



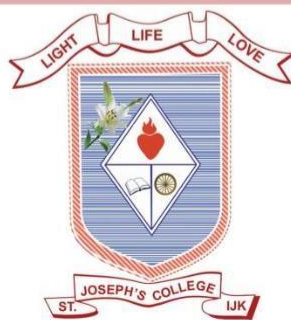
ST. JOSEPH'S COLLEGE (AUTONOMOUS)

IRINJALAKUDA

(Affiliated to University of Calicut)

ST. JOSEPH'S COLLEGE (AUTONOMOUS)

IRINJALAKUDA



CURRICULA AND SYLLABI FOR

M.Sc. Zoology

Under Choice Based Credit & Semester System

With effect from 2023 Admission

St. Joseph's College (Autonomous), Irinjalakuda

Board of Studies in Zoology

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FOREWORD

The future of the credibility of the higher education system depends on the success of the implementation of autonomy. The anticipated outcome of the whole exercise depends on the mainstay of any educational institution- the curricular aspects. As an autonomous college since 2016, St. Joseph's has the mandate to visualize appropriate curricula for particular programmes, update and revise them periodically, and make sure that the expected outcomes are successfully achieved.

A wide range of course options that are in tune with the emerging national and global trends and relevant to the local needs were considered by the institution prior to the P.G. restructuring exercise. Diversity and flexibility, career orientation, skill acquisition, and research enhancement were considered and a structured feedback system established to gather the opinions and suggestions of all the stakeholders including the students, the faculty, the staff, the industry experts, the alumnae, the parents and the employers.

Curricula evolved also took into account the attainment of program, program specific and course outcomes. Evaluation of the curricular intake and delivery is done at the year end to find suggestions for change.

I Sincerely acknowledge the members on the various Boards of Studies and on the Academic Council for their time and expertise in helping us come to a decision regarding Curricula and Syllabi restructuring and redesigning. Thanks, are also due to the team IQAC for their relentless endeavors in enhancing the quality of education delivery, and in particular, for their efforts to organize workshops and invited talks to orient the faculty and students towards the necessities implied in the restructuring process. I would also like to thank the Heads of Departments and faculty and staff who co-operated with the same.

Principal



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St. Joseph's College, (Autonomous), Irinjalakuda
Department of Zoology
(2023 Admission)

Preface

Higher Education scenario in Kerala has been going through turbulent transformations in recent times with the grant of autonomy to colleges by the State Government. There is no doubt about the qualitative worth of the institutions handpicked for autonomy. However, there are apprehensions about the absorption and implementation of the package of autonomy. St. Joseph's College was given autonomy in the year 2016 and has since then been endeavouring to reinvent itself.

Academic autonomy has given us the freedom to recreate our own curriculum and syllabus keeping in mind the challenges and changing needs of the society, the nation, the industry, and the world. Hence, a structured feedback on the requirements of the new millennium was sought from all the relevant stakeholders of the institution- students, faculty, alumnae, parents, industry experts, employers etc.

The suggestions of the stakeholders were incorporated into the curricula and syllabi and presented in the respective Boards of Studies for discussion. The changes pointed out were duly considered and the restructured syllabi are then presented to, and ratified by, the Academic Council.

The role of the IQAC of the college in the above exercise is laudatory. The Cell spearheads all the quality enhancement endeavours, including that of curriculum and syllabus redesigning. By organizing workshops, seminars and hands on training sessions, the cell has facilitated a smooth conduct of the restructuring process. At the end of the year, an evaluation of the syllabi followed is also undertaken, with suggestions noted down for future changes.

As an institution that wishes seriously to provide enhanced quality education to young women students in order to empower them to be fit for the changing world, St. Joseph's College is bravely facing the challenges even as it is happily handling the possibilities, that autonomy has brought to it. Academic enriching programmes, skill – based micro credentials, ICT up gradations, promotional activities for a culture of research, etc. are a few of the multifarious responsibilities invested with the college in its restructuring of curriculum and redesigning of syllabus.

I specially thank the IQAC, the Heads of various departments the faculty, and staff, directly in charge of the syllabus revision, for their sincere and dedicated efforts.

St. Joseph's College, (Autonomous), Irinjalakuda

STUDENT ATTRIBUTES



The motto of the institution is “Light, Life, Love”

Light for the illumination of the heart and mind

Life for the fullness of growth – physical, mental, intellectual and spiritual

Love for fellowship with the Supreme & with one another

The motto enshrines the vision of the Founders for the students and constitutes the foundation for the acquisition of the following student attributes envisioned by the institution.

- Empowerment
- Lifelong Learning
- Holistic Development
- Value Orientation
- Social Responsibility
- Nation Building Capacity
- Green Thinking
- Creativity & Innovation
- Acquiring Life Skills
- Discipline
- Leadership / Team skills
- Problem solving skills
- Communicability

The above Student Attributes will be attained in the span of their student life at St. Joseph's College through various activities such as

- Curricular, Co-curricular & extra-curricular
- Sports, games, fine arts and cultural
- Enrichment / certificate courses
- Extension / outreach programmes
- Healthy / Best practices



PROGRAMME OUTCOMES

At the end of a postgraduate programme, the student would have:

Acquired the ability for critical thinking and problem solving

Attained life skills and communication skills

Inculcated moral and ethical values

Become a promoter of unpolluted environs and proactive society

Developed a culture of research and lifelong learning

Become an empowered woman aware of global perspectives and national realities



PROGRAMME SPECIFIC OUTCOME

	Program Specific Outcomes
PSO1	Understand ecological impact on animal behavior and the interdisciplinary relationship of Zoology with Physics, Mathematics and Statistics to acquire knowledge and its application in Zoology.
PSO2	Conceive the normal physiological, metabolic processes as well as the embryonic development, to understand the developmental syndromes, metabolic disorders and its hormonal regulation.
PSO3	Understand genetics and analyze the cytogenetics principle considering the advancements in the research in human genome and genomes of other model organisms.
PSO4	Acquire skills to carry out experimental techniques and methods of statistical analysis appropriate for the various biological experimental conditions.



AIMS AND OBJECTIVES

First Semester

To explore the chemical process and synthesis of biologically active molecules within and related to living organisms

To learn the genetic phenomenon through cytological analysis of chromosomes and various interactions between cells.

To study the biological system and biological processes through interdisciplinary approach.

To prove every hypothesis by statistical measurements to generate wide range of interest in research field.

To understand and resolve many of the environmental and ecological issues that confront us

To acquaint with different behavioral patterns among animals.

Second Semester

To study the relationships among the physiological functions in different systems of organisms which has practical applications for health and disease management.

To understand the molecular basis of heredity, genetic variation and expression patterns of genes.

To study biological diversity and the evolutionary relationships among organisms, both extinct and modern.

To develop skills necessary to analyze chemicals and physio-chemical reactions quantitatively and qualitatively.

To demonstrate common and advanced laboratory practices in cell and molecular biology.

To provide an insight into the quantitative study and use of ecological, physiological and systematic principles.



Third Semester

To learn about the underlying principles of body's defense mechanisms and various molecules involved in immune system function.

To gets a comprehensive idea and rational explanation of the intricate arrangements occurring during development of animals.

To familiarize different types of hormone and their action.

To understand the clinical, industrial and environmental significance of microbes

To familiarize the advanced tools and techniques in gene cloning, cell culture and its ethical and social implications.

To create skills for microbial culturing.

To develop skills in the preparation of permanent slides of animal tissues.

Fourth Semester

To develop an awareness of genetic etiology and clinical management of a wide range of genetic diseases.

To get an awareness of the diagnosis, treatment and counseling of various genetic disorders.

To discuss the genetics of cancer and new genetic technologies to be used in the management and treatment of the disease.



COURSE DESIGN

The M.Sc. Zoology programme includes

Core courses

Elective Courses

Project Work / Dissertation

Comprehensive Viva-voce

Audit Courses

The M.Sc. Zoology programme contains 13 compulsory Core courses, 5 Elective Courses, 1 Project Work / Dissertation, 1 Comprehensive Viva-voce and 2 Audit Courses. (credits for each course is 4).

No course carries more than 4 credits. The student can select any Choice based elective course offered by the department which offers the core courses, depending on the availability of teachers and infrastructure facilities, in the institution.

Duration of the programme

The minimum duration for completion of a four semester PG Programme is 2 years. The maximum period for completion is 4 years. The duration of each semester will be 90 working days, inclusive of examinations, spread over five months. Odd semesters will be held from June to October and even semesters from November to March subject to the academic calendar of St. Joseph's College (Autonomous) Irinjalakuda.

Programme structure

The M.Sc. Zoology programme include three types of courses: Core courses, Elective courses and Audit Courses. Project Work and Comprehensive Viva-voce are mandatory for all regular programmes and these shall be done in the end semester. Total credit for the M.Sc. Zoology programme is 80 (eighty), this describes the weightage of the course concerned and the pattern of distribution is as detailed below:



Course types	Total Weightage
Core courses	52
Elective Courses	20
Project Work / Dissertation	4
Comprehensive Viva-voce	4
Minimum attendance required	75 % (in each semester)

Elective courses shall be spread over either in the Third & Fourth Semesters combined or in any one of these Semesters (III / IV). Study Tour / Field visit / Industrial visit / Trip for specimen collection may be conducted as a part of the Programme.

Semester	Course Title	Suggested Area
I	Ability Enhancement Course (AEC)	a) Documentation and scientific writing b) Paper review on a topic of choice. c) Internship for a minimum of 40 hours. d) Industrial or Practical training for a minimum of 40 hours. e) Community linkage programme for a minimum of 40 hours. f) Seminar presentation on a frontier area of biological research. The topic should be from outside the syllabus.
II	Professional Competency Course (PCC)	a) Statistical (SPSS/R/any software relevant to the programme of study) softwares b) Museum curation skills (Taxidermy etc.)

Courses and Credit distribution

The required number of credits as specified in the syllabus/regulations must be acquired by the student to qualify for the degree. A student shall accumulate a minimum of 80 credits for the successful completion of the M.Sc. programmes.



Semester	Course	Credit	Total Credit
I	Core Courses (Theory)	12	12
II	Core Courses (Theory + Practical)	12+12	24
III	Core Courses (Theory) + Elective Courses (Theory)	8+4	12
IV	Core Courses (Theory + Practical)	4 + 4	8
	Elective Courses (Theory + Practical)	8 + 8	16
	Project Work / Dissertation	4	4
	Comprehensive Viva-voce (Optional)	4	4
Total credit			80

Audit Courses:

In addition to the above courses there will be two Audit Courses (*Ability Enhancement Course & Professional Competency Course*) with 4 credits each. The college will conduct examinations for these courses in respective semesters and intimate /upload the results of the same to the Controller of Examinations of St. Joseph's College (Autonomous) Irinjalakuda. The College will intimate/upload the results of the same to the University on the stipulated date during the third semester. The credits will not be counted for evaluating the overall SGPA & CGPA. The details of Audit courses are given below.



Semester	Course	Teaching Hours	Credit
I	<i>Audit Course I:</i> <i>Ability Enhancement Course (AEC)</i>	0	4
II	<i>Audit Course II:</i> <i>Professional Competency Course (PCC)</i>	0	4

Project Work / Dissertation & Comprehensive Viva-Voce

There is a Project work with dissertation and Comprehensive Viva-Voce as separate courses relating to the core area under study in the end Semester and included in the Core Courses. Viva-voce related to Project work is one of the criteria for Project Work evaluation. Students have to submit a Project Report / Dissertation in the prescribed structure and format as a part of the Project Work undertaken. There will be External and Internal evaluation for Project Work/ Comprehensive Viva-Voce and these shall be combined in the proportion of 4:1.



COURSE CODE FORMAT

The following are the common guidelines for coding various courses in order to get a uniform identification. It is advisable to assign a nine Digit Code (combination of Alpha Numerical) for various courses as detailed below:

First two digits indicate the code of college SJ

Next three digits indicate the Programme/discipline code (ZOL for Zoology, ENG for English, MCM for M.Com, CHE for chemistry, PHY for physics, MLM for Malayalam, SKT for Sanskrit, HTY for History etc.)

Sixth digit is the Semester indicator which can be given as 1, 2, 3 & 4 respectively for I, II, III & IV Semester (ZOL1, ZOL2, ZOL3, Etc).

Seventh digit will be the Course Category indicator as detailed below:

Sl No	Nature of Course	Course Code
1	Core Courses	C
2	Elective Courses	E
3	Project	P
4	Comprehensive Viva	V
5	Practical / Lab	L
6	Audit Courses	A

Last two digits indicate the serial number of the respective courses. If there is one digit it should be prefixed by '0'(Zero). (01, 02, etc)

If the number of courses in one category is only one (eg: Viva, Project etc.), assign the course serial number as 01.

Examples:

Sl. No	Code	Details
1	SJZOL1C01	M.Sc. Zoology I Sem Core Course No1
2	SJZOL3E09	M.Sc. Zoology III Sem Elective paper No. 9
3	SJZOL4P07	M.Sc. Zoology IV Sem Project Work paper number 7
4	SJZOL2L01	M.Sc. Zoology II Sem Practical No. 1
5	SJZOL4V08	M.Sc. Zoology IV Sem Viva paper No. 8



STRUCTURE OF THE PROGRAMME

The following table shows the structure of the programme which indicates course code, course title, instructional hours and credits.

Scheme- Core Course Theory

Course Code	Title of the course	Total Credits	Total hours/ semester	Weightage	
				External Weightage	Internal Weightage
Semester I					
SJZOL1C01	Biochemistry and Cytogenetics	4	90	30	5
SJZOL1C02	Biophysics and Biostatistics	4	90	30	5
SJZOL1C03	Ecology and Ethology	4	90	30	5
Semester II					
SJZOL2C04	Physiology	4	90	30	5
SJZOL2C05	Molecular Biology	4	90	30	5
SJZOL2C06	Systematics and Evolution	4	90	30	5
Semester III					
SJZOL3C07	Immunology	4	90	30	5
SJZOL3C08	Developmental Biology and Endocrinology	4	90	30	5
Semester III					
SJZOL3C09	Biotechnology and Microbiology	4	90	30	5

**Scheme- Elective Courses theory (selected courses)**

Course Code	Title of the course	Total Credits	Total hours/ semester	Weightage	
				External Weightage	Internal Weightage
Semester IV					
SJZOL4E10	Human Genetics 1: Clinical Genetics	4	90	30	5
Semester IV					
SJZOL4E11	Human Genetics II: Diagnostic Genetics	4	90	30	5
SJZOL4E12	Human Genetics III: Cancer Genetics & Genetic Services	4	90	30	5

Scheme- Core Course practical

Semester II					
Course Code	Title of the course	Total Credits	Total Hours in Two semesters	Weightage	
				External Weightage	Internal Weightage
SJZOL2L01	Biochemistry, Biophysics and Biostatistics	4	120	24	5
SJZOL2L02	Physiology, Molecular Biology and Cytogenetics	4	120	24	5
SJZOL2L03	Ecology, Ethology, Systematics and Evolution	4	120	24	5

**Scheme- Core Course practical**

Semester IV					
Course Code	Title of the course	Total Credits	Total Hours in Two Semesters	Weightage	
				External Weightage	Internal Weightage
SJZOL4L04	Immunology, Developmental biology, Endocrinology, Biotechnology, Microbiology and Micro techniques	4	120	24	5

Scheme- Elective Course practical (selected courses)

Semester IV					
Course Code	Title of the course	Total Credits	Total Hours in Two semesters	Weightage	
				External Weightage	Internal Weightage
SJZOL4L05	Human Genetics I & II	4	120	30	5
SJZOL4L06-	Human Genetics III	4	120	30	5

Scheme- Project work / dissertation and comprehensive viva-voce

Semester IV				
Course Code	Title of the course	Total Credits	Weightage	
			External Weightage	Internal Weightage
SJZOL4P07	Project Work	4	24	5
SJZOL4V08	Viva Voce (Project-2 + General-2)	4	24	5

**Scheme- Audit Courses**

Course Code	Title of the course	Total Credits	Total hours/ semester	Weightage	
				External Weightage	Internal Weightage
Semester I					
SJAUZOL1A01	Climate change- Life on Earth	4	0	20	0
Semester II					
SJAUZOL2A02	Museum Curation Skill	4	0	20	0

**Scheme- Elective Courses theory (Remaining available options as elective courses)**

Course Code	Title of the course	Total Credits	Total hours/ semester	Weightage	
				External Weightage	Internal Weightage
Semester III					
SJZOL3E09	Entomology 1: Morphology and Taxonomy	4	90	30	5
SJZOL3E09	Environmental Biology 1: Man, Environment & Natural Resources	4	90	30	5
SJZOL3E09	Fishery Science 1: Taxonomy, Biology, Physiology & Ecology	4	90	30	5
SJZOL3E09	Wildlife Biology 1: Biodiversity & Biota	4	90	30	5
Semester IV					
SJZOL4E11	Entomology II: Anatomy and Physiology	4	90	30	5
SJZOL4E11	Environmental Biology II: Environmental pollution	4	90	30	5
SJZOL4E11	Fishery Science II: Capture & Culture Fisheries	4	90	30	5
SJZOL4E11	Wildlife Biology II: Wildlife Conservation	4	90	30	5
SJZOL4E12	Entomology III: Agricultural Medical & Forensic Entomology	4	90	30	5
SJZOL4E12	Environmental Biology III: Environmental Conservation	4	90	30	5
SJZOL4E12	Fishery Science III: Harvesting, Post-harvesting Technology & Marketing	4	90	30	5



SJZOL4E12	Wild Life Biology III: Wildlife Management	4	90	30	5
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Scheme- Elective Courses practical (Remaining available options as elective courses)

Semester IV					
Course Code	Title of the course	Total Credits	Total Hours in Two semesters	Weightage	
				External Weightage	Internal Weightage
ZOL4L05	Entomology I & II	4	120	24	5
	Environmental Biology I & II	4	120	24	5
	Fishery Science I & II	4	120	24	5
	Wildlife Biology I & II	4	120	24	5
ZOL4L06	Entomology III	4	120	24	5
	Environmental Biology III	4	120	24	5
	Fishery Science III	4	120	24	5
	Wildlife Biology III	4	120	24	5



EVALUATION AND GRADING

The evaluation scheme for each course will contain two parts; (a) Internal/Continuous Assessment (CA) and (b) External / End Semester Evaluation (ESE). Of the total, 20% weightage will be given to Internal evaluation/Continuous assessment and the remaining 80% to External/ESE and the ratio and weightage between Internal and External is 1:4.

a) Internal/Continuous Assessment (CA) : 20 marks

b) External / End Semester Evaluation (ESE) : 80 marks

Primary evaluation for Internal and External shall be based on 6 letter grades (A+, A, B, C, D and E) with numerical values (Grade Points) of 5, 4, 3, 2, 1 & 0 respectively.

Grade Point Average:

Internal and External components are separately graded and the combined grade point with weightage 1 for Internal and 4 for external shall be applied to calculate the Grade Point Average (GPA) of each course. Letter grade shall be assigned to each course based on the categorization based on Ten-point Scale. There is no revaluation for PG Programme (due to double valuation)

Evaluation of Audit Courses:

The examination and evaluation will be conducted by the college either in the normal structure or MCQ model from the Question Bank and other guidelines provided by the University/BoS. The Question paper will be for minimum 20 weightage and a minimum of 2-hour duration for the examination. The marks of audit courses one and two will be forwarded to Controller of Examinations of St. Joseph's College (Autonomous) Irinjalakuda in time of respective semesters. The result will be intimated / uploaded to the University during the Third Semester.



Phases for Evaluation:

I Phase: To be done by the concerned Teacher/Examiner based on 6 Point Scale

Evaluation of all individual External Theory courses and Internal evaluation

Evaluation of Project Work External and Internal

Evaluation of External and Internal Practical Courses

Evaluation of External and Internal Comprehensive Viva-voce

Phase - GPA Calculation - To be done by St. Joseph's College (Autonomous)

Consolidation of External and Internal for Theory Courses (Calculation of GPA)

Consolidation of External and Internal for Project Work (Calculation of GPA)

Consolidation of External and Internal for Practical Courses (Calculation of GPA)

Consolidation of External and Internal for Comprehensive Viva-voce (Calculation of GPA)

Phase - SGPA Calculation - To be done by St. Joseph's College (Autonomous) Irinjalakuda

Calculation of Semester Grade Point Average. This is the consolidated net result (Grade) in a particular Semester.

IV Phase - CGPA Calculation - To be done by St. Joseph's College (Autonomous) Irinjalakuda

Calculation of Consolidated Grade Point Average. This is the consolidated net result (Grade) of a Programme.

