HSNC University, Mumbai

(2024-2025)

Ordinances And Regulations

With Respect To

Choice Based Credit System (CBCS)

For The Programme Under

The Faculty of Science & Technology

Curriculum – M.Sc. in Life Sciences

Postgraduate Programme

2024-2025

Syllabus For M.Sc. Life Sciences

(With Effect From The Academic Year Of 2024-2025)

M.Sc. LIFE SCIENCES - BOARD OF STUDIES

1. The Board of Studies shall consist of the following members, namely: —
   a. One head of the Department from amongst the Schools, Centers and Constituent Colleges, of the University in the relevant subject of the University nominated by the Vice Chancellor in consultation with the Dean concerned: -

Sr. No.	Name	Designation	Contact Details
1.	Dr. Tejashree Shanbhag	Chairperson Professor & Head, Dept of Life Sciences	9892370263 tejashree.shanbhag@kccollege.edu.in
2.	Dr. Shalini Rai	Co-Chairperson Professor Dept of Life Sciences	9987326613 shalini.rai@kccollege.edu.in

   b. Two to five teachers each having minimum five years teaching experience amongst the full-time teachers of the Departments, Schools, Centers and Constituent Colleges of the University in the relevant subject nominated by the Vice-Chancellor in consultation with the Dean of the respective faculty: -

Sr No.	Name	Designation	Contact Details
1.	Dr. (Ms.) Aashu Vajpai	Assistant Professor	9702073377 aashu.vajpai@kccollege.edu.in
2.	Dr. Suvarna Sharma	Assistant Professor	9869525362 suvarna.sharma@kccollege.edu.in
3.	Dr. Mayuresh Joshi	Assistant Professor	9967639400 mayuresh.joshi@kccollege.edu.in

   c. One Professor/Associate Professor from other Universities or professor/Associate Professor from colleges managed by Parent Body; nominated by Parent Body: -

Sr. No.	Name	Designation	Contact Details
1.	Dr. Prashant Ratnaparkhi	Associate Professor & Head, Dept of Life Sciences, St. Xavier's College (Autonomous).	9969414268 prashant.ratnaparkhi@xaviers.edu
2.	Dr. Nilima Gajbhiye	Associate Professor & Head, Dept of Life Sciences, Ramnarain Ruia College.	8879518970 hodlifescience@ruiacollege.edu

d. Four external experts from Industry / Research / eminent scholar in the field relevant to the subject nominated by the Parent Body:

Sr. No.	Name	Designation	Contact Details
1.	Dr. Ajit Gokhale	Founder and leader, Natural Solutions.	9870423023 ajit.naturalsolutions@gmail.com
2.	Dr. Nilima Kulkarni	Retd., Head & Associate Professor, Dept of Zoology, K.E.T.'s V.G.Vaze College, Mulund. Member-Managing Committee & Former Chairperson, Mulund Vibhag, Hariyali- NGO.	96199 11705 drneelimakulkarni@gmail.com
3.	Mr. Isaac Kehimkar	Chairman / Director, iNaturewatch Foundation, Navi Mumbai Member of Butterfly Specialist Group, IUCN-SSC Plot No. F74, R No. 14, Ganesh CHS, Off, Navrang Junction, Sector 12, Kharghar, Navi Mumbai, Maharashtra 410210.	96199 11705 isaackehimkar@gmail.com

e. Top rankers of the Final Year Graduate and Final Year Post Graduate examination of previous year of the concerned subject as invitee members for discussions on framing or revision of syllabus of that subject or group of subjects for one year nominated by the Vice Chancellor. The Board of Studies, at its first meeting, shall elect one of the members as a Chairperson of the Board of Studies from amongst its members, subject that no person shall be Chairperson of the Board of the studies, for a second consecutive term whether as an elected, nominated or co-opted member, as the case may be.

Sr. No.	Name	Designation	Contact Details
1.	Dr. Priya Londhe	Senior Medical Science Liason, GiLead Sciences, Boston MA	+1(618)967-3776 priyalondhe@gmail.com
2.	Ms. Ashwini Jadhav	Senior Executive Social Change The Recycling Company	81698 21875 ashwini@threco.com
3.	Mr. Romil Dagha	Ph.D. Research Scholar, Department of Life Sciences, KC College	80976 60104 romil.dagha@kccollege.edu.in

PART –I

Outline of Choice Based Credit System as outlined by University Grants Commission:

The Definitions Of The Key Terms Used In The Choice Based Credit System And Grading System Introduced From The Academic Year2020-2021 Are As Under:

Core Course: A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

Elective Course: Generally, a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

1.1. Discipline Specific Elective (DSE) Course: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/ Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by the main discipline/subject to study).

1**.2. Dissertation/Project:** An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper.

P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.

Choice Based Credit System: CBCS allows Learners to choose inter- disciplinary, intra-disciplinary courses, skill oriented papers (even from other disciplines according to their learning needs, interests and aptitude) and more flexibility for Learners.

Honors Program: To enhance employability and entrepreneurship abilities among the learners, through aligning Interdisciplinary / Intradisciplinary courses with Degree Program. Honors Program will have **40 additional credits to be undertaken by the learner across three years essentially in Inter / Intra Disciplinary course.**

A learner who joins Regular Undergraduate Program will have to opt for Honors Program in the first year of the Program. However, the credits for honors, though divided across three years, can be completed within three years to become eligible for award of honors Degree.

1. **Program:** A Program is a set of courses that are linked together in an academically meaningful way and generally ends with the award of a Degree Certificate depending on the level of knowledge attained and the total duration of study, B.Sc. Programs.
2. **Course:** A 'course' is essentially a constituent of a 'program' and may be conceived of as a composite of several learning topics taken from a certain knowledge domain, at a certain level. All the learning topics included in a course must necessarily have academic coherence, i.e. there must be a common thread linking the various components of a course. A number of linked courses considered together are in practice, a 'program'.
3. **Bridge Course:** Bridge course is visualized as Pre semester preparation by the learner before commencement of regular lectures. For each semester the topics, whose knowledge is considered as essential for effective and seamless learning of topics of the Semester, will be specified. The Bridge Course can be conducted in online mode. The Online content can be created for the Bridge Course Topics.
4. **Module and Unit:** A course which is generally an independent entity having its own separate identity, is also often referred to as a 'Module' in today's parlance, especially when we refer to a 'modular curricular structure'. A module may be studied in conjunction with other learning modules or studied independently. A topic within a course is treated as a Unit. Each course should have exactly 3 Units.
5. **Self-Learning: 20% of the topics will be marked for Self-Learning.** Topics for Self-Learning are to be learned independently by the Learner, in a time- bound manner, using online and offline resources including online lectures, videos, library, discussion forums ,fieldwork, internships etc.

6. Evaluative sessions (physical/online), equivalent to the credit allocation of the Self Learning topics, shall be conducted, preferably, every week for each course. Learners are to be evaluated real time during evaluative sessions. The purpose of evaluative sessions is to assess the level of the Learners' learning achieved. In the topics earmarked for Self-Learning. The teacher's role in these evaluative sessions will be that of a Moderator and Mentor, who will guide and navigate the discussions in the sessions, and offer concluding remarks, with proper reasoning on the aspects which may have been missed by the Learners, in the course of the Self-Learning process.
7. The modes to evaluate self-learning can be a combination of the various methods such as written reports, handouts with gaps and MCQs, objective tests, case studies and peer learning. Groups can be formed to present self- learning topics to peer groups, followed by Question-and-Answer sessions and open discussion. The marking scheme for Self-Learning will be defined under Examination and Teaching.
8. The topics stipulated for self-learning can be increased or reduced as per the recommendations of the Board of Studies and Academic Council from time to time. All decisions regarding evaluation need to be taken and communicated to the stakeholders may be preferably before the commencement of a semester. Some exceptions are made in exigencies, like the current situation arising from the lockdown, but such ad hoc decisions are to be kept to the minimum possible.
9. **Credit Point**: Credit Point refers to the 'Workload' of a learner and is an index of the number of learning hours deemed for a certain segment of learning. These learning hours may include a variety of learning activities like reading, reflecting, discussing, attending lectures / counseling sessions, watching specially prepared videos, writing assignments, preparing for examinations, etc.
10. Credits assigned for a single course always pay attention to how many hours it would take for a learner to complete a single course successfully. A single course should have, by and large a course may be assigned anywhere between 2 to 8 credit points wherein 1 credit is construed as corresponding to approximately 15 learning hours.
11. **Credit Completion and Credit Accumulation:** Credit completion or Credit acquisition shall be considered to take place after the learner has successfully cleared all the evaluation criteria with respect to a single course. Thus, a learner who successfully completes a 4 CP (Credit Point) course may be considered to have collected or acquired 4 credits. Learner level of performance above the minimum prescribed level (viz. grades / marks obtained) has no bearing on the number of credits collected or acquired. A learner keeps on adding more and more credits as he completes more and more courses successfully. Thus, the learner 'accumulates' course wise credits.
12. **Credit Bank:** A Credit Bank in simple terms refers to stored and dynamically updated information regarding the number of Credits obtained by any given learner along with details regarding the course/s for which Credit has been given, the course-level, nature, etc. In addition, all the information regarding the number of Credits transferred to different programs or credit exemptions given may also be stored with the individual's history.
13. **Credit Transfer:** (performance transfer) When a learner successfully completes a program, he/she is allowed to transfer his/her past performance to another academic program having some common courses and Performance transfer is said to have taken place.
14. **Course Exemption:** Occasionally, when two academic programs offered by a single university or by more than one university, may have some common or equivalent course-content, the learner who has already completed one of these academic programs is allowed to skip these 'equivalent' courses while registering for the new program. The Learner is 'exempted' from 'relearning' the common or equivalent content area and from re-appearing for the concerned examinations. It is thus taken for granted that the learner has already collected in the past the credits corresponding to the exempted courses.

