HSNC UNIVERSITY, MUMBAI
Board of Faculty of Science & Technology
Board of Studies in the Subjects of Life Sciences

1. **Name of Chairperson/Co-Chairperson/Coordinator: -**
    a. **Dr. Sagarika Damle –Chairperson–** Associate Professor, Head, Department of Life Sciences, sagarika.damle@kccollege.edu.in, 9820360383
2. Two to five teachers each having minimum five years teaching experience amongst the full time teachers of the Departments, in the relevant subject.
    a. **Dr. Tejashree Shanbhag** Associate Professor, Department of Life Science, K. C. College, tejashree.shanbhag@kccollege.edu.in ,9892370263
    b. **Dr. Shalini Rai** Associate Professor, Department of Life Science, K. C. College, shalini.rai@kcollege.edu.in ,9987326613
    c. **Dr. (Ms.) Aashu Vajpai** Assistant Professor, Department of Life Science, K. C. College, aashu.vajpai@kccollege.edu.in ,97020 73377
    d. **Dr. Suvarna Sharma** Assistant Professor, Department of Life Science, K. C. College, Suvarna.sharma@kccollege.edu.in, 9869525362
3. One Professor / Associate Professor from other Universities or professor / Associate Professor from colleges managed by Parent Body ; nominated by Parent Body;-
    a. **Dr. Jacinta D'souza** Professor, School of Biological Sciences, UM-DAE Center for Excellence In Basic Sciences, University of Mumbai jacintad@gmail.com 9820770314
4. Four external experts from Industry / Research / eminent scholar in the field relevant to the subject nominated by the Parent Body;
    a. **Dr. Deepak Modi** - Eminent Scholar Research Scholar Scientists- F Molecular and Cellular Biology NIRRH, Parel Mumbai, deepaknmodi@yahoo.com, 9987176249
    b. **Dr. Seema Das –** Researcher - Head of the Department Department of Life Science & Biochemistry St. Xavier's College, Autonomous 5, Mahapalika Marg, Mumbai-400 001, seema.das@xaviers.edu, 9820384851
    c. **Dr. Laxmikant Deshpande –** Industry expert Industry Expert Wetland Management System, Godrej & Boyce Mfg. Co. Ltd, Vikhroli, Mumbai amartd@godrej.com , 9167344890
    d. **Dr. Ahmad Ali –** Researcher, Assistant Professor, Department of Life Sciences UDLS, Kalina Campus, Vidyanagari, Santacruz, Mumbai 400098, ahmadali@mu.ac.in , 9870941656

5. 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.
    a. **Dr. Anuja Pande -** Research scholar – Alumnus, SRI International-Post Doctoral Fellow, Virginia USA, anuja.pande@gmail.com , 001-225-610-8801
    b. **Dr. Fatema Bhinderwala**- Academician – Alumnus, Coordinator- Certificate course in Bioinformatics, Sophia college, Mumbai, fatema3010@gmail.com , 9819657642
    c. **Dr. Hitesh Goswami -** Industry Alumnus, Entrepreneur CEO- 4basecare, Bangalore, hitesh@4basecare.com , 7892138638

Part –I

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

R. **: The Definitions of The Key Terms Used in The Choice Based Credit System And Grading System Introduced From TheAcademicYear2020-2021AreAs Under:**

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

2. **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.

   2.1 **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 main discipline/subject of study).

   2.2 **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.

   2.3 **Generic Elective (GE) Course:** An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective. 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.

3. **Choice Base Credit System:** CBCS allows students 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 students.

4. **Honors Program:** To enhance employability and entrepreneurship abilities among the learners, through aligning Inter Disciplinary / Intra Disciplinary courses with Degree Program. Honours 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 Honours Program in the first year of the Program. However, the credits for honours, though divided across three years can be completed within three years to become eligible for award of honours Degree.

5. **Program:** A Program is a set of course 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.

6. **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'.

7. **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.

8. **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.

9. **Self-Learning: 20% of the topics will be marked for Self-Learning.** Topics for Self-Learning are to be learned independently by the student, in a time- bound manner, using online and offline resources including online lectures, videos, library, discussion forums, fieldwork, internships etc.

   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 students' learning achieved in the topics are marked 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 students, in the course of the Self-Learning process.

   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.

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 preferably before the commencement of a semester. Some exceptions may be made in exigencies, like the current situation arising from the lockdown, but such adhoc decisions are to be kept to the minimum possible.

10. **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 especially prepared videos, writing assignments, preparing for examinations, etc. 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 30 to 40 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 successfully more and more courses. 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

O*** The fees for transfer of credits or performance will be based on number of credits that a learner has to complete for award of the degree.**

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.

INTERNAL ASSESSMENT: - It is defined as the assessment of the learners on the basis of continuous evaluation as envisaged in the credit-based system by way of participation of learners in various academic and correlated activities in the given semester of the programme.

A). Internal Assessment – 40% 40 marks

Practical's (internal Components of the Practical Course

1. For Theory Courses

Sr. No.	Particulars	Marks
1	**ONE** class test / online examination to be conducted in the given semester	15 Marks
2	One assignment based on curriculum (to be assessed by the teacher Concerned	10 Marks
3	Self-Learning Evaluation	10 Marks
4	Active participation in routine class instructional deliveries	05 Marks

2. For Courses with Practicals

Each practical course can be conducted out of 50 marks with 20 marks for internal and 30 marks for external

Practical's (Internal component of the Practical Course)

Sr. No	Evaluation type	Marks
1	Two Best Practicals /Assignments/Presentation /Preparation of models/ Exhibits **Or** One Assignment/ project with class presentation to be assessed by teacher concerned	10
2	Journal	05
3	Viva	05

The semester end examination (external component) of 60 % for each course will be as follows:

i) **Duration** – **2 Hours** ii) **Theory Question Paper**

Pattern: -

1. There shall be four questions each of 15 marks. On each unit there will be one question and the fourth one will be based on entire syllabus.
2. All questions shall be compulsory with internal choice within the questions. (Each question will be of 20 to 23 marks with options.)
3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depend on the weightage of the topic.

The marks will be given for all examinations and they will be converted into grade (quality) points. The semester-end, final grade sheets and transcripts will have only credits, grades, grade points, SGPA and CGPA.

3. **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.

4. **Self-Learning Evaluation**

- **20% OF THE TOPICS OF CURRICULUM ARE LEARNED BY THE STUDENT THROUGH SELF LEARNING USING ONLINE / OFFLINE ACADEMIC RESOURSE SPECIFIED IN THE CURRICULUM.**

- **HENCE 20% OF THE LECTURES SHALL BE ALLOCATED FOR EVALUATION OF STUDENTS ON SELF LEARNING TOPICS**

- The identified topics in the syllabus shall be learnt independently by the students 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**

  3 Sub Topics
  Each evaluative session shall carry 3 Marks (3 x 3 Units = 9 Marks). Students who participate in all evaluative sessions shall be awarded 1 additional Mark.
  4 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**

  3 Evaluative sessions
  Each evaluative session shall carry 3 Marks (3 x 3 = 9 Marks). Students who participate in all evaluative sessions shall be awarded 1 additional Mark
  4 **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
- Group discussion
- You-Tube videos (Marks shall be based on the quality and viewership)
- Improvisation of videos
- Role Play followed by question-answers

TEACHERS CAN FRAME OTHER METHODS OF EVALUATION ALSO PROVIDED THAT THE METHOD, DULY APPROVED BY THE COLLEGE EXAMINATION COMMITTEE, IS NOTIFIED TO THE STUDENTS AT LEAST 7 DAYS BEFORE THE COMMENCEMENT OF THE EVALUATION SESSION AND IS FORWARDED FOR INFORMATION AND NECESSARY ACTION AT LEAT 3 DAYS BEFORE THE COMMENCEMENT OF THE EVALUATION SESSION

- Viva Voce
- Any other innovative method

SEMESTER END EXAMINATION: - It is defined as the examination of the learners on the basis of performance in the semester end theory / written examinations.
B. Semester End Examination-60 % ***60 Marks***

1) Duration – These examinations shall be of 2 Hours duration.
2) Question Paper Pattern: -
   i. There shall be four questions each of 15 marks.
   ii. All questions shall be compulsory with internal choice within the questions.
   iii. Question may be sub-divided into sub-questions a, b, c, d & e only and the allocation of marks depends on the weightage of the topic.