Internal Evaluation / Continuous Assessment (CA)

Continuous Assessment will be based on a predetermined transparent system involving



periodic two written tests, assignments, seminars and attendance in respect of theory courses and based on tests, lab skill and records/viva in respect of practical courses. The criteria and percentage of weightage assigned to various components for internal evaluation are as follows:

(a) Theory:			
Sl. No	Component	Percentage	Weightage
1	Examination /Test	40%	2
2	Seminars / Presentation	20%	1
3	Assignment	20%	1
4	Attendance	20%	1
(b) Practical:			
1	Lab Skill	40%	4
2	Records/viva	30%	3
3	Practical Test	30%	3

Attendance weightage 1 can be distributed as follows

Attendance	Internal weightage	Marks
Above 90%	1	5
85–89%	0.8	4
80–84%	0.6	3
76–79%	0.4	2
75%	0.2	1

Grades given for the internal evaluation are based on the grades A+, A, B, C, D & E with grade points 5, 4, 3, 2, 1 & 0 respectively. The overall grades will be as per the Ten Point scale. There shall be no separate minimum Grade Point for internal evaluation. To ensure transparency of the evaluation process, the internal assessment marks awarded to the students in each course in a semester will be published on the notice board before 5 days of commencement of external examination. There will not be any chance for improvement of



internal marks. The course teacher will maintain the academic record of each student registered for the course.

Examination /Test: For each course there shall be class test/s during a semester. Grades should be displayed on the notice board. Valued answer scripts shall be made available to the students for perusal.

Seminars / Presentation: Every student should deliver Seminar/Presentation as an internal built –in component of the curriculum transaction for every course and must be evaluated by the respective course teacher in terms of structure, content, presentation and interaction. The soft and hard copies of the seminar report are to be submitted to the course teacher.

Assignment: Each student will be required to do assignment/s as an internal built – in component of the curriculum transaction for each course. Assignments after valuation must be returned to the students. The teacher shall define the expected quality of the above in terms of structure, content, presentation etc. and inform the same to the students. Punctuality in submission is to be considered.

Lab Skill: Students in the science stream are required to combine their classroom methods with hands on practical sessions in the laboratories. The teacher shall assess the skills of the student and the quality of application of theoretical knowledge.

Records/viva: Records are submitted by science students for documenting the textual and classroom knowledge along with their practical lab skills. Neatness, accuracy and precision are also evaluated here. Viva voce is conducted to assess the grasp of knowledge gained by the student and to test their communication skills in the translation of the knowledge.

Practical Test: It is conducted for students in the science stream to assess their scientific temper and application of theoretical knowledge. The sense of precision and accuracy is also taken into account.



External / End Semester Evaluation (ESE)

The semester-end examinations in theory courses will be conducted by the Controller of Examination St. Joseph's College (Autonomous) Irinjalakuda with question papers set by external experts. The evaluation of the answer scripts will be done by examiners based on a well-defined scheme of valuation. The external evaluation will be done immediately after the internal valuation. The language of writing the examination should be in English.

Pattern of Questions For External/ESE:

Questions will be set to assess the knowledge acquired, standard, and application of knowledge, application of knowledge in new situations, critical evaluation of knowledge and the ability to synthesize knowledge. Due weightage will be given to each module based on content/teaching hours allotted to each module. The question will be prepared in such a way that the answers can be awarded A+, A, B, C, D, E Grades. Different types of questions shall be given different weightages to quantify their range given in the following model:

Sl. No.	Type of Questions	Individual weightage	Total Weightage	Number of questions to be answered
1	Short Answer type questions	2	$2 \times 4 = 8$	4 out of 7
2	Short essay/ problem solving type	3	$3 \times 4 = 12$	4 out of 7
3	Long Essay type questions	5	$5 \times 2 = 10$	2 out of 4
Total			30	18

End Semester Evaluation in Practical Courses will be conducted and evaluated by both Internal and External Examiners. Practical examination will be at the end of II and IV semesters and each will be of 4 hours duration. The pattern/types of questions will be different for each papers subject to the condition that the total weightage should be 24 and individual weightage of types of questions should be as given in the table below.



Sl. No.	Type of Questions	Individual weightage
1.	Major Experiment	8
2.	Minor Experiment	5
3.	Identification/Spotters	1
4.	Record	2

Evaluation of project work / dissertation

There will be External and Internal evaluation with the same criteria for Project Work done and the grading system shall be followed. One component among the Project Work evaluation criteria will be Viva-voce (Project Work related) and the respective weightage will be 40%. Consolidated Grade for Project Work is calculated by combining both the External and Internal in the Ratio of 4:1 (80% & 20%). For a pass in Project Work, a student has to secure a minimum of P Grade in External and Internal examination combined. If the students could not secure minimum P Grade in the Project work, they will be treated as failed in that attempt and the students may be allowed to rework and resubmit the same in accordance with the University exam stipulations. There shall be no improvement chance for Project Work. The External and Internal evaluation of the Project Work shall be done based on the following criteria and weightages as detailed below:

Criteria for the evaluation of dissertations:

Sl. No	Criteria	Weightage External	Weightage Internal
1	Introduction, review of literature etc.	2	3
2	Objectives and relevance of the study	3	
3	Methodology	4	
4	Results	3	
5	Discussion and interpretation	4	3
6	Conclusions	3	
7	Involvement of the students	1	
8	Style and neatness of the dissertation	1	
9	References	3	
Total Weightage		24	6



Criteria for the Viva-voce

Sl. No	Criteria	Weightage External	Weightage Internal
A. Presentation of project work- (Power Point Presentation)			
1	Quality and correctness of slides	2	3
2	Clarity of presentation	3	
3	Communication skill	3	
4	Answers to questions	4	
Sub total		12	3
B. Criteria for the Viva-voce			
5	Knowledge of the student	4	3
6	Communication skill	3	
7	Answers to questions	5	
Sub total		12	3
Grand Total Weightage		24	6

Conduct of comprehensive viva-voce

There will be External and Internal Comprehensive Viva-voce at the end of the IVth Semester; the External Conduct and internal Conduct of the Viva-voce are mandatory.

For a pass in Comprehensive viva-voce, a student has to secure a minimum of P Grade in External and Internal examination combined. If the students could not secure minimum P Grade in the Comprehensive viva-voce, they will be treated as failed in that attempt and the student may reappear for the same next time in accordance with the University exam stipulations. There shall be no improvement chance for Comprehensive viva-voce.



DIRECT GRADING SYSTEM

Direct Grading System based on a 10 – Point scale is used to evaluate the performance (External and Internal Examination of students). For all courses (Theory & Practical)/Semester/Overall Programme, Letter grades and **GPA/SGPA/CGPA** are given on the following way:

First Stage Evaluation for both Internal and External done by the Teachers concerned in the following Scale :

Grade	Grade Points
A+	5
A	4
B	3
C	2
D	1
E	0

b) The Grade Range for both Internal & External shall be :

Letter Grade	Grade Range	Range of Percentage (%)	Merit / Indicator
O	4.25 – 5.00	85.00 – 100.00	Outstanding
A+	3.75 – 4.24	75.00 – 84.99	Excellent
A	3.25 – 3.74	65.00 – 74.99	Very Good
B+	2.75 – 3.24	55.00 – 64.99	Good
B	2.50 – 2.74	50.00 – 54.99	Above Average
C	2.25 – 2.49	45.00 – 49.99	Average
P	2.00 – 2.24	40.00 – 44.99	Pass
F	< 2.00	Below 40	Fail
I	0	-	Incomplete
Ab	0	-	Absent

'B' Grade lower limit is 50% and 'B+' Grade lower limit is 55%



No separate minimum is required for internal evaluation for a pass, but a minimum P Grade is required for a pass in the external evaluation. However, a minimum P grade is required for pass in a course. A student who fails to secure a minimum grade for a pass in a course will be permitted to write the examination along with the next batch.

Improvement of Course—The candidates who wish to improve the grade / grade point of the external examination of a course/s they have passed already can do the same by appearing in the external examination of the concerned semester along with the immediate junior batch.

Betterment Programme One time- A candidate will be permitted to improve the CGPA of the Programme within a continuous period of four semesters immediately following the completion of the programme allowing only once for a particular semester. The CGPA for the betterment appearance will be computed based on the SGPA secured in the original or betterment appearance of each semester whichever is higher.

Semester Grade Point Average (SGPA) – Calculation

The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses taken by a student. After the successful completion of a semester, Semester Grade Point Average (SGPA) of a student in that semester is calculated using the formula given below.

$$\text{Semester Grade Point Average - SGPA (S}_j\text{)} = \Sigma(\text{C}_i \times \text{G}_i) / \text{Cr} \text{ (SGPA= Total Credit Points awarded in a semester / Total credits of the semester)}$$

Where 'S_j' is the th semester, 'G_i' is the grade point scored by the student in the th course 'C_i' is the credit of the th course, 'Cr' is the total credits of the semester.

Cumulative Grade Point Average (CGPA) – Calculation

$$\text{Cumulative Grade Point Average (CGPA)} = \Sigma(\text{C}_i \times \text{S}_i) / \text{Cr} \text{ (CGPA= Total Credit points awarded in all semesters/Total credits of the programme)}$$



Where C_1 is the credit of the I^{st} semester S_1 is the SGPA of the I^{st} semester and Cr is the total number of credits in the programme. The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme. The SGPA and CGPA shall be rounded off to 2 decimal points. For the successful completion of a semester, a student should pass all courses and score a minimum SGPA of 2.0. However, the students are permitted to move to the next semester irrespective of their SGPA.



CONSOLIDATED SCHEME FOR I TO IV SEMESTERS

PROGRAMME STRUCTURE

SEMESTER I

COURSE CODE	COURSE TITLE	HOURS	CREDIT
SJZOL1C01	Biochemistry and Cytogenetics	90	4
SJZOL1C02	Biophysics and Biostatistics	90	4
SJZOL1C03	Ecology and Ethology	90	4
SJAUZOL1A01	Climate change- Life on Earth	0	4

SEMESTER II

COURSE CODE	COURSE TITLE	HOURS	CREDIT
SJZOL2C04	Physiology	90	4
SJZOL2C05	Molecular Biology	90	4
SJZOL2C06	Systematics and Evolution	90	4
SJAUZOL2A02	Museum Curation Skill	0	4
SJZOL2L01	Biochemistry, Biophysics and Biostatistics		4
SJZOL2L02	Physiology, Molecular Biology and Cytogenetics		4
SJZOL2L03	Ecology, Ethology, Systematics and Evolution		4

**SEMESTER III**

COURSE CODE	COURSE TITLE	HOURS	CREDIT
SJZOL3C07	Immunology	90	4
SJZOL3C08	Developmental Biology and Endocrinology	90	4
SJZOL3C09	Biotechnology and Microbiology	90	4

SEMESTER IV

COURSE CODE	COURSE TITLE	HOURS	CREDIT
SJZOL4C10	Human Genetics 1: Clinical Genetics	90	4
SJZOL4E11	Human Genetics II: Diagnostic Genetics	90	4
SJZOL4E12	Human Genetics III: Cancer Genetics & Genetic Services	90	4
SJZOL4L04	Immunology, Developmental Biology, Endocrinology, Biotechnology, Microbiology & Microtechnique		4
SJZOL4L05	Human Genetics I & II		4
SJZOL4L06	Human Genetics III		4
SJZOL4P07	Project Work		4
SJZOL4V08-	Viva Voce (Project-2 + General-2)		4



Syllabi for Core Courses

Semester: 1

Name of Course: SJZOL1C01 - BIOCHEMISTRY AND CYTOGENETICS

Credits: 4:0:0

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Recognize the structure and functioning of biologically important molecules.	PO1 PSO3	U	F, C	2
CO2	Understand the chemistry of Carbohydrates, lipids, amino acids, proteins and nucleic acids in detail.	PO1, PO5 PSO3	Z	F, C	22
CO3	Describe the mechanism of enzyme action and identify the classes of enzymes and factors affecting action	PO1, PO5 PSO3	U	F, C	7
CO4	Discuss the Laws of Thermodynamics and its relationship to chemical equilibria	PO1, PO5, PSO3	A	F, C, P	2
CO5	Describe the metabolism of carbohydrates, lipids and proteins	PO1, PO5, PSO3	U	F, C	21
CO6	Describe cellular membrane structure and function, fine structure and function of cell organelles.	PO1, PO5, PSO3	U	F, C	11
CO7	Explain the cell cycle and its regulatory processes.	PO1, PO5, PSO3	U	F, C	6
CO8	Distinguish the communications of cells with other cells and to the environment.	PO1, PO5, PSO3	A	F, C	6
CO9	Explain the central intracellular signal transduction pathways and the mechanism of cell death.	PO1, PO5, PSO3	U	F, C	13
Total Number of Hours					90

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create
***F-factual, C-conceptual, P-practical/procedural**



FIRST SEMESTER THEORY

SJZOL1C01 - BIOCHEMISTRY AND CYTOGENETICS

(90 hrs)

Part A. Biochemistry (54 hrs)

Unit - I - Chemistry and functions of Biomolecules

1. Introduction (2 hrs)

1.1 Macromolecules and their subunits

1.1. Chemical bonds of biomolecules (Covalent and Non-covalent bonds)

2. Carbohydrates (8hrs)

2.1. Classification of carbohydrates with examples-

2.1.1 Structure of monosaccharides- glucose, fructose, galactose, mannose and ribose.

2.1.2. Methods of representation of sugars (Ball and stick, projection formula and perspective formula)

2.1.3. Isomerism - Structural isomerism (functional group isomerism) and stereo isomerism (optical isomerism)- mention epimer, anomer and enantiomer with examples, Mutarotation

2.1.4. Biological roles of monosaccharides.

2.2. Structure and biological roles of maltose, sucrose, lactose, trehalose and cellobiose.

2.3.1. Homopolysaccharides - Structure and biological roles of cellulose, starch, glycogen, inulin and chitin

2.3.2. Heteropolysaccharide - Structure and biological roles of hyaluronic acid, chondroitin, chondroitin sulphate, keratan sulphate, heparin and agar-agar.

3. Proteins (6 hrs)

3.1. Amino acids

3.1.1. Classification: (a) on the basis of number of amino and carboxyl group (b) on the basis of the chemical composition of side chain (c) based on the polarity of side chain (R)

3.1.2. Amphoteric properties of amino acids



3.1.3. pK value and Isoelectric point (pI) of amino acids

3.1.4. Peptide bond and peptides (di, tri, tetra, oligo and polypeptide).

3.2. Structure of protein

3.2.1. Primary structure, Secondary structure (Alpha helix, Beta-parallel & antiparallel and Beta-pleated sheet), random coil conformation, Tertiary structure, Quarternary structure.

3.2.2. Brief note on protein domains, motifs, folds and Ramachandran plot.

3.2.3. Biological roles of proteins

4. Lipids (5 hrs)

4.1. Classification of lipids -Simple lipids (fats, oils and waxes), compound lipids (phospholipids, glycolipids, lipoproteins and sulpholipids) and derived lipids.

4.2. Biological roles of lipids - as food reserves (storage lipids), structural lipids in membrane, as signals, as co-factors, as pigments, as insulators, as vitamin carriers etc

4.3. Prostaglandins - Chemical nature and functions.

4.4. Fatty acids - definition; essential fatty acids

4.5. Classification with examples- Saturated, unsaturated, hydroxyl and cyclic fatty acids

4.6. Nomenclature of fatty acids - Genevan system

5. Nucleic acids (3 hrs)

5.1. Structural organization of DNA (Watson -Crick model)

5.2. Structural organization of t-RNA;

5.3. Biological roles of nucleotides and nucleic acids

Unit - II – Enzymes (7 hrs)

Classification- (I.U.B. system)

Mechanism of enzyme action: Formation of enzyme substrate complex- Michaelis-Menten theory, Fischer's template theory and Koshland's induced fit theory. Factors



influencing enzyme action

Enzyme kinetics - Michaelis-Menten equation - derivation; significance of K_m and V_{max} Values. Lineweaver-Burk equation and double reciprocal plot of enzyme reaction.

Enzyme inhibition - Competitive, non-competitive and uncompetitive inhibition (distinguish kinetically), suicide inhibition and feedback inhibition

Classification, Structure and functions of Vitamins. Vitamins as co-enzymes.

Unit - III – Bioenergetics

(2 hrs)

Laws of thermodynamics and biological system- Enthalpy, Entropy, Free energy concept .

Energy of activation, Standard free energy change.

Role of ATP as a free energy carrier in the biological system. group transfer.

Unit - IV - Metabolism and biosynthesis of biomolecules

1. Carbohydrate metabolism

(8 hrs)

- 1.1. Glycolysis - (PFK as pacemaker - Hexokinase conformation and change by glucose), Fate of pyruvic acid
- 1.2. Citric acid cycle; Pyruvate dehydrogenase complex and ketoglutarate dehydrogenase complex
- 1.3. Electron transport system and oxidative phosphorylation; Redox potential, Chemiosmotic hypothesis; inhibitors of electron transport chain
- 1.4. Gluconeogenesis, Glycogenesis, Glycogenolysis; regulation of glycogen synthesis and breakdown .
- 1.5. Pentose phosphate pathway (HMP pathway) and its significance
- 1.6. Uronic acid pathway

2. Amino acid metabolism

(4 hrs)

- 2.1. Biosynthesis and degradation of amino acids - glutamic acid, phenyl alanine, methionine, tryptophan, isoleucine, histidine, valine.



- 2.2. Fate of amino acids in the body
- 2.3. Transamination, Decarboxylation and deamination reactions in the biological system.

3. Lipid metabolism (5 hrs)

- 3.1. Oxidation of fatty acids
- 3.2. Biosynthesis of fatty acids
- 3.3. Biosynthesis of cholesterol

4. Nucleic acid metabolism (4 hrs)

- 4.1. Biosynthesis and degradation of purines and pyrimidines

Part B. Cytogenetics (36 hrs)

1. Introduction to Cytogenetics (1 hr)

2. Membrane structure and function (4 hrs)

- 2.1. Molecular organization of cell membrane - Lipid bilayer and membrane protein.
Molecular models of cell membrane.
- 2.2. Cell permeability-osmosis, diffusion, ion channels, active transport, membrane pumps.
- 2.3. Mechanism of sorting and regulation of intracellular transport.
- 2.4. Electrical properties of membranes.
- 2.5. Microvilli and cell coat.

3. Structural organization and function of intracellular organelles- (6 hrs)

Nucleus, Mitochondria, Golgi complex, Lysosomes, Endoplasmic reticulum, Ribosomes, Peroxisomes and Cytoskeleton.

4. Cell Cycle and Regulation. (6 hrs)

- 4.1 Mitosis and meiosis, their regulation
- 4.2. steps in cell cycle,
- 4.3. regulation and control of cell cycle
- 4.4. Alteration of cell cycle regulation in cancer



5. Cellular communication

(6 hrs)

- 5.1. General principles of cell communication
- 5.2. Cell-cell interactions – cell adhesion and roles of different adhesion molecules
- 5.3. Intercellular attachments- gap junctions, desmosomes, intermediary and tight junctions.
- 5.4. Interaction of cells with extracellular matrix: Integrins. Focal adhesion and hemidesmosomes.
- 5.5. Interaction of cells with other cells: Selectins, Immunoglobulins, Cadherins, Adherens.

6. Cell signaling

(9 hrs)

- 6.1. Signal transduction
- 6.2. Concept of cell-signaling
- 6.3. Signaling through cell surface receptors: G protein linked receptors; signaling via cAMP, PKA, IP3, Ca²⁺/calmodulin, PKC, Ca-MK, Enzyme linked receptors, Receptor tyrosine kinase (RTK), signaling of growth factors, Tyrosine kinase associated receptors, JAK- STAT signaling pathway, Receptor protein tyrosine phosphatase (PTP), Receptor serine/threonine kinase, Receptor guanyl cyclase, cGMP, PKG, Histidine kinase associated receptors
- 6.4. Bacterial chemotaxis and quorum sensing
- 6.5. Receptor desensitization
- 6.6. Signaling by nitric oxide, carbon monoxide
- 6.7. Signaling network

7. Apoptosis and its significance

(4 hrs)

- 7.1 Necrosis; Programmed and induced cell death
- 7.2 Process of apoptosis: Initiation, Execution: cytochrome C, caspases, Phagocytosis
- 7.3 Regulation of apoptosis - Extracellular and Intracellular
- 7.4 Apoptosis in *Caenorhabditis elegans*, *Drosophila*, mammals and bacterial population
- 7.5 Genes involved in apoptosis.



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Watson J. D., Hopkins N. H., Roberts, J. W., Steits, J. A. and Weiner, A. M. (1987). Molecular Biology of the Gene 4th Edition. The Benjamin Cumming. Publishing Company. Menlo Park, California.

**Semester: 1****Name of Course: SJZOL1C02 - BIOPHYSICS AND BIOSTATISTICS****Credits: 4:0:0**

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Demonstrate knowledge of the fundamental concepts in physics and chemistry that underlie biological processes.	PO1, PSO1	A	F, C	17
CO2	Recall and relate the concepts of radioactivity and its applications	PO1, PSO1	A	F, C	9
CO3	Recall and explain the techniques and underlying theory of UV- Visible, IR, NMR and ESR and mass spectroscopy	PO1, PO5, PSO1	U	F, C	5
CO4	Identify and differentiate working principle, instrumentation and applications of various bio-analytical instruments.	PO1, PO5, PSO1	Z	F, C, P	21
CO5	Understand the application of nanotechnology in health care.	PO1, PO3 PO5, PSO1	U	F, C	2
CO6	Demonstrate an understanding of the central concepts of modern statistical theory and their probabilistic foundation.	PO1, PO5, PSO1	A	F, C, P	9
CO7	Recognize the importance of data collection and its role in determining scope of inference.	PO1, PO3 PO5, PSO1	U	F, C	4
CO8	Apply hypothesis testing via some of the statistical distributions.	PO1, PO3 PO5 PSO1	A	F, C, P	9
CO9	Interpret statistical results correctly, effectively, and in context.	PO1, PO3 PO5 PSO1	Z	F, C, P	14
Total Number of Hours					90

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural**



FIRST SEMESTER THEORY

SJZOL1C02 - BIOPHYSICS AND BIOSTATISTICS

(90 Hours)

Part A. Biophysics (54 hrs)

1. Colloidal System (3 hrs)

- 1.1. Crystalloids and Colloids,
- 1.2. Properties of colloids- Kinetic, optical and electrical properties- Electrosmosis, Cataphoresis, Coagulation.
- 1.3. Forms of colloids, Suspensions and Emulsions, preparation and properties of emulsions.
- 1.4. Biological importance of colloids.