Part-II

The Scheme of Teaching and Examination:
The performance of the learners shall be evaluated in two components: Internal Assessment with 40% marks by way of continuous evaluation and by Semester End Examination with 60% marks by conducting the theory examination.

Teaching Hours –

Unit (1 to 3)	**Total Lectures**	**Credit**	**Total Marks**
Theory	45	3	60
Practical	30	1	40 (25P + 15 Internal)

Evaluation Pattern – 100 Marks
Theory Assessment – 60 Marks

Q-No.	**Particulars**	**Marks**
Q-1	All Units	15 Marks
Q-2	Unit-I	15 Marks
Q-3	Unit-II	15 Marks
Q-4	Unit-III	15 Marks

Internal Assessment – 15 Marks

Sr. No.	**Particulars**	**Marks**
1	Self-Learning Evaluation – Active participation in routine class instructional deliveries Overall Performance – Attendance Record	15 Marks

Practical Assessment – 25 Marks (50 Marks converted into 25 Marks)

Sr. No	**Evaluation type**	**Marks**
1	Two Best Practical a. Evaluation of One Program	20 Marks
	b. Evaluation of Second Program	20 Marks
2	Journal	05 Marks
3	Viva	05 Marks

Date:	Time:	Semester: I	Total Marks: 60
Subject Code:	Program: M.Sc. Life Sciences	Subject:	

N.B. – (1) All questions are compulsory. (2) Figures to the right indicate full marks

Q.1	A	Attempt any Three out of Six of the following: - (5 Marks Each)	15 Marks
	1.	Unit - I	
	2.	Unit – I	
	3.	Unit - II	
	4.	Unit – II	
	5.	Unit – III	
	6.	Unit - III	
Q2		**Attempt any Three out of Six of the following: - (5 Marks Each)**	**15 marks**
	1.	Unit - I	
	2.	Unit - I	
	3.	Unit - I	
	4.	Unit - I	
	5.	Unit - I	
	6.	Unit - I	
Q.3		**Attempt any Three out of Six of the following: - (5 Marks Each)**	**15 marks**
	1.	Unit - II	
	2.	Unit - II	
	3.	Unit - II	
	4.	Unit - II	
	5.	Unit - II	
	6.	Unit - II	
Q.4		**Attempt any Three out of Six of the following: - (5 Marks Each)**	**15 marks**
	1.	Unit - III	
	2.	Unit - III	
	3.	Unit - III	
	4.	Unit - III	
	5.	Unit - III	
	6.	Unit - III	

Project and Assignment: Project or Assignment, which can in the following forms:

- Case Studies;
- Videos;
- Blogs;
- Research paper (Presented in Seminar/Conference), Field Visit Report;
- Presentations related to the subject (Moot Court, Youth Parliament, etc.);
- Internships (Exposition of theory into practice);
- Open Book Test;
- Any other innovative methods adopted with the prior approval of Director Board of Examination and Evaluation.

Self-Learning Evaluation

- 20% OF THE TOPICS OF CURRICULUM ARE LEARNED BY THE Learner THROUGH SELF LEARNING USING ONLINE / OFFLINE ACADEMIC RESOURCE SPECIFIED IN THE CURRICULUM.
- HENCE 20% OF THE LECTURES SHALL BE ALLOCATED FOR EVALUATION OF LEARNERS ON SELF LEARNING TOPICS
- The identified topics in the syllabus shall be learnt independently by the Learners in a time bound manner preferably from online resources. Evaluative sessions shall be conducted by the teachers and will carry 10 Marks. CLUB the self-learning topics into 3-4 GROUPS OF TOPICS ONLY FOR EVALUATION.
- PRESCRIBE TIME DURATION (IN DAYS) FOR COMPLETION OF EACH GROUP OF TOPIC AND EARMARK SELF LEARNING EVALUATION LECTURES IN THE TIMETABLE. HENCE EACH GROUP OF TOPIC CAN BE ASSIGNED 3 REGULAR LECTURES FOR THIS EVALUATION FOR ENTIRE CLASS

Sub Topics

- Each evaluative session shall carry 3 Marks (3 x 3 Units = 9 Marks). Learners who participate in all evaluative sessions shall be awarded 1 additional Mark.
- Sub Topics

  Each evaluative session shall carry 2.5 Marks (2.5 x 4 Units = 10 Marks)

  Evaluation Of Self Learning Topics Can Commence In Regular
  Lectures Assigned For Self Learning Evaluation In The Timetable
  Evaluative sessions

  Each evaluative session shall carry 3 Marks (3 x 3 = 9 Marks). Learners who participate in all evaluative sessions, shall be awarded 1 additional Mark.

Evaluative sessions

Each evaluative session shall carry 2.5 Marks (2.5 x 4 =10 Marks).

Methods for Evaluation of Self-learning topics:

Seminars/presentation (PPT or poster), followed by Q&A − Objective questions /Quiz /Framing of MCQ Questions.

Debates

- Debates
- Group discussion
- You-Tube videos (Marks shall be based on the quality and viewership)
- Improvisation of videos
- Viva Voce
- Any other innovative method

Teachers Can Frame Other Methods Of Evaluation Also Provided That The Method, Duly Approved By The College Examination Committee, Is Notified To The Learners At Least 7 Days Before The Commencement Of The Evaluation Session And Is Forwarded For Information And Necessary Action At Least 3 Days Before The Commencement Of The Evaluation Session.

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(With Effect from The Academic Year Of 2024-2025)

Section D Preamble

The M.Sc. Life Sciences program is started with an aim to make the Learners employable after Post-Graduation and impart industry oriented training.

1. **Course Objective:** The main objectives of the course are:
    a. To inculcate the knowledge base on sustainable development with a view to balance our economic, environmental and social needs, allowing prosperity for now and future generations.
    b. To train the learners to undertake major initiatives in the efficient management of natural resources and the prevention of environmental pollution with focus on Sustainable Development.
    c. To equip individuals to solve problems of environmental pollution and environmental degradation through before end of pipe (BEOP) interventions, over and above the use of conventional way of end-of-pipe (EOP) interventions.
    d. To promote understanding of efforts that can be made at the Industry and Government level to improve the environment, the economy and the quality of life of biotic and abiotic communities.
    e. To use environmental management tools that help to improve the quality of the environment, to assess local vulnerabilities with respect to climate, natural disasters and to achieve sustainable developmental needs.

2. **The new syllabus is aimed to achieve the following objectives**.
    a. The syllabus spanning two years covers the industry endorsed relevant courses.
    b. The Learners will be ready for the jobs available in different fields like:
    c. Every Industry sector (such as Automobile, Food Processing, Chemical, Pharmaceutical, Powern including Renewable Energy, Textile, Fertilizer, Cement, Infrastructure, Steel, Refinery, Tyre, etc. and other industry sectors), Pollution Control Boards, Municipal Corporations,
    d. Environmental Consultancy firms,
    e. NGO's, Banks (study feasibility of environmental projects),
    f. Research & Development Laboratory,
    g. Multi-star Hotels (manage WasteWater Treatment Facilities, Environmental Management Systems), Hospitals (Environmental Quality Control, Hospital Waste Management),
    h. Waste Management Industries Certifying / Audit agencies.