THE MARKS OF THE INTERNAL ASSESSMENT SHOULD NOT BE DISCLOSED TO THE STUDENTS TILL THE RESULTS OF THE CORRESPONDING SEMESTER IS DECLARED.

HSNC University Mumbai
(2021-2022)

Ordinances and Regulations
With Respect to
Choice Based Credit System (CBCS)

For the Programmes Under
The Faculty of Science and Technology

For the Course
Life Sciences

Curriculum – Second Year Undergraduate Programmes
Semester - III and Semester - IV

2021-2022

Section C
Life Sciences

Part 1: Preamble

The knowledge of Physiology is crucial for understanding and evaluating underlying biological processes, behavioral states and animal response to different biological, social and environmental stimuli. Comparative approach to Physiology emphasizes the synchronous working of Endocrine system and Nervous system. This provides a cohesive understanding of physiology by comparing and contrasting diverse mechanisms. Further understanding normal physiology also provides an insight on any kind of malfunctioning which may lead to a disease or disorder. It also highlights the role of the Immune System in curbing the pathogens and furnishes the knowledge on several prophylactic, preventive measures and treatments of disease.

Living system consists of organic complexities that in various permutations and combinations makeup the organism. To understand the comprehensive functioning of a cell from prokaryotic or eukaryotic origin it is necessary to study it at molecular level. Knowledge of the biochemical and physical principles behind their regulation and integration is the key to deciphering the living complexity.

Population dynamics of the human population is not only dependent on biological forces but also social forces. Evolutionary concepts and Population studies offer the learners an insight into the basics in Evolution with the underlying principles of Genetic forces. Quantification is an important aspect of modern biology. To understand biological variation and its quantification, an insight for designing experiments and knowledge of different statistical tools and techniques is necessary. Bioinformatics is the necessary tool to visualize and interpret the biological data using '*In-silico*' methods.

1. Course objective:

Paper I:

- The learner would understand Physiology as an experimental scientific discipline which is of central importance in medicine and related health sciences. It provides a thorough understanding of normal body function, enabling more effective treatment of abnormal or disease states.
- Comparative approach to Physiology should indicate and remind learners that in isolated, narrow sub disciplines there is also a wealth of information that can be obtained from unrelated and distant organisms. Thus, comparing diverse mechanisms provides a cohesive understanding of physiology.
- An emphasis on plant and animal physiology is crucial for understanding and evaluating underlying biological processes, behavioural states, plant and animal response to different biological, social and environmental stimuli. Learners would understand how organisms, organ systems, organs, cells, and bio-molecules carry out the chemical or physical functions that exist in a living system.

Paper II:

- Learners shall be able to develop skill and acquire knowledge in fundamentals of Biochemical phenomena and will develop disciplinary approach towards theory and practical in the diversified areas of Biochemistry.
- To develop in depth knowledge and understanding of biomolecules, key biochemical concepts, principles and theories related to the subject
- To equip learners with appropriate tools of analysis in different areas of Biochemistry ranging from Metabolism, Nutrition, Plant Biochemistry, Enzymology, Clinical Biochemistry and Molecular Biology with respect to theoretical, practical, and analytical skills to address the queries in the area of study.
- To provide learners with the knowledge and skill base that would enable them to undertake further studies in biochemistry and related multidisciplinary areas.

Paper III:

- Study of Evolution orients the learner to trace back the history of Evolution and the major evolutionary concepts put forth by eminent scientists.
- The topic of Speciation strengthens the understanding of interdependence of species with one another within the Ecosystems. By studying Population Genetics, learners will understand the concepts of allelic changes in response to natural selection, genetic drift, mutation, and gene flow.
- Biostatistics, enables the learner to handle the biological data with an emphasis on concepts of Qualitative and Quantitative data management.
- The use of software tools in visualizing and analysing molecular data would be the prime focus of the Bioinformatics unit. It will also enable the learners to acquaint themselves with basic computational languages used for Bioinformatics.
- A well-equipped learner can be prompted to pick up some project ideas and implement them.

2. Process adopted for Curriculum Designing:

- This curriculum for the Second Year Students of Life Sciences has been developed by maintaining a student centric learning pedagogical approach, which has been further aimed at being outcome-oriented and curiosity-driven.
- Using creative and Bloom-based approach, rote -learning has been avoided and imaginative abilities of the students have been fostered. The curriculum has been designed to be more inclined towards self-discovery of concepts.
- Feedback from the stakeholders, including the students, subject experts, alumni and industry partners has been referred to in the up-dation of the syllabus.
- Modifications and changes have been done in the syllabus with respect to the current needs and requirements of the industrial professionals' sectors of the subject.

3. Relevance of Revised Curriculum: Salient features

Paper I:

Semester III

- The revised syllabus has incorporated the classification of Endocrine glands on the basis of their mode of action for better understanding of functioning of the Endocrine system.
- An overall description of the Nervous system has been done by inclusion of Autonomic Nervous System. Addition of Neuromuscular junction and Chemical Synapses with Acetylcholine as an example helps in understanding of transmission of impulses. Role of Phytochrome in controlling plant movements has been introduced as it is one of the most important photoreceptors that influences plant development. Circadian Rhythm in plants has been introduced to understand the plants movements.
- *Dictyostelium discoideum* has been introduced as an example of Fruiting body formation in Slime molds to have a better understanding of Alternation of generations in plants with the existing example of *Adiantum.* PCOS/PCOD being the most prevailing female reproductive disorders it has been included.

Semester IV

- An introduction of Anandamide along with the existing hormones involved in energy balance for understanding the Fuel Homeostasis. An overview of Shikimic pathway, role of secondary metabolites and enzymes is introduced to understand Plant defense mechanism. Inclusion of COVID-19 and Mucormycosis has been done for educating the learner regarding the Current Pandemic.
- Botulism as an example of Foodborne infection, Leptospirosis as a bacterial disease have been introduced giving an emphasis on different types of infection with respect to the source of infection. In lieu of the prevalence of its susceptible infection in the Mumbai Metropolitan Region.

Paper II:

Semester III

- An inclusion of 7th class of Translocase enzymes and effect of additional environmental factors of light and salt on enzyme action is included to broaden the understanding regarding the enzymes. Inclusion of more examples from Industry would acquaint the learners with importance of enzymes in Pharmaceutical and Food Industry.
- History with elucidation of the catabolic nature of the two important pathways of Carbohydrate metabolism- Glycolysis and Citric Acid cycle was added to make students understand and get interested in the subject and relate better with the subject.
- A Concept of Free energy and ATP as “Energy Currency” is added for better understanding of Bioenergetics. Oxidative damage to Mitochondria with medical/ application-based study related to Huntington’s and Parkinson’s disease is added, to make the learner aware of the importance of these metabolic pathways and energetics of the cell.
- Introduction about the mobilization and transport of lipids is included along with catabolism of lipids. To understand the abnormalities in absence of Urea cycle hormones, the topic of genetic defects is included.

Semester IV

- Cholesterol being one of the most important lipids in Animal Physiology, the topic of biosynthesis and regulation is introduced. Electron Transport in Photosynthetic bacteria is added to provide the learner with the understanding of the role of water and other sources during photophosphorylation and also comparing the two pathways.
- Salvage pathways for Pyrimidine is a new addition along with the *de novo* synthesis of Purine and Pyrimidine nucleotides which will provide learners with the basis of selection of drugs as metabolic blockers and inhibitors.
- Overview of cDNA is introduced to understand it as a biomolecular tool. Tools and Techniques used in the study of Molecular Phylogeny is introduced for better understanding of the analysis of the molecular data.

Paper III:

Semester III:

- Introduction to Evolution with an emphasis on theory of Abiogenesis and Lamarckism in addition to Theory of Natural Selection has been done for a holistic understanding of the process of evolution.
- The addition in Biostatistics helps the learner to have a clear understanding of the basics and applicability in the fields of Research and Industry. Inclusion of software-based applications and languages useful in Bioinformatics will acquaint the learners with basics in programming skills.