2. Diffusion and Osmosis (4 hrs)

- 2.1. Fick's laws and diffusion coefficient.
- 2.2. Gibb's Donnan equilibrium.
- 2.3. Application of diffusion processes in biology: haemolysis.
- 2.4. Osmosis, Osmotic concentration, Osmotic pressure and osmotic gradient.
- 2.5. Vant Hoff's laws
- 2.6. Electrolytic and ionic balance in biological fluid.

3. PH (2 hrs)

- 3.1 Dissociation of water.
- 3.2. Dissociation of a weak acid.
- 3.3. Henderson Hasselbalch equation.
- 3.4. Electrometric determination of pH, pH meter
- 3.5. PH value calculation.
- 3.6. Buffer –Importance of buffers in biology.

4. Bioacoustics (5 hrs)

- 4.1. Characteristics of sound.
- 4.2. Physical basis of hearing.
- 4.3. Physical organization of ear.
- 4.4. Physical aspects of sound transmission in the ear.



- 4.5. Audible sound frequency.
- 4.6. Pitch perception and theories.
- 4.7. Infrasonic and ultrasonic sounds.
- 4.8. Echolocation; receiving and analyzing echoes

5. Radiation Biology (9 hrs)

- 5.1. Radioactivity, different types ionizing radiations and their sources
- 5.2. Radioactive disintegration. Decay curve, half-life.
- 5.3. Biological effects of ionizing radiations – effects at macromolecular, cellular and organ system level, effects of whole body irradiation-Radiation therapy.
- 5.4. Biological applications of radioisotopes.
- 5.5. Radiation dosimetry- dose units and dose measurement.
- 5.6. Radiation Detectors - GM Counter, Solid and Liquid Scintillation Counter, Proportional counter, Semiconductor detectors.
- 5.7. Autoradiography

6. Biophysical methods (Brief account of the following) (5 hrs).

- 6.1. Properties of electromagnetic radiations.
- 6.2. Molecular analysis using UV / visible spectroscopy.
- 6.3. Mass spectroscopy.
- 6.4. NMR and Electron Spin Resonance (ESR) spectroscopy -Applications
- 6.5. Structure determination using X-ray diffraction crystallography.
- 6.6. Circular dichroism.
- 6.7. Surface Plasma Resonance (SPR)

7. Electrophysiological methods (Brief) (3 hrs)

- 7.1. Single neuron recording.
- 7.2. Patch clamp recording.
- 7.3. ECG.
- 7.4. Brain activity recording.
- 7.5. Lesion and stimulation of brain.
- 7.6. Pharmacological testing.



7.7. PET (Positron Emission Tomography), MRI, fMRI, CAT.

8. Principles and applications of (8 hrs)

8.1. Fluorescent, Interference, Scanning and Transmission electron microscopes (SEM & TEM)

8.2. Resolving powers of different microscopes.

8.3. Different fixation and staining techniques for EM (freeze-etch and freeze fracture methods for EM-image processing methods in microscopy).

8.4. Laser and its applications in Biology

9. Separation Techniques (10 hrs)

9.1. Chromatography - Different types - Adsorption, Partition and Ion exchange chromatography

9.1.1 Column chromatography

9.1.2 Paper chromatography

9.1.3 Thin- layer chromatography

9.1.4 Gel-filtration.

9.1.5. Gas chromatography,

9.1.6 Affinity chromatography,

9.1.7 HPLC

9.2. Electrophoresis

9.2.1 Paper electrophoresis

9.2.2 Disc electrophoresis

9.2.3 PAGE, Two dimensional PAGE, Highvoltage Electrophoresis

9.2.4 Factors affecting electrophoretic mobility

9.3. Isoelectric focusing.

10. Influence of gravity (3 hrs)

10.1. Human body posture in the gravitational field

10.2. Influence of G force.

10.3. sForce of centrifugal acceleration - importance of aviation and space travel

10.4. Effect of positive G. Force & negative G. Forces.



10.5. Protection against G. Force

10.6. Influence of linear acceleration on the body

11. Nanotechnology (2 hrs)

11.1. Definition

11.2. Nanotechnology and its applications in the field of health care.

11.3. Role of nanotechnology in environmental management.

Part B –Biostatistics (36 hrs)

1. Introduction (2 hrs)

1.1 Biostatistics: Definition,

1.2 Characteristics of Statistics

1.3 Importance and usefulness of statistics

1.4 Limitations of Statistics

2. Research Design (2 hrs)

2.1. Meaning and objectives of Research

2.2. Meaning, need and features of Research Design

2.3. Important concepts relating to research design

2.4. Different research designs

2.5. Basic principles of experimental designs

3. Data (4 hrs)

2.1. Types of data: classification based on Source of data, Compilation, Variable, Nature .

2.2. Methods of data collection and classification.

2.3. Types of sampling methods.

2.4. Advantages and disadvantages of census and sampling method.

2.5. Class intervals- exclusive and inclusive method

2.6. Frequency curve (types. skewness, kurtosis, ogive)

4. Statistical Methods: Measures of central tendency and dispersal (4 hrs)

3.1. Mean, (raw data, discrete series and continuous series)



3.2. Standard deviation, Standard error, degree of freedom (raw data, discrete series and continuous series)

3.3. Quartile deviation- Box- whisker plot

5. Probability distributions (3 hrs)

4.1. Basic concepts and definition:

4.2. Laws of probability

4.3. Probability distribution: - Binomial, Poisson and Normal

6. Statistical inference (problems to be discussed) (7 hrs)

6.1 Difference between parametric and non-parametric statistics;

5.2. Testing of hypothesis

5.3. Errors

5.4. Confidence interval; levels of significance, Critical region;

5.5. Normality test

5.6. t-test, chi-square test, F-test, ANOVA

5.7. Kruskal-Wallis, Mann-Whitney

7. Correlation and Regression (problems to be discussed) (7 hrs)

6.1. Types of correlation.

6.2. Methods to measure correlation- Scatter diagram.

6.3. Karlpearson's coefficient of correlation, Spearman's correlation

6.4. Types of regression analysis

6.5. Regression equations

6.6. Difference between regression and correlation analysis

8. Ecological data analysis (problems to be discussed) (7 hrs)

7.1. Alpha diversity

Shannon diversity index, Simpsons Dominance index, Pielou's evenness index, Margalef species Richness, Fisher's apha,

7.2. Beta diversity

Morisita Horn index, Sorenson index, Bray-Curtis similarity



References

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**Semester: 1****Name of Course: SJZOL1C03 - ECOLOGY AND ETHOLOGY****Credits: 4:0:0**

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Explain the interaction of organisms with the physical and biological environment.	PO1,PO3, PO4, PO5, PSO1	U	F, C	3
CO2	Illustrate the flow of energy through ecosystems with reference to trophic levels and ecological efficiency.	PO1,PO4, PO5, PSO1	U	F, C,	9
CO3	Describe population structures and growth, and identify the factors that limit the distribution and abundance of populations.	PO1,PO5 PSO1	U	F, C	7
CO4	Compare and contrast the effects of competition, predation, and mutualism on individual life histories and behaviour, population growth, community structure and change including the process of ecological succession.	PO1,PO2,PO3, PO4 , PO5, PSO1	Z	F, C, P	13
CO5	Describe the characteristics of the major biomes and ecosystems of the Earth in general and special emphasis on Biogeographical zones of India.	PO1,PO3,PO4,PO 5, PSO1	U	F, C	10
CO6	Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.	PO1, PO2, PO3,PO4,PO5, PO6 , PSO1	E	F, C, P	12
CO7	Understand Animal behavior and response of animals to different instincts	PO1, PO2, PO5, PO6, PSO1	U	F, C	7
CO8	Understand of cognitive/behavior neurobiology, thus allowing then to correlate the animal behavior under different situations including navigations and migration.	PO1, PO4, PO5, PSO1	U	F, C	11
CO9	Explain the behavior of animals, with particular emphasis on group living and parental care	PO1,PO2,PO3,PO 4,PO5, PO6 PSO1	U	E, C, P	18
Total Number of Hours					90

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural**



FIRST SEMESTER THEORY

SJZOL1C03 - ECOLOGY AND ETHOLOGY (90 Hours)

Part-A-Ecology (54 hrs)

1. Introduction (3hrs)

1.1. Habitat and niche

1.1.1. Concept of habitat and niche

1.1.2. Niche width and overlap

1.1.3. Fundamental and realized niche

1.1.4. Resource partitioning

1.1.5. Character displacement

2. Ecosystem ecology (9 hrs)

2.1. Structure and function--biotic and abiotic interactions

2.2. Ecosystem energetics

2.3. Primary production

2.4. Energy flow models

2.5. Mineral cycling (CNP)

2.6. Trophic levels, Food chain, food web and secondary production

2.7. Decomposers and detritivores

3. Population Ecology (7 hrs)

3.1. Characteristics of a population

3.2. Methods of estimating population density of animals, ranging patterns through direct, indirect and remote observations

3.3 Sampling methods in the study of behaviour, habitat characterization

3.4. Ground and remote sensing methods

3.5. Population growth curves, Life tables, survivorship curves, population regulation, Life history strategies (r and k selection), concept of metapopulation– Demes and dispersal, interdemec extinctions, age structure of populations.

3.6. Growth and regulation of human population



4. Species interaction (5 hrs)

4.1. Types of interactions, interspecific competition, Herbivory, Carnivory, Pollination, Symbiosis; mutualism, commensalisms and proto co- operation

5. Community Ecology (4 hrs)

5.1. Nature of communities.

5.2. community structure and attributes

5.3. Characteristics of a biotic community.

5.4. Species diversity and latitudinal gradients in diversity.

5.4 Edges and ecotones.

6. Ecological succession (4 hrs)

Types, mechanisms, changes involved in succession .

6.2 Concept of climax

7. Biogeography (6 hrs)

7.1. Major terrestrial biomes: (a) Tropical rain Forest (b) Grassland (c) Desert (d) Chaparral (e) Temperate deciduous Forest (f) Temperate boreal forest (g) Tundra (h) Savanna

7.2. Theory of island biogeography

8. Biogeographical zones of India (4 hrs)

Trans Himalayan zone; (b) Himalayan zone; (c) Desert zone; (d) Semiarid zone; (e) Western Ghats zone; (f) Deccan plateau zone; (g) Gangetic plain zone; (h) North east zone. (i) Coastal zone; (j) Islands present near the shore line.

9. Applied Ecology (8 hrs)

9.1 Carbon credit, Carbon trading, Blue Carbon

9.2 Green building technology and its ecological importance.

9.3 Discuss the benefits and disadvantages of the idea of (brief)

a. Inter linking of major rivers of India,

b. Sethusamudram ship canal project.

c. Biodiversity with special reference to India-status monitoring and documentation, major drivers of biodiversity change.



10. Conservation Biology (4 hrs)

10.1 Principles of conservation.

10.2 Major approaches to management,

10.3 Indian case studies on conservation / management strategy (concepts of project tiger, Biosphere reserves).

Part B. Ethology (36 hrs)

1. Introduction (1 hr)

2. Concepts of Ethology (4 hrs)

2.1. Ethology as different from the other schools studying animal behavior like behaviourism.

2.2. Behaviour as a reaction to stimuli - sign stimuli, social releasers, Ethograms, super normal stimuli, stimulus filtering.

2.3. Concepts of Fixed Action Patterns (FAP), Innate Releasing Mechanism(IRM), Action Specific Energy(ASE), Concepts of Learning and Imprinting.

3. Motivating factors (2 hrs)

3.1. Types of motivation

3.2. General factors in motivation; Studies of motivation in guppies;

4. Conflict behaviour- stress-displacement activities- Ritualization. (2 hrs)

5. Instinctive behaviour & reflex action, (1 hrs)

6. Learning- Neural basis of learning, memory, cognition (2 hrs)

7. Adaptiveness of behaviour (3 hrs)

7.1 JP Scott's categories of behavior

8. Circadian rhythms and its regulation (3 hrs)

8.1. Concept of circadian rhythm

8.2. Biological clocks

8.3. Neural basis of sleep and arousal

8.4. Navigation & migration

8.5. Jet lag



9. Orientation and behavior (3 hrs)

- 9.1. Types of orientation
- 9.2. Reafference theory of Von Holst & Mittel Steadt.
- 9.3. Habitat selection and optimality in foraging

10. Parental care (6 hrs)

- 10.1. Mating systems, Parental investment and Reproductive Success.
- 10.2. Development of behavior.
- 10.3. Social communication; Social dominance; Use of space and territoriality; domestication and behavioural changes
- 10.4. Social behaviour of termites & Primates;

11. Evolution and advaptiveness of behaviour (4 hrs)

- 11.1. Proximate and Ultimate factors.
- 11.2. Altruism, Kin selection, inclusive fitness, selfish gene theory, cultural transmission of behaviour.

12. Hormones and Behaviour- (5 hrs)

- 12.1. Hormones of gonads, adrenal gland , Pituitary gland,-Hormonal effects on different behavioural patterns
- 12.2. Maternal behaviour- mechanism of hormonal action.

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**Semester: 1 AUDIT COURSES - Ability enhancement course (AEC)****Name of Course: SJAUZOL1 A01- Climate Change: Life on Earth****Credits: 2:0:0**

Seminar presentation on a frontier area of biological research. The topic should be from outside the syllabus.

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Critically read and prepare review on scientific literature.	PO1PO2, PO3, PO4, PO5,PO6 PSO1	E	F, C, P	0
CO2	Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.	PO1PO2, PO3, PO4, PO5,PO6 PSO1	E	F, C, P	0
CO3	Understand the transnational character of environmental problems and ways of addressing them, including interactions across local to global scales.	PO1PO2, PO3, PO4, PO5,PO6 PSO1	U	F, C, P	0
CO4	Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.	PO1PO2, PO3, PO4, PO5,PO6 PSO1	E	F, C, P	0
CO5	Understand the critical issues facing the environment at local, regional, national, and global scales.	PO1PO2, PO3, PO4, PO5,PO6 PSO1	U	F, C, P	0
CO6	Articulate the interdisciplinary context of environmental issues.	PO1PO2, PO3, PO4, PO5,PO6 PSO1	Z	F, C, P	0
	Total Number of Hours				0

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural**



SJAUZOL1 A01-Climate Change: Life on Earth

Introduction

1.1. Weather Versus Climate

1.2. Climate Change definition, Evidences of climate change- surface temperature, precipitation, ocean pH, sea-level and Arctic sea-ice extent.

1.3. Anthropogenic and non-anthropogenic factors causing climate change-

1.4. Challenges of climate changes a general overview (brief)

Global warming and climate change

2.1. Greenhouse Gases- production, emission and effects

2.2. The Carbon Cycle: Ocean and Biosphere - Ocean and Biosphere Feedbacks

2.3. Global warming and climate change

Consequences and Impacts of climate change

3.1. Impact on different ecosystems- influence on ecosystem structure and function

3.1.1. Impact on Himalayan glaciers

3.2. Climate change and biodiversity

3.3. Effects on human life.

3.3.1. Psychological impacts of global climate change

3.3.2. Impact on agriculture.

3.4. Climate change and infectious diseases

3.5. Impact of anthropogenic climate changes on the risk of natural disasters

Climate change and evolution

4.1. Evolutionary responses to climate change

4.2. Climate change and human evolution

Mitigation of climate change

5.1. Reducing Carbon Emissions: Bottom-Up Approaches

5.2. Reducing Carbon Emissions: Top-Down Approaches

5.3. Global action on climate change- (UNFCCC)- **Kyoto Protocol, The Paris Agreement**

5.4. India: National action plan on climate change (NAPCC)

**Semester: 2****Name of Course: SJZOL2C04 - PHYSIOLOGY****Credits: 4:0:0**

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Explain the process of digestion, absorption and different factors which regulate the process of digestion.	PO1, PO5 PSO2	U	F, C	10
CO2	Describe Process of urine formation in kidney and acid base balance.	PO1, PO5 PSO2	U	F, C	12
CO3	Understand the process of oxygen and carbon dioxide transport in body.	PO1, PSO2	U	F, C	10
CO4	Outline the basic control processes of the nervous systems and explain diseased states of the brain in detail.	PO1, PO5, PSO2	K	F, C	21
CO5	Associate and discuss the process of sensory perception.	PO1, PO5, PSO2	E	F, C, P	20
CO6	Illustrate the basic concept and interrelationship among blood pressure, blood flow and functioning of the heart.	PO1, PO5, PSO2	Z	F, C, P	8
CO7	Explain the functions of lymph and lymphatic system.	PO1, PO5, PSO2	U	F, C	5
CO8	Understand the way different systems interact to yield integrated physiological responses to challenges such as exercise, fasting and ascent to high altitude, and how they can sometimes fail.	PO1, PO5, PSO2	U	F, C	4
Total Number of Hours					90

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural**



SECOND SEMESTER THEORY

SJZOL2C04 - PHYSIOLOGY (90 Hours)

1. Nutrition (10 hrs)

- 1.1. Constituents of normal diet and their daily requirements.
- 1.2. Physiological calorie value of food stuffs.
- 1.3. Antioxidant nutrients.
- 1.4. Movements of GI tract: deglutition, gastric motility and emptying, intestinal motility and defecation.
- 1.5. The role of hormones and neurotransmitters in the control of gastrointestinal motility.
- 1.6. Energy balance and obesity-causes and consequences.
- 1.7. BMR and its significance.
- 1.8. Body Mass Index (BMI)

2. Excretory System (12 hrs)

- 2.1. Introduction: Brief description of different types of excretory organs in different animal groups (flame cells, green glands, malpighian tubules).
- 2.2. Functional anatomy of mammalian kidney, nephron and juxtaglomerular apparatus structure, parts and function.
- 2.3. Urine formation (glomerular filtration, tubular reabsorption and tubular secretion)
- 2.4. Regulation of water balance -Mechanism of concentration of urine – Counter Current system (counter current multiplier and counter current exchanger).
- 2.5. Renal regulation of acid- base balance & electrolyte balance.
- 2.6. Structure of urinary bladder, micturition reflex and micturition.
- 2.7. Renal clearance – definition, concept and significance; clearance value of urea, creatinine, phosphate, potassium, chloride and sodium.

3. Respiratory system (10 hrs)

- 3.1. Introduction: Brief description of major respiratory organs (tracheal system, book lungs, gills and ctenidia).
- 3.2. Physiological anatomy and histology of respiratory passage and lungs.
- 3.3. Mechanism of pulmonary ventilation (inspiration & expiration) .



- 3.4. Alveolar ventilation, dead space and its effect on alveolar ventilation.
- 3.5. Role of surfactant in alveolar expansion.
- 3.6. Pulmonary volumes and capacities – definition & normal values (tidal volume, inspiratory reserve volume, expiratory reserve volume, residual volume, functional residual capacity, inspiratory capacity, vital capacity, total lung capacity).
- 3.7. Exchange of gases- partial pressures involved-lung and tissues.
- 3.8. Oxygen dissociation curve – factors affecting binding of oxygen to haemoglobin (PO₂, PCO₂, CO, pH, body temperature, diphosphoglyceric acid level, foetal haemoglobin and also myoglobin).
- 3.8. Neural and chemical regulation of respiration: Respiratory centres & factors regulating respiration.

4. Nervous system

(21 hrs)

- 4.1. Organisation of human brain.
 - 4.1.1. Cerebrum and cerebral lobe.
 - 4.1.2. Cerebral cortex and its functional areas- Motor cortex, Broca's area , somatosensory cortex and its association area, gustatory cortex, visual cortex and its association area, auditory cortex and its association area, olfactory cortex, wernick's area, Brodman map, cerebral dominance.
 - 4.1.3. Cortical white matter- commissures, association fibers, projection fibers, corpus callosum and fornix, basal nuclei-organisation and function.
 - 4.1.4. Brain stem- organisation and function.
 - 4.1.5. Cerebellum- structure and function.
 - 4.1.6. Diencephalon – organisation and function.
- 4.2. Functional brain systems - Limbic system and reticular formation.
- 4.3. Protection of brain – Meninges, cerebrospinal fluid- formation and function, blood brain barrier and its function.
- 4.4. Diseased states of brain - schizophrenia, Alzheimer's disease, Senile dementia & Parkinson's disease.
- 4.5. Memory- definition, types of memory- short term, intermediate long term and long term memory, consolidation of memory.



- 4.6. PNS and Autonomic nervous system.
- 4.7. Spinal cord – structure.
- 4.8. Reflex action, reflex arc, monosynaptic and polysynaptic reflexes, inverse stretch reflex and golgi tendon organ.