3. **The passed out candidates/students can have opportunity to serve as Sustainability Executives:**
    a. Operations and Marketing Managers
    b. Environmental Engineers
    c. Industrial Production Managers
    d. Environmental Managers
    e. Environmental Scientists
    f. Environmental Chemists
    g. Environmental Consultants
    h. Project Officers
    i. Freelancers In the Field Of Environment

4. **Process adopted for curriculum designing:** The department has conducted multiple meetings with academic partners, industry partners. After discussion with them, the changes in the syllabus were introduced with the view that Learners need to learn the core concepts in detail.

5. **Salient features, how it has been made more relevant:** After discussion and interaction with the industry partners and understanding the requirement of the industries certain changes in the syllabus are introduced.

6. **Learning Outcomes:** It is expected to improvise the soft skill as well as hardware skills for the Learners.

7. **Input from stakeholders (Which sections have been modified) with relevant introduction:** There are modifications suggested by the Industry person to make changes in the syllabus provided by University of Mumbai and add a few more topics to the already developed syllabus.

Structure and Titles as per NEP

Program Name: M.Sc. **Subject: Life Sciences**

(Theory: 15 Lecture hours= 1 Credit & Practical: 30; Lecture hours= 1 Credit;

Sem	Theory / Practical	Paper Code	Course Title	No. of Credits	No.of Lectures	Total Credits
I	Theory	US-MLSC-101	Cell Biology	3	45	8+4=12 (Major)
	Practical	US-MLSC-P101	Practicals based on Cell Biology	1	30	
	Theory	US-MLSC-102	Biochemistry	3	45	
	Practical	US-MLSC-P102	Practicals based on Biochemistry	1	30	
	Theory	US-MLSC-103	Virology and Immunology	3	45	
	Practical	US-MLSC-P103	Practicals based on Immunology	1	30	
	Theory	US-MLSC-DSE-P101	Field Biology, Forest Ecology & Conservation Documentation	3	45	4 (DSE)
	Practical	US-MLSC-DSE101	Practicals based on Field Biology	1	30	
	Mi 20 (RM)			4	60	4 (Minor)

Sem	Theory/ Practical	Paper Code	Course Title	No. of Credits	No. of Lectures	Total Credits
II	Theory	US-MLSC-201	Inheritance Biology	3	45	8+4 = 12 (Major)
	Practical	US-MLSC-P201	Practicals based on Inheritance Biology	1	30	
	Theory	US-MLSC-202	Developmental Biology, Neurobiology and Animal Behaviour	3	45	
	Practical	US-MLSC-P202	Practicals based on Developmental Biology, Neurobiology and Animal Behaviour	1	30	
	Theory	US-MLSC-203	Genetic Engineering, Genomics and Proteomics	3	45	
	Practical	US-MLSC-P203	Practicals based on Genetic Engineering, Genomics and Proteomics	1	30	
	Theory	US-MLSC-DSE201	Remote Sensing, Environmental Monitoring & Instruments in Monitoring and Environmental Modeling	3	45	4 (DSE)
	Practical	US-MLSC-DSE-201	Practicals based on Remote Sensing, Environmental Monitoring and Instruments in Monitoring	1	30	

Internship/Apprenticeship

Year	Sem.	Paper	Paper Code	Course Title	No of Credits	No of Lectures	Total Credits
1	I						
	II			Internship/ Apprenticeship	4	60	4

Part 2 - The Scheme of Teaching and Examination is as under:

Summary - Master's First Year Semester I Internal and External Detailed Evaluation Scheme

Sr.No.	Subject Code	Subject Title	Periods Per Week					Credits	Internal		Total Marks
			Units	S. L	L	T	P		S.L.E		
1	**US-MLSC-101**	Cell Biology	3	20%	3			3	15	60	75
2	**US-MLSC-P101**	Practicals based on Cell Biology			0		6	1		25	25
3	**US-MLSC-102**	Biochemistry	3	20%	3			3	15	60	75
4	**US-MLSC-P102**	Practicals based on Biochemistry			0		6	1		25	25
5	**US-MLSC-103**	Virology and Immunology	3	20%	3			3	15	60	75
6	**US-MLSC-P103**	Practicals based on Immunology			0		6	1		25	25
7	**US-MLSC-DSE101**	Field Biology, Forest Ecology & Conservation Documentation	3	20%	3			3	15	60	75
8	**US-MLSC-DSE-P101**	Practicals based on Field Biology			0		6	1		25	25

Summary - Master's First Year Semester II Internal and External Detailed Evaluation Scheme

Sr.No.	Subject Code	Subject Title	Periods Per Week					Credits	Internal		Total Marks
			Units	S. L	L	T	P		S.L.E		
1	**US-MLSC-201**	Inheritance Biology	3	20%	3			3	15	60	75
2	**US-MLSC-P201**	Practicals based on Inheritance Biology			0		6	1		25	25
3	**US-MLSC-202**	Developmental Biology, Neurobiology and Animal Behaviour	3	20%	3			3	15	60	75
4	**US-MLSC-P202**	Practicals based on Developmental Biology, Neurobiology and Animal Behaviour			0		6	1		25	25
5	**US-MLSC-203**	Genetic Engineering, Genomics and Proteomics	3	20%	3			3	15	60	75
6	**US-MLSC-P203**	Practicals based on Genetic Engineering, Genomics and Proteomics			0		6	1		25	25
7	**US-MLSC-DSE201**	Remote Sensing, Environmental Monitoring & Instruments in Monitoring and Environmental Modeling	3	20%	3			3	15	60	75
8	**US-MLSC-DSE-P201**	Practicals based on Remote Sensing, Environmental Monitoring & Instruments in Monitoring and Environmental Modeling			0		6	1		25	25

M. Sc. Part I: OUTLINE SEMESTER I

COURSE CODE	SEMESTER I	CREDIT	LECTURE
US-MLSC-101	**Cell Biology**	**3**	**45**
UNIT I	Cell and Cellular Organisation	1	15
UNIT II	Cell Cycle and Regulation	1	15
UNIT III	Cell Signalling and Communication	1	15
US-MLSC-P101	**Practicals based on Cell Biology**	**1**	**30**
US-MLSC-102	**Biochemistry**	**3**	**45**
UNIT I	Fundamentals of Biochemistry	1	15
UNIT II	Regulation of Metabolic Pathways and biosynthesis	1	15
UNIT III	Bioenergetics	1	15
US-MLSC-P102	**Practicals based on Biochemistry**	**1**	**30**
US-MLSC-103	**Virology and Immunology**	**3**	**45**
UNIT I	Fundamental concepts of Virology	1	15
UNIT II	Immunology	1	15
UNIT III	Tools and Techniques in Biology	1	15
US-MLSC-P103	**Practicals based on Immunology**	**1**	**30**
US-MLSC-DSE101	**Field Biology, Forest Ecology & Conservation Documentation**	**3**	**45**
UNIT I	Field Biology	1	15
UNIT II	Forest Ecology	1	15
UNIT III	Conservation Documentation	1	15
US-MLSC-DSE-P101	**Practicals based on Field Biology, Forest Ecology & Conservation Documentation**	**1**	**30**

M. Sc. Part I: Detailed Syllabus

SEMESTER I

PAPER I – CELL BIOLOGY

Course code	Title	Lectures
US-MLSC-101	**Cell Biology**	**45**
	Unit I: Cell and Cellular Organisation **1. Cell Structure and Function:** Cell organelles and their functions, Cell wall, Cell membrane, Plasma membrane, modification of Plasma membrane and Intracellular junctions, Protoplasm, Nucleus, the Actin-Myosin Cytoskeleton, the Extracellular matrix, Chloroplasts, Endosome, Microbodies, Ribosome, Centriole, Peroxisomes. **2. Membrane Structure and Transport:** a. Structure – Models and resemblance to Fluid Mosaic of Lipids, Proteins, and Carbohydrates. b. Membrane transport – Passive, Active and Facilitated transport and examples of each, Membrane Proteins, Pumps, Channels, Transporters, bBiogenesis of Membrane proteins, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes osmosis and its effect on animal and plant cell pressure. c. Membrane potential and transport, Transport and Calcium Signaling, Vesicle Transport and Receptor Mediated Endocytosis. d. Nucleus and Nuclear Transport, Example - Nerve cells, ion channels, synapse, Ca^{++} regulated events.	**15**
	Unit II: Cell Cycle and Regulation: 1. **Overview of Cell cycle & Apoptosis:** a. Overview of cell cycle. b. Apoptosis and cell regeneration: Mechanisms, intrinsic and extrinsic pathways of cell death, caspases, central regulators ofAapoptosis, role of signaling pathways, p53 and Apoptosis, Ubiquitination, Autophagy, Role of stem cells – adult stem cells and embryonic stem cells, progenitor cells, proliferation of differentiated cells, applications of adult stem cells. c. Cancer: interaction of cancer cells with normal cells and its role in metastasis, therapeutic interventions of uncontrolled cell growth. 2. **Homeostasis:** Homeostasis-single-celled and multicellular organisms, types of homeostasis, homeostatic control mechanisms – positive and negative feedback mechanisms and their components, control of body temperature - endothermic and exothermic animals, basal metabolic rate and its relation to the thermoneutral zone, homeostatic imbalance and its effects.	**15**

