroscopy, Prentice Hall (1998). 4.Marimuthu, R., Microscopy and Microtechniques. MJP Publishers (2008).
6. Molecular Fluorescence: principles and Applications by B. Valeur. 2nd edition.Wiley (2013).
7. NMR – Conformation of Biological Molecules by G. Govil and R.V. Hosur. 1stedition. Springer-Verlag (2011).
8. NMR of proteins and nucleic Acids by K. Wuthrich. 1st edition. Wiley IntersciencePublications (1988).
9. Optical methods in Biology by E.M. Slayter. 1st edition. John Wiley (1970).
10. Principles of Fluorescence Spectroscopy by J. Lakowicz and R. Joseph. 2ndedition. Springer (1999).
11. Wilson K and Walker J., Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press (2005).

I SEMESTER - BIOLOGICAL SCIENCES
Course Content

Course Title/Code: **BIOINSTRUMENTATION**	Course Credits: **2**
Course Code: **BSSE-01P**	L-T-P per week: 0-0-4
Total Contact Hours: **28**	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.

I SEMESTER - BIOLOGICAL SCIENCES

BSSE-01P: BIOINSTRUMENTATION (Skill Based)

No. of Credits: 2 **No. of hours: 28**

PRACTICALS	
Bioinstrumentation	
• Accuracy and precision of pipettes • Calibration of pH meter • Buffer preparation • Dilution techniques • Preparation of hypertonic, isotonic and hypotonic solutions • Centrifugation: Density gradient • Spectroscopy: Absorption spectra of proteins and Nucleic acids • Verification of Beer Lambert law • Determination of concentration of nucleic acids • Agarose gel electrophoresis • SDS PAGE • Paper Chromatograph • Thin layer chromatography	

Pedagogy:

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

II SEMESTER - BIOLOGICAL SCIENCES
Core Course Content

Course Title/Code: **ANIMAL SYSTEMATICS**	Course Credits: **4**
Course Code: **BS-02T**	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.

II - SEMESTER BIOLOGICAL SCIENCES
BS-02T: ANIMAL SYSTEMATICS

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

Aim and Objectives: ✓ To understand the basis for classification of lower to higher Non-Chordates and Chordates. ✓ To interpret and understand the fundamental principles of invertebrate and vertebrate classification. ✓ To provide the students with an opportunity to develop basic knowledge about the life cycle of invertebrates across different phyla. ✓ To comprehend the evolutionary trends in vertebrate structures and functions. ✓ To understand various adaptations in mammals making them the most evolved class in Animal Kingdom.	
Unit I	**14 hrs**
Systematics of Lower Invertebrates • **Introduction to Animal Systematics:** Nomenclature, Principles of Classification. • General characteristics and Classification (upto Order) of Phylum Protozoa, Porifera, Coelenterata, Ctenophora, Platyhelminthes and Aschelminthes with suitable examples. • Life cycle of *Plasmodium, Trypanosoma, Obelia, Fasciola hepatica, Taenia solium, Ascaris lumbricoide*s.	
Unit II	**14 hrs**
Systematics of Higher Invertebrates • General characteristics and Classification (upto Order) of Phylum Annelida, Arthropoda, Mollusca and Echinodermata with suitable examples. • Life cycle of Leech, Cockroach, Fresh water mussel and Star fish.	
Unit III	**14 hrs**
Classification of Chordates • Origin of Phylum Chordata. • Systematic position and general characteristics of Subphylum Hemichordata, Urochordata and Cephalochordata with suitable examples. • Systematic position and general characteristics of Subphylum Vertebrata. • General characteristics and classification of Pisces, Amphibia, Reptilia, Aves and Mammalia (up to Orders) with suitable examples.	
Unit IV	**14 hrs**
Comparative Vertebrate Anatomy • Comparative account of Dogfish, Frog, Lizard, Pigeon and Rabbit: **Digestive system** (parts of alimentary canal, digestive glands.) **Respiratory system** (Respiratory organs, Mechanism of respiration, Accessory respiratory organs.) **Circulatory system** (Parts of circulatory system, Evolution of heart in vertebrates) Adaptations in Mammals with suitable examples.	