5. Special senses (16 hrs)

5.1. Vision:

- 5.1.1. Structure of eyeball
- 5.1.2. Fluid systems of the eye
- 5.1.3. Layers of Retina and photoreceptors (rods & cones)
- 5.1.4. Brief notes on the neuronal cell types and neural circuitary of the retina and visual pathways from retina to visual cortex
- 5.1.5. Image formation
 - 5.1.5.1. Formation of image on the retina.
 - 5.1.5.2. A brief general account of electrophysiology of vision
 - 5.1.5.3. Photochemistry of vision & colour vision

5.2. Taste:

- 5.2.1. Primary sensations of taste (agents and site of sensation)
- 5.2.2. Taste buds (location, structure, receptors and nerve supply)
- 5.2.3. Physiology of taste (receptor stimulation, generation of nerve impulse by taste buds and its transmission to CNS)

5.3. Smell:

- 5.3.1. Olfactory membrane and receptor cells
- 5.3.2. Physiology of olfaction (stimulation of olfactory cells and transmission of smell signals to CNS)

6. Tactile response: (brief note) (4hrs)

- Mechanoreceptors and their stimulation
- Pain receptors and their stimulation
- Thermal receptors and their stimulation



7. Cardiovascular system

(8hrs)

- 7.1. Introduction: Brief description of vertebrate hearts
- 7.2. Structural organization of myogenic heart (in human beings).
- 7.3. Physiological anatomy of cardiac muscle – specialized tissue.
- 7.4. Heart as a pump.
- 7.5. Cardiac cycle.
- 7.6. Neural and chemical regulation of heart function.
- 7.7. Blood volume and blood pressure, blood volume regulation
- 7.8. Physiological anatomy of coronary blood flow, coronary blood flow and its control.
- 7.9. Ischemic heart disease – mention causes.

8. Lymphatic System

(5 hrs)

- 8.1. Lymph channels of the body.
- 8.2. Composition and formation of lymph.
- 8.3. Functions of lymph and lymphatic system including role of it in controlling Interstitial fluid protein concentration, interstitial fluid volume and interstitial fluid pressure.

9. Environmental Physiology

(4 hrs)

- 9.1. Thermal regulation.
 - 9.1.1. Comfort zone, normal body temperatures (oral, skin & core).
 - 9.1.2. Temperature regulating mechanism (hot & cold), body temperature – physical, chemical, neural regulation (mention the role of hypothalamus, thyroid and adrenal glands).
 - 9.1.3. Acclimatization

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**Semester: 2****Name of Course: SJZOL2C05 - MOLECULAR BIOLOGY****Credits: 4:0:0**

CO	CO Statement	PO/ PSO	CL	I	C	C	Class Hrs
CO1	Explain concepts of DNA replication and repairing mechanisms.	PO1, PO5, PSO2	U		F, C		16
CO2	Describe the connection between DNA and RNA .	PO1, PSO2	U		F, C		10
CO3	Define codon and explain their role in Transcription.	PO1, PO5, PSO2	U		F, C		5
CO4	Differentiate the structure of prokaryotic and eukaryotic ribosomes as well as the translation process.	PO1, PO5, PSO2	Z		F, C		10
CO5	Explain control of gene expression at transcription and translation level.	PO1, PO5, PSO2	U		F, C		10
CO6	Compare the structure and characteristics of eukaryotic, prokaryotic and organelle genome in detail.	PO1, PO5, PSO2	Z		F, C		18
CO7	Understand the concept of Interrupted genes, Gene families and Transposons	PO1, PO5, PSO2	U		F, C		16
CO8	Illustrate the molecular mechanisms involved in recombination of DNA with special emphasize on Holliday model.	PO1, PO5, PSO2	A		F, C		5
	Total Number of Hours						90

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural**



SECOND SEMESTER

SJZOL2C05 - MOLECULAR BIOLOGY (90 Hrs)

1. DNA replication (11 Hrs)

- 1.1. Semidiscontinuous synthesis-Okazaki fragments
- 1.2. Replication origin and replication fork
- 1.3. Unit of replication, extra chromosomal replicon of bacterial Ti plasmid
- 1.4. Enzymes/proteins of replication- Primase, Replisomes, Helicase, DNA polymerases, Single strand binding proteins, Topoisomerases and Ligase;
- 1.5. Fidelity of replication
- 1.6. Replication of the ends of eukaryotic chromosome – role of telomerase
- 1.7. Models of DNA replication –Rolling circle model and looped rolling circle model, D-loop model, θ -model.
- 1.8. Inhibitors of DNA replication – Methotrexate and Fluorodeoxyuridylate

2. Safeguard systems of DNA (5 Hrs)

- 2.1. Restriction: significance, role and features of Type I, II & III restriction enzymes
- 2.2. Modification: enzymes and significance
- 2.3. Repair:
 - 2.3.1. Major kinds of damage to DNA and causes
 - 2.3.2. Repair mechanisms: Direct reversal, Mismatch repair, Excision repair, Recombination repair, SOS response

3. Transcription of mRNA in prokaryotes and eukaryotes (10 Hrs)

- 3.1. Structural organisation and life span of mRNA; monocistronic and polycistronic mRNA
- 3.2. Transcription in prokaryotes and eukaryotes
 - 3.2.1. Promoter (mention Pribnow, TATA, CAAT and GC box), enhancer and silencer sites
 - 3.2.2. Transcription factors; Transcription activators and repressors
- 3.3. Characteristic features of RNA polymerases of phages, prokaryotes and eukaryotes and their functions
- 3.4. Post transcriptional modification of RNA
 - 3.4.1. Capping



3.4.2. Polyadenylation

3.4.3. Splicing

3.5. RNA editing: site specific deamination and role of gRNAs

3.6. RNA transport

4. Genetic code (5 Hrs)

4.1. Characteristics of genetic code

4.2. Start codons and stop codons

4.3. Degeneracy of the code: Wobble hypothesis and isoacceptor tRNAs

4.4. Special features of the genetic code in mitochondria, mitochondrial tRNA

4.5. Variations in the genetic code in *Mycoplasma* and *Tetrahymena*

4.6. Point mutations that alter genetic code (missense, nonsense & frameshift)

5. Ribosome: The site of protein synthesis: (2 Hrs)

5.1. Structure

5.2. Composition; Reconstitution experiments

5.3. Active centres

5.4. Biogenesis of ribosome in eukaryotes

6. Translation in prokaryotes and eukaryotes: (8 Hrs)

6.1. Aminoacylation of tRNA & initiation, elongation and termination of protein synthesis

6.2. Aminoacyl tRNA synthetases & initiation, elongation and termination factors

6.3. Translational proof-reading

6.4. Differences in protein synthesis between prokaryotes and eukaryotes

6.5. Translational inhibitors in prokaryotes and eukaryotes – role of tetracycline, streptomycin, neomycin, chloramphenicol, erythromycin, puromycin and diphtheria toxin

6.6. Post- translational modification of proteins: protein folding (role of chaperones) and biochemical modifications

7. Control of gene expression at transcription and translation level: (10 Hrs)

7.1. Regulation of gene expression in Phages – alternate patterns of gene expression for control of lytic and lysogenic cycle in λ phage



7.2. Regulation of gene expression in bacteria – basic features of lac, tryptophan, arabinose and galactose operons

7.3. Regulation of gene expression in viruses

7.4. Regulation of gene expression in eukaryotes –

7.4.1. Role of chromatin in regulating gene expression

7.4.2. Activation and repression of transcription

7.4.3. Regulation of translation by gene arrangement

7.4.4. Regulation of translation by alternate pathways of transcript splicing

7.4.5. Antisense RNA strategies for regulating gene expression

7.4.6. si RNA and mi RNA in regulation

8. Eukaryotic genome: (7 Hrs)

8.1. Special features of eukaryotic genome

8.2. Structure of chromatin and chromosomes, heterochromatin, euchromatin –unique and repetitive DNA

8.3. Features, components and reassociation kinetics of Unique, Moderately repetitive and Highly repetitive DNA

8.4. Junk DNA, Satellite DNA and Selfish DNA

8.5. Cot value and complexity of genome

8.6. Organisation of eukaryotic genome

9. Interrupted genes (4 Hrs)

9.1. Definition and explanation

9.2. Organisation and special features of interrupted genes

9.3. Evolution of interrupted genes

10. Gene families: (6 Hrs)

10.1. Definition and concept

10.2. Classification with example

10.2.1. Simple multigene family - organisation of rRNA gene in *Xenopus*

10.2.2. Complex multigene family - organisation of histone genes in sea urchin and tRNA genes in *Drosophila*



- 10.2.3. Developmentally controlled complex multigene family e.g., globin gene
 - 10.2.3.1. Globin genes and its products
 - 10.2.3.2. Organisation of globin genes and its expression in Man
 - 10.2.3.3. Evolution of globin genes
- 10.2.4. Concept of an evolutionary clock
- 10.2.5. Pseudogenes
- 10.3. Phylogenetic and adaptive diversification in gene families
- 11. Transposable genetic elements - Transposons** (6 Hrs)
 - 11.1. Definition, features and types
 - 11.2. Transposition and mechanism
 - 11.3. Transposons in bacteria
 - 11.3.1. IS elements
 - 11.3.2. Tn family
 - 11.3.3. Mu phage as a transposable element
 - 11.4. Transposons in eukaryotes
 - 11.4.1. SINE, Alu family; LINE, L1
 - 11.4.2. P elements in *Drosophila*
 - 11.4.3. Transposons in Maize
 - 11.5. Retroviruses and transposition
- 12. Molecular mechanisms involved in recombination of DNA:** (5 Hrs)
 - 12.1. Genetic recombination – types with example
 - 12.1.1. Site specific recombination
 - 12.1.2. Non-homologous recombination
 - 12.1.3. Homologous recombination
 - 12.2. Molecular mechanism involved in homologous recombination of DNA in eukaryotes-
Holliday model: Holliday intermediate, heteroduplex DNA, gene conversion
 - 12.3. Role of Rec A protein in genetic recombination



13. Microbial genetics

(5 Hrs)

13.1. Prokaryotic genome- *Escherichia coli* genome – basic features

13.2. Methods of genetic transfers in bacteria– transformation (in *Streptococcus pneumoniae*), conjugation and sexduction, transduction

13.3. Brief note on mapping genes by interrupted mating (in bacteria)

14. Organelle genome and extrachromosomal inheritance

(6 Hrs)

14.1. Chloroplast genome: special features

14.2. Mitochondrial genome

14.2.1. Special features of yeast mitochondrial genome, petite mutants

14.2.2. Special features of human mitochondrial genome.

14.3. Extrachromosomal inheritance- inheritance of mitochondrial and chloroplast genes, maternal inheritance.

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Snustad, D.P. and Simmons, M.J.(2000). Principles of Genetics. 2nd ed. John Wiley and Sons Inc.

**Semester: 2****Name of Course SJZOL2C06 - SYSTEMATICS AND EVOLUTION****Credits: 4:0:0**

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Explain the process, procedures, and purpose of the scientific classification of animals	PO1, PO3, PO5, PSO1	U	F, C	17
CO2	Differentiate various concepts of the species and theories of classification	PO1, PO5, PSO1	Z	F, C	17
CO3	Distinguish different kinds of taxonomic characters and function of each in detail.	PO1, PO5, PSO1	Z	F, C	6
CO4	Discuss the development and nature of the current system of zoological nomenclature	PO1, PO2, PO3, PO5, PSO1	U	F, C	6
CO5	Critically evaluate the ethics and impediments in taxonomic research.	PO1, PO2, PO3, PO5, PO6, PSO1	E	F, C	8
CO6	Validate the mechanism of natural selection and sexual selection using appropriate examples.	PO1, PO5, PSO1	E	F, C	7
CO7	Define and differentiate different mechanisms involved in the evolution.	PO1, PO5, PSO1	K	F, C	7
CO8	Differentiate many prevailing hypotheses of the origin of animal life on Earth	PO1, PO5, PSO1	A	F, C	13
CO9	Summarize the stages in primate evolution including Homo	PO1, PO5, PO6, PSO1	U	F, C	9
Total Number of Hours					90

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural**



SECOND SEMESTER

SJZOL2C06 - SYSTEMATICS AND EVOLUTION (90 Hours)

Part –A: Systematics (54 Hrs)

I. Introduction	(1 hr)
1. Definition and basic concepts in Systematics and Taxonomy	(4 hrs)
1.1. Levels of Taxonomy	
Alpha, Beta and Gamma taxonomy	
1.2 Importance and applications of taxonomy	
1.3 Goals of taxonomy	
1.4 Definition of systematics	
1.5 Definition of classification	
2. Species	(4 hrs)
3.1 Monotypic species	
3.2 Polytypic species	
3.3 Ecospecies and Cenospecies	
3.4 Morphospecies	
3.5 Super species	
3.6 Species as a Population Complex	
3. Species Concepts	(6 hrs)
4.1 Typological Species Concept	
4.2 Nominalistic Species Concept	
4.3 Biological Species Concept	
4.4 Evolutionary Species Concept	
4.5 Difficulties in the application of the biological species concept	
5. Classification	(7 hrs)
5.1 Uses of Classification	
5.2 Purpose of Classification	
5.3 Theories of Classification	
(a) Essentialism (b) Nominalism (c) Empiricism	(d) Cladism (e)



Evolutionary Classification

5.4 Hierarchy of Categories

5.5 The objectives of classification

6. Taxonomic Collections and the Process of identification (8 hrs)

6.1 Taxonomic collections: Types of collections, Value of Collection

6.2 Purpose of scientific collection

6.3 Preservation of Specimens

6.4 Labeling

6.5 Curating of collections

6.6 Curating of types

6.7 Identification- Methods of identification

6.8 Use of keys, types of keys.

6.9 Merits and demerits of different keys

6.9.1 Description and publication

7 .Taxonomic Characters (6 hrs)

7.1 Nature of taxonomic characters

7.2 Taxonomic characters and adaptation

7.3 Kinds of taxonomic characters

Morphological (b) Physiological (c) Ecological (d) Ethological and (e)

Geographical characters

7.4 Taxonomic characters and classification

7.5 Taxonomic characters and evolution

7.6 Functions of taxonomic characters

8. Zoological Nomenclature (6 hrs)

8.1 Brief History of nomenclature

8.2 International Code of Zoological Nomenclature

8.3 The nature of scientific names

8.4 Species and infraspecies names

8.5 Gender of generic names

8.6 Synonyms and Homonyms



8.7 The Law of Priority

8.8 Rejection of names

8.9 Type method and different kinds of types

9. Newer trends in systematics (4 hrs)

9.1 DNA Bar coding

9.2 Molecular systematics

9.3 Chemo taxonomy and serotaxonomy

9.4 Cytotaxonomy

9.5 Numerical taxonomy

9.6 Cladistics

10. Ethics related to taxonomic publications (4 hrs)

10.1 Authorship of taxonomic papers

10.2 Correspondence

10.3 Suppression of data

10.4 Undesirable features of taxonomic papers

10.5 Taxonomist and user communities

11. Taxonomic impediments (4 hrs)

11.1 Impediments in taxonomic collections and maintenance

11.2 Shortage of man power

11.3 Lack of funding for taxonomic research

11.4 Lack of training and library facilities

11.5 Impediments in publishing taxonomic work

11.6 Solutions to overcome the impediments

Improve international co-operation (b) Development of taxonomic centers

(c) Need for efficient international networking (d) the desired end product

Part- B Evolution (36 Hrs)

1. Natural Selection: (7 hrs)

1.1 Mechanism of natural selection- directional, disruptive and stabilizing selection

1.2 Natural selection in islands

1.3 Sexual selection; intrasexual and intersexual selection- secondary sexual



characteristics-sexy son hypothesis, good gene hypothesis

2 The Mechanisms (7 hrs)

2.1 Population genetics- populations, gene pool, gene frequency, Hardy-Weinberg law, founder principle, bottleneck effect and genetic drift as factors in evolution

2.2 Evidence for evolution: DNA evidence, fossil evidence, embryological evidence, geological evidence (The evolutionary time scale; Eras, periods and epoch), evolution in action, imperfection of evolution

2.3 Co-evolution: microevolution, macroevolution, convergent evolution (homoplasy), divergent (parallel) evolution

3 Tempo of evolution (5hrs)

3.1 Gradualism Vs punctuated equilibrium

3.2 Anagenesis Vs Cladogenesis

4 Molecular evolutions (8 hrs)

4.1 Neutral theory of molecular evolution

4.2 Molecular divergence

4.3 Molecular drive

4.4 Origin of new genes and proteins

4.5 Molecular clocks, genetic equidistance, human mitochondrial molecular clock

4.6 Phylogenetic relationships- homologous sequence of proteins and DNA, orthologous and paralogous evolution, nucleotide sequence analysis

5 Evolutionary trends (9 hrs)

5.1 Biochemical evolution- Collapse of orthogenesis

5.2 Stages in primate evolution including Homo: dry and wet nosed primates, prosimians and simians, human and the African apes, African origin for modern humans, Y chromosome Adam and mitochondrial Eve

5.3 Can evolution explain language? Communication, speech, language and self awareness in primates.



References

Part -A Systematics

- David.M.H, Craig Mortiz and Barbara K.M (1996) Molecular Systematics. Sinauer Associates, Inc
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Part- B Evolution

- Coyne, J.A and Allen O.H (2004) Speciation. Sinauer Associates Inc. Massachusetts, USA
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- McHenry, H.M (2009) Evolution. In Michael Ruse & Joseph Travis. Evolution: The first four Billion Years. Cambridge, Massachusetts: The Belknap Press of Harvard University Press.p 265.
- Motoo Kimura (1983) The neutral theory of molecular evolution. Cambridge University Press.
- Roderick D.M. Page and Edward. C.H. (2000) Molecular Evolution: A Phylogenetic Approach:



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Strickberger, M.W. (2000) Evolution, Jones and Bartett Publishers, London. 38

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Futuyma, D.J. (2005). Evolution. Sinauer Associates Inc. Sunderland, Massachusetts.

Jon C. Herron and Scott Freeman (2014). Evolutionary analysis.

**Semester: 2- AUDIT COURSE- Professional Competency Course (PCC)****Name of Course SJAUZOL2 A02- MUSEUM CURATION SKILL****Credits: 2:0:0**

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Describe and discuss the roles of an art curator in the modern world	PO1, PO2, PO3, PO5 PSO1	U	F, C, P	
CO2	Demonstrate a awareness of how museums communicate complex ideas to a general audience.	PO1, PO2, PO3, PO5 PSO1	Z	F, C, P	
CO3	Understand the nature and work performed in Museum	PO1, PO2, PO3, PO5 PSO1	U	F, C	
CO4	Develop research skills that focus on objects or things preserved in Museum collections.	PO1, PO2, PO3, PO5 PSO1	A	P	
CO5	Critically review specialized literature in the field.	PO1, PO2, PO3, PO5, PO6 PSO1	E	F, C, P	
	Total Number of Hours				0

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural**



SJAUZOL2 A02 - MUSEUM CURATION SKILL

I. What is a museum?

Discuss the definitions of museums according to the American Association of Museums, International Community of Museums, National Association of Exhibit Designers.