Semester IV:

- Geological Time Scale has been introduced to trace down the evolutionary history of organisms. Introduction of statistical software tools will provide support for the theory-based topics and make the learners Industry ready.
- As per the recent demand in the industry, an introduction of new software tools, would equip the learner to manage and analyse biomolecular data.

4. Learning Outcomes:

- A Comparative approach to Physiology with reference to Control and Coordination in plants and animals would make the learners more interested in Physiological processes. This knowledge can be extrapolated to Model systems for an in-depth study in the subject.
- Learners will develop an ability to relate various interrelated physiological and metabolic events of any biological system. The students will learn about analysis of experimental or secondary data and will be encouraged to apply the tools of Statistics in Biological research problems.
- Learners will be able to develop good experimental and quantitative skills encompassing preparation of laboratory reagents, conducting experiments, analyses of data and interpretation of results. Learners would develop a keen interest and aptitude to work safely and effectively in a laboratory.

- Acquiring the understanding about the basic Life processes, would prompt the learners to take up projects in the areas related to Cell signalling, Defence mechanisms, Phytochemistry, Disease Biology, Biochemistry, Population Genetics and Bioinformatics.
- Learners will develop an ability to critically evaluate a problem and find a solution based on scientific concepts.
- Learners will be aware of the current developments in different disciplines of Biological Sciences and avenues for research and higher academic achievements in Life Sciences.

5. **Input from stakeholders (Which Sections have been modified) with relevant introduction:**
   - The suggestion of the members of the Board of Studies to provide a holistic learning approach of theory and practicals are incorporated.
   - More training and application-based approaches need to be introduced which will help learners apply their knowledge in the subject to their Post graduate studies and in research work.
   - More hands-on and skill-based practical sessions have been added in Biochemistry, Phytochemistry and Microbiological experiments.
   - Emphasis should be on the use of digital record maintenance and understanding of specimens *in lieu* of ethics.
   - To modify syllabus to make learners aspire for Higher education, confident of clearing entrance exams, be industry oriented and employable after Graduation.
   - To help learners to develop generic skills, self-employment and entrepreneurship.

HSNC, UNIVERSITY, MUMBAI
KISHINCHAND CHELLARAM COLLEGE
SECOND YEAR B.Sc. LIFE SCIENCES SYLLABUS
Academic Year 2021-22

Sr. No.	Choice Based Credit System			Subject Code	Remarks
1	Core Course (Life Sciences)			USLSC 301 USLSC 302 USLSC 303 USLSC 3P1 USLSC 3P2 USLSC 3P3	NIL
2	Elective Course	Discipline Specific Elective (DSE) Course		-	
		2.1	Interdisciplinary Specific Elective (IDSE) Course	-	
		2.2	Dissertation/Project	-	
		2.3	Generic Elective (GE) Course	-	
3	Ability Enhancement Courses (AEC)			US-SFC	
	Skill Enhancement Courses (SEC)			-	

Evaluation Pattern:

Second Year B.Sc.- Semester III
Internal and External Assessment Details: (60-40 Pattern)

Sr. No	Subject Code	Subject Title	Periods Per Week							Seasonal Evaluation Scheme				Tot al Mark s
			Unit s	S. L.	L	T	P		Cre dit	S. L. E	C T	T A	SEE	
1	USLSC 301	COMPARATIVE PHYSIOLOGY	3	20 % *	3	0	0		2	10	20	10	60	100
2	USLSC 302	LIFE PROCESSES AT THE TISSUE, ORGAN AND ORGANISM LEVELS A BIOCHEMICAL APPROACH	3	20 % *	3	0	0		2	10	20	10	60	100
3	USLSC 303	POPULATION APPROACH: POPULATION AND COMMUNITIES AS REGULATORY UNIT	3	20 % *	3	0	0		2	10	20	10	60	100

3	USLSC 3P1, 3P2, 3P3	**PRACTICALS BASED ON COURSE 1 OF THEORY**			**0**	**0**	**9**		**2**				**50 (30+20)**	**150**
	Total Hours / Credit								**06**	**Total Marks**				**450**

***Three lectures/Unit to be taken for CONTINUOUS Self - Learning Evaluation**

Second Year Semester – III Units – Topics – Teaching Hours

S.N	Subject Code	Subject Unit Title		Hours/ Lectures	Total No. of hours/lectures	Credit	Total Marks
1	USLSC 301	I	Homeostasis	15	45 L	2	100 (60+40)
		II	Control and Coordination in Plants and Animals	15			
		III	Developmental Biology	15			
2	USLSC 302	I	Enzymes and their Environment	15	45L	2	100 (60+40)
		II	Metabolism - Energy from Carbohydrates	15			
		III	Metabolism - Energy from Lipids and Proteins	15			
3	USLSC 303	I	Concepts in Evolution and Population Genetics	15	45L	2	100 (60+40)
		II	Biostatistics	15			
		III	Bioinformatics	15			
4	USLSC 3P1	I	Practical based on Paper 1 of theory	3	45x2= 90L lectures per batch	2	100 (80+10+10)
	USLSC 3P2	II	Practical based on Paper 2 of theory	3			
	USLSC 3P3	III	Practical based on Paper 3 of theory				
			TOTAL			6	300

- **Lecture Duration – 48 Minutes**
- **One Credit =15 Classroom Teaching Hours**

SYLLABUS OF S. Y. B. SC LIFE SCIENCES
(Semester Based Credit and Grading System)
To be implemented from Academic year 2021 - 2022

Semester III
USLSC 301 – Paper I – Theory – Control and Coordination

Unit I	**Homeostasis**	**(15L)**
	A. Homeostatic mechanisms and Cellular communication	
	a. Control systems in homeostasis and components of homeostatic control	1
	b. An overview of cell signalling and biochemical basis of cell signalling – Release, Transport and Storage of chemical messengers, communication of signal to target cell	2
	B. Cell signalling in the Nervous system and Endocrine system	
	a. Receptors and Regulation (up and down regulation)	3
	b. Regulation of cell signalling: 1^{st}, 2^{nd} and 3^{rd} order feedback mechanisms.	
	C. An Overview of Endocrine glands and their hormones	
	a. Classification of hormones on the basis of their nature and mode of action	1
	i. **Group I hormones** – Steroid and Thyroid hormones	
	ii. **Group II hormones** – Peptide hormones (Insulin and Glucagon) and amines (Catecholamine)]	
	b. **Endocrine glands** - Hypothalamus, Anterior Pituitary, Pineal, Thyroid, Parathyroid, Pancreas, Adrenal cortex, Testis and Ovary.	4
	D. Overview of Ecdysone Steroid hormone	
	E. Plant hormones and their role in Homeostasis - Ethylene, Cytokinin, Abscisic acid, Gibberellic acid, Auxins (Structure and Functions)	1 3
Unit II	**Control and Coordination in Plants and Animals**	**(15L)**
	A. Animals:	
	a. Phylogenetic development of the Nervous System – Nerve net- Hydra, Nerve plexus- Starfish and Ganglionated nervous system-Earthworm.	1
	b. Human Nervous System – Central, Peripheral and Autonomous Nervous Systems	3
	c. Nature of the Nerve Impulse – Resting potential, Action Potential	1
	d. Transmission of Nerve impulses	2
	i. Synapses-Nervous, Neuromuscular	
	ii. Chemical Messengers: Acetylcholine	
	e. Behaviour and behavioural adaptations (Neuronal) – Overview of Innate and Learned behaviour Eg. Behavioural Strategies in Bird Migration (Physiological Aspect-Accumulation of body fat and thermoregulation)	3

	B. Plants: a. Plant movements – Tropisms, Taxes, Nasties and Kinesis – discuss with suitable examples with reference to physiology b. Study of Phytochrome and its role in plant control and coordination c. Circadian Rhythm in Plants	 2 2 1
Unit III	**Developmental Biology**	**(15L)**
	A. Reproduction and Development a. Basis of Sex Determination i. In Plants: Maize ii. In Animals: Role of SRY gene and Aromatase iii. Role of environmental factors in sex determination in plants and animals, E.g., Turtles (Animal), *Equisetum* (Plant) b. Parthenogenesis E.g., Honey Bees c. Plant-animal interaction for reproduction e.g., Fig wasp d. Sex Reversal e. Alternation of generations in plants e.g., *Adiantum,* Fruiting body formation in Slime molds *(Dictyostelium discoideum)* f. General Principles of Gametogenesis in Human Reproductive system i. Sex differentiation of gonads, internal and external genitalia ii. Spermatogenesis and Oogenesis iii. Ovarian and testicular functions, Puberty and regulation of uterine changes in Menstrual cycle, Menopause iv. Female Reproductive Disorders- PCOS/PCOD **B. Development in Plants** i. Microsporogenesis and Megasporogenesis. ii. Types of ovules and Double fertilization/ Triple fusion. iii. Development of embryo in monocot and dicot plants **C. Early Development in Animals:** Embryo Development- Till Gastrulation in Frog.	 3 1 1 1 1 4 3 1