Suggested Readings:

Non-Chordates:

1. Barnes, R.D.1974. Invertebrate Zoology, 3rd ed., W.B. Saunders Co., Philadelphia.
2. Barrington, E.J.W. 1976. Invertebrate Structure and Function, 1st ed.,Thomas Nelson and Sons Ltd., London.
3. Jorden, E. L. and Verma, P.S. 2009. Invertebrate Zoology, S. Chand Publishers, New Delhi.
4. Richard, C. Brusca & Gary, J. Brusca, 2016. Invertebrates, 3rd Ed., Sinauer Associates. Inc., Publishers, USA.
5. Kotpal, R.L. 2019. Invertebrates, 12th ed., Rastogi Publications, Uttar Pradesh.

Chordates:

1. Jorden, E. L. and Verma, P.S. 2013. Chordate zoology, S. Chand Publishers, New Delhi.
2. Kotpal, R.L. 2019. Vertebrates, 5 th Ed., Rasthogi Publications, Uttar Pradesh.
3. Kisia S. M. 2010. Vertebrates, 1 st Ed., CRC Press, USA.
4. Prosser CL. 1973. Comparative Animal Physiology. WB Saunders and Company.
5. William James Marler, P R; Hamilton. 1966. Mechanisms of Animal Behaviour. John Wiley & Sons, New York.

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**

II SEMESTER - BIOLOGICAL SCIENCES
Core Course Content

Course Title/Code: **ANIMAL SYSTEMATICS**	Course Credits: **2**
Course Code: **BS-02P**	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: 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.

II SEMESTER - BIOLOGICAL SCIENCE

BS-02P: ANIMAL SYSTEMATICS

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

PRACTICALS	
Systematics of Non-Chordates	**28 hrs**
• Study of museum specimen of lower invertebrates: **Protozoa** - *Paramoecium*, *Vorticella*, *Plasmodium*, *Euglena*, *Trypanosoma*, *Noctiluca*, *Entamoeba*, *Amoeba*. **Porifer**a - *Leucosolenia*, *Gemmule*, *Euspongia* (Bath sponge), *Euplectella* (Venus flower basket), *Hyalonema* (glass rope sponge)**.** **Coelentarata** - *Obelia*, *Aurelia*, Sea anemone, *Physalia*, *Velella*, *Porpita*, Corals [*Fungia*, *Astrea*, *Gorgonia*, *Meandrina* (Brain coral), *Penantula* (Sea pen)]. **Platyhelminthes** - Liver fluke, Tape worm, *Planaria*, *Schistosoma* (Blood worm). **Aschelminthes** - *Ascaris*, *Ancylostoma* (Hook worm), Filarial worm. • Study of museum specimen of higher invertebrates: **Annelida** - Earth worm, Nereis, Aphrodite, Leech, Sabella, Tubifex, Arenicola. **Arthropoda** - Lepas, Balanus, Centipede, Millipede, Scorpion, *Peripatus*, *Limulus*, Prawn, Crab, Lobster, Grasshopper. **Mollusca** - Sepia, Octopus, Chiton, Patella, Dentalium, Fresh water mussel, *Pila globosa* (snail), *Nautilus*, *Murex*, *Xancus*, *Cypraea*. **Echinodermata** - Sea urchin, Starfish, Sea cucumber, Brittle star, Sea lily. • Demonstration of dissection of: **Cockroach**- Digestive and Nervous system. **Silk moth**- Reproductive system • Mounting and display of mouth parts of cockroach. • Setae mounting in Earth worm. • Field visits to museums, butterfly parks and natural habitats of invertebrates.	
Systematics of Chordates	**28 hrs**
• Study of Museum Specimen of lower vertebrates- • **Pisces** - *Scoliodon*, Eel, *Tetradon*, *Macropodus*, *Ophiocephalus*, *Narcine*, *Protopterus*, *Stegostoma*, *Notopterus* • **Amphibia** -Salamander, *Ichthyophis*, Axolotl larva • Study of Museum Specimen of higher vertebrates – **Reptilia** - *Calotes*, *Mabuya*, *Phrynosoma*, *Draco*, *Varanus*, *Chamaeleon*, *Naja naja*, *Viper*, *Sphenodon* **Aves**- Ostrich, Archaeopteryx, Owl, **Mammalia** - Bat, Loris, Pangolin, Porcupine. • Demonstration of Dissection – **Scoliodon** - Mounting of Placoid scale, Ampulla of Lorenzini and Arterial system **Rat**- Male and Female Reproductive system. • Identification of skull of chordates - Frog, *Varanus*, Fowl, Rabbit and Human	

Pedagogy:

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

II SEMESTER - BIOLOGICAL SCIENCES
Course Content

Course Title/Code: **CELL BIOLOGY**	Course Credits: **4**
Course Code: **BSM-02T**	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.