Role of Museums

The Museum Today
Museums and Education
Museums and the Promotion of Unity

Functions of a museum

Acquisition of Materials:
Recording of Materials:
Preservation of Materials:
Research:
Exhibition of Materials:
Education:

Art Museums
Botanical Gardens
Children's Museums
History Museums
Historic Houses/ Sites
Historical Societies
Living History Sites
Military Museums/ Battlefields
Natural History Museums
Science Museums/ Science Centers
Special Interest Museums
University Museums
Zoos

V. Museum Ethics and Code of Conduct

Institutional Standing
Financial Resources
Personnel
Professional Conduct
Display & Exhibition
Other Resources

The fixed specimen; The fluid preserve; The container:
Steps for the preservation of specimens for scientific study

**Semester: 2****Name of Course** SJZOL2L01- Biochemistry, Biophysics and Biostatistics**Credits: 4:0:0**

CO	CO Statement	PO/ PSO	CL	KC
CO1	Understand Good laboratory practices in a chemistry/biochemistry laboratory.	PO1,PO2, PO3, PO4, PO5, PO6 PSO4	U	F,C,P
CO2	Apply the scientific method to the processes of experimentation and hypothesis testing.	PO1, PO2, PO5, PSO4	A	F,C,P
CO3	Construct skill and proficiency in preparation of laboratory reagents.	PO1, PO5, PSO4	E	F,C,P
CO4	Analyze the chromatographic techniques and apply the min isolating and characterizing different biological molecules.	PO1, PO5, PSO4	C	F,C,P
CO5	Differentiate the properties of carbohydrates, proteins, lipids, DNA and, RNA, their importance in biological systems.	PO1, PO5, PSO4	A	F,C,P
CO6	Understand the concepts of preparation of buffers.	PO1, PO5, PSO4	U	F,C,P
CO7	Apply hypothesis testing via some of the statistical distributions.	PO1, PO2, PO3, PO5, PSO4	A	F,C,P
CO8	Calculate (with technology) and interpret summary statistics for a quantitative variable, including mean, median and standard deviation.	PO1,PO5 PSO4	E	F,C,P

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**Semester: 2**

Name of Course SJZOL2L02 – Physiology, Molecular Biology & Cytogenetics

Credits: 4:0:0

CO	CO Statement	PO/ PSO	CLKC	
CO1	Correlate the physiological action of digestive enzymes at different conditions.	PO1, PO5 PSO4	Z	F,C,P
CO2	Practice the medical laboratory techniques.	PO1, PO2, PO3, PO5, PO6 PSO4	A	F,C,P
CO3	Observe and identify the cell cycle stages and chromosomes	PO1, PO5, PSO4	A	F,C,P
CO4	Identify the karyotype of the given clinical condition.	PO1, PO2, PO3, PO5, PO6 PSO4	U	F,C,P
CO5	Estimate the levels of biomolecules; DNA, RNA and Protein in different samples	PO1, PO5, PSO4	E	F,C,P
CO6	Demonstrate the normal cardiac, respiratory, digestive physiology of different model organisms	PO1, PO5, PSO4	U	F,C,P

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural**

**Semester: 2****Name of Course** SJZOL2L03 – Ecology, Ethology, Systematics and Evolution**Credits: 4:0:0**

CO	CO Statement	PO/ PSO	CL	KC
CO1	Apply the practical knowledge in describe the differentiating properties of terrestrial, aquatic and marine ecosystem.	PO1, PO3, PO4, PO5, PO6 PSO4	A	F,C,P
CO2	Analyze the physico-chemical and biological parameters of water and soil.	PO1, PO3, PO4, PO5, PO6 , PSO4	Z	F,C,P
CO3	Illustrate the importance of cooperation and reconciliation in social groups	PO1, PO2, PO3, PO4, PO5, PO6, PSO4	U	F,C,P
CO4	Design methods of basic data collection and construct proper experimental design on cooperative behaviour of animals.	PO1, PO2, PO3, PO5, PSO4	C	F,C,P
CO5	Understand basic taxonomic procedures	PO1, PO5, PSO4	U	F,C,P
CO6	Construct and analyze different taxonomic key.	PO1, PO2, PO3, PO5 PSO4,	Z	F,C,P
CO7	Compare and interpret concepts of evolution	PO1, PO5 PSO4,	Z	F,C,P
CO8	Evaluate gene frequency based on Hardy – Weinberg equilibrium.	PO1, PO5 PSO4,	E	F,C,P
CO9	Critically reflect the importance of the preservation and management of natural and semi-natural habitats of conservation importance.	PO1, PO2, PO3, PO4, PO5, PO6 PSO4,	E	F,C,P
CO 10	Experimentally demonstrate and the opportunity to apply content knowledge and skills in a context outside the classroom.	PO1, PO2, PO3, PO4, PO5, PO6 PSO4,	E	F,C,P

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural**



FIRST SEMESTER PRACTICALS

SJZOL2L01 - BIOCHEMISTRY

Actual acidity and titrable acidity of a strong and a weak acid.

Comparison of the buffering capacities of two buffers of same pH

Qualitative tests for carbohydrates

Qualitative tests for monosaccharides (Glucose and fructose)

Qualitative tests for disaccharides (Lactose, Maltose & Sucrose)

Qualitative tests for polysaccharides (Dextrin & Starch)

Identification of unknown carbohydrates (Glucose, Fructose, Lactose, Maltose,

Quantitative estimation of carbohydrates

1.1. Estimation of blood glucose by colorimetric method (Somogy-Nelson method/ O-Toluidine method)

1.2. Estimation of total carbohydrate by phenol-sulphuric acid method

Qualitative tests for proteins

Colour reactions with proteins (Albumin, Casein, Peptones & gelatin)

Precipitation reactions with proteins (Albumin, Casein, Peptones & gelatin)

Identification of unknown protein (Albumin, Casein, Peptones & gelatin)

Qualitative tests for non-protein nitrogenous substances (urea, uric acid and creatinine)

Identification of unknown carbohydrates, protein and non-protein nitrogenous substances from a given solution.

Quantitative estimation of proteins

Estimation of proteins by Biuret method

Isolation of casein from cow's milk

Quantitative estimation of non-protein nitrogenous substances Quantitation of blood urea by diacetyl monoxine method Determination of urine creatine by alkaline picrate method

Quantitative estimation of lipids

Estimation of total serum cholesterol by Zak's method

Saponification number of oils - coconut oil & ground nut oil.

Iodine number of fats



SJZOL2L02 - CYTOGENETICS

Homogenization, cell fractionation and isolation of nuclear fraction.

Preparation and maintenance of *Drosophila* larva.

Preparation of salivary gland polytene chromosome from *Drosophila* larva.

Grasshopper testes- squash preparation to study various meiotic stages.

Study of normal human karyotype (male and female) .

Study of genetic syndromes- Down's , Klinefelter's , Turner's and Edward's.

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SJZOL2L01 - Biophysics and Biostatistics

Biophysics

pH meter and measurement of pH

Paper chromatography of amino acids

Separation and identification of amino acids in mixtures

Thin layer chromatography.

Gel electrophoresis.

Determination of unknown concentration of coloured solutions by calibration curve using colorimeter.



Absorption spectrum and max of a coloured solution (KMnO_4).

Drawings using Camera lucida.

Biostatistics

Preparation of frequency table with given data

Diagrammatic presentation of census data in Kerala in the form of bar diagrams and pie diagrams. (prepare same graph in Excel and keep print out)

Graphic presentation of population distribution in the form of histogram, frequency polygon and frequency curve. (prepare same graph in Excel and keep print.

Computation of measures of central dispersion anthropometric data of School children. (prepare same in Excel and keep print outs and add steps for excel)

Simulation of binomial and poisson distributions .

Estimation of mean number of children per family(data from at least 10 families nearby campus) (prepare same in Excel and keep print outs and add steps for excel).

Designing of an experiment for the comparison of efficacy of a few diets on different types of animals by the method of ANOVA. (Prepare same in Excel and keep prints out and add steps for excel).

Regression analysis and correlation analysis of a data of height and weight of a group of students. (prepare same in Excel and keep print outs and add steps for excel)

References

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White, D.C.S.(1974).Biological Physics, Chapman and Hall. London.

John T (2002) Practical statistics for environmental and biological scientists .John Wiley and Sons.



SJZOL2L03 - Ecology and Ethology

Part A. Ecology

Identification of marine planktons.

Quantitative estimation of marine planktons.

Estimation of BOD in polluted water sample.

Estimation of salinity in water samples.

Estimation of nitrates-nitrogen in water samples.

Separation and identification of soil arthropods using Berlese funnel.

Determination of moisture content of soil sample.

Determination of water holding capacity of soil sample.

Testing the transparency of water using Secchi disc

Determination of primary productivity in pond water using light and dark bottle.

Study of termitarium / ant colony

Principle and application of the following instruments-GPS, Thermo hygrometer, Altimeter, Air samplers, soil samplers, Berlese funnel, Lux meter, anemometer, Rain gauge, Plankton net, Plankton counting chamber, Weather balloon, Secchi disc etc (at least six items)

FIELD STUDY-A study tour of at least five days duration (need not be at a stretch) to observe the ecology and behaviour of animals should be under taken. The places of visit include inter tidal region, fresh water bodies, lakes, rivers, hill streams, wetlands, mangroves, forests grasslands, drinking water treatment plants, and sewage treatment plants. A report of the field study is to be included in the practical record to be submitted at the time of examination.

Part B Ethology

Studying and reporting the behaviour and ecology of animals in selected fields (Social spider/ Jungle babbler/white headed babbler or Bonnet Macaques)

Foraging behaviour of ants.

Study of circadian rhythm

Behavioural reaction to moisture and light



References:

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- Goodenough, J; McGuire B. and Robert, W. (1993) Perspectives on Animal Behaviour. John Wiley and Sons, Lond.
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- Bonnie,J, Plager and Ken Yamkawa (2003). Exploring Animal Behaviour in Laboratory and Field. Academic press.
- Michael, P.(1984). Ecological methods for field and laboratory investigations. Tata McGraw Hill publishing co.
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- George,T, Franklin, L. Burton and David, S.H.(2002). Waste water Engineering-Metcalf and Eddy.4th ed. Inc. Tata McGraw Hill publishing co.

SECOND SEMESTER PRACTICALS

SJZOL2L02 – PHYSIOLOGY

Kymograph: working principle and applications

Effect of different substrate concentration, pH and temperature on human salivary amylase activity. colorimetric method, plot graphs.

Qualitative demonstration of digestive enzymes in cockroach – amylases, lipases, proteases, invertases and controls.

Digestion in a vertebrate and calculation of peptic value.

Influence of temperature and pH on the ciliary activity in fresh water mussel/mytilus using silver foil. Plot graph

Determination of respiratory quotient – estimation of O₂ consumption by an aquatic animal.

Determination of the rate of salt loss and gain in an aquatic animal (fish or crab).

Estimation of urea and ammonia in human urine. Titrimetric method.

Rate of glucose – absorption – calculation of Cori coefficient.

Estimation of haemoglobin of Fish/Man – Sahli's method.

Blood volume determination by dye dilution method (Vertebrate).

Blood: clotting time, bleeding time, rouleaux formation, preparation of haemin crystals.



Enumeration of RBCs in human blood.
Determination of lactic acid in muscle tissue.
Differential count of human WBCs
Haematocrit and ESR of human blood.
WBC total count

References:

Oser B. L.(1965). Hawk's Physiological chemistry, McGraw Hill Book Company
Hill R.W., Wyse G.A. (1989), Animal Physiology 2nd edition. Harper Collins Publishers
Schmidt-Nielsen, K. (1997), Animal Physiology, adaptation and environment, Cambridge University Press.
Dounersberger, Anne.B.Lesak, Anne,C and Timmons, Maichael,J.(1992).A laboratory Text Book Of Anatomy and Physiology. 5th ed. D.C.Heath & Co.

SJZOL2L02- MOLECULAR BIOLOGY

Estimation of DNA by Diphenyl Amine method
Estimation of RNA by Orcinol method
Estimation of Protein by Lowry's method.
Isolation of genomic DNA.
Isolation of DNA from Liver/Spleen/Thymus.
Study of principle and application of DNA finger printing.

References

Brown, T.A. (1998): Molecular biology Lab Fax. Vol. 1 and 2, Academic press
Brown, T.A. (2007): Essential Molecular Biology – A practical approach Vol. 2, Oxford University Press
Wilson & Walker (2006): Principles and techniques of Biochemistry and Molecular biology, Cambridge University Press.



SJZOL2L03- SYSTEMATICS AND EVOLUTION

Systematics

Collection, Preservation and Curation of specimens

Identification of animals (Fishes/insects/any other) up to family/ generic / species level- minimum 15 specimens.

Preparation of dichotomous (simple bracket) keys to selected families with reference to insect orders Orthoptera, Hemiptera, Coleoptera, Diptera and Hymenoptera (minimum five specimens from each order)

Evolution

Exercises in convergent evolution.

Exercises in divergent evolution.

Sympatric and Allopatric speciation.

Exercises in co-evolution.

Calculation of genotype / gene frequency based on Hardy –Weinberg equilibrium.

**Semester: 3****Name of Course: SJ ZOL3C07 – IMMUNOLOGY****Credits: 4:0:0**

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Describe which cell types and organs present in the immune response.	PO1, PO5, PSO2	U	F, C	8
CO2	Define antigen and describe how antigens affect the adaptive defenses.	PO1, PO5, PSO2	C	F, C	18
CO3	Design a model of Immunoglobulins	PO1, PO5, PSO2	E	F, C	10
CO4	Describe immune cell Activation, maturation and the expression of their receptors.	PO1, PO5, PSO2	U	F, C	16
CO5	Discuss complement system and role of MHC in immune system	PO1, PO5, PSO2	A	F, C	14
CO6	Recall the success of various transplant procedures.	PO1, PO5, PO3, PO6, PSO2	K	F, C	8
CO7	Exemplify the adverse effect of immune system including Allergy, hypersensitivity and autoimmunity	PO1, PO5, PSO2	Z	F, C	11
CO8	Elucidate the reasons for immunization and aware of different vaccination	PO1, PO3, PO5, PO6, PSO2	E	F, C	5
Total Number of Hours					90

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural**



THIRD SEMESTER THEORY

SJZOL3C07 IMMUNOLOGY

(90 Hours)

1. Introduction (1 hour)
2. Hematopoiesis (7 hours)
 - 2.1. Hematopoiesis – Lymphoid and myeloid lineages.
 - 2.2. Hematopoietic growth factors.
 - 2.3. Genes that regulate hematopoiesis.
 - 2.4. Regulation of hematopoiesis.
 - 2.5. B- Lymphocytes, T- lymphocytes and Antigen presenting cells.
3. Antigens (8 hours)
 - 3.1. Immunogenicity, Antigenicity.
 - 3.2. Factors that influence immunogenicity.
 - 3.3. Adjuvants.
 - 3.4. Haptens.
 - 3.5. Epitopes.
 - 3.6. Properties of B-cell and T- cell epitopes.
4. Immunoglobulins (Antibodies) (10 hours)
 - 4.1. Structure and function of Antibody molecules.
 - 4.2. Generation of Antibody diversity.
 - 4.3. Immunoglobulin gene.
 - 4.4. Antigenic determinants of immunoglobulin - (a) Isotype (b) Allotype (c) Idiotypic.
 - 4.5. B-cell receptor (BCR).
 - 4.6. Monoclonal Antibodies.
 - 4.7. Production of Monoclonal Antibodies (Hybridoma technology).
 - 4.8. Clinical uses of Monoclonal Antibodies.
 - 4.9. Antibody Engineering.
5. Antigen Antibody interactions (10 hours)
 - 5.1. Strength of antigen – antibody interactions.(a) Antibody affinity (b) Antibody avidity.
 - 5.2. Cross- reactivity.



5.3. Precipitation reactions.

5.4. Immunotechnics – ELISA, RIA, WesternBlot, Immunoelectrophoresis,
Flow cytometry and fluorescence.

6. Generation of B-cell and T-cell responses. (9 hours)

6.1. Humoral immunity.

6.2. Cellular immunity.

6.3. T- Cell receptor, TCR-CD3 complex.

6.4. Activation, maturation and differentiation of B-Cells.

6.5. Activation, maturation and differentiation of T- Cells.

7. Immune effector mechanism. (7 hours)

7.1. Cytokines.

7.2. Properties of cytokines.

7.3. Cytokine antagonists.

7.4. Cytokine secretion by TH1 and TH2-cells.

7.5. Cytokine related diseases. (a) Bacterial septic- shock (b) chaga's disease) (c)
lymphoid and myeloid cancers.

7.6. Therapeutic uses of cytokines.

7.7. Toll- like receptors.

8. The Complement system. (6 hours)

8.1. The complement components.

8.2. The functions of complement components.

8.3. Complement activation (a) Classical pathway (b) Alternate pathway (c) Lectin pathway.

8.4. Regulation of complement system.

8.5. Biological consequences of complement activation.

8.6. Complement deficiencies.

9. Major Histocompatibility Complex (MHC) (8 hours).

9.1. General organization and inheritance of MHC.

9.2. MHC molecules and genes.



9.3. Cellular distribution of MHC.

9.4. Antigen- processing and presentation- Exogenous and Endogenous pathways.

9.5. Presentation of non- peptide antigens.

10. Transplantation immunology (8 hours)

10.1. Auto graft, Allograft, Isograft and xenograft

10.2. Immunological basis of graft rejection.

10.3. Role of cell- mediated responses.

10.4. Transplantation antigens.

10.5. General immune suppressive therapy.

11. Hypersensitivity Reactions. (5 hours)

11.1. Allergens.

11.2. IgE- mediated (type- I) hypersensitivity.

11.3. Antibody- mediated cytotoxic (type- II) hypersensitivity.

11.4. Immune complex- mediated (type- III) hypersensitivity.

11.5. TDTH- mediated (type- IV) hypersensitivity

12. Vaccines. (5 hours)

12.1. Active and passive immunization.

12.2. Whole organism vaccines.

12.3. Recombinant vector vaccines.

12.4. DNA vaccines.

12.5. Synthetic peptide vaccines.

12.6. Multivalent vaccines.

13. Immunity and malnutrition and immune deficiency diseases. (6 hours)

13.1. Immunity and malnutrition.

13.2. Primary immune deficiency diseases. (a)Burton's disease (b) Di-George syndrome and SCID.

13.3. Secondary immune deficiency - AIDS.

13.4. Transmission of HIV.

13.5. Vaccines to prevent AIDS.



13.6. Autoimmunity (systemic and organ specific brief)

References

- Abdul K Abbas and Andrew H. Lichtman (2004). Basic immunology –Functions and Disorders of the immune system. (second edition, Elsevier Science, USA)
- Abdul K Abbas and Andrew H. Lichtman (2003). Cellular and Molecular Immunity (fifth edition, Elsevier Science, USA).
- Godkar, P.B (1998): A Text Book of Medical Laboratory Technology. Bhalani Bhalani Publishing House Mumbai.
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- Ivan .M.Roitt(2002). Essentials of Immunology. ELBS, New Delhi.
- Shetty, N (1993) Immunology: Wiley Eastern Ltd, New Delhi.
- Richard, Coico and Geoffrey, Sunshine (2009). Immunology- A short course. Wiley Blackwell. C A, USA.
- David Male, Jonathan Brastoff, David Roth and Ivan Roitt (2006). Immunology. Mosby, Edinburgh, UK.
- Hannigan, B.M., Moore, C.B.T. and Quinn, D.G.(2010). Immunology. Viva Books, New Delhi.
- Khan F,H,(2009). Elements of Immunology. Pearson Education ,New Delhi.
- Thomas J. Kindt, Barbara, A., Osborne And Richard, A.Goldsby.(2007). Kuby Immunology. 6th ed. W.H.Freeman, New York.
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**Semester: 3****Name of Course: SJZOL3C08–DEVELOPMENTAL BIOLOGY & ENDOCRINOLOGY****Credits: 4:0:0**

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Define and explain the basic concepts of development with the help of suitable examples.	PO1, PO5, PSO2	K	F, C	6
CO2	Discuss the process of gametogenesis and events during fertilization.	PO1, PO5, PSO2	U	F, C	10
CO3	Compare and contrast the process of organogenesis in the various model organisms discussed during this unit.	PO1, PO5, PSO2	Z	F, C	10
CO4	Interpret the experiments that demonstrate the inductive functions of these tissues.	PO1, PO5, PSO2	E	F, C	7
CO5	Explain the principal cellular mechanisms of development and identify the genetic and molecular elements that are involved.	PO1, PO5, PSO2	A	F, C	8
CO6	Compare the process of metamorphosis, regeneration and ageing in different model organisms.	PO1, PO5, PSO2	A	F, C	7
CO7	Understand the environmental regulation and evolutionary changes of the animal development.	PO1, PO5, PSO2	U	F, C	6
CO8	Describe the synthesis, modes, regulation and mechanism of action of hormone.	PO1, PO5, PSO2	U	F, C	10
CO9	Identify pathophysiology of the glands, organs, tissues and cells that synthesize and secrete hormones, hormone precursors and associated compounds.	PO1, PO5, PSO2	K	F, C	16
CO10	Distinguish the male and female reproductive hormones and its mechanism of action in each sex.	PO1, PO5, PSO2	Z	F, C	10
Total Number of Hours					90

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural**



THIRD SEMESTER THEORY

SJZOL3C08–DEVELOPMENTAL BIOLOGY & ENDOCRINOLOGY

(90 Hours)

Part- A - DEVELOPMENTAL BIOLOGY (54hrs)

1. Introduction: Basic concepts of development (6 hrs)

1.1. Cell fate, potency, determination and differentiation.

1.2 Commitment

1.3. Specification - autonomous, conditional, syncytial .

1.4. Genomic equivalence and cytoplasmic determinants

1.5. Morphogenetic gradients

1.6. Genomic Imprinting

1.7. The stem cell concept- Progenitor cells, Adult stem cells, Mesenchymal stem cells, Multipotent adult stem cells, Pluripotent Embryonic stem cells, Stem cell therapy.

2. Gametogenesis, fertilization and early development (10 hrs)

2.1. Production of gametes- Spermatogenesis and Oogenesis, Ultra structure of gamates

2.2 Cell surface molecules in sperm-egg recognition in animals (sea urchin and mammals)

2.3 Zygote formation-

2.3.1. Encounter of sperm and egg

2.3.2. Capacitation

2.3.3. Acrosome reaction

2.3.4. Activation of ovum

2.3.5 Amphimixis

2.3.6. Prevention of Polyspermy (Fast block and Slow block)

2.4 Cleavage and blastula formation

2.5 Gastrulation and formation of germ layers in amphibia

2.6 Embryonic fields

3. Embryogenesis and Organogenesis (10 hrs)

3.1 Axis formation in amphibians - The phenomenon of the Organizer- Nieuwkoop center, primary embryonic induction, mechanism of axis formation



- 3.2 Anterior posterior patterning in Amphibians - Hox code hypothesis
- 3.3 Anterior posterior patterning in *Drosophila* – anterior forming genes (bicoid, hunchback), posterior forming genes (nanos, caudal), terminal forming gene (torso), segmentation genes- gap genes, pair rule genes, segmentation polarity genes, homeotic selector genes, realtor genes
- 3.4 Dorso- ventral patterning in *Drosophila*- dorsal protein gradient
- 3.5. Limb development in chick- Formation of the Limb Bud, Generating the Proximal-Distal Axis of the Limb, Specification of the Anterior-Posterior Limb Axis, Generation of the Dorsal-Ventral Axis
- 3.6. Insect wings and legs formation
- 3.7. Vulva formation in *Caenorhabditis elegans*.
- 3.8. Eye lens induction.
- 3.9. Differentiation of neurons

4. Cellular and Molecular basis of development (7 hrs)

- 4.1. Induction and competence- cascade of induction- reciprocal and sequential inductive events, instructive and permissive interactions.
- 4.2. Epithelial- Mesenchymal interactions- paracrine factors - The Hedhog family, The Wnt family, Juxtacrine signaling and cell patterning, notch pathway.
- 4.3. Cellular interactions concerned in fertilization, blastulation, gastrulation and organogenesis.
- 4.5. Molecular basis of cellular differentiation – Cadherins.