	Unit III :Cell Signaling & Communication **1. Cell signaling:** a. Types of Signaling, Mechanisms of cell signaling in prokaryotes and eukaryotes- give examples, Hormones and their receptors, cell surface receptor- G-protein Coupled Receptors, signaling through G-protein coupled receptors, receptor activation and regulation. b. Cell signaling and cancer-Receptor Tyrosine Kinases: Her2 and Breast Cancer, Oncogenes & Mechanisms for Blocking Kinase Activity, Ras/MAPK Pathways and the Targeting of Intracellular Signaling Pathways, cancer therapy. **2. Cell Communication:** a. Host parasite interaction: Recognition and entry processes of different pathogens like bacteria, and viruses into animal and plant host cells, alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells. b. Cell-Cell Interaction: Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission, and its regulation.	**15**

Outcome:

1. This enables Learners a strong foundation on the basic unit of life and, the Learner has a strong foundation on the functions of the cell.
2. This skill-based course introduces the Learners to the concepts in tissue culture applicable to plants and animals and also taught their applications in biotechnology and biochemical research which will enable the Learners to explore entrepreneurial avenues in this field.
3. Learners will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.
4. Learners will understand the cellular components underlying mitotic cell division and apply their knowledge of cell biology to selected examples of changes or losses in cell function. These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.
5. They can recognize and discuss the main types of cell communication, including the signal molecules integral to the main types, and understand the importance of cell signaling in biology and to be able apply this knowledge in future laboratory work.
6. Know and be able to discuss the major groups of intracellular-and membrane-bound receptors, be able to give examples of such receptors and to understand and discuss central cellular signal pathways in eukaryotic cells.

Reference:

1. Edition and above. Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell (2003): Molecular Cell biology: W.H.Freeman & Co Ltd.
2. Arnold Berk, Chris A. Kaiser, Harvey Lodish et al. (2016): Molecular Cell biology: W.H.Freeman & Co Ltd.
3. Cell Biology 3rd edition: Thomas D. Pollard, William C. Earnshaw, Jennifer LippincottSchwarts, Graham Johnson.
4. Cell Biology by C.B. Powar.
5. Ostman, A. and Bohmer, F-D. (2001) 'Regulation of receptor tyrosine kinase signaling by protein tyrosine phosphatases', *Trends in Cell Biology*, vol. 11, no. 6, pp. 258–66.
6. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. (2002) *Molecular Biology of the Cell* (4th edn), Garland Science, New York.

Course code	Title	Lectures
US-MLSC-P101	**Practicals based on Cell biology**	**30**
	Microscopy • Counting of viable and non-viable yeast cells using Haemocytometer. • Observation of epithelial cells. • Study of leaf cells. • Microtomy of tissue. **Study of organelles** • Isolation of mitochondria from suitable source – SDH. • Isolation of chloroplast – spectrophotometric estimation and profiling. • Isolation of Plasma membrane from RBC. • Temporary squash preparation of onion/garlic root-tip cells to study stages of mitosis.	

PAPER II – BIOCHEMISTRY

Course code	Title	Lectures
US-MLSC-102	**Biochemistry**	**45**
	Unit I: Fundamentals of Biochemistry **1. Overview of Biomolecules Principles of Biochemistry:** a. Principles of biophysical chemistry: (pH, buffer, reaction kinetics, thermodynamics, colligative properties). Stabilizing interactions: Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc. **2. Carbohydrates:** Types and chemical properties. **3. Lipids:** Storage Lipids; Structural Lipids in Membranes; Lipids as Signals, Cofactors, and Pigments. **4. Amino Acids, Proteins and Enzymes:** a. Types and chemical properties. Structure of Proteins. Protein Denaturation and Folding. b. Conformation of proteins (Ramachandran plot; domains; motif and folds, Stability of protein structures). c. Enzymes - Enzyme classification, mechanism of enzyme catalysis, isozymes; Enzyme kinetics and enzyme inhibition. **5. Nucleotides and Nucleic Acids:** Nucleic Acid Chemistry, Types of RNA, Stability of nucleic acid structures. Purification and Separation of nucleic acids, Absorption spectra of Nucleic acids.	**15**

	Unit II: Regulation of Metabolic Pathways and biosynthesis 1. **Carbohydrate Biosynthesis:** Carbohydrate Biosynthesis, Photosynthetic Carbohydrate Synthesis. Coordinated Regulation of Glycolysis and Gluconeogenesis, Coordinated Regulation of Glycogen Synthesis and Breakdown. 2. **Biosynthesis of Starch and Sucrose, Synthesis of Cell Wall, Polysaccharides:** Plant Cellulose and Bacterial, Peptidoglycan, Integration of Carbohydrate. 3. **Amino Acid Biosynthesis:** Biosynthesis of Amino Acids, Nucleotides, and Related Molecules: Overview of Nitrogen Metabolism, Molecules Derived from Amino Acids 4. **Biosynthesis and Degradation of Nucleotides.** 5. **Lipid Biosynthesis:** Biosynthesis of Fatty Acids and Eicosanoids, Biosynthesis of Triacylglycerols, Biosynthesis of Membrane Phospholipids, Biosynthesis of Cholesterol, Steroids, and Isoprenoids.	**15**
	Unit III: Bioenergetics 1. **Bioenergetics and Thermodynamics;** Phosphoryl Group Transfers and ATP; Chemiosmosis theory. 2. **Glycolysis:** Pathways for Glycolysis, group transfer, biological energy transducers. Fates of Pyruvate under Anaerobic Conditions: Pentose Phosphate Pathway of Glucose Oxidation; TCA cycle. 3. **Oxidative Phosphorylation:** Electron-Transfer Reactions in Mitochondria, ATP Synthesis, Regulation of Oxidative Phosphorylation. 4. **Fatty Acid Catabolism:** Digestion, Mobilization, and Transport of Fats; Oxidation of Fatty Acids; Ketone Bodies. 5. **Photosynthesis:** Harvesting Light Energy, Light Absorption, Light - Driven Electron Flow, C3, Photorespiration, C4 and CAM Pathways.	**15**

Outcome:

1. Through this course the Learners are exposed to the importance of biological macromolecules and acquire knowledge in the quantitative and qualitative estimation of biomolecules.
2. They study the influence and role of structure in reactivity of biomolecules.
3. Learners will be introduced to the structure, properties and roles of carbohydrates, lipids and nucleic acids and their importance of vitamins in biological systems.
4. They can independently identify and quantitate various biomolecules in the laboratory.
5. Emphasis will be on the association between structure and function of various biomolecules at a chemical level with a biological perspective as well as hands-on approach and laboratory techniques.
6. Learners will gain profound knowledge about various disorders associated with metabolic pathways and comprehend the concept of bioenergetics and thermodynamic principles in biology.

References:

1. L. Stryer (2002): Biochemistry, W.H. Freeman and Co. 5th Edition.
2. Nelson David L., Cox Michale. Lehninger (2008.): Principles of Biochemistry 5th Edition.Publisher: New York.
3. Voet, Donald, Voet Judith, Pratt, Charlotte W. (2006): Fundamentals of Biochemistry: Life at the molecular Level 2nd Edition. Publisher: Asia, John Wiley & Sons.
4. William J. Marshall, Stephan K. Bangert, Elizabeth S.M. Ed. S.M (ed.) Marshall, Clinical Biochemistry: Metabolic And Clinical Aspects by (2008) Publisher: Elsevier Science Health Science Div.
5. Murray, R. K., Bender, D. A., Botham, K. M., Kennelly, P. J., Rodwell, V. W. and Weil, P. A., Harper's Illustrated Biochemistry, The McGraw-Hill Companies, Inc.
6. Plummer, D. T., An Introduction to Practical Biochemistry, Tata McGraw Hill Publishing Company.
7. Biochemistry by Satyanarayana, Dr Ahmad, Ameera. (2013). U Satyanarayana Biochemistry 4th Revised.
8. Cooper, T. G., The Tools of Biochemistry, Wiley India Pvt. Ltd.