II SEMESTER - BIOLOGICAL SCIENCES

BSM-02T: CELL BIOLOGY

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

Aims and objectives: ✓ To appreciate the cell as a basic unit of life and learn the structure and functions of various cell organelles. ✓ To understand various cellular processes like transport, signaling, movement, division, ageing and death.	
Unit I	**14 hrs**
Introduction to the Cell: ● **The origin and evolution of the cell:** molecules to first cell, prokaryotes to eukaryotes, single cell to multicellular organisms. **Organization of cell:** ● **Intracellular organelles:** The nucleus, mitochondria, lysosomes, peroxisomes, golgi apparatus, plastids, vacuoles and endoplasmic reticulum. ● **Cell membrane:** ● Structure of model membrane, the lipid bilayer, membrane proteins, membrane carbohydrates. **Transport of molecule:** ● **Membrane transport of small molecules:** gap junctions, ATP powered pump, symporters, antiporters, ion channels, non-gated ion channels and resting potential, voltage gated ion channel and action potential. ● **Movement of water:** Osmosis, tonicity, hydrostatic pressure and aquaporins. ● **Membrane transport of macromolecules:** Electrical properties of membrane, endocytosis, exocytosis, transport of molecules between the nucleus and cytosol.	
Unit II	**14 hrs**
Cell Signaling and Communication: ● **General principles of cell signaling:** Autocrine, juxtacrine, paracrine, synaptic, endocrine, Signalling molecules. ● **Cell surface receptors:** G-protein coupled cell surface receptors and small intracellular mediators, enzyme coupled cell surface receptors. **The cytoskeleton and cell movement:** ● **Components of cytoskeleton:** Actin, myosin, intermediate filaments, ● **Cell movement:** Intracellular movement and change in cell shape, locomotion of cell, microtubules, motor proteins, kinesin and dynein powered movements, cilia and centrioles.	

Unit III	14 hrs
Cell division and Cell Cycle: ● **Mitosis:** phases of the cell cycle, components of cell cycle control systems, cell cycle checkpoints, G_1/ S cyclins, S- cyclins, M- cyclins, DNA damage check points, cell cycle checkpoint inhibitors ● **Meiosis:** a special type of cell division. **Cell senescence and cell death:** ● **Cellular ageing:** telomere regulation, proteostasis, mitophagy and oxidative stress, antioxidant defence mechanism of the cells. ● **Cell death:** Apoptosis- intrinsic and extrinsic apoptotic pathways, necrosis, necroptosis and autophagy.	
Unit IV	**14 hrs**
Stem cells and Cancer cells: ● **Stem cells:** Tissue maintenance and renewal, Properties of stem cells, classification of stem cells (embryonic vs adult), stem cell niche and its role in stem cell renewal and differentiation. ● **Cancer:** Cancer as a micro evolutionary process -different types of cancer, origin of cancerous cell, development of cancer, angiogenesis, invasion, metastasis, cancer stem cells and significance in tumorigenesis. ●	

Suggested readings:

1. Albert B., Johnson A., Lewis J., Raff M., Roberts K. and Walter P. 2014. Molecular biology of the cell. Garland Sciences, 6th edition.
2. Cooper G. 2018. The Cell: A molecular approach. Sinauer Associates Inc, 8th edition.
3. De Roberts E. D. P. and De Roberts E. M. F. 2010. Cell and Molecular Biology. Walters Kluwer, 8th edition.
4. Karp G., Iwasa J. and Marshall W. 2018. Cell Biology. Wiley publication., 8th edition.
5. Lodish H., Berk A., Zipursky S. L., Matsudaira P., Baltimore D. and Darnell J. 2000. Molecular cell biology. Freeman Press, 4th edition.
6. Pollard. T. D. and Earnshaw, W.C. 2002. Cell Biology. Saunders, 3rd edition.

Learning outcomes:

- Visualisation of cell as the basic unit of life.
- Understand the structure and function of various cellular organelles and its significance
- Have a better understanding on how cellular components work together to carry out life functions.
- Acquire a better understating on how cellular processes enable organism to meet their basic needs.