5. Genetic basis of development (8 hrs)

- 5.1. Differential gene transcription –Promoters and Enhancers, DNA methylation, Transcription factors, Silencers and Insulators.
- 5.2. Differential RNA processing- X chromosome inactivation- dosage compensation- sex determination
- 5.3. Control of gene expression at the level of translation-Differential mRNA longevity, selective inhibition of mRNA translation, Selective activation of mRNA translation, micro RNAs, Control of RNA expression by cytoplasmic localization.
- 5.4. Post translational regulation of gene expression.



- 5.5. Models of cell differentiation- hematopoiesis, myogenesis, differentiation of neural crest cells.
- 5.6. Reversibility of patterns of gene activity-cell fusion, transdifferentiation.
- 6. Metamorphosis, Regeneration and Ageing (7 hrs)**
 - 6.1. Metamorphosis in Amphibians and Insects and their hormonal control
 - 6.2. Types of regeneration - Super, Hetero, Epimorphic, Morphallactic and Compensatory regeneration, Histological process during regeneration
 - 6.3. Ageing – The biology of senescence, cellular and extra cellular ageing, Genes and ageing, DNA repair enzymes, Ageing and the insulin signaling cascade, The mTOR pathway, Chromatin modification, Wear and tear, Oxidative damage, Mitochondrial genome damage, genetically programmed ageing .
- 7. Environmental regulation of animal development (4 hrs)**
 - 7.1 Environmental regulation of normal development - types of polyphenism
 - 7.2 Environmental disruptions of normal development (Teratogenesis) Teratogenic agents - Alcohol, retinoic acid, Bisphenol A(BPA), heavy metals, pathogen, Testicular Dysgenesis Syndrome, DES as an endocrine disruptor, Endocrine disruptors as obesogens
 - 7.3. Environmental oestrogens.
 - 7.4. Impact of pesticide on development.
- 8. Developmental Mechanisms of Evolutionary change- (2hrs)**
Heterotopy, Heterochrony, Heterometry, Heterotypy. (Brief)

Part B- ENDOCRINOLOGY (36 hrs)

- 1. Endocrine glands and their Hormones (Brief account) (5 hrs)**
 - 1.1. Hormone secreting organs and tissues -skin, liver, kidney, heart.
 - 1.2. General classes of chemical messengers- Peptide, thyroid, steroid hormones, neurotransmitters and pheromones
 - 1.3. Synthesis and delivery of hormones- storage, secretion and transportation
 - 1.4. Control of hormone secretion.
 - 1.5. Physical characteristics of hormones - latency, post-secretary modification and half- life



1.6. Physiological roles of hormones.

2. General mechanisms of Hormonal action (5 hrs)

2.1. Hormone Receptors and transducers;

2.1.1. Types of receptors- g protein coupled receptors, steroid receptors and nitric oxide receptors,

2.1.2. Regulation of receptor number, receptor activation

2.2. Second messengers of hormone action- cAMP, cGMP, inositol triphosphate, diacylglycerol ,

2.3. Receptor signal transduction

2.4. Eicosanoids and hormone action

Anatomy of endocrine glands; structure, physiological functions, and control of secretion of their hormones and pathophysiology (13 hrs)

3.1. Hypothalamus

3.2. Hypophysis

3.3. Thyroid

3.4. Parathyroid

3.5. Adrenal

3.6. Pancreas

4. Hormones and male reproductive physiology (7 hrs)

4.1. Synthesis, chemistry, and metabolism of androgens

4.2. Endocrine control of testicular function

4.3. Physiological roles of androgens and estrogens

4.4. Pathophysiology

5. Hormones and female reproductive physiology (3 hrs)

5.1. Synthesis, chemistry, and metabolism of Ovarian steroid hormones

5.2. Physiological roles of Ovarian steroid hormones

5.3. Hormonal regulation of female monthly rhythm

5.4. Hormonal factors in pregnancy, parturition and lactation



6. Neurohormones

(3 hrs)

- 6.1. Gases as neural messengers
- 6.2. Endorphins- physiological roles, mechanism of action and pathophysiology
- 6.3. Brain hormones and behaviour
- 6.4. Neuroendocrine pathophysiology

References Developmental biology

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- Lash, J & J. R. Whittaker. Concepts of development.
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Endocrinology

- Bentley, P. J. (1998). Comparative vertebrate endocrinology.3rd ed.Cambridge University Press
- Bern, H. A. Text book of comparative endocrinology
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- London. Hazelwood, R. (1990). The endocrine pancreas, EnglewoodCliffs, Prentice
- Hall, NJ. Horrbin, D. F. Essentials of Biochemistry, endocrinology and nutrition.



Prakash Lohr. Hormones and human health

Nelson R. J. Introduction to behavioral endocrinology

Norris D. O. (2005). Vertebrate endocrinology.

Vinzen, G. et al, (1992). Adrenal cortical steroid hormones, Englewood Cliffs, Prentice Hall,

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**Semester: 3****Name of Course: SJZOL3C09- BIOTECHNOLOGY& MICROBIOLOGY****Credits: 4:0:0**

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Understand the steps involved in recombinant DNA technology	PO1, PO5, PSO3	U	F, C	6
CO2	Explain the construction of rDNA & c DNA library and their applications.	PO1, PO3, PO5, PSO3	U	F, C	10
CO3	Describe the types of PCR and applications in Biotechnology and genetic engineering	PO1, PO5, PSO3	U	F, C	3
CO4	Understand the steps of gene synthesis and applications of molecular markers.	PO1, PO5, PSO3	U	F, C	6
CO5	Discuss the applications of recombinant DNA technology in agriculture, production of therapeutic proteins, animal culture, media preparation and transgenic animals.	PO1, PO3, PO5, PSO3	A	F, C	23
CO6	Discuss IPR, ethical and social implications in the field of biotechnology.	PO1, PO2, PO3, PO5, PO6, PSO3	E	F, C, P	6
CO7	Classify and explain the structure and general characteristics of Microorganisms.	PO1, PO5, PSO3	U	F, C	12
CO 8	Understand nutritional requirements, utilization of energy and growth of microbes.	PO1, PO5, PSO3	U	F, C	11
CO9	Discuss list of microbial diseases and various methods to control microbes	PO1, PO3, PO5, PO6, PSO3	U	F, C	8
CO10	Explain industrial and environmental application of microbiology	PO1, PO3, PO5, PSO3	U	F, C	5
Total Number of Hours					90

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural**



THIRD SEMESTER THEORY

SJZOL3C09- BIOTECHNOLOGY & MICROBIOLOGY (90 hours)

Part - A. BIOTECHNOLOGY (54 Hrs)

1. Introduction (1 hr)
Definition, branches, scope and importance
2. Vectors (5 hrs)
 - 2.1. Cloning vectors –
 - 2.1.1. Plasmids: pBR322 and pUC
 - 2.1.2. Phages: λ gt10 and M13 vector
 - 2.1.3. Cosmids: general features
 - 2.1.4. Phagemids: general features
 - 2.1.5. Viruses: SV40 and CaMV
 - 2.1.6. Transposones; Ac transposon and Ds transposon of Maize, P-element of *Drosophila*
 - 2.1.7. Artificial chromosomes: BAC, YAC and MAC.
 - 2.2. Shuttle vectors: applications and example
 - 2.3. Expression vectors: mention commonly used promoters in expression vectors (Nopaline synthase (*nos*) promoter from T-DNA, 35 S RNA promoter of CaMV, Polyhedrin promoter from Baculovirus)
3. Different steps involved in *in vivo* cloning (3hrs)
 - 3.1. Construction of chimeric DNA (Blunt end ligation, cohesive end ligation, homopolymer tailing, use of linkers)
 - 3.2. Selection of transformed cells –blue white selection method, colony hybridization, Plaque hybridization
 - 3.3. Amplification – Multiplication, Expression, and integration of the DNA insert in host genome
4. Molecular probes (3 hrs)
 - 4.1. Production



4.2. Labelling

4.3. Applications

4.4. FISH, McFISH and GISH

5. Genomic and cDNA library (4 hrs)

5.1. Construction

5.2. Screening –By DNA hybridization, Screening by immunological assay, and screening by protein activity.(Refer unit 4-Molecular Biotechnology by Glick and Pasternak-ASM press)

5.3. Blotting techniques- Southern blot, Northern blot, Western blot, Dot blot and Slot blot.

5.4. Chromosome walking

6. Polymerase Chain Reaction (3 hrs)

6.1. Basic PCR – raw materials and steps involved

6.2. Inverse PCR, Anchored PCR, Asymmetric PCR, PCR for mutagenesis and Real Time PCR

6.3. Applications of PCR in Biotechnology and genetic engineering

7. Molecular markers: detection and applications (3 hrs)

7.1. RFLP

7.2. AFLP

7.3. RAPD

7.4. Minisatellites (VNTR)

7.5. Microsatellites (SSR)

7.6. SNPs

8. Isolation, sequencing and synthesis of genes (3 hrs)

8.1. Isolation (for specific proteins and tissue specific proteins)

8.2. DNA sequencing – Maxam and Gilbert's chemical degradation method, Sanger's dideoxynucleotide synthetic method.

8.3. Synthesis of gene-Chemical synthesis of tRNA gene, Synthesis of gene from mRNA, Gene synthesis machines

9. Transfection methods and transgenic animals (3 hrs)

9.1. Definition, Methods - Electroporation, DNA micro injection, Calcium phosphate



precipitation, Dextran mediated transfer, shot gun method, virus mediated, lipofection method, engineered embryonic stem cell method

9.2. Transgenic animals for human welfare

10. Biotechnology - Animal and human health care (4 hrs)

10.1. Vaccines

10.2. Disease diagnosis

10.3. Gene therapy

10.4. Transplantation of bone marrow, artificial skin,

10.5. Antenatal diagnosis

10.6. DNA finger printing

10.7. Forensic medicine

11. *In vitro* fertilization (3 hrs)

11.1. *In vitro* fertilization and embryo transfer in human

11.2. *In vitro* fertilization and embryo transfer in live stock

12. Animal cell and tissue culture (3 hrs)

12.1. Culture media – natural and artificial

12.2. Culture methods – primary explantation techniques, various methods of cell and tissue culture

12.3. Tissue and organ culture

13. Gene Silencing techniques (2 hrs)

13.1. Antisense RNA

13.2. RNAi

13.3. Gene knockouts and Knock out mouse

14. Cloning- (2 hrs)

14.1. Cloning procedures (adult DNA cloning, Therapeutic cloning, Embryo cloning) –

14.2. Advantages and disadvantages of cloning

15. Environmental biotechnology (3 hrs)

15.1. Pollution control – cleaner technologies, toxic site reclamation, removal of oil spill, reducing of pesticides and fertilizers, biosensors, biomonitoring.



- 15.2. Restoration of degraded lands - reforestation using micro propagation,
development of stress tolerant plants

16. Agricultural Biotechnology (3 hrs)

- 16.1. Biofertilizers
16.2. Insect pest control (Pheromones, hormone mimics & analogues)
16.3. Biopesticides (Baculovirus, *Bacillus thuringiensis*, NPV)

16. Intellectual property rights (3 hr)

- 16.1. Intellectual property protection,
16.2. Patents, copy right, trade secrets, trademarks
16.3. GATT and TRIPS, patenting of biological materials,
16.4. International co-operation, obligation with patent applications, implications of
patenting- current issues

17. The ethical and social implications - (3 hrs)

- 17.1. Ethics of Genetic engineering - Social impacts - Human safety-Virus
resistant plants- Animals and ethics-
17.2. Release of GEOs-Use of herbicide resistant plants-Human genome
alterations by biotechnology
17.3. Social acceptance of biotechnology-Transgenic crops - Social acceptance of
medical biotechnology- Acceptance of GM crops for food and pharmaceutical
production, Social acceptance of Industrial biotechnology.

Part-B-MICROBIOLOGY (36 Hours)

1. Introduction- (1 hr)

- 1.1 History and scope of microbiology
1.2 Contributions of Louis Pasteur, Robert Koch, Alexander Flemming and Edward Jenner.

2. Microbial Taxonomy and Phylogeny (3 hrs)

- 2.1. Major characteristics (classic and molecular)
2.2. Numerical taxonomy
2.3. Taxonomic ranks



- 2.4. Phylogenetic studies
- 2.5. Phenetic classification
- 2.6. Bergey's Manual (mention major groups)
- 1. Bacterial cell structure and function (5 hrs)
 - 3.2. Plasma membrane and internal system - Cytometrix, inclusions, ribosomes, nucleoid
 - 3.3. Bacterial cell wall Peptidoglycan - structure-
 - 3.4. Gram positive and gram negative cell wall- Mechanism of gram staining
 - 3.5. Components external to cell wall; pili and fimbriae, capsule and slime layers, Flagella and motility
- 4. Microbial nutrition (4 hrs)
 - 4.1. Nutritional requirements,
 - 4.2. Nutritional types (Auto, Hetero, Chemo, Phototrophs & Obligate parasites)
 - 4.3. Culture media and types of media.
 - 4.4. Mixed microbial population and pure cultures.
- 5. Microbial growth (4 hrs)
 - 5.1. Growth curve -synchronous growth
 - 5.2. Continuous culture
 - 5.3. Influence of environmental factors on growth
 - 5.4. Measurement of growth
 - 5.5. Measurement of cell numbers- Petroff, Hassuer counting Chamber, Spread plate and pour plate techniques
 - 5.6. Measurement of cell mass-Turbidity and microbial mass measurement
- 6. Utilization of energy (3hrs)
 - 6.1. Biosynthetic process-peptidoglycan synthesis, amino acid synthesis,
 - 6.2. Non synthetic processes -Bacterial motility and transport of nutrients.(biochemical reactions not required).
- 7. Viruses (3 hrs)
 - 7.1. General structural properties
 - 7.2. Types: DNA viruses, RNA viruses, and enveloped viruses



8. Microbial diseases (4 hrs)

- 8.1. Human diseases caused by bacteria- Typhoid, Cholera, Tetanus, Leprosy, Tuberculosis and Pneumonia.
- 8.2. Human diseases caused by viruses- AIDS, Rabies, Measles, Swine Flu, Bird flu, SARS
- 8.3. Fungal diseases- Candidiasis

9. Control of microorganisms (4 hrs)

- 9.1. Disinfectants; A - physical- Heat, filtration and radiation. B- Chemical agents
 - Phenol and Phenolic compounds, alcohols, halogens and aldehydes.
- 9.2. Antibiotics- Penicillin, Cephalosporins, Chloramphenicol, Tetracyclines
- 9.3. Microbial drug resistance.

10. Microbial fermentation (2 hrs)

- 10.1. Lactic acid fermentation - Homolactic and heterolactic fermenters, Mention dairy products
 - cheese and yogurt
- 10.2. Alcoholic fermentation.

11. Environmental microbiology (3 hrs)

- 11.1 Microbiological analysis of drinking water.
- 11.2. Microbial Bioremediation
- 11.3. Biogas plant.

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Part- A- Biotechnology

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Part B- Microbiology

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- Hans G. Schlegel (2008): General Microbiology-Cambridge low price editions.
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**Semester: 4****Name of Course: ELECTIVE COURSE –HUMAN GENETICS -1****SJZOL4E10 - CLINICAL GENETICS****Credits: 4:0:0**

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Distinguish Mendel's principles and its deviations in the inheritance of disease causing genes with the help of pedigree chart.	PO1, PO3, PO5 PSO3	Z	F, C, P	12
CO2	Integrate the skills in human genetics with capability for karyotyping and nomenclature of metaphase chromosome bands.	PO1, PO2, PO3, PO5, PO6 PSO3	A	F, C, P	8
CO3	Adequately relate the factors involved in spontaneous abortions and its genetic background.	PO1, PO3, PO5, PO6, PSO3	U	F, C,	15
CO4	Understand the chromosome anomalies and associated diseases.	PO1, PO3, PO5, PSO3	U	F, C	20
CO5	Mention the basics of biotechnology tools that can be used in clinical diagnosis and treatment.	PO1, PO3, PO5, PSO3	K	F, C	5
CO6	Introduction to gene manipulation methods in human, recombinant DNA technology; gene modifications, somatic and germ-line therapy.	PO1, PO3, PO5, PO6 PSO3	U	F, C	12
CO7	Explain the signal transduction pathways with special emphasize on the molecules that can be targeted for treatment of genetic disorders.	PO1, PO5 PSO3	U	F, C	8
CO8	Summarize the advancement in computerized biology information, introduction to genomics and proteomics databases.	PO1, PO3, PO5, PO6 PSO3	U	F, C, P	10
Total Number of Hours					90

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural**



FOURTH SEMESTER THEORY
ELECTIVE COURSE – HUMAN GENETICS -1
SJZOL4E10 - CLINICAL GENETICS
(90Hours)

- 2. Cytogenetics** (12 hrs)
- 2.1. Concept of gene-Allele, multiple alleles, pseudoallele, complementation tests.
- 2.2. Chromosomal basis of inheritance- Mendelian and Non –Mendelian inheritance in humans- Dominant, recessive, lethal, sex linked, sex influenced, mitochondrial and multifactorial,
- 2.3. Pedigree analysis.
- Cytogenetic techniques:
- 2.1. Routine cytogenetic techniques of PBLC and preparation of stained slides and nomenclature, ISCN, SCE, MN Banding techniques- C, G, Q, Acridine orange, NOR R, and DAPI (5 hrs)
- 2.2. Specialized techniques: HRB, fragile sites, PCC, Karyotyping, interpretation (3 hrs)
- Chromosome abnormalities and clinical phenotypes
- 3.1. Abnormalities of Chromosome Number- polyploidy, aneuploidy. Factors causing aneuploidy, non-disjunction. (2hrs)
- 3.2. Autosomal aneuploid syndromes- trisomy 21, trisomy 18, trisomy 13. (4hrs)
- 3.3. Sex chromosome aneuploid syndromes- Turner, Klinefelter, Triple X, XYY. X - inactivation. (4hr)
- 3.4. Abnormalities of Chromosome Structure: Duplication, deletion, translocation, reciprocal translocation, Robertsonian translocation, microdeletion and syndromes. Uniparental disomy, Imprinting, ring chromosome, inversion, isochromosome, Chromosome instability syndromes. Spontaneous abortions (5hrs)
- 3. Medical Genetics** (20 Hrs)
- 2.1 Hematological disorders-
- 2.1.1. Hemoglobinopathies- - Sickle cell anemia, Thalassemia



- 2.1.2. disorders of stasis and coagulation disorders- Haemophilia A & B, Disseminated intravascular coagulation Thrombocytopenia, Von Willebrand's disease, hypoprothrombinemia. (3 hrs)
- 2.2 Skeletal disorders: Achondroplasia, Osteogenesis imperfecta (3 hrs)
- 2.3 Neuromuscular disorders-Muscular dystrophies, spinal muscular dystrophy, myotonic dystrophy, neurofibromatosis, tuberous sclerosis, Parkinson's disorders, Huntington chorea (5 hrs)
- 2.4 Renal disorders- Renal cystic disorders, disorders of urinary tract, nephritic diseases (2 hrs)
- 2.5 Respiratory disorders-cystic fibrosis, asthma (2 hrs)
- 2.6 Endocrine disorders- thyroid, pancreas, pituitary, gonads (5 hrs)

Medical Biotechnology (25 Hrs)

- 3.1 Introduction to Biotechnology in medical sciences.- Recombinant DNA technique for Human diseases (2hr)
- 3.2. Applications of r-DNA technology: Medical products developed by using biotechnology tools (3hrs)
- 3.2.1. Metabolic engineering and genetic changes for overproduction of - insulin, interferon and growth hormones,
- 3.2.2. Major r-DNA products (in brief) (8 hrs)
- 3.2.2.1. Somatic cell hybridization and Recombinant monoclonal antibodies
- 3.2.2.2. Recombinant tissue plasminogen activator
- 3.2.2.3. Recombinant erythropoietin
- 3.2.2.4. Recombinant antibiotics
- 3.2.2.5. Recombinant blood clotting factor VIII,
- 3.2.2.6. Recombinant hepatitis B vaccine.
- 3.3. Diagnostics tools- (6 hrs)
- 3.3.1.1. Nucleic acid sequence as diagnostic tool
- 3.3.1.2. PCR- types of PCR- RT-PCR, Fluorescent PCR
- 3.3.1.2.1. Primer designing and purification
- 3.4. Emerging trends (6 hrs)



3.4.1. Gene therapy in human-history, different types germ line, zygote and somatic cell gene therapy, SCID

3.4.2. RNA interference technology

3.4.3. Biochips

3.4.4. Liposome-based drug delivery

3.4.5. Bionanotechnology

4. Bioinformatics (10 Hrs)

4.1 Overview, databanks, techniques of alignment, role of bioinformatics in the analysis of genomic information, genomics, proteomics (5 hrs)

4.2 Biological databases - Nucleic acid – GenBank, EMBL, DDBJ. Protein – Swissprot, TrEMBL. Structural – PDB. Submitting sequences to databases – BankIt, SequIn, WebIn, and Sakura. Sequence retrieval by Entrez. (5hrs)

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- Gardner Mc Kinley *et al*: Chromosome abnormalities and genetic counselling.
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**Semester: 4****Name of Course: SJZOL4E11- DIAGNOSTIC GENETICS****Credits: 4:0:0**

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Describe the genetics behind list of inborn errors of metabolism in humans.	PO1, PO2, PO3, PO5, PO6 PSO3	U	F, C	25
CO2	Understand the role of developmental genetics in defining biological processes	PO1, PO3, PO5 PSO3	U	F, C	25
CO3	Identify the opportunities of the technique “ART” in infertility clinics.	PO1, PO2, PO3, PO5, PO6 PSO3	Z	F, C	5
CO4	Explain different molecular biology and biotechnology protocols as the diagnostic tools of genetic diseases.	PO1, PO2, PO3, PO5, PO6 PSO3	U	F, C	15
CO5	Critically evaluate the significance of different prenatal diagnosis techniques in the treatment of genetic disorders in its historical and future perspectives.	PO1, PO2, PO3, PO5, PO6 PSO3	E	F, C	20
	Total Number of Hours				90

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural**



FOURTH SEMESTER ELECTIVE COURSE

HUMAN GENETICS –II SJZOL4E11- DIAGNOSTIC

GENETICS (90 Hours)

1. Biochemical Genetics (25 hrs)

- 1.1. Inborn errors of metabolism -Definition and mode of inheritance
- 1.2. Disorders of carbohydrate metabolism- Galactosemia, essential fructosuria, fructose intolerance, glycogen storage disorders Mucopolysaccharides
- 1.3. Diseases of amino acid metabolism- Phenylketonuria, tyrosinosis, alkaptonuria, albinism, maple syrup urine disease, homocystinuria and histidinuria
- 1.4. Disorders of lipid metabolism- Tay Sach's disease, Goucher's disease
- 1.5. Disorders of nucleic acid metabolism- Primary gout, Leish nyhan syndrome
- 1.6. Mineral metabolism disorders- Wilson disease, Menkes disease
- 1.7. Disorders of porphyrins - inherited porphyrias
- 1.8. Peroxisomal disorders - Zellweger syndrome, X linked adrenoleukodystrophy
- 1.9. Disorders of Vitamin D metabolism- Hereditary Vitamin D Dependency Type 1 (VDDR- 1)-1-A-Hydroxylase Deficiency, Hereditary Vitamin D-Dependent Rickets Type 2 (VDDR- 2).