Course code	Title	Lectures
US-MLSC-P102	**Practicals based on Biochemistry**	**30**
	• Estimation of Total activity of following enzymes - (Optimum pH, Optimum temperature, Optimum Enzyme Concentration, Optimum Substrate Concentration, Km and Vmax using Michelis Menton and Lineweaver burk plot, specific activity): a. Amylase from Sweet Potatoes. b. Urease from Jack Beans Meal/ Soya bean Seeds. c. Lipase from Groundnut Seeds. d. Transaminase from Germinating Moong Seeds. e. Alkaline phosphatase from Germinating Moong Seeds. • Isolation and estimation of RNA and DNA from suitable source. • Estimation of: a. Proteins by Biuret or Bradford or Folin-Lowry or BCA methods. b. Amino acids by Acid Ninhydrin method. c. Glucose by Anthrone or Folin-Wu or DNSA methods. • Estimation of Glucose by GOD-POD Method.	

PAPER III – VIROLOGY AND IMMUNOLOGY

Code	Title	Lectures
US-MLSC-103	**Virology and Immunology**	**45**
	Unit I: Fundamental concepts in Virology **1.** Principles of virus structure. **2.** Virus replication strategies. **3.** Viral conquest of the host cell. **4.** Emerging viral diseases. **5.** Viroids and prions. **6.** Plant phages: TMV. **7.** Protists viruses: Chlorella viruses. **8.** Animal viruses: HIVs and their replication. **9.** Bacteriophages: phage λ, phage Mu-1. **10.** Cultivation and purification of viruses.	**15**
	Unit II: Immunology **1.** Overview of lymphoid system, cells of the immune system, primary and secondary lymphoid organs, tertiary lymphoid tissues. Antigen concept, criteria of antigens, immunogen, antibodies (structure, specificity, diversity), antigen-antibody interactions. **2.** T-cell and B-cell receptors, receptor ligand interaction, signaling in T-cell and B-cell, Cytokines and Chemokines. **3.** Development of T and B cells. T and B cell activation, differentiation and memory. **4.** Hypersensitivity, inflammation and transplantation immunology: Type I (Allergy), Type II (antibody mediated) and Type III (immune complex mediated) and Type IV (delayed type) hypersensitivity reaction, chronic inflammation, autoimmunity. **5.** Antigen processing and presentation: Major Histocompatibility Complex, MHC restriction, Antigen processing and antigen presentation (endogenous and exogenous processing pathways), Tolerance, Establishment and maintenance of Tolerance, Central and Peripheral Tolerance, Transplantation immunology	**15**

	Unit III: Tools and Techniques in Biology **1. Microscopic techniques:** Fluorescence (Immuno), Confocal and Electron Microscopic techniques—principles and applications. **2. Biophysical Method:** a. Molecular analysis using UV/visible, Fluorescence, Circular Dichroism, NMR and ESR spectroscopy Molecular structure determination using X-ray diffraction and NMR, Molecular analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods. **3. Histochemical and Immunotechniques** a. Antibody generation, Detection of molecules using ELISA, RIA, Blotting techniques, Immunoprecipitation, Flow cytometry and detection of molecules in living cells, *In situ* localization by techniques such as FISH and GISH. Immunodiagnosis, Haemagglutination and Haemagglutination inhibition assays, Complement fixation, Immunohistochemistry (IHC). **4. Nucleic acid based techniques:** Nucleic acid hybridization, PCR, microarray and sequencing. **5. Analytical techniques:** Chromatography (GC, MS, IE) techniques, Emerging techniques in viral diagnostics, Tracer Techniques Alpha, Beta, Gamma and X Rays, GM Counter and Scintillation counter **6. Software in Diagnostics**	**15**

Outcome:

1. This course gives an overview on the immune system including organs, cells and receptors.
2. The learner understands the molecular basis of antigen recognition, antigen-antibody reactions and will develop an appreciation for principles of immunology and its applications in treating human diseases.
3. Learners will understand about Immunodeficiency diseases and role Immune tolerance and principles of autoimmunity.
4. Describe and review the elements of the viral life cycle and to explain the rationale behind the Baltimore classification system of viruses and present example viruses for each Baltimore group.
5. To understand the viral strategies to evade host immune and cellular factors (by use of examples of viruses relevant for human disease) and to understand the viral pathogenesis.

References:

1. Janis Kuby (2002): 5th Immunology 5th Edition, Publisher; W. H. Freeman.
2. Judy Owen, Jenni Punt, Sharon Stranford (2013): Kuby Immunology 7th Edition. W.H.Freeman & Co Ltd.
3. Janeway, C. A., Travers, P., Walport, M. and Shlomchik, M. J., Immunobiology, Garland Science.
4. Delves, P., Martin, S., Burton, D. and Roitt, I., Roitt's Essential Immunology. Wiley-Blackwell.
5. David M. Knipe, Peter M. Howley, (2007). 5th edition., vol. 1, Fields Virology. (ISBN; 978-0- 7817-6060-7).
6. Practicals of Biochemistry by Wilson and Walker (Cambridge Edition).

Course code	Title	Lectures
US-MLSC-P103	**Practicals based on Immunology**	**30**
	• Grouping of blood and Rh typing. • Isolation and purification of IgG from serum • Immunoblotting assay for protein detection • Precipitation reaction by double immunodiffusion (Ouchterlony method) and radial immunodiffusion (Mancini's method) • Immunoprecipitation assay • Detection of antigens or antibodies by ELISA – Indirect and Sandwich ELISA • Phage titration • Latex agglutination	

DSE I - FIELD BIOLOGY, FOREST ECOLOGY & CONSERVATION DOCUMENTARY

Course code	Title	Lectures
US-MLSC-DSE-101	**Field Biology, Forest Ecology & Conservation Documentation**	**45**
	Unit I: Field Biology **1. Ecosystems:** a. Basics features / types; b. Energy flow in ecosystems; c. Ecological productivity - ecosystem modeling; d. Systems approach to resource management and conservation. **2. Population and Biotic Community:** a. Concept of Population: Population attributes, population growth; population fluctuation, 'r' and 'k' selection, concept of density dependent and density independent action of population regulation, Ecade and Ecotypes. b. Concept of Biotic Community: Attributes, structure and composition, stratification, Ecotone and Edge effect, keystone species induced community changes. c. Interspecific Interactions: Positive and negative interspecific interactions (commensalism, mutualism, predation, competition, parasitism, antibiosis), coevolution, ecological problems of humanity, protection of nature and biological variability. d. Operation and complexity, allelopathy. e. Ecological Succession: Stages and mechanism of succession, trends and stages of community development, concept of climax, climax theories. f. Concept of Habitat and Ecological Niche, niche types, niche width and overlap, ecological equivalent, competition and niche, niche segregation, assessment of the health of the habitat.	**15**
	Unit II: Forest Ecology **1.** Forest types of India, distribution of Indians forests, factor governing distribution of Indian forests. **2. Forest as an ecosystem:** Structural attributes: Dominant plant species of different forests, phytosociological attributes; density and dominance relations of different forest communities, forest stratification and canopy structure, microclimate. **3. Functional Attributes:** (a) Productivity of different forests. (b) Material cycling: Process of nutrient cycling in forests, nutrient cycling in temperate and tropical forests, litter production and decomposition. **4. Forest Floor Ecology:** Seed placement and germination in forests, seedlings growth, seedling establishment strategies, characteristics of soils of different forests. **5.** Ecological characteristics of tropical and temperate forests of India, important wildlife of India, man-forest interactions.	**15**
	Unit III: Conservation Documentation **1. An introductory course in photography of Wildlife and nature, and story-telling using visual tools:** a. Basic technical elements of photography; b. Use of light and speed for different kinds of photographs, motion photography; c. Workings of different kinds of cameras and lenses; d. Basic rules for composing Wildlife and Nature Photography; e. Using photography as an effective tool for conservation story telling.	

	2. Introduction to Documents, Records & Writing: a. Introduction to Wildlife Photography; b. Photo Editing and Processing; c. Writing Captions and Stories; d. Portfolio Development and Presentation; e. Ethics in Wildlife Photography; f. Legal and Permit Requirements: **i.** Legal considerations related to photographing Wildlife, including permits for photographing protected species or in certain locations. **ii.** Copyright laws and usage rights associated with Wildlife photographs.	

Outcome:

1. Demonstrate and understand the principles of ecology.
2. Understanding of the complex interaction of humans and forest ecosystems.
3. Interpreting forest conservation, forest ecology and resource management and to exhibit forest menstruation skills, techniques for ecological measurements.
4. Exhibition of forest menstruation skills, techniques for ecological
5. Measurements.
6. Understanding of data collection, analysis and interpretation of forest ecology.
7. Understanding of Wildlife photography and documentary.
8. Role of Ecotourism and community.