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**

II SEMESTER - BIOLOGICAL SCIENCES
Course Content

Course Title/Code: **CELL BIOLOGY**	Course Credits: **2**
Course Code: **BSM-02P**	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.

II SEMESTER - BIOLOGICAL SCIENCES

BSM-02P: CELL BIOLOGY

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

PRACTICAL	
• Study of Barr body using buccal smear of volunteers • Identification of blood groups • Vital staining of mitochondria • Counting of red blood cells, white blood cells and yeast cells using haemocytometer • Measurement of the size of cells using micrometry • Squash preparation of onion root tip for the study of mitosis stages • Squash preparation of onion flower buds for the study of meiosis stages • Squash preparation of grasshopper testis for the study of meiosis stages • Trypan blue exclusion test for cell viability • Study on osmotic behaviour of red blood cells • Experiment to study the photoelectric effect	

Pedagogy:

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

II SEMESTER - BIOLOGICAL SCIENCES
Course Content

Course Title/Code: **BIOPHYSICS**	Course Credits: **3**
Course Code: **BSOE-02T**	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.

II SEMESTER - BIOLOGICAL SCIENCE

BSOE-02T: BIOPHYSICS (Open Elective)

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

Aims and Objectives: ✓ To understand the physical and chemical interaction between molecules ✓ Students to learn many relevant applications of fundamental physics to biological science and medicine.	
Unit I	**14 hrs**
Fundamentals of Biophysics: • **Matter and energy:** Photo electric effect, quantum theory of light, de Broglie wave equation, wave function, atomic models, Bohr's atomic energy levels. • **Biomolecular interactions:** Water-properties and interactions of water, association of macromolecules, supramolecular interactions, protein-protein interactions, protein nucleic acid interactions, lipid/membrane-protein interactions • **Thermodynamics:** Laws of Thermodynamics, Gibbs free energy, Entropy and enthalpy and its relationship, Relation between standard free energy change and equilibrium constant, Redox reactions and a brief account on photo and chemo-bioenergetics.	
Unit II	**14 hrs**
• **Protein structure analysis:** Alpha helix and Beta sheet structure of proteins (fibroin structure), conformation of protein – Ramachadran plot, Tertiary conformation • **Protein thermodynamics:** Free energy and entropic forces, solvent interactions and solvent entropy, polypeptide chains in water, the folding process, folding pathways, simulations and predictions, experimental studies on folding, Excitement and relaxation of protein structure, equilibrium fluctuations, kinetics of proteins, proteins as complex systems. • **Spectroscopy:** Instrumentation and application of UV - visible spectrophotometer, fluorescence spectroscopy, NMR, Mass spectroscopy, IR, Raman. X-ray diffraction in determining molecular structure of proteins.	
Unit III	**14 hrs**
• **Radiation biophysics:** Special characteristics of atmosphere long wave and short wave radiation, radiation fluxes in natural environment, the ultraviolet region absorption and scattering, alpha, beta, gamma and x-radiation, cosmic radiation, absorption of electromagnetic radiation and interaction with matter, comparison of different ionizing radiations, radiation as environmental pollutant, radioisotopes, detection and measurement of radiation, effect of radiation at cellular levels-structural and functional changes, interaction with biological macromolecules, interaction of carcinogens/anti-cancer agents with DNA, RNA and nucleoproteins.	

• **Biological effects of light:** Importance of Light, Radiant energy, Light interaction with biological materials, Effect on growth patterns in plants-Phytochrome system, Photochemical mechanism, Phototrophism, Photoperiodism, Solarization, Photodynamic action, UV light on living system,Photoreactivation, Lethal effects on animals and plants.	

Suggested Readings:

1. Ackerman, E. 1967. Biophysical Sciences. Prentice Hall, NY.
2. Cantor R. and Schimmel P.R, W.H. Freeman. Biophysical chemistry
3. Casey, E.J. 1969. Biophysics, Concept and Mechanics. Affiliated East West Press.
4. David Freifelder, W H Freeman and company. Physical Biochemistry
5. Narayan, P. 2000. Essentials of Biophysics. New Age Int. Pub. New Delhi.
6. Roy, R. N. 2007.A Text book of Biophysics. New Central Book Agency (P) Ltd.
7. Stanford, A.L. Academic Press. Foundations of Biophysics

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**