2. Developmental Genetics (25 hrs)

- 2.1. Human embryo development- Cleavage, 2 cells, 4 cells, 8 cells, 16 cells, 32 cells, Morula, Blastula, Gastrula, Organogenesis
- 2.2. Gonadal differentiation
- 2.3. Placental types, implantation, developmental features of human foetus- first lunar month to tenth lunar month First, second and third trimester
- 2.4. Formation of extra embryonic tissue
- 2.5. Study of human birth defects- Syndromology, Dysmorphology, Neural tube defect, Anencephaly, Meningocele, Spina bifida, Herlequin ichthyosis

3. Reproductive Genetics (5 hrs)

- 3.1. Spermatogenesis, oogenesis



- 3.2. Computer Assisted Semen Analysis (CASA).
- 3.3. Assisted Reproductive Techniques (ART) IUI, IVF, ICSI, ZIFT, GIFT
- 3.4. Pre-implantation Genetic Diagnosis (PGD)

4. Molecular Diagnosis (15 hrs)

- 4.1. DNA fingerprinting.
- 4.2. Linkage analysis - RFLP, blotting techniques (southern, northern and western)
- 4.3. Gene sequencing
- 4.4. Probes- Preparation and classification, in-situ hybridization, FISH, mFISH, fiber FISH, application of FISH.
- 4.5. CGH, SKY, Micro array, Microchips, Comet assay

5. Prenatal Diagnosis. (20 hrs)

- 5.1 Historical perspective
- 5.2 Non-invasive techniques- Ultrasonography, foetal MRI
- 5.3 Invasive techniques- Amniocentesis, chorionic villus sampling sampling, foetal skin sampling,
- 5.4 Chromosome analysis, metabolic disorders, DNA Analysis
- 5.5. Current knowledge of prenately diagnosed genetic disorders, haemoglobinopathies, coagulation disorders.
- 5.6 Treatment of genetic disorders

References

- Devlin, T.M. (1994): Text book of Biochemistry with clinical correlations (3rd edn.)
Discovery School: Test Tube Babies –CD
- Emery, A.E.H. and Rimoin D.L. (1983): Principles and Practice of Medical Genetics, Vol. II, Churchill Livingstone, Chap.99
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Basic Human Genetics

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Monograph in Medical Genetics.

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Scriver *et al.* (2002): The metabolic and molecular basis of inherited diseases. 8th edition,
McGraw- Hill.

Stratchan, T. and Read, A.P. (2001): Human molecular Genetics. John Wiley, New York

Strickberger : Genetics

Sushama Bai, S: Clinical evaluation of Newborn Infants and

Children Tomarin Robert, H: Principles of Genetics

Turnpenny Peter D *et al*: elements of Medical Genetics

Vides Julio Collado: Gene Regulation and Metabolism

Weatherall, D.J. and Clegg. (1981): The Thalassaemia Syndromes (Ed.3).

**Semester: 4****Name of Course: SJZOL4E12 – CANCER GENETICS AND GENETIC SERVICES****Credits: 4:0:0**

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Understand the genetic mechanisms of cancer development and progression	PO1, PO4 PO5, PSO3	K	F, C	2
CO2	Explain different types cancers and its genetic background	PO1, PO3, PO5, PSO3	U	F, C	12
CO3	Discuss the role of genomic instability in cancer progression.	PO1, PO5, PSO3	U	F, C	16
CO4	Critically evaluate the role of genetic counseling in genetic services.	PO1, PO2, PO3, PO5, PO6, PSO3	E	F, C, P	15
CO5	Explain molecular biology and biotechnology protocols, including PCR, gene isolation and cloning, gene mapping, and sequence analysis (basic bioinformatics) as part of genetic services and diagnosis.	PO1, PO3, PO5, PO6 PSO3	U	F, C	15
CO6	Identify the criterias to be followed and the substantiating challenges in the maintenance of medical ethics in genetic services.	PO1, PO2, PO3, PO5, PO6, PSO3	Z	F, C, P	10
CO7	Understand the immune system related diseases and its treatments.	PO1,PO5, PSO3	U	F, C	5
CO8	Discuss the genetic effects of radiation and its clinical applications in the diagnosis and treatments.	PO1, PO4, PO5, PSO3	U	F, C	5
CO9	Test the reliability and usefulness of genetic services in a population based on the epidemiological and dermatoglyphic studies.	PO1,PO2,P O3,PO5, PO6 , PSO3	A	F, C, P	10
Total Number of Hours					90

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural**



**FOURTH SEMESTER THEORY ELECTIVE COURSE –
HUMAN GENETICS –III
SJZOL4E12 – CANCER GENETICS AND GENETIC SERVICES (90 Hrs)**

- 1. Cancer Genetics (30 hrs)**
 - 1.1 Genetic basis of cancer: Neoplasms, Tumorigenesis, Apoptosis (2 hrs)

Classification, diagnosis, prognosis, treatment
 - 1.2 Leukemia- ALL, CLL, AML, CML, Philadelphia chromosome, bcr-abl gene fusion, PML-RARA gene fusion (4 hrs)
 - 1.3 Solid tumors: Breast cancer, prostate cancer, retinoblastoma, osteosarcoma, Two hit hypothesis (5 hrs)
 - 1.4 Reticulo-endothelial system: lymphomas- Burkitt, Non- Hodgkin lymphoma, Multiple myeloma (3 hrs)
 - 1.5 Oncogene families: Cancer causing genes, Tumor suppresser genes, Protooncogene, DNA repair gene. Mechanism of oncogene expression, over expression of oncogenes, cellular oncogene producers. (8 hrs)
 - 1.6 Telomeres and Telomerases- Introduction and function of telomeres and telomerases, steps involved, DNA repair and damage. Regulation of telomere length, genetic disorders and telomeres (Progeria, Ataxia Telangiectia) (3 hrs)
 - 1.7. Genomic instability and cancer. Mutation rates in normal and neoplastic cells, mutation and genomic instability, common DNA damaging agents (environmental, chemical, physical, biological). Chemotherapy and mechanism of anticancer drugs. (5 hrs)
- 2. Genetic Counseling (15 hrs)**
 - 2.1 Definition, Indication for genetic counseling, Steps in genetic counselling (5 hrs)
 - 2.1 Premarital genetic counselling (3 hrs)
 - 2.2 Psychological aspects of genetic counseling, Special considerations in genetic counselling (4 hrs)
 - 2.3 Pre-natal counseling and Population screening (3 hrs)
- 3. Genetic engineering (10 hrs)**



3.1 Introduction- Molecular tools of genetic engineering	(1 hr)
3.2 Vectors- methods of gene transfer	(2 hrs)
3.3 Gene cloning strategies- DNA amplification, Gene libraries, site `directed mutagenesis, and protein engineering- manipulation of gene expression in host	(4 hrs)
3.4. Basic techniques in genetic engineering	(2 hrs)
3.5. Agarose gel electrophoresis, Counter clamped homogenous electric field electrophoresis (CHEF), PAGE, SDS – PAGE	(1 hr)
4. Gene Mapping and cloning	(5 hrs)
4.1 Physical mapping, gene mapping, linkage analysis, recombination frequencies, LOD score, linkage equilibrium, linkage disequilibrium	(2 hrs)
4.2 Human Genome Project: Objectives, achievements and applications Positional cloning, Sequence tagged sites, Genomic library.	(2 hrs)
4.3 Chromosome walking, chromosome jumping	(1 hr)
5. Ethics	(10 hrs)
5.1 Medical ethics in India and Abroad	(2 hrs)
5.2 Organ banks, human cloning, genetic registries	(2 hrs)
5.3 IVF ethics	(3 hrs)
5.4 PND act, MTP act	(2 hrs)
5.5 ELSI of new genetics	(1 hr)
6 Immunogenetics	(5 hrs)
6.1 Major Histocompatibility Complexes - General organization of MHC and disease association.	(1 hr)
6.2 Blood group system- Genetics of ABO and Rh factor, Rh incompatibility	(1 hr)
6.3 Immune system in health and diseases-Immune response to infectious disease, Primary and secondary deficiencies, autoimmunity, SCID, Wiskott Aldrich syndrome, Agamaglobulinemia	(3 hrs)
7. Radiation Genetics	(5 hrs)
7.1 Biological effect of radiation, dosimetry	2hrs



7.2 Radiation sensitizers, radio protectors and other factors. Radiation protection – radiation safety, maximum permissible doses. Clinical applications of radiation biology – in therapeutic radiology, diagnostic radiology and nuclear medicine. (3 hrs)

8. Population Genetics (10 hrs)

8.1 Twin studies (1 hr)

8.2 Dermatoglyphics- qualitative and quantitative parameters. Dermatoglyphics in medical disorders (2 hrs)

8.3 Epidemiology- descriptive and analytical methods (3 hrs)

8.4 Hardy Weinberg equilibrium- Properties of equilibrium populations Selection favouring and against heterozygotes (2 hrs)

8.5 Nonrandom mating in human populations- consequences of inbreeding, Genetic load (2 hrs)

References

Brown, T. A. (1995). Gene Cloning –3rd Ed, Chapman and Hall publications.

thPrimrose, S., Twyman, R. and Old, B. (2001)-. Principles of Gene manipulation 6 Edition Blackwell Scientific Publication.

Sambrook J. *et al* (2000). Molecular Cloning – A Laboratory Manual Cold-Spring Harbor Lab Press.

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Campbell, A.M. and Heyercold, L.J.(2002). Discovering Genomics, Proteomics and Bioinformatics. Spring Harbor Lab Press.

Arthur M.Lesk (2002) – Introduction to Bioinformatics – Oxford University press.

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Mount (2001) – Bioinformatics – Cold Spring Harbor Laboratory Press.

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Tubiana. M, Dutereix. J, and Wambersie. A .(1990). Introduction to Radiobiology. Taylor & Francis, London, NY.

Obe. G and Natarajan. A.T. (1994). Chromosomal Alterations – Origin and significance,



springer – verlag, Berlin, Heidelberg.

A.E.H. Emery and D.L. Rimoin: Principles and Practice of Medical Genetics, Vol. III, Churchill Livingston,

Kowles Richard: Solving Problems in Genetics

Banerjee Pranab Kumar: Problems in Genetics, Mol. Genetics and evolutionary Genetics

Xion Jin: Essential Bioinformatics

Harper Joyee C: Preimplantation Genetic Diagnosis.

Harper Peter S: Practical Genetic Counseling



Elective Courses theory

(Remaining available options as elective courses)

Semester: 4

Name of Course: SJZOL4E09 – Entomology 1: Morphology and Taxonomy

Credits: 4:0:0

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Demonstrate understanding of insect identification, structure, and function	PO1, PO4 PO5, PSO1	K	F, C	5
CO2	Understand key morphological characteristics that define taxonomic lineages to identify insects.	PO1, PO3, PO5, PSO1	U	F, C	31
CO3	Utilize identification keys effectively to identify lower taxonomic levels	PO1, PO2, PO5, PSO1	E	F, C	36
CO4	Demonstrate and categorize insects based on basic ecological, behavioral, morphological, physiological attributes.	PO1, PO2, PO3, PO5, PO6, PSO1	Z	F, C	18
Total Number of Hours					90

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create

***F-factual, C-conceptual, P-practical/procedural**



FOURTH SEMESTER THEORY
ELECTIVE COURSE- ENTOMOLOGY-I
SJZOL4E09 -MORPHOLOGY AND TAXONOMY
(90 Hours)

Introduction (5 hrs)

- 1.1. Origin and evolution of insects: Ancestry of insects based on fossil studies. Phylogeny of insects: Atelocerata hypothesis, Pancrustacea theory. Mention phylogenomics studies.
- 1.2. Fossil insects. Mention extinct orders: Archodonata, Blattoptera, Coxoplectoptera, Diaphanopterodea, Glosselytrodea, Meganisoptera, Megasecoptera, Miomoptera, Monura, Palaeodictyoptera, Protelytroptera, Protodiptera, Protorthoptera and Titanoptera.

Insect classification (31 hrs)

Introduction to classification of insects. Mention Apterygota, Exopterygota, Endopterygota, Hemimetaboly and Holometaboly. **(1 hr)**

- 2.1. Apterygota:** Diagnostic characteristics, biology and economic importance of the following Orders: Collembola, Protura, Diplura, Archeognata (Microcoryphia) and Thysanura. Locomotion in Collembola. **(3 hrs)**

- 2.2. Exopterygota:** Diagnostic characteristics, biology and economic importance of the following Orders and families mentioned under each order. Special topics mentioned under each order. **(12hrs)**

Ephemeroptera.

Odonata-mention dragon flies and damselflies, mouthparts of naiads, mating behavior.

Isoptera- Castes, Termitarium, economic importance.

Phasmida.

Blattaria- Mention economic importance and important species.

Mantodea & Mantodea.

7. Orthoptera- Families: Acrididae, Tettigonidae, Gryllidae, Gryllotalpidae. Stridulatory organs in Orthoptera; Locusts.
8. Thysanoptera.



Hemiptera; Families- Cicadidae, Jassidae, Cercopidae, Membracidae, Aphididae, Nepidae, Gerridae, Pentatomidae, Reduviidae. Medical importance of Reduviidae; Polymorphism in Aphids; Stridulation in Cicada.

Psocoptera.

Phthiraptera- Mention *Pediculus humanus* and its parasitic adaptations.

Dermaptera- Sexual dimorphism and parental care.

Plecoptera.

Embioptera.

Zoraptera.

2.3. Endopterygota: Diagnostic characteristics, biology and economic importance of the following Orders and families mentioned under each order. Special topics mentioned under each order. (15 hrs)

Coleoptera- Families: Curculionidae, Scarabaeidae, Carabidae, Cerambycidae, Lampyridae, Chrysomelidae, Elateridae, Meloidae. Mention cantharidin and bioluminescence.

Lepidoptera. Butterflies and Moths. Families: Noctuidae, Sphingidae, Saturniidae, Pyralidae, Papilionidae, Nymphalidae, Hesperidae, Pieridae, Lycaenidae, Geometridae. Migration in butterflies; Butterfly farming; Silk moths.

Hymenoptera: Families: Vespidae, Sphecidae, Megachilidae, Apidae, Eumenidae, Xylocopidae, Formicidae, Evanidae, Braconidae, Ichneumonidae, Chalcididae, Eulophidae, Eurytomidae and Pteromalidae. Parasitic hymenoptera and biological control; Honeybees and honey production; Honeybee venom; Swarm intelligence and its application.

Diptera: Suborders: Nematocera and Brachycera. Families: Muscidae, Culicidae, Calliphoridae, Sarcophagidae, Simuliidae, Tipulidae, Glossinidae, Drosophilidae, Psychodidae. Disease vectors; Dipterans and forensic entomology; Dipterans and bio-surgery; *Drosophila* as experimental model.

Siphonoptera: Mention plague.

Strepsiptera. Mention stylopization.

Neuroptera. Mention Antlions.



Mecoptera .

Megalaoptera.

Raphidioptera.

Trichoptera.

External morphology (36 hrs)

3.1. Segmentation and division of the body

3.2. General morphology of the Head

3.2.1. Opisthognathous, hypognathous and prognathous –

3.2.2. Head segmentation- theories about the segmentation of the head

3.2.3. Head skeleton- different sutures and sclerites –

3.2.4. Tentorium –

3.2.5. Modification in head capsules –

3.2.6. Cephalic appendages –

3.2.6.1. Antenna: structure, function & types

3.2.6.2. Gnathal appendages: types, structure & function

3.2.6.3. Mouth parts of insects

3.2.7. Cervix

3.3. Thorax

3.3.1. Thoracic segmentation

3.3.2. Thoracic skeleton

3.3.3. Endothorax

3.3.4. Thoracic appendages

3.3.4.1. Modifications of thoracic legs

3.3.4.2. Wings: origin and evolution of wings, structure, venation, wing coupling apparatus, morphological variations

3.4. Abdomen

3.4.1. Segmentation

3.4.2. Skeletal composition

3.4.3. Pregenital and post genital segments



3.4.4. Abdominal appendages

3.5. External genitalia: male and female

Ecology and Behaviour (18 hrs)

4.1. Aquatic insects

4.1.1. Factors influencing the aquatic life

4.1.2. Food capture; modifications

4.1.3. Respiration in semi-aquatic and in truly aquatic insects

4.1.4. Oviposition methods

4.1.5. Anchorage, locomotion

4.1.6. Adaptations of swimming forms

4.2. Gall forming insects:

4.2.1. Definition and features

4.2.2. Formation, economic importance

4.2.3. Common gall pests

4.2.4. Extent of gall making habits

4.2.5. Gall as dwelling place, the position of gall

4.2.6. Classification of galls by Orders

4.2.7. Adaptation for the gall making habits

4.2.8. Origin and types of galls (open & closed)

4.2.9. Physiology of gall formation

4.3. Leaf mining insects

4.3.1. Definition and identification

4.3.2. Forms of leaf mines, economic importance

4.3.3. Extent of the leaf mining habits

4.3.4. Feeding habits and frass disposal

4.3.5. Ecological aspects of leaf mining

4.4. Insect-plant interdependence (co-evolution)

4.5. Social insects – social organisation

4.6. Caste differentiation



- 4.7. Aspects of social behaviour with reference to honey bee, termite and ant
- 4.8. Communication – acoustic, visual, tactile and chemical method (pheromones)
- 4.9. Adaptations of parasitic and predatory insects

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Web sources:

- https://en.wikipedia.org/wiki/Category:Extinct_insect_orders (Extinct insect orders)
<http://science.sciencemag.org/content/346/6210/763> (Phylogenomics studies).