Unit	SELF LEARNING EVALUATION	SUGGESTED LINKS
I	**Homeostasis**	
	1. Arthropod moulting (steroid) hormone: Ecdysone 2. Abnormalities of Endocrine hormones 3. Effect of environmental factors on production of Plant hormones	- https://projects.ncsu.edu/cals/course/ent425/library/tutorials/internal_anatomy/molting.html - https://www.niddk.nih.gov/health-information/endocrine-diseases
II	**Control and Coordination in Plants and Animals**	
	1. Habituation as a Learned Behaviour with an example of Aplysia 2. Reflex as response 3. Imprinting	- https://www.coursera.org/learn/neurobiology - https://onlinecourses.nptel.ac.in/noc21_ge17/preview - https://onlinecourses.nptel.ac.in/noc21_e

		e101/preview - https://www.etoosindia.com/courses/neet/500518/neural-control-and-coordination-by-aa-mam/detail.do
III	**Developmental Biology**	
	1. Role of Environmental factors in Sex Determination – Ants/ Termites 2. Parthenogenesis in wasps 3. Alternation of generation in *Pteris* 4. Pregnancy, Parturition, Lactation	- https://onlinecourses.swayam2.ac.in/cec20_bt03/preview - https://opentextbc.ca/biology/chapter/13-1-how-animals-reproduce/

PRACTICAL - USLSP1

(Based on paper I)

Note: C, R, T, I → Concept, Relevance, Technique, Instrumentation

A. **Instrumentation / Technique (I /T**)	
B. **Process / Concept and immediate Relevance (C, R)**	
a. Extraction, Purification techniques	
b. Analysis / Estimation	
c. GLP (Good Laboratory practices) incorporated into every practical	
C. Practical aspect of the paper will also be supported by Research papers to understand the application of the learned techniques and advantages in the field.	
D. Evaluation and internal assessment can be made by ATP (Alternative to Practical) questions.	
1. Good Laboratory Practices – Role of QA/QC/Material Safety Data Sheet (MSDS) (**C, R)**	1
2. Demonstration of Reproductive system and location of Endocrine glands in Albino Mouse Male and Female (Preserved specimen/ Model/ Virtual dissection). **(C, R, T)**	4
a. Reproductive system	
b. Endocrine Glands	
3. Study of Histology of Endocrine glands of Mammal from Permanent slides. **(C, R, T)**	1
4. Demonstration of Microtome technique and preparation of slides from plant/ animal tissues. **(C, R, T, I)**	1
5. Study of Developmental stages of Frog (Egg to Tadpole to Adult). **(C, R)**	1
6. Study of Floral parts from the given flower (*Hibiscus* and *Pancratium*) Study of microscopic structure of Anthers, Ovules, Seed structure (Maize/ Okra/ Any other suitable plant seed) (One dicot and one monocot seed). **(C, R, T)**	1
7. Study of Pollen germination Using *Vinca* flower (*in vitro*) **(C, R, T)**	1
8. a. Study of Pollen germination in *Vinca* (*in vivo*) and tracing the path of the Pollen tube along the stylar canal using Aniline blue stain. **(C, R, T)**	1
b. Study of inhibitory effect of some chemical/ environmental factors on Pollen germination. **(C, R, T)**	1
9. Detection of activity of Gibberellic acid in Seed germination (Dose dependent response). **(C, R, T)**	1
10. Observation and Study of locally collected Leaf Gall and any other one plant disease. **(C, R, T)**	1

USLSC 302 – PAPER II – THEORY
Life Processes at the Tissue, Organ and Organism Levels
A Biochemical Approach -I

Unit I	**Enzymes and their Environment**	**(15L)**
	1. Classification (With one example of each type) (Inclusive of the 7th Class of Translocases EC 7)	2
	2. Effect of Environmental factors on Enzyme Action- Effect of pH, Temperature, Salt and Water, Light	2
	3. Co-enzymes and Cofactors: NAD, FAD, Mn, Mg, Zn and Cu (One reaction each with significance and application)	2
	4. Kinetics- Concept of Km and Vmax - Michaelis Menten equation and Lineweaver Burk plot	3
	5. Regulation of Enzyme action: Activators, Inhibitors and Feedback Mechanism	3
	6. Allosteric enzymes (Kinases in Glycolysis) and their significance in metabolic regulation- E.g., Carboxylase in Animals and Phosphorylation enzymes in plant	2
	7. Overview of Extraction, Purification and Specific activity	1
Unit II	**Metabolism - Energy from Carbohydrates**	**(15L)**
	A. Carbohydrate metabolism: a. History and elucidation of pathways b. Glycolysis- Process and metabolic regulation c. Citric Acid Cycle – Process and metabolic regulation d. Importance as a central amphibolic pathway unifying all primary biological processes	8
	B. Bioenergetics: a. Basic Thermodynamics: Concept of Free energy b. Electron Transport System: i. Localisation ii. Sequence of Electron Transporters iii. ATP as Energy currency - Structure of ATP Synthase Complex	3
	C. Oxidative Phosphorylation a. Mitchell's Chemiosmotic Hypothesis b. ATP synthesis c. Control of respiration, uncoupling and metabolic poisons d. Oxidative damage to Mitochondria: Huntington's & Parkinson's Disease	4
Unit III	**Metabolism - Energy from Lipids and Proteins**	**(15L)**
	A. Lipids - Catabolism: a. Digestion mobilization and transport of Fatty acids b. Lipolysis c. Role of Carnitine in Mitochondrial permeability	7

	d. Beta– Oxidation of fatty acids and integration into Kreb's bicycle e. Overview of Ketone bodies and their significance **B. Amino Acids - Catabolism**: a. Protein Degradation liberating amino acids b. Deamination & ammonia disposal by Urea cycle, Genetic defects in Urea cycle- A Biochemical approach. c. Decarboxylation & integration into Kreb's bicycle	8

Unit	SELF LEARNING EVALUATION	SUGGESTED LINKS
I	**Enzymes and their environment**	
	1. Techniques of Enzyme Purification: Dialysis, Gel-filtration, Ion-exchange, Affinity chromatography and Spectrophotometry 2. Specific Enzymes with their actions- RuBisCO, LDH, Invertase, Endonuclease 3. Industrial Applications of Enzymes	https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=2
II	**Metabolism - Energy from Carbohydrates**	
	1. Glycolysis- Brief Historical background and overview 2. Citric Acid Cycle – Brief Historical background and overview 3. Role of Uncouplers- DNP- Thermogenesis **4.** Metabolic poisons – in Drug discovery	https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=2 - Path- P-04- M-03, M-30
III	**Metabolism - Energy from Lipids and Proteins**	
	1. Ketone bodies and their significance 2. Catabolic pathways for Alanine, Glycine and Serine 3. Catabolic pathways for Cysteine, Tryptophan, and Threonine	https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=2 - Path- P-05 https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=2 - Path -P-14

USLSP2

Practical Based on Paper II

Note: C, R, T, I → Concept, Relevance, Technique, Instrumentation

A. **Instrumentation / Technique (I /T**)
   a. pH Metry
   b. Colorimetry - Titration

B. **Process / Concept and immediate Relevance (C, R)**
   a. Extraction, Purification techniques
   b. Analysis / Estimation
   c. GLP (Good Laboratory practices) incorporated into every practical
   d. Acid, bases and buffers

C. Practical aspect of the paper will also be supported by Research papers to understand the application of the learned techniques and advantages in the field.