References:

1. Modern Concepts of Ecology (E.D. 5) by Kumar H. D.
2. Global Biodiversity Assessment by Heywood V.H. & Watson, R.T.
3. Conservation biology: voices from the Tropics by Gibson, L. & Raven, P.HG.
4. Cultural, Ecology and Sustainable Development, Mittal, Delhi by Sukanta K Chaudhury.

Course code	Title	Lectures
US-MLSC-DSE-P101	**Practical on Field Biology, Forest Ecology & Conservation Documentation**	**30**
	• Determination of Total Organic Matter in soil. • Determination of Total Dissolved Solids. • Determination of Total Hardness. • Determination of CO_2 in the atmosphere by volumetric method. • Determination of COD, BOD, OD from the given sample. • Determination of MPN Value. • Effect of Salinity on Stress Hormones in Plants productivity. • Documentary making - Photo, Video, Article. • Conceptualising Ecotourism spot. • ANN - use computational biology to a selected area. • Herbarium preparation (Plant and animal Storage).	

M.Sc. Part I: OUTLINE

SEMESTER II

Course code	SEMESTER II	CREDIT	LECTURE
US-MLSC-201	**Inheritance Biology**	**3**	**45**
UNIT I	Principles of Genetics	1	15
UNIT II	Genetic recombination and Molecular Pathology	1	15
UNIT III	Bacterial and Viral Genetics	1	15
US-MLSC-P201	**Practicals based on Inheritance biology**	**1**	**30**
US-MLSC-202	**Developmental Biology, Neurobiology and Animal Behaviour**	**3**	**45**
UNIT I	Developmental Biology	1	15
UNIT II	Neurobiology	1	15
UNIT III	Animal Behaviour	1	15
US-MLSC-P202	**Practicals based on Developmental Biology, Neurobiology and Animal Behaviour**	**1**	**30**
US-MLSC-203	**Genetic Engineering, Genomics and Proteomics**	**3**	**45**
UNIT I	Post Translational Modification	1	15
UNIT II	Gene Cloning	1	15
UNIT III	Techniques of Genomics and Proteomics	1	15
US-MLSC-P203	**Practicals based on Engineering, Genomics and Proteomics**	**1**	**30**
US-MLSC-DSE-201	**Remote Sensing, Environmental Monitoring, Instruments In Monitoring, Environmental Modelling**	**3**	**45**
UNIT I	Remote Sensing, GIS And GPS	1	15
UNIT II	Environmental Monitoring and Instruments In Monitoring	1	15
UNIT III	Environmental Modeling	1	15
US-MLSC-DSE-P201	**Practicals based on Remote Sensing, Environmental Monitoring & Instruments In Monitoring and Environmental Modeling**	**1**	**30**

M.Sc. Part I: Detailed Syllabus
SEMESTER II

PAPER I – INHERITANCE BIOLOGY

Course code	Title	Lectures
US-MLSC-201	**Inheritance biology**	**45**
	Unit I: Principles of Genetics **1. Extension and modifications of Mendelism:** a. Deviation from Mendel's Dihybrid phenotype, Linkage (Sutton's view on linkage, Morgan's view on linkage). b. Bateson & Punnet's Coupling & Repulsion hypothesis, Cuenot's odd yellow mice. **2. Non-Mendelian inheritance:** a. Cytoplasmic inheritance, extranuclear inheritance (mitochondrial, chloroplast) b. Non-chromosomal inheritance, maternal inheritance, uniparental inheritance. **3. Linkage and Crossing over:** a. Chromosome theory of Linkage (kinds & groups). b. Types & theories of Crossing over, mechanism of Meiotic Crossing over, cytological detection of Crossing over, the significance of Crossing over. **4. Allelic Variation and Gene function:** a. Types of genetic interaction Atavism/Reversion, Penetrance, Expressivity, Pleiotropism, Modifying genes. b. Chromosomal variation – Euploidy, Nondisjunction and Aneuploidy (segregation - plants and humans, Polyploidy (Plants and Animals), Induced Polyploidy, applications of Polyploidy. **5. Eukaryotic gene mapping:** a. Haploid mapping (2-point and 3-point cross), Diploid mapping (Tetrad analysis), determination of linkage groups, determination of map distance, determination of gene order, cytological mapping, deletion mapping, somatic cell hybridization, mapping with molecular markers. b. Genomic position effects on Gene expression.	**15**
	Unit II: Genetic Recombination and Molecular Pathology: **1. Genetic Recombination:** a. Types, Breakage and Rejoining and Heteroduplexes, Branch migration, Mismatch Base Pairs and Their Resolution. b. Pairing of DNA molecules, Recombination in bacterial transformation, Exchange between homologous double-stranded molecules. c. Models for Homologous Recombination, The Asymmetric Strand Transfer Model, The recBC Protein, Transformation in -Yeast. **2. Mutations and DNA repair:** Types of Mutations, Mutagenesis, Mutational Hot Spots, accumulation of mutations in our DNA, role of mutations in evolution, detection of mutation, repair pathways. **3. Molecular Pathology:** a. Nomenclature of mutations & databases of mutations, Loss of function mutations, Gain of function mutations. b. Molecular pathology from gene to disease, Molecular pathology from disease to gene, Molecular pathology of chromosomal disorders.	**15**

	Unit III: Bacterial and Viral Genetics **1. Bacterial genome structure:** Physical organization of bacterial genomes (Structure of the bacterial nucleoid, Replication, and partitioning of the bacterial genome and Genome of Archaea). **2. Mechanism of genetic exchange:** a. Plasmids-Plasmid and bacterial sex (Types of plasmids- F Plasmid: a Conjugate plasmid). b. Mobilization of Non-conjugative plasmid, R plasmid, Col plasmid Copy number and incompatibility, Episomes. **3. Bacteriophages:** a. Stages in the Lytic Life Cycle of a typical phage – E.coli Phage T7. b. Immunity to infection, Prophage integration, Induction of prophage, Induction & Prophage excision, Repressor. c. Structure of the operator and binding of the repressor and the Cro product, Decision between the Lytic and Lysogenic cycles. d. Transducing phages, (E. coli phage phiX174, filamentous DNA phages, Single-stranded RNA phages, The Lysogenic Cycle). **4. Bacteriophage Genetics:** a. Phage T4 - Benzer's fine structure of gene, Plaque Formation and Phage Mutants. b. Genetic recombination in the lytic cycle, (concept of recon, muton, cistron), deletion mapping – examples mutation at rII locus.	**15**

Outcome:

1. Learners will gain knowledge on Mendelian genetics, their principles and gene interaction.
2. They learn about chromosomal aberrations and structure of chromosomes and will gain a basic understanding on human genetics and heredity.
3. Learners will learn the basic principles of inheritance at the molecular, cellular and organismal levels.
4. Learners will gain technical know-how on versatile techniques in recombinant DNA technology and will have an understanding on application of genetic engineering techniques in basic and applied experimental biology.
5. Proficiency in designing and conducting experiments involving genetic manipulation.
6. They will know about the Application of bacterial and eukaryotic plasmids in research.

References:

1. Benjamin Pierce (2013). Genetics: A Conceptual Approach 5th Edition. W. H. Freeman And Company.
2. Walker John and Ralph Rapley (2015). Molecular Biology and Biotechnology 6th Edition. RSC Publishing.
3. Russell P. (2010). iGenetics: A Molecular Approach 3rd Edition. Pearson Publishers.
4. Lewin B. Micheal Stone (2008). Genes IX. Jones and Barlett Publishers Ltd.
5. Genetics: Analysis & Principles. Robert J. Brooker 7th Edition. Mc Graw Hill Publication.
6. Principles of Genetics. Snustad Simmons. 2008. 6th Edition. John Wiley Publication.
7. Concepts of Genetics. Klug, WS., Cummins, MR., Spencer, C., Palladino, MA. 2020. 10th Ed. Pearsons Publication.
8. Mendelian Inheritance in Man: A Catalog of Human Genes and Genetic Disorders, VA. McKusick, I & II.

Course Code	Title	Lectures
US-MLSC-P201	**Practicals based on Inheritance biology**	**30**
	• Plasmid Isolation. • Restriction Digestion. • Transformation in E. coli DH5α. • Phage growth and Titration. • Temporary preparation of polytene chromosomes from salivary gland cells of Drosophila/ Chironomus. • Study of chromosome structures in human karyotype. • Pedigree chart/gene mapping.	