D. Evaluation and internal assessment can be made by ATP (Alternative to Practical) questions.

I.	**pH meter - (I, C, T)**	
	1. Principle & Instrumentation	1
	2. Determination of pH (titration of Acids/Bases/Buffers/ 'chameleon balls'). *(In FY the students are introduced to the concept of pH measurement of familiar liquids-here tech & details are given- practically understanding buffering using **Glycine / titration curve)***	1
	3. **Protein precipitation by pH manipulation** (Casein from Milk/ Curds) *(From previous experiment and pH manipulation, proteins are precipitated **(C, R)***	1
II.	**Enzymology:**	
	4. Effect of Temperature/pH/Inhibitors on enzyme action	1
	5. Histochemical localization of Enzymes (Acid Phosphatase) **(C, T)** *(Enzyme activity can be localized)*	1
	Study of Enzyme activity and Kinetics:	1
	6. Extraction and purification of enzyme (Using suitable techniques- Column Chromatography and Dialysis)	1
	7. Determination of Km of enzyme e.g., Urease (from Jack beans)/Lipase/Protease (from Detergents) **(I, C, T)** *(Detection and estimation of Enzyme activity by Colorimetry)*	
III.	**Estimation / Quantification:**	1
	8. Colorimetric Protein Estimation by Folin Lowry/Ciocalteu (Enzyme extract / Casein from previous expts.). (**I, C, T)** *(Proteins, such as the isolate from experiment* 3 *can be estimated by colour reaction)* (**C, T, R)**	
	9. Colorimetric Cholesterol estimation / total Lipid Estimation from egg. *(Lipid metabolism is an important component of our systems, content can be estimated by colour reaction)/* Colorimetric estimation of Inorganic Phosphates by Stannous chloride method. (**C, T, R)** *(Estimation of biologically relevant inorganic ions by colorimetric method)*	1
IV.	10. Titrimetric estimation of Ascorbic acid (Vit C). (**C, T, R)** *(Estimation of biological materials by non-colorimetric method)*	1

USLSC 303 – Paper III – THEORY

Population Approach: Population and Communities as Regulatory Unit-I

UNIT I	**Concepts in Evolution and Population Genetics**	**(15L)**
	A. Overview of Theories of Evolution: Theory of Abiogenesis, Lamarckism, Natural Selection given by Charles Darwin and Alfred Wallace	3
	B. Study of Evolution in context of human genetic diseases (BRCA–I / Huntington's/ Thalassemia).	3
	C. Populations and Allelic Frequencies: a. Genetic Drift: Founder's Effect and Bottle Neck Effect b. Migration c. Mutation d. Change in Gene Frequencies due to Selection, Hardy Weinberg Equilibrium	5
	D. Variability: a. Origin of Variability b. Polymorphism c. Kinds of Selection: Directional, Stabilizing and Disruptive d. Selectionist vs Neutralist Theory	4
UNIT II	**Biostatistics**	**(15L)**
	1. Probability definition, Addition and Multiplication theorems, Random variable, Probability mass function	1
	2. Binomial, Poisson and Normal distribution	5
	3. Bivariate data, Scatter diagram and its uses, Karl Pearson's Correlation Coefficient, Spearman's Rank Correlation Coefficient	4
	4. Regression equations and their uses	3
	5. Continuous Normal Variable (Probability density functions, Integration)	2
UNIT III	**Bioinformatics**	**(15L)**
	A. Overview of Bioinformatics as a discipline and its applications	2
	B. Data Mining in Bioinformatics - Use of Virtual Libraries a. EMBnet: The European Molecular Biology Network b. NCBI: The National Center for Biotechnological Information c. Pub Med and OMIM and their applications	4
	C. Concept of Databases: Primary, Secondary and Composite databases	1
	D. Types of Databases a. Nucleotide Database (Prokaryotic and Eukaryotic Gene to be discussed) b. Protein Database (PDB / ExPASy) c. Species Database (Yeast, Arabidopsis and Human)	5
	E. Role of IT in Bioinformatics – Introduction to Languages used in Bioinformatics – BioPerl, Python	3

Unit	SELF LEARNING EVALUATION	SUGGESTED LINKS

I	**Concepts in Evolution and Population Genetics**	
	1. Natural Selection: An argument between Charles Darwin and Alfred Russel Wallace 2. Evidence for Evolution: Comparative anatomy, Embryology, Fossil records and Living Fossils, Serology 3. Evolution and Genetic Disorders	- https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/anthropology/08._human_population_genetics_/12.models_of_natural_selection/et/6190_et_m12.pdf - https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000035ZO/P000891/M020603/ET/1498651609PopulationGeneticsQuad1.pdf
II	**Biostatistics**	
	1. Probability sums on Addition and Multiplication theorems and conditional probability 2. Central Tendency 3. Graphical Representation of Data	- https://epathshala.nic.in/watch.php?id=662 - Introduction to Biostatistics-Course(nptel.ac.in)
III	**Bioinformatics**	
	1. History of Bioinformatics with important milestones 2. Concept of Information Network and Common terminologies used: WWW, IP address, TCP/IP, FTP, HTTP, HTML and URLs 3. Databases and their Applications	- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=305 - https://www.coursera.org/learn/bioinformatics-pku#syllabus - https://swayamprabha.gov.in/index.php/ program/archive_he/9

PRACTICALS USLSC3
(Based on paper III)

Note: C, R, T, I → Concept, Relevance, Technique, Instrumentation

A. **Instrumentation / Technique (I /T**)
B. **Process / Concept and immediate Relevance (C, R)**
   a. GLP (Good Laboratory practices) incorporated into every practical
C. Practical aspect of the paper will also be supported by Research papers to understand the application of the learned techniques and advantages in the field.
D. Evaluation and internal assessment can be made by ATP (Alternative to Practical) questions.

1. Introduction to R and SPSS Software (Any One) **(C, R)**	2
2. Correlation: Karl Pearson's and Spearman's Rank Coefficient (Using MS EXCEL and Any One Software) **(C, R)**	1
3. Regression Analysis (Using MS EXCEL and Any One Software) **(C, R)**	1
4. Normal Distribution using suitable example **(C, R)**	1
5. Database searching: Nucleotide, Protein, Species **(C, R)**	2
6. Sequence Similarity Search Tools – BLAST **(C, R)**	1
7. Introduction Python **(C, R)**	1
8. Testing of Hardy-Weinberg law using suitable examples of gene and allelic	1

frequencies – Sex linked (One each) **(C, R)** 9. Project proposal based on Bioinformatics/Biostatistics/ Population Genetics Evolution **(C, R, T, I)**	3

REFERENCES

SEM III (Theory)

Paper I

- Plant physiology Taiz and Zeiger (5th edition) (2010) Pub: Sinauer Associates.
- Fundamentals of physiology - A Human perspective L Sherwood 5th edition (2006) Pub: Thomson Brooks
- Principles of Animal Physiology C Moyes and Schulte 2nd edition (2007) Pearson Education
- Developmental Biology: Scott Gilbert (9th edition) (2010) Sinauer Associates.
- Textbook of Medical Physiology, International EditionGuyton and Hall,12th Edition.
- Inderbir Singh'S Textbook of Human Histology with Colour Atlas and Practical Guide: With color Atlas and Practical Guide, (2016), Jaypee Brothers Medical Publishers.
- Embryology of Angiosperms, Bhojwani and Bhatnagar 4th edition (1999) New Delhi Vikas Pub
- Vander's Human Physiology, Widmaier, Raff, Strand (10th edition,) (2006) Mc Graw Hill Int. Edition.
- Richard Jones Kristin H Lopez, Human Reproductive Biology, 4th Edition, eBook ISBN: 9780123821850, Hardcover ISBN: 9780123821843, Imprint: Academic Press. 2013
- Heide Schatten, Human Reproduction: Updates and New Horizons, Copyright © 2017 by John Wiley & Sons, Inc., Print ISBN:9781118849583; Online ISBN:9781118849613; DOI:10.1002/9781118849613
- S. K. Verma, and Mohit Verma. A textbook of Plant Physiology, Biochemistry and Biotechnology. S. Chand Publications, New Delhi, 2018
- Kishan Gopal Ramawat, Jean-Michel Mérillon, K. R. Shivanna, Reproductive Biology of Plants, 1st Edition, CRC Press, 2014 ISBN 9781482201321
- Tandon, Rajesh, Shivanna, K.R., Koul, Monika (Eds.), Reproductive Ecology of Flowering Plants: Patterns and Processes, 2020, Springer Publications, ISBN 978-981-15-4210-7

Paper II

- Lehninger's Principles of Biochemistry (2008), 5th Edition, Nelson, D.L., and Cox, M.M., W.H. Freeman and Co.
- Biochemistry (2006) 6th Edition, Berg, J.M., Tymoczko, J.L. and Stryer, L. W.H. Freeman and Co.
- Outlines of Biochemistry, 5th Edition by Eric Cohn and Paul Stumpf John Wiley and Sons 2019.
- Berg.J.M., Tymenko.J.L. and Stryer.L. (2002). Biochemistry, (5th edition). New York.W.H.Freeman and Co.

- Zubay G.L, Parson W.W. and Vance D.E. (1993). Principles of Biochemistry, (2nd edition). CBS Publishers and Distributors.
- Fundamentals of Biochemistry (2001) 9th Revised Edition, Deb, A.C. New Central Book Agency (p) Ltd.
- Voet's Principles of Biochemistry, 5th Edition, Global Edition Donald Voet, Judith G. Voet, Charlotte W. Pratt Wiley Publication ISBN: 978-1-119-45513-4 August 2018
- BIOS Instant Notes in Biochemistry Paperback – Illustrated, 31 March 2011by David Hames and Nigel Hooper (Author) Taylor & Francis Publication ISBN 13-978-0415608459
- Harper's Illustrated Biochemistry 31/e 31st Edition, (Kindle Edition) by Victor W. Rodwell (Author), David Bender (Author), Kathleen M. Botham (Author), & 2 More

Paper III

- Strickberger's Evolution – B. Hall and B. Hallgrimsson 4th Edition (2008) Jones and Bartlett Publishers
- Remarkable Creatures: Epic Adventures in Search of the Origin of Species Sean B. Carrol, (2009). Mariner Books,
- Population Genetics, M.B.Hamilton, (2009). Wiely-Blackwell,
- Population Genetics: A Concise Guide J.H.Gillespie, (2004) Johns Hopkins University Press.
- Biostatistics by P Ramakrishnan (Saras Publication), 2005
- Biostatistics by P N Arora and P K Malhan (Himalaya Publication), 2006
- Statistical Methods by R J Shah (Seth Publication)
- Descriptive Statistics by R J Shah (Seth Publication)
- Introduction to Bioinformatics by Arthur Lesk https://drive.google.com/file/d/0B9bX852JMJ__ZjUyOTc4ZjgtNWI2OS00OTA4
- Bioinformatics- Practical Guide to Genes and Proteins Edited by Andreas D. Baxevanis and B.F. Francis Ouellette
- Bioinformatics- Computational Genetics, Wiley (2001)
- Introduction to Bioinformatics lectures https://www.cs.helsinki.fi/bioinformatiikka/mbi/courses/08-09/itb/lectures/itb0809-slides-p1-431.pdf
- Bioinformatics, Sequence Analysis and Phylogenetics file:///C:/Users/Vivek%20Damle/Desktop/BioInf_I_Notes.pdf
- Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins -Andreas D. Baxevanis, B. F. Francis Ouellett John Wiley & Sons, 24-Mar-2004
- Evolution by Monroe Strickberger, Jones and Bartlett Learning 2000
- Molecular Evolution and Phylogenetics https://www.seecoalharbour.com/book/molecular-evolution-and-phylogenetics/
- Paul Gries, et al., Practical Programming: An Introduction to Computer Science Using Python 3, Pragmatic Bookshelf, 2/E 2014.
- Magnus Lie Hetland, Beginning Python: From Novice to Professional, Apress.
- https://swayam.gov.in/nd1_noc19_cs41/preview
- https://docs.python.org/3/

SEM III (Practical)

Practical I
• Developmental Biology: A Very Short Introduction, By Lewis Wolpert, 2nd Edition, Oxford University Press, USA, 2011. • College Botany Volume I; - by Gangulee, Das and Dutta, New Central Book Agency, 2011.
Practical II
• Practical Plant Biochemistry (2014) by Muriel Wheldale Onslow Publisher: Cambridge University Press; Reissue edition (3 April 2014) ISBN-13: 978-1107634312 https://www.researchgate.net/publication/301647645_PRACTICAL_BIOCHEMISTRY/link/571f81ea08aed056fa234bac/download • An Introduction to Practical Biochemistry | 3rd Edition July 2017 by David Plummer McGraw Hill Education; 3rd edition (1 July 2017) ISBN-10: 9780070994874, ISBN-13: 978-0070994874 • Practical Textbook of Biochemistry for Medical Students (English, Paperback, Vasudevan DM) Publisher: Jaypee Brothers Medical Publishers, ISBN: 9789352705146, 9789352705146
Practical III
• Biostatistics by P Ramakrishnan (Saras Publication), 2005 • Biostatistics by P N Arora and P K Malhan, Himalaya Publishing House. 2010. • Statistical Methods by R.J. Shah – Seth Publications. Tenth edition • Descriptive Statistics by R.J. Shah, Seth Publications. Eighth edition. • Research Methodology: Methods and Techniques, by C. R. Kothari, New Age International publications, Third Edition, 2016 • https://www.w3schools.com/python/ • https://www.tutorialspoint.com/python/index.htm • https://www.learnpython.org/

SECOND YEAR B.SC – SEMESTER IV

Second Year Semester IV Internal and External Assessment Details: (60-40 pattern)

Sr. No.	Choice Based Credit System			Subject Code	Remarks
1	Core Course (Life Sciences)			USLSC 401 USLSC 402 USLSC 403 USLSC 4P1 USLSC 4P2 USLSC 4P3	NIL
2	Elective Course	Discipline Specific Elective (DSE) Course		-	
		2.1	Interdisciplinary Specific Elective (IDSE) Course	-	
		2.2	Dissertation/Project	-	
		2.3	Generic Elective (GE) Course	-	
3	Ability Enhancement Courses (AEC)			US-SFC	
	Skill Enhancement Courses (SEC)			-	

Sr. No.	Subject Code	Subject Title	Periods Per Week						Credit	Seasonal Evaluation Scheme				Tot al Marks
			Units	S. L.	L	T	P			S. L. E	CT	TA	SEE	
1	USLSC 401	COMPARATIVE PHYSIOLOGY	3	20% *	3	0	0		2	10	20	10	60	100
2	USLSC 402	LIFE PROCESSES AT THE TISSUE, ORGAN AND ORGANISM LEVELS A BIOCHEMICAL APPROACH	3	20% *	3	0	0		2	10	20	10	60	100
3	USLSC 403	POPULATION APPROACH: POPULATION AND COMMUNITIES AS REGULATORY UNIT	3	20% *	3	0	0		2	10	20	10	60	100
3	USLSC 4P1, 4P2, 4P3	PRACTICALS BASED ON COURSE 2 OF THEORY			0	0	9		2				50 (30+20)	150
	Total Hours / Credit								06	Total Marks				450

***Three lectures/Unit to be taken for CONTINUOUS self -learning Evaluation.**

Second Year Semester – IV Units – Topics – Teaching Hours

S.N	Subject Code	Subject Unit Title		Hours/ Lectures	Total No. of hours/lectures	Credit	Total Marks
1	USLSC 401	I	Homeostasis to Stress	15	45 L	2	100 (60+40)
		II	Homeostasis during infections	15			
		III	Infectious Diseases	15			
2	USLSC 402	I	Metabolism - Anabolism of biomolecules	15	45L	2	100 (60+40)
		II	Nucleic Acids	15			
		III	Regulation of Gene expression	15			
3	USLSC 403	I	Evolution and its Consequences	15	45L	2	100 (60+40)
		II	Biostatistics	15			
		III	Molecular Phylogeny and Bioinformatics	15			
4	USLSC 4P1	I	Practical based on Paper 1 of theory	3	45x2= 90L lectures per batch	2	100 (80+10+10)
	USLSC 4P2	II	Practical based on Paper 2 of theory	3			
	USLSC 4P3	III	Practical based on Paper 3 of theory				
			TOTAL			6	300

- **Lecture Duration – 48 Minutes**
- **One Credit =15 Classroom Teaching Hours**