PAPER II – DEVELOPMENTAL BIOLOGY, NEUROBIOLOGY AND ANIMAL BEHAVIOUR

Course code	Title	Lectures
US-MLSC-202	**Developmental Biology, Neurobiology and Animal Behavior**	**45**
	Unit I: Developmental Biology **1. Model organism studies:** *Drosophila melanogaster/ Caenorhabditis elegans/ C. Saccharomyces cerevisiae/ Danio rerio/ Escherichia coli.* **2. Morphogenesis and organogenesis:** a. Animals: Cell aggregation and differentiation in Dictyostelium; limb development and regeneration in vertebrates; metamorphosis. b. Plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxis; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum. **3. Programmed cell death, aging and senescence** **4. Developmental genetics –** Genetic determinants of developments in drosophila, control of development in drosophila and flower development, epigenetic changes in development, development and apoptosis, development and evolution. **5. Transgenic fish** using transposons, transgenic model for zebrafish, ABC model in plants.	**15**
	Unit: II Neurobiology **1. Nervous system:** Neurons, action potential, gross neuro-anatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture. **2. Neurobiology:** a. Glia: Types of Glia cells and their structure and function. b. Synapses & Synaptic Transmission-Types of synapses, Synaptic potentials (graded potentials) and their integration (EPSP, IPSP). c. Electrophysiological techniques to understand the electrical properties of the neuron – Patch-clamp and Voltage-clamp. d. Computational Neuroscience: Introduction, historical perspective and goals: Origin and scope of the field. **3. The Altered Brain:** Changes in structure and function of brain with age, Cognitive decline in diseases – Dementia and Alzheimer's, Axon degeneration and its effects, Differential regenerative capacity of CNS and PNS, Therapeutic interventions to promote regeneration of CNS axons, blood brain barrier, Role of neural stem cells in regeneration. **4. Neuroimaging Technique:** a. Study of Functional Anatomy – PET, MRI, fMRI. b. X-Ray Imaging. c. Advanced visualization techniques.	**15**
	Unit: III Animal Behaviour **1.** Approaches and methods in study of behavior: a. Proximate and ultimate causation. b. Altruism and evolution-Group selection. c. Kin selection, Reciprocal altruism. d. Development of behavior, Social communication, Social dominance. e. Domestication and behavioral changes. **2.** Neural basis of learning, memory, cognition, sleep and arousal; Biological clocks.	**15**

	3. Use of space and territoriality. **4.** Mating systems, Parental investment and Reproductive success, Parental care. **5.** Aggressive behavior, Habitat selection and optimality in foraging. **6.** Migration, orientation and navigation.	

Course code	Title	Lectures
US-MLSC-P202	**Practical based on Developmental Biology, Physiology and Neurology**	**30**
	• Study of developmental stages of Chick/Fish/Drosophila/*C. elegans*. • Placental types in Mammals. • Acridine/Comet assay for apoptosis in suitable source. • Assaying IAA oxidase activity in green and senescent leaves. • Preparation of blood smears and staining with Leishman stain (WBC, RBC and Platelet count). • Study of ECG/EEG in humans. • LDH Activity in muscles from suitable source, • Computational Neurosciences, Modeling the neuron components - variables and parameters. • Use of differential equations and matrices to understand structural abnormalities. • Study of components of membrane, electric circuits. • Study of artificial circuits: Hodgkin-Huxley model and GHK equation. • Neural Network – practical aspects of human brain.	

Outcome:

1. Students will be able to explain and understand the anatomy and physiology of cardiovascular, digestive and excretory systems.
2. It will help to understand the concepts of development, mechanism of gamete production and fertilization in animals.
3. Explain the anatomy and physiology of the central nervous system and the peripheral nervous system including the structure and function of the sensory and motor systems.
4. Students can trace the stages and control of plant development and explain important processes typical to plant metabolism.
5. They can explore signaling in plants and compare these processes with the animal systems which will help them review, predict and summarize the plant responses to stress.

Reference:

1. L. Wolpert, R. Beddington, J. Brockes, T. Jesell and P. Lawrence. (2002): Principles of Development, Oxford University Press.
2. W.A. Miller (1997): Developmental Biology. Springer – Verlag.
3. Scott F. Gilbert (2010): Developmental Biology, Sinauer Associates, Inc., Sunderland, MA Ninth Edition.
4. C. Guyton and J.E.Hall (2006): Text Book of Medical Physiology 11th Edition. College Publishers.
5. G. Tortora and S. Grabowski John. (2003): Principles of Anatomy and Physiology, 10th edition. Wiley & Sons, Inc. G. M. Shepherd (): Fundamentals of Neurobiology, University Press, 3rd Edition.
6. C.U.M. Smith (): Elements of Molecular Neurobiology, Wiley and sons Publication.
7. Dr. Himanshu Arora Dr. Mohan P. Arora (2016): Developmental Biology. Himalaya Publishing House.
8. M. F. Baer, B.W.Connors & M. A. Paradiso, William & Wilkins, Baltimore (2020): Neuroscience: Exploring the brain. 4th edition. Jones & Bartlett Learning.
9. B. I. Ballinsky' Saunders: An Introduction to Embryology, College Publishing Co. 4th Ed.
10. Buchanan, Gruissem and Jones (2015): Biochemistry and Molecular Biology of Plants. Wiley Blackwell.
11. Taiz and Zeiger (2003): Plant Physiology 3rd Edition: Sunderland: Sinauer Associates.
12. Lincoln Taiz, Eduardo Zeiger, Ian M. Møller, and Angus Murphy (2015): Plant Physiology and Development, 6th Edition. Sinauer Associates.
13. Hans-Walter Heldt Birgit Piechulla (2021): Plant Biochemistry 5th Edition. Academic Press.

PAPER III - GENETIC ENGINEERING, GENOMICS AND PROTEOMICS

Course code	Title	Lectures
US-MLSC-203	**Genetic Engineering, Genomics and Proteomics**	**45**
	Unit I: Post Translational Modification **1. Regulation of Gene expression in Prokaryotes:** a. Transcriptional regulation - inducible and repressible system, positive regulation and negative regulation. b. Operon concept – Ara operons, the galactose operon, relative positions of Promoters and Operators, Regulons, Master switches. c. Regulation of Translation, Regulation of the synthesis of Ribosomes, Unregulated changes in gene expression, Feedback Inhibition. RNA interference, mRNA half-life, riboswitches, ribozymes. **2. Gene expression in Eukaryotes:** a. Regulatory strategies in Eukaryotes, Gene alteration (Gene loss, Gene amplification, Gene rearrangement: the joining of coding sequences in the immune system). b. Transcriptional Control by hormones and signaling factors, Regulation mediated through Transcription factors, Regulation of enhancer activity, role of chromatin changes in regulating gene expression, role of nucleosome remodeling and post-translational modifications in transcription initiation. c. Methylation and epigenetics, Regulation of processing, regulation through RNA splicing, RNA degradation and RNA interference, Translational control, Regulation of gene expression in plant cells by light. Diseases associated with defects in regulation.	**15**
	Unit II: Gene Cloning **1. Essentials of Gene cloning:** a. Clone: Overview of the procedure, Gene library, Hybridization, Importance of DNA Cloning. b. Principles of Cell-based DNA Cloning and cell independent DNA cloning. **2. Isolation, identification and manipulation of genes** a. Modification of nucleic acids- Cutting and Joining DNA – Ligation, Alkaline Phosphatase, Double Digest, Modification of Restriction Fragments ends, ligation independent gene cloning, methylases, Nucleases, T4 polynucleotide kinases. b. Phage display techniques, Gene shuffling, Production of chimeric proteins. **3. Cloning Vectors and their properties –** a. Essential components of vectors and their significance- (ori, reporter genes, detection markers, linkers, polylinkers, adapters, promoters, RBS, signal sequences, termination sequence, fusion sequence). b. Expression vectors, Vectors for cloning and expression in Eukaryotic cells, Super vectors: YACs and BACs, viral expression systems for mammals. **4. Gene Transfer Technology** a. Gene transfer: Microinjection, Electroporation, Transfection, Microprojectile, ShotGun method, Ultrasonication, Liposome fusion, Microlaser. b. Genetic engineering in animals: Production of transgenic mice, ES cells can be used for gene targeting in mice. c. Genetic engineering in plants: Use of Agrobacterium tumefaciens and A. rhizogenes, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors.	**15**

	Unit III: Techniques of Genomics and Proteomics **1. Genomics:** a. Genome sequencing – Next-Generation Sequencing - Solexa, ion proton, etc, BAC end sequencing, Radiation hybrid mapping. HAPPY mapping, STS, ESTs, SNPs. b. Sequencing length polymorphism (AFLPs), Fiber fish, optical mapping and CGH, metagenomics. **2. Functional Genomics:** a. Identification and analysis of individual genes, positional cloning, Gene trap, High-throughput analysis of gene function- Tissue Arrays, SAGE, Subtractive hybridization, , Array methods, Macroarrays, Protein arrays. b. Transcriptome and Bisulphite sequencing, RNA fingerprinting, cell-based methods and assays, GFP Techniques and alternatives to GFP, Fluorescence Recovery After Photobleaching (FRAT). **3. Proteomics and Beyond:** a. Protein-DNA interactions – sequence specific DNA binding, DNA binding motifs, thermodynamics. b. Analysis of the transcriptome, Proteomics- Expression analysis & Characterization of proteins, Metabolomics and global biochemical networks. c. Single Nucleotide Polymorphisms - The nucleolar proteome, Mapping disease-associated SNPs.	**15**

Outcome:

1. Learners will understand the principles/concept of Pro and Eukaryotic genetics, and its application in research.
2. By the end of the course, Learners will have an understanding of the basic steps of gene cloning and the role of enzymes and vectors responsible for gene manipulation, transformation and genetic engineering.
3. Learners will have detailed knowledge of gene transfer methods and identifying suitable hosts for cloning and will acquire theoretical knowledge in the techniques, tools, and application and safety measures of genetic engineering.
4. This paper introduces the basic biology of proteins and the new advanced science called proteomics which aims to look into the entire set of proteins in the milieu.