USLSC 401 – PAPER I – THEORY
Comparative Physiology

Unit I	**Homeostasis to Stress**	**(15L)**
	A. Thermal Physiology:	
	a. Plant adaptation in extreme hot and cold conditions	2
	b. Thermal strategies in Poikilotherms and Homeotherms, Ecto- and Endotherms	1
	c. Temperature regulating Reflexes, Acclimatization	1
	d. Thermogenesis: Shivering and Non – shivering thermogenesis, Hyperthermia induced by Pyrogens	1
	e. Hypothermia, Frost bite, Hyperthermia and Fever	1
	f. Antifreeze proteins	1
	B. Fuel Homeostasis during Exercise and Stress:	
	a. Regulation of energy stores: Control of Food Intake: Role of the Central Nervous System	2
	b. Role of Leptin, Ghrelin, Kisspeptin and Anandamide	3
	c. Eating disorders: Anorexia and Bulimia Nervosa	2
	d. Hypoglycemia, Increased Plasma Cholesterol	1
Unit II	**Homeostasis during infections**	**(15L)**
	A. Defence mechanisms in Plants	4
	a. Physical defence mechanism in plants - thorns, prickles, trichomes, spines	
	b. Overview of Shikimic acid pathway, Role of Secondary metabolites (Alkaloids, Nitrogen and Sulphur containing compounds, Phenolics, Terpenoids) and enzymes (Chitinase, Phenylalanine Ammonia Lyase) in defence mechanisms of plants	
	B. Defence mechanisms in Animals	
	a. Innate and Adaptive Immunity	
	b. Mechanisms of Innate Immunity – In Invertebrates (haemocytes) and in Vertebrates (physical and physiological barriers, phagocytosis, and inflammation)	1 3
	c. Overview of Haematopoiesis – Development of T and B cells	
	C. Host-Parasite Relationship	3
	a. Virulence factors and Toxins: virulence factors, exotoxins, enterotoxins, endotoxins	4
	b. Host factors in infection: host risk factors, innate resistance e.g., *Agrobacterium tumefaciens*	
	c. Parasite escape mechanisms	
Unit III	**Infectious Diseases**	**(15L)**
	A. Introduction to Disease Biology with respect to terminologies, epidemiology, aetiology, pathology (of target tissue only), diagnosis, therapy, preventive measures and vaccines)	2
	a. Vector borne Diseases: Malaria	1

	b. Viral Diseases: Covid 19, Herpes	3
	c. Bacterial Diseases: Tuberculosis, Botulism, Leptospirosis	3
	d. Fungal Diseases: Ringworm, Mucormycosis	2
	e. Helminthic Diseases: Filariasis	1
	B. Infections in Plants	
	a. Viral: Tobacco Mosaic Virus	1
	b. Bacterial: Crown Gall bacterial infection	1
	c. Fungal: Puccinia Infection	1

Unit	SELF LEARNING EVALUATION	SUGGESTED LINKS
I	**Homeostasis to stress**	
	1. Strategies and examples of Plants in tolerating Water Stress 2. Comparative study of Hibernation and Torpor 3. Overweight and obesity 4. Type I and Type II Diabetes 5. PICA eating disorder	- https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight - http://epathshala.nic.in/QR/books/9 Science/Diabetes.pdf - https://www.mooc-list.com/tags/eating-disorders
II	**Homeostasis during infections**	
	1. Surface protectants (Wax, Cutin and Suberin) as plant defence systems 2. Host parasite relationship – Symbiosis, Mutualism 3. Host Parasite relationship - Commensalism, Amensalism 4. Enzymes in Plant defence - 3- glucanase, polyphenol oxidase 5. Role of Jasmonic acid for plant defence	- https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000035ZO/P000888/M016707/ET/1518784108M02AnimalassociationandHostparasiteinteractionPart-2Quad1.pdf
III	**Infectious Diseases**	
	1. Ebola virus disease (EVD) 2. Powdery mildew of Pea caused by by *Erysiphe* 3. Citrus Canker caused by *Xanthomonas* 4. Typhoid 5. Late blight of Potato caused by *Phytophthora* 6. Candidiasis 7. Hepatitis	- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=1 - https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=35

PRACTICAL USLSCP1

(Based on paper I)

Note: C, R, T, I → Concept, Relevance, Technique, Instrumentation

A. **Instrumentation / Technique (I /T**) B. **Process / Concept and immediate Relevance (C, R)** a. Extraction, Purification techniques b. Analysis / Estimation c. GLP (Good Laboratory practices) incorporated into every practical C. Practical aspect of the paper will also be supported by Research papers to understand the application of the learned techniques and advantages in the field. D. Evaluation and internal assessment can be made by ATP (Alternative to Practical) questions.	
I) To identify novel plant compounds for anti-microbial activity and determining their toxicity:	
1. Demonstration of extraction of Secondary Metabolites using Soxhlet and reflux apparatus **(C, R, T, I)**	2
2. Detection of Plant alkaloids, saponins, tannins and volatile oils from suitable plant source using Qualitative tests. **(C, R, T)**	1
3. Alkaloid separation by TLC **(C, R, T, I)**	1
4. Streak plating (T, Pentagon and Quadrant) to isolate microorganisms from a mixed culture using 2 different media **(C, R, T, I)**	2
5. Antibiotic sensitivity of microorganisms (Plant extract, Tetracycline/ Gentamycin) using Disc Diffusion Method. **(C, R, T)**	2
6. Study of effect of Temperature and Chemicals (Control and Test) on heart-beat of Daphnia. **(C, R, T, I)**	2
II) Diagnostic Techniques:	
7. ABO blood typing **(C, R, T, I)**	1
8. Widal Qualitative Test for Typhoid **(C, R, T, I)**	1
9. Immuno Lateral Flow Chromatographic Test for the Detection of Infection from given sample (**C, R, T, I)**	1

USLSC402 - PAPER II - THEORY

Life Processes at the Tissue, Organ and Organism Levels

A Biochemical Approach-II

Unit I	**Metabolism - Anabolism of biomolecules**	**(15L)**
	A. Carbohydrate Anabolism a. Gluconeogenesis b. Pentose Phosphate Pathway c. Short account of polysaccharide synthesis - Glycogen	4
	B. Lipids Anabolism a. Fatty acid biosynthesis b. Cholesterol (4 Stages –Condensation, Conversion, Polymerization and Cyclization) – Biosynthesis and Regulation c. Prostaglandin biosynthesis and regulation	3
	C. Overview of Amino acid Anabolism	2
	D. Photosynthesis a. General idea of Pigment Molecule and Light harvesting Complex b. Photophosphorylation: i. Electron Transport in Photosynthetic bacteria ii. One and Two centre reaction scheme for NADPH and ATP formation via electron transport c. Role of ATP and NADPH in CO_2 fixation d. Path of Carbon fixation in Photosynthesis: C3 and C4 e. Photorespiration	6
Unit II	**Nucleic Acids**	**(15L)**
	A. Chemistry of Nucleic Acids – **Pathways of Purine and Pyrimidine Biosynthesis** a. *de novo* pathways for Purine & Pyrimidine synthesis b. Regulation of Purine and Pyrimidine *de novo* synthesis c. Salvage pathway – Purine and Pyrimidine d. Significance of Salvage pathway with an example of Lesch Nyhan syndrome and Toxoplasmosis	5
	B. DNA replication in Eukaryotes Process and enzymes- with domains of DNA polymerase	3
	C. Transcription a. **Prokaryotes** – Processes - Binding, Initiation, Elongation & Termination b. **Eukaryotes** - RNA polymerases along with promoters, RNA processing of rRNA, tRNA and mRNA (5'cap, poly A tail)	5
	D. Overview of Reverse transcription and cDNA	2
Unit III	**Regulation of Gene expression**	**(15L)**
III	**A. Regulation of Gene Expression and its significance:** a. Overview of Gene Regulation b. Operon Model - *C. elegance*	10

	c. Intron splicing with Calcitonin gene/ Sex determination in Drosophila) d. Hormonal Control: i. In Plants: e.g., Gibberellic Acid in Seed Germination ii. In Animals: Steroid hormone- Glucocorticoid e. Gene Silencing by Protein degradation – Knock in and Knockouts, RNAi with Application **B. Translation:** Comparative Account of Translation process in Prokaryotes and Eukaryotes **C. Post Translational Modification** – Glycosylation, Phosphorylation, Methylation and Acetylation	3 2

Unit	SELF LEARNING EVALUATION	SUGGESTED LINKS
I	**Metabolism - Anabolism of biomolecules**	
	1. Fatty Acid Biosynthesis Is Tightly Regulated 2. Triacylglycerol Biosynthesis in Animals Is Regulated by Hormones 3. Biological activities of Prostaglandins with applications. 4. ATP Synthesis: A comparison with oxidative phosphorylation 5. Hill reaction- A brief historical background 6. Kranz Anatomy and CAM Pathway 7. Comparison of C3 and C4 Pathways 8. Steroids and Isoprenoids: Biosynthesis and Regulation	- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=2 Path- P-05 - https://www.bookrix.com/_ebook-dr-manisha-majumdar -de-plant-physiology-1/
II	**Nucleic acids**	
	1. Meselson and Stahl Experiment *2.* DNA Replication in *E. coli* 3. Overview of Prokaryotic transcription 4. Inhibitors of transcription process 5. Application of Reverse Transcriptase and cDNA 6. Anticancer Drug: Inhibitors of Purine and Pyrimidine Pathways 7. mRNA Vaccines for COVID - 19	- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=2 Path – P-03-M-01, 04, 14
III	**Regulation of Gene expression**	
	1. Overview Translation in Prokaryotes and Eukaryotes 2. Operon Model in Bacteria- trp and lac 3. The role of RNA in controlling Gene expression with practical applications	- https://epgp.inflibnet.ac.in/Home/ ViewSubject?catid=2), - https://swayamprabha.gov.in/index.php/program/archive_he/9 - (https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=3

PRACTICAL USLSCP2

Practical Based on Paper II

Note: C, R, T, I → Concept, Relevance, Technique, Instrumentation

A. Instrumentation / Technique (I **/ T**)

i. Polyacrylamide Gel Electrophoresis (PAGE)- (Demonstration)

ii. Chromatography – Paper, Thin layer, Column

B. Process / Concept and immediate Relevance (C and R)

i. Extraction, Purification

ii. Analysis / Estimation

iii. GLP (Good Laboratory practices) incorporated into every practical Separation /Extraction technique

C. Practical aspect of the paper will also be supported by Research papers to understand the application of the learned techniques and advantages in the field.

D. Evaluation and internal assessment can be made by ATP (Alternative to Practical) questions.

1	Study of absorption spectra of Nucleic Acids **(C, R, T, I)**	1
2	Protein separation by PAGE (Comparison between Coomassie Blue and Silver Nitrate Staining Methods) **(C, R, T, I)** *(Separation techniques for charged materials based on electrophoretic mobility)*	1
3	Detection of DNA fragments by Restriction Digest and Agarose gel **(C, R, T, I)**	1
4	Extraction and Detection RNA quantification of RNA/Ribose Sugars (**C, T)** *(Extraction of nucleic acid and detection by colour reaction and quantification by colorimetry)*	2
5	Chromatography of Food dyes/ Secondary plant metabolites – Circular Paper (**C, T)** *(Separation and detection by colour reaction)*	1
6	Thin Layer Chromatography for separation of Plant pigments (Slide technique) (**C, T, R)** *(Separation techniques for charged, uncharged materials based on solvent partition)*	1
7	Estimation of Total Chlorophyll Content **(C, R, T, I)** *(Estimation by using calculations after colorimetric analysis)*	1
8	Solvent Extraction of Lipids **(C, R, T, I)** *(Extraction of lipid and proportional estimation by weight)*	1

USLSC 403 - Paper III - THEORY

Population Approach: Population and Communities as Regulatory Unit-II

UNIT I	**Evolution and its Consequences**	**(15L)**
	A. Origin of Species: a. Geological Time Scale b. Biological Species concept, Morphological Species. c. Allopatric and Sympatric Speciation, isolating mechanism preventing exchange in populations d. Rates of Speciation- Punctuated or Gradual	5
	B. Human Evolution: a. Origin of Human Evolution b. Factors contributing to Human Evolution: Bipedalism, Improvement in Food Acquisition, Improved Predator Avoidance and Reproductive Success, Hunter Gatherer societies and Evolution of Communication – Speech and Language	6
	C. Evolution and Society: a. Cultural, Biological and Social Evolution b. Eugenics and Gene Machine vs Intelligent Design Arguments	4
UNIT II	**Biostatistics**	**(15L)**
	1. Hypothesis and its types, Errors in testing and its types, Level of Significance	3 3
	2. Analysis of Variance (ANOVA): One way classification, F-test	3
	3. Test for equality of two means, Paired and unpaired t-test	3
	4. Introduction to Non- Parametric tests	3
	5. Chi Square test for Independence 2x2 table	
Unit III	**Molecular Phylogeny and Bioinformatics**	**(15L)**
	A. Molecular Phylogenetics a. Immunological Techniques b. Amino acid sequence comparison c. Nucleic Acid Hybridization techniques d. Tools and Techniques- DNA Sequencing, Restriction Digestion, PCR	5
	B. DNA sequence Data analysis a. Annotation of Putative genes and ORF finding b. Genetic code and Frame translation to amino acids, Concept of Six Frame Translation and its significance	7
	C. Phylogenetic Analysis a. Phylogenetic Trees – Types and Methods of tree building b. Parsimony principle and limitations of Molecular Phylogenetic Trees c. Molecular Clocks and their significance	3

Unit	SELF LEARNING EVALUATION	SUGGESTED LINKS
I	**Evolution and its Consequences**	
	1. Reproductive Technologies and Genetic Engineering-impact on Human Culture. 2. Life history of a Species - Plant/Animal 3. Tool making, Altruism and Kin Selection 4. Human Karyotyping - Normal and Abnormal (Numerical and Structural)	- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=3 – p04 - https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S001174BS/P001210/M030587/ET/1526884992P13_M27_ET.pdf
II	**Biostatistics**	
	1. Applications of Mann-Whitney Test 2. Applications of Wilcoxon Test 3. Comparison between Parametric and Non-Parametric tests	- nptel.ac.in - Statistics 101: ANOVA, A Visual Introduction - YouTube, - http://ndl.iitkgp.ac.in/
III	**Molecular Phylogenetics and Bioinformatics**	
	1. Deciphering the Genetic code wrt Codon Translation 2. Molecular Tools and Techniques 3. Phylogenetic Tree Building using online software tools 4. Use of r DNA technology in Molecular Phylogeny	- https://swayamprabha.gov.in/ index.php/program/archive_he/9 - https://nptel.ac.in/courses/102/107/102107028/ - https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=2

PRACTICALS USLSCP3

(Based on paper III)

Note: C, R, T, I → Concept, Relevance, Technique, Instrumentation

A. Instrumentation / Technique (I / **T**)

i. Polyacrylamide Gel Electrophoresis (PAGE)- (Demonstration)

ii. Chromatography – Paper, Thin layer, Column

B. Process / Concept and immediate Relevance (C and R)

i. Extraction, Purification

ii. Analysis / Estimation

iii. GLP (Good Laboratory practices) incorporated into every practical Separation /Extraction technique

C. Practical aspect of the paper will also be supported by Research papers to understand the application of the learned techniques and advantages in the field.

D. Evaluation and internal assessment can be made by ATP (Alternative to Practical) questions.

1. Evolution - a. Development of Brain - Evolutionary Aspect (Invertebrate to Vertebrate) **(C, R)** b. Study of Fossils (Any two) **(C, R)**	1
2. Structural Annotation - ORF finding using Six Frame Translation **(C, R)**	1

3. MSA using suitable software - Clustal Omega/ Multalign **(C, R)**	1
4. Phylogenetic analysis – Phylogenetic tree building- UPGMA/ Software based **(C, R)**	1
5. Applications of t - distribution **(C, R)**	1
6. Analysis of Variance one way classification **(C, R)**	2
7. Chi square distribution (In statistics, use of Excel should be introduced) **(C, R)**	1
8. Non-Parametric Tests **(C, R)**	1
9. Introduction to LaTeX and Beamer **(C, R)**	1
10. Project report based on Bioinformatics/Biostatistics/ Population Genetics / Evolution **(C, R, T, I)**	5

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