References:

1. Old, RW. and Primrose, SB., Principles of Gene Manipulation: An Introduction to Genetic Engineering, University of California Press.
2. Glick, BR, Pasternak, J and Patten, CJ Molecular Biotechnology: Principles and Applications of Recombinant DNA, ASM Press.
3. Glover, DM., Gene Cloning: The Mechanics of DNA Manipulation, Springer-Science, Business Media, B. V.
4. Brown T. A (2016). Gene Cloning and DNA Analysis: An Introduction. 7th Edition. Wiley and Sons.
5. Primrose, S. B., & Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics.
6. Green, MR. and Sambrook, J., Molecular Cloning: A Laboratory Manual, Cold Spring Harbor Lab, NY.

Course code	Title	Lectures
US-MLSC-P203	**Practicals based on Genetic Bioengineering**	**30**
	• Bacterial gene expression (using Lac promoter system). • Restriction enzyme digestion and Ligation. • PCR amplification of 16S rRNA and Amplicon molecular size determination. • RT-PCR from suitable source. • Bacterial Gene Expression and GFP cloning. • Southern Hybridization. • Protein purification: a. Salt precipitation. b. Affinity chromatography.	

DSE II -
REMOTE SENSING, ENVIRONMENTAL MONITORING AND INSTRUMENTS IN MONITORING AND ENVIRONMENTAL MODELLING

Course code	Title	Lectures
US-MLSC-DSE-201	**Remote Sensing, Environmental Monitoring and Instruments In Monitoring and Environmental Modelling**	**45**
	Unit I: Remote Sensing , GIS And GPS **1. Remote Sensing:** a. Active and Passive Remote Sensing. b. Principles and Basic Concepts of Remote Sensing. c. Aerial Photography and image recognition. d. Sensors & platforms. e. IRS satellites & their sensors. f. Application of remote sensing in environmental studies (Land use mapping, Forest survey and Habitat analysis, Water management, Drought monitoring and flood studies, Wetland survey , Rainfall estimation, Pollution studies, Soil conservation , Watershed management, Vegetation mapping). **2. Geographical Information System (GIS):** a. GIS - Basic principles, Techniques, Application in Environmental Sciences. b. Types of Geographical Data; Data Structure; Vector and Raster data: their Advantages and Disadvantages. c. Components of GIS, Hardware, Software and Organization Context. d. Data: Spatial and Non-Spatial. e. Data Input: Digitizer, Scanner: Editing, Raster and Vector data structures: Comparison of Raster and Vector Data Structure. f. Analysis using raster and Vector Data: Retrieval, Reclassification, Overlaying, Buffering: i. Data Output: Printers and Plotters. ii. Importance of Geographical Information System in environmental studies. **3. Global Positioning System (GPS):** a. Basic principles. b. Applications to Environmental studies. c. Point source pollution. d. Hazard monitoring and Assessment.	**15**
	Unit II: Environmental Monitoring And Instruments In Monitoring **1. Environmental Monitoring:** a. Environmental Quality with reference to Air, Water and Soil. b. Deterioration of Environmental Quality and Role of Anthropogenic activities. c. Methods of assessment of Environmental quality: Short-term studies/surveys; Rapid assessment; Continuous short; Long-term monitoring. d. Advantages of Environmental Monitoring. **2. Instruments in Monitoring:** a. Sampling Techniques of Air, Water and Soil b. Photometric and Spectrometric Methods of Analysis: ICP-OES, FLAME ETC. c. Electro-analytical Methods: Potentiometry, Conductometry, Voltammetry d. Chromatographic Methods of Analysis - LC, HPLC, UPLC, GC	**15**

	Unit III: Environmental Modeling **1.** Definition, Classification, Examples of models for environmental systems. **2.** Introduction to Air Quality models; Meteorology, Atmospheric stability and turbulence, Gaussian plume model and modifications. **3.** Introduction to River, Estuarine and Lake Hydrodynamics, Stratification and Eutrophication of lakes. Dissolved oxygen model for streams, Temperature models. **4.** Transport and fate of pollutants in Aquatic systems. **5.** Noise Modelling - Fundamentals of the Noise, Noise and Sound intensity, Power, Pressure, Noise Attenuation, methods and calculations, Noise scales and ratings, Highway Noise Model. **6.** Highway Noise Barriers and their designs, Noise Contouring Estimation of Noise Impacts. **7.** AutoCAD for designing of an ETP/STP/CETP- equipment layout, Hydraulic profile, P&ID	**15**

Course code	Title	Lectures
US-MLSC-DSE-P201	**Remote Sensing, Environmental Monitoring &Instruments in Monitoring and Environmental Modeling**	**30**
	• Interpretation of Aerial photographs and preparing weather reports based on it. • Interpretation of Afforestation/Deforestation Photographs from with the help of drone. • Data retrieval from satellite and determination of Chlorophyll A content • Determination of Relative Humidity • Biodiversity Index Reporting • Preparation of EIA • GIS/GPS based mapping of waste collection sites / waterbody / industrial zones	

Outcome:

1. Prepare EIA.
2. Interpret Aerial photographs to prepare weather reports.
3. Learn to use the Google Search Engine.
4. Data retrieval from satellite.
5. Use of GPS / GIS.

References:

1. Burough, P.A. and McDonnel, R. 1998. Principles of Geographical Information Systems. Oxford University Press, NY.
2. Campbell, J.B. (2nd Ed), 1996. Introduction to Remote Sensing. Taylor and Francis.
3. Christopher, J. 1997. Geographical Information Systems and Computer Cartography. Longman.
4. Reeves, Robert G. 1999. Manual of Remote Sensing, (Vols. I & II). American Society of Photogrammetry and Remote Sensing, USA.
5. Sabins, F. F. Jr. (2nd Ed). 1986. Remote Sensing: Principles and Interpretation. W.H. Freeman & Co.
6. 7.Environmental Impact Analysis by Jain R.K. & Others Pollution Management in Industries by Trivedi R. K. ISO14001 by Schoffman A. Tordini A.
7. Environmental Impact Assessment by Canter Larry W.
8. Environmental Auditing by A.K. Srivastava.
9. Handbook Of Environmental Laws, Acts Guidelines, Compliances & Standards Vol-I & VII by R.K. Trivedi.
10. Atmospheric Chemistry and Physics by Seinfeld, J.H and Pandis, S.N.
11. Principles of Surface Water Quality Modelling and Control by Thomann, R.V and Muller, J.A.
12. Survival models and data analysis: Elandt. Johnson and Johnson, John wiley and sons Inc.
13. Mathematical models in Biology and Medicine: J. N. Kapur Affiliated East-west press Pvt. Ltd. Bangalore.
14. Remote Sensing and GIS - M. Anji Reddy Principles of GIS for Land - Burrough P.A. Resources Assessment.

Industrial Training:

- Learners shall be required to go for Industrial training (4 credits) of four weeks during summer vacation after completion of Semester II examination and submit a Industrial Training Report.
- The training will be evaluated during Semester IV on the basis of a report and presentation.
- Dissertation:
- Dissertation based on project work the project work (10 credits) will be carried out by the Learners in Semester IV and work will be evaluated on the basis of dissertation and presentation.
- Field Study:
- Field Study and Report thereof Learners are required to visit any local industry, river or other site and prepare a study report thereof in Semester II.
- The field study will be evaluated on the basis of report and presentation.