Semester: 4

Name of Course: SJZOL4E09 – Environmental Biology 1: Man, Environment & Natural Resources

Credits: 4:0:0

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Analyse the impact of lifestyle on the environment and climate	PO1, PO3, PO4, PO5, PSO1	Z	F, C	30
CO2	Demonstrate and awareness of ecosystems in the context of coupled human-environmental interactions.	PO1, PO2, PO3, PO4, PO5, PSO1	U		10
CO3	Describe energy transformations across trophic levels	PO1, PO4, PO5, PSO1	U		25
CO4	Evaluate various types of natural resources, human impact on these resources, and common resource management practices.	PO1, PO2, PO3, PO4, PO5, PO6, PSO1	E	F, C, P	25
Total Number of Hours					90

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create

***F-factual, C-conceptual, P-practical/procedural**



FOURTH SEMESTER THEORY

ELECTIVE COURSE - ENVIRONMENTAL BIOLOGY- I

SJZOL4E09 - MAN, ENVIRONMENT & NATURAL RESOURCES (90 hours)

Weather and climate (15 hrs)

- 1.1. Atmosphere- structure and composition; Local winds: Sea and land breezes; Polar easterlies, Westerlies; Trade winds;
- 1.2. Indian and African Monsoon;
- 1.3. Inversions: temperature or thermal inversions- causes –consequences –subsidence inversion;
- 1.4. Clouds and their formation

Cloud categories: low, middle, and high clouds: Cirrus (Ci), Cirrocumulus (Cc), and Cirrostratus (Cs), Altocumulus (Ac), Altostratus (As), and Nimbostratus (Ns), Cumulus (Cu),

Element and factors of climate; (15 hrs)

- 2.1. External factors: solar radiation- Plate tectonics - Milankovitch Theory – Orbital eccentricity - obliquity- axial precession.
- 2.2. Internal factors: earth's orography- oceanic and continental influence- Deforestation- surface albedo- snow and ice- volcanic activity-dust particles- Greenhouse gas concentrations -Atmosphere- ocean heat exchange-Atmospheric carbon dioxide Variations- human influences
- 2.3. Global climate changes – causes and consequences.
- 2.4. Physical evidence for climatic change – Historical and archaeological evidence- Glaciers – Vegetation -Ice cores – Dendroclimatology- Pollen analysis-Sea level change

Human population (10 hrs)

- 3.1. Exponential growth – geometric growth or geometric decay- Malthusian growth model - population momentum age structure – population pyramid, age structure diagram

Types of population pyramid - Young and aging populations – youth bulge -



- 3.3. Current trends in global population with reference to developed and developing countries
- 3.4. Population explosion –Baby boom –History of population growth Projections Of population growth
Demographic transition, Carrying capacity – Human population in India

Ecosystem (25 hrs)

- 4.1. Ecosystems-a) types, natural & artificial, agroecosystems, city ecosystems and Spacecraft ecosystems
- 4.2. Functions of Ecosystems-
- 4.3. Ecological energetics - Fixation and utilization of energy-
- 4.4. Primary production, factors affecting & measurements of primary production,
- 4.5. Ecological efficiencies- ratios within and between trophic levels,
- 4.6. Lindmann's work, Single channel, Y shaped and universal energy flow models.
- 4.7. Place of man in the food chain, Human expropriation of primary production, Nutrient cycling, selection, diversity, decomposition and stability.
- 4.8. Development of ecosystems, Types and factors controlling, changes in the trends of ecological attributes,
- 4.9. Relevance of ecosystem development concept to human ecology and evolution of ecosystems
- 4.10. Human impact on ecosystems, Human settlements, Human cultural evolution, Environmental crisis,
- 4.11. Environmental protection and sustainable development, Creating sustainable cities suburbs and towns,
- 4.12. Meeting human needs while protecting the environment.

Resources of the Earth – Renewable & Non renewable (25 hrs)

- 5.1. Natural resources-Renewable and nonrenewable natural resources.
- 5.2. Depletion of natural resources and its effects.
- 5.3. Aquaculture. Economically important crustaceans, mussels, oysters, clams and sea weeds.(Brief)



- 5.4. Fishery resources of Kerala with special reference to fresh water ornamental species.
- 5.5. Marine products - Food value of fish, Fish meal, fish body oil, Fish liver oil, Fish maw and other products.
- 5.6. Forest products -major and minor products of both plant and animal origin.
- 5.7. Economically important insects and their products-Honey, Lac and Silk.
- 5.8. Plantation crops, and their products and uses (Tea, coffee, Rubber, Coconut, Cashew nut, Cardamom).
- 5.9. Mineral resources with special reference to India. Over exploitation and environmental problems citing case studies from India.
- 5.10. Water as a resource – Characteristics of water. Major water compartments.
Hydrological cycle. Water management and conservation – Rain water harvesting technique, Surface and ground water resources of Kerala
- 5.11. Energy resources
- 5.12. Conventional energy sources (coal, Oil and natural gas and oil shale)
- 5.13. Non conventional energy sources -solar energy, wind energy, geothermal energy, hydropower, biomass, biogas, Tidal energy, Energy from waste, Hydrogen, and Nuclear energy.
- 5.14. Energy crisis.

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Semester: 4

Name of Course: SJZOL4E09 – Fishery Science 1: Taxonomy, Biology, Physiology & Ecology

Credits: 4:0:0

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Understand basic knowledge of the taxonomy of fish	PO1, PO5, PSO2	U	F, C	10
CO2	Describe life history and locomotion of fishes	PO1, PO3, PO5, PSO2	U	F, C	17
CO3	Demonstrate basic knowledge of the biology (, physiology, anatomy and habitat needs) of representative fish	PO1, PO4, PO5, PSO2	Z	F, C	38
CO4	Explain oceanography and ecology of fishes	PO1, PO3, PO5, PO6, PSO2	R	F, C, P	25
Total Number of Hours					90

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create

***F-factual, C-conceptual, P-practical/procedural**



FOURTH SEMESTER THEORY

ELECTIVE COURSE - FISHERY SCIENCE - I

SJZOL3E09 –TAXONOMY, BIOLOGY, PHYSIOLOGY & ECOLOGY (90 Hours)

Fish Taxonomy (10 hrs)

- 1.1. Fundamentals of fish taxonomy
- 1.2. Classification of fin fishes – mention the following families [referring to their orders] with common or economically important examples: Hemiscyllidae, Carcharhinidae, Sphyrnidae, Notopteridae, Anquillidae, Clupeidae, Chanidae, Cyprinidae, Bagridae, Siluridae, Claridae, Heteropneustidae, Ariidae, Salmonidae, Harpodontidae, Hemiramphidae, Belonidae, Aplocheilidae, Poecilidae, Syngnathidae, Platycephalidae, Ambassidae, Carangidae, Teraponidae, Leiognathidae, Gerreidae, Nandidae, Cichlidae, Mugilidae, Trichiuridae, Channidae, Cyanoglossidae and Tetraodontidae.

Integument (7 hrs)

- 2.1. Exoskeleton
- 2.2. Skin and scales
- 2.3. Colouration
- 2.4. Chromatophores and pigments
- 2.5. Structure, function and modification of fins

Locomotion (5 hrs)

- 3.1. Body shape and musculature

Life history of fishes (5 hrs)

- 4.1. Reproduction, reproductive hormones, reproductive behaviour, oviparity, ovoviviparity
- 4.2. Age and growth
- 4.3. Migration

Digestive physiology (8 hrs)

- 5.1. Food and feeding
- 5.2. Feeding behaviour



5.3. Feeding mechanism

5.4. Digestive enzymes

5.5. Absorption

Circulatory physiology (6 hrs)

6.1. Heart

6.2. Blood, blood cells, blood pigments and functions of blood

6.3. Circulation

Respiratory physiology (6 hrs)

7.1. Gills and Accessory respiratory organs

7.2. Gas transport

Excretory and Osmoregulatory physiology (6 hrs)

8.1. Excretory organs

8.2. Osmoregulation in marine, brackish water and fresh water fishes

Endocrine physiology (6 hrs)

9.1. Endocrine glands – structure and function

9.2. Regulation of endocrine secretion

9.3. Crustacean neurosecretory system and its role in reproduction

Adaptive physiology (6 hrs)

10.1. Deep sea fishes

10.2. Cave dwelling fishes

10.3. Hill stream fishes

Oceanography (15 hrs)

11.1. Ecological subdivisions of the sea

11.2. Major topographic features of continental shelf, continental slope and ocean floor

11.3. Physico-chemical properties of sea water

11.4. Ocean currents

11.5. Ocean productivity



11.6. Coral reefs

Brackish water ecology (5 hrs)

12.1. Characteristics of brackish and estuarine waters

12.2. Estuarine productivity

Limnology

13.1. Classification of inland waters – ponds, lakes, rivers and reservoirs.

13.2. Physico-chemical properties of inland waters

References

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**Semester: 4****Name of Course: SJZOL4E09 – Wildlife Biology 1: Biodiversity & Biota****Credits: 4:0:0**

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Understand the basic terms in biodiversity and conservation	PO1, PSO1	U	F,	6
CO2	Explain Biology and Taxonomy of mammals.	PO1, PO4, PO5, PSO1	U	F, C	30
CO3	Explain Biology and Taxonomy of birds.	PO1, PO4, PO5, PSO1	U	F, C	30
CO4	Understand Biology and Taxonomy of fishes, Amphibians & Reptiles	PO1, PO4, PO5, PSO1	U	F, C,	10
CO5	Analyze the Sociobiology& Territoriality of different animals	PO1, PO2, PO3, PO4, PO5, PSO1	Z	F, C,	14
Total Number of Hours					90

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural**



FOURTH SEMESTER THEORY ELECTIVE COURSE: WILDLIFE BIOLOGY-I

SJZOL4E09 - BIODIVERSITY AND BIOTA (90 Hours)

Introduction (6 hrs)

- 1.1. Biodiversity: Definition
- 1.2. Kinds of biodiversity
- 1.3. Biodiversity hot spots
- 1.4. Endemism
- 1.5. Western Ghats Biodiversity

Biology and Taxonomy of Mammals & Birds (60 hrs)

Biology and Taxonomy of the following animals with special emphasis on Western Ghats (Biology should include population status, distribution, feeding and breeding habits, major threats to their survival and conservational significance)

2.1. Mammals (30 hrs)

Order: Primates

Apes: Gibbon,

Monkeys: Macaques (Bonnet, Rhesus, Assamese and Lion tailed) Langurs (Common, Capped, Golden, Nilgiri)

Lemurs: Slender Loris and Slow

Loris Order: Carnivora

Cats: Tiger, Lion, Leopard, Fishing cat, Leopard cat, Jungle cat, Indian Wild Dog, Wolf, Jackal, Indian Fox

Otters: Common Otter, Smooth Indian Otter

Bears: Sloth bear, Brown bear, Himalayan black bear, Sun bear Panda: Giant panda, Red panda

Hyaena: Striped hyaena

Civets: Malabar civet, Small Indian civet, Common palm civet



Mongoose: Common mongoose, Small Indian mongoose, striped necked mongoose

Order: Artiodactyla

Cervids: Chital, Sambar, Barking deer, Mouse deer.

Bovids: Indian Antelope, Four horned Antelope, Nilgiritahr, Indian bison.

Suids: Indian Wild boar.

Order: Proboscidae : Indian Elephant

Order: Perisodactyla : One horned Rhinoceros.

Order: Pholidota : Indian Pangolin

Order: Lagomorpha : Hispid hare

Order: Insectivora : Tree shrew, Hedgehog

Order: Rodentia : Indian Giant squirrel, Grizzled giant squirrel, Porcupine, Flying squirrel, striped palm squirrel

Order: Chiroptera : Indian flying fox, short nosed fruit bat, Indian pipistrella

Order: Cetacea: Gangetic dolphin, Common dolphin, Sperm Whale.

Order: Sirenia: Sea cow

2.2. BIRDS (30 hrs)

2.2.1. Habitat preference

2.2.2. Flocking and aggregation.

2.2.3. Foraging behaviour,

2.2.4. Food competition and selection

2.2.5. Courtship and pair selection,

2.2.6. Brood parasitism and cooperative breeding.

2.2.7. Vocalisation and its Role in birds

2.2.8. Flyways and peculiarities of bird migration in the Indian Subcontinent

2.2.9. Avian classification and distribution with special reference to Indian species. Order: Columbiformes: Blue Rock pigeon, Spotted Dove.

Order: Podicipediformes: Little Grebe

Order: Pelecaniformes: Little and Large Cormorant, Darter



Order: Ciconiformes : Pond heron, Large egret, Little egret, Median egret,
Grey heron, Purple heron

Order: Ansariformes: Bar headed goose, Lesser whistling teal

Order: Gruiformes: Indian Moorhen, Purple moorhen, White breasted waterhen

Order: Charadriiformes: River tern, Red wattled Lapwing, Yellow wattled Lapwing,
Black headed gull, Bronze winged jacana, Pheasant tailed jacana.

Order: Falconiformes: Hawks, Vultures.

Order: Cuculiformes: Indian cuckoo, Koel, Crow pheasant

Order: Coraciformes: White breasted kingfisher, Small blue kingfisher, Pied
Kingfisher, Brown headed kingfisher, Chestnut headed Beak eater, Small green
Beak eater, Hornbill

Order: Pisciformes: Lesser Golden backed woodpecker, Indian golden backed
woodpecker, Small green barbet

Order: Psittaciformes: Rose ringed parakeet, Blossom headed parakeet, Lorikeet

Order: Strigiformes: Indian horned owl, Mottled wood owl, Barn owl

Order: Apodiformes: Palm swift

Order: Passeriformes: Black headed Oriole, Golden Oriole, Tree Pie, Drongo, Racket tailed
Drongo, Red whiskered Bulbul, Red vented Bulbul, Black headed Babbler, White
headed Babbler, Munia, Magpie Robin, Jungle Babbler, Purple Sunbird, Purple
rumped sunbird, Indian Roller, Indian Robin, White cheeked Bulbul, Tickell's flower
pecker, Thick billed flower pecker, Paradise flycatcher.

2.2.10. Globally endangered Indian birds and their classification (At least 20 species).

2.2.11. Endemic Indian birds and endemic bird areas.

2.2.12. Economic importance of birds- beneficial and harmful role.

Fishes, Amphibians & Reptiles (10 hrs)

3.1 FISHES -Endangered and Endemic fishes of Western Ghats (Brief account with threat to
their survival).



3.2. AMPHIBIA -Amphibians endemic to Western Ghats (Brief account with threat to their survival)

3.3 REPTILES

Order: Crocodilia : Gharial, Estuarine crocodile, Marsh crocodile.

Order: Testudines : Logger headed sea turtle, Green Sea Turtle, Hawk's Bill Turtle, Olive Ridley Turtle, Leatherback Sea Turtle.(Brief account with threat to their survival)

Order: Squamata : Indian Monitor Lizards (Brief account only)

Endangered and endemic snakes of Western Ghats (Brief account only)

Sociobiology& Territoriality (10 hrs)

4.1 Sociobiology of Lion, Elephant and Deer

4.2 Territoriality and functions of territory.

Principles & Hypothesis (4 hrs)

5.1 Gondwana principle

5.2 Satpura Hypothesis

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**Semester: 4****Name of Course: SJZOL4E11- ANATOMY AND PHYSIOLOGY****Credits: 4:0:0**

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Understand the integument and nutrition in insects	PO1, PO5, PSO2	U	F, C	11
CO2	Demonstrate basic knowledge of the biology (, physiology, anatomy and habitat needs) of representative fish	PO1, PO4, PO5, PSO2	U	F, C	50
CO3	Evaluate endocrine and reproductive system of insects	PO1, PO5, PSO2	E	F, C	17
CO4	Understand the Embryogenesis of insects	PO1, PO4, PO5, PSO2	U	F, C	6
CO5	Describe life history and locomotion of fishes	PO1, PO4, PO5, PSO2	U	F, C	6
Total Number of Hours					90

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural**



FOURTH SEMESTER ELECTIVE COURSE

ENTOMOLOGY – II SJZOL4E11- ANATOMY AND PHYSIOLOGY (90 Hours)

The Integument (6 hrs)

- 1.1. Histology-basic components
- 1.2. Chemical and physical properties
- 1.3. Moulting and sclerotisation
- 1.4. Hormonal control and function

Nutrition (5 hrs)

- 2.1. Nutritional requirement- water, minerals, vitamins, carbohydrates, proteins, fatty acids, sterols, nucleic acids, inorganic salts and micro-organisms.
- 2.2. Nutrition and growth, development, reproduction

Digestion and Assimilation (8 hrs)

- 3.1. Anatomy and histology of gut
- 3.2. Digestive enzymes – carbohydrases, proteases, lipases
- 3.3. Physiology of digestion
- 3.4. Digestion of wood, keratin, wax and silk
- 3.5. Extra intestinal digestion.
- 3.6. Role of microbiota in digestion

Circulatory system (8 hrs)

- 4.1. Cellular elements in haemolymph
- 4.2. Composition of haemolymph
- 4.3. Dorsal vessels, accessory pumping sinuses and diaphragm
- 4.4. Heart beat rate and control of heart beat
- 4.5. Course of circulation of haemolymph

Excretory system (6 hrs)

- 5.1. Malpighian tubules-anatomy & histology - Hemipteran, Coleopteran and Lepidopteran types
- 5.2. Physiology of excretion
- 5.3. Dietary problems - salt and water balance- control



5.4. Nitrogenous excretion-synthesis of uric acid, formation of excreta

Ventilatory system (6 hrs)

- 6.1. Structure of trachea, tracheole, air-sacs, spiracles
- 6.2. Types of ventilatory process - passive, active and bulk flow
- 6.3. Respiratory pigments
- 6.4. Cyclic release of carbondioxide and nervous control of ventilation
- 6.5. Ventilation in aquatic insects, endoparasitic insects and during moulting

Nervous system (14 hrs)

- 7.1. Anatomy and histology of brain, ganglia and nerves
- 7.2. Reception and transmission of stimuli, production and control of nerve impulses and transmission.
- 7.3. Sense organs - anatomy, histology and physiology of mechanoreceptors - tactile senses, proprioceptors, sound perception, chemoreceptors, photoreceptors, thermoreceptors and hygromoreceptors
- 7.4. Sound production and light production.

Muscular system (8 hrs)

- 8.1. Histomorphology of muscles, skeletal muscles, visceral muscles
- 8.2. Neuromuscular junctions
- 8.3. Excitation of muscle fibres, activation of muscle fibres, role of fast and slow axons
- 8.4. Muscle development and maintenance

Endocrine and exocrine glands (8 hrs)

- 9.1. Histomorphology of neurosecretory cells and endocrine glands (corpora cardiaca, corpora allata and Prothoracic glands)
- 9.2. Hormones and their functions
- 9.3. Mechanism of hormone action
- 9.4. Pheromones and their function

Reproductive system and morphogenesis (9 hrs)

- 10.1. Development of primordial germ cells
- 10.2. Reproductive system- structure-male and female



- 10.3. Fertilization and oviposition
- 10.4. Formation of blastoderm and extraembryonic membranes
- 10.5. Sex determination and parthenogenesis

Embryogenesis (6 hrs)

- 11.1. Differentiation of germ layers
- 11.2. Segmentation, appendage formation, organogenesis
- 11.3. Polyembryony, paedogenesis, viviparity, oviparity, eclosion,
- 11.4. Postembryonic development-hatching, larval development and control, polyphenism, diapause.

Locomotion (6 hrs)

- 12.1. Terrestrial and aquatic, basic structure of a leg
- 12.2. Maintenance of stance and patterns of movements
- 12.3. Patterns of aquatic movements
- 12.4. Structure of wings, modifications, mechanism of wing movement
- 12.5. Aerodynamics and control of wing beat.

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Semester: 4

Name of Course: SJZOL4E11- Environmental Biology II: Environmental pollution

Credits: 4:0:0

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Evaluate the major sources, effects and management protocols of Air pollution	PO1, PO5, PSO2	U	F, C	35
CO2	Analyse the major sources, effects and management protocols of Air pollution	PO1, PO4, PO5, PSO2	U	F, C	40
CO3	Understand the major sources, effects and management protocols of terrestrial pollution	PO1, PO5, PSO2	E	F, C	15
Total Number of Hours					90

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create

***F-factual, C-conceptual, P-practical/procedural**



FOURTH SEMESTER ELECTIVE COURSE –ENVIRONMENTAL BIOLOGY-II

SJZOL4E11 - ENVIRONMENTAL POLLUTION (90 Hrs)

1: AIR POLLUTION (35 hrs)

- 1.1 Primary air pollutants: occurrence, sources and sinks of the following pollutants: (a) compounds of carbon, (b) compounds of sulphur, (c) compounds of nitrogen, (d) gaseous halogens, (e) ozone, (f) mercury, (g) particulate matter
- 1.2 Sampling of air using sampling train and orifice flow meter
- 1.3 Method of sampling and monitoring of the following gaseous air pollutants (Two methods for each pollutant)
 - Oxides of Carbon, Hydrocarbons
 - SO₂, H₂S, Mercaptans
 - Oxides of Nitrogen, Ammonia
 - Ozone
- 1.4 Sampling sizing of Particulate matter. Sample collection - settlement, filtration, particle count, evaluation by optical microscopy, particle size analysis - projected diameter and statistical diameter (Feret's diameter and Martin's diameter).
- 1.5 Interaction of air pollutants in the atmosphere. Secondary pollutants: photochemical smog, acid rain, and greenhouse effect,
- 1.6 Effect of air pollution:
 - On materials, buildings, metals etc.
 - On vegetation
 - (c) On weather and atmospheric conditions
 - On human health- a brief survey of major air pollution episodes.
- 1.7 Air pollution- abatement technology, basic principles of design and working of:
 - Bag filters (b) Inertial collection- cyclones (c) Electrostatic precipitators (d) Scrubbers (e) Adsorption (f) Device for controlling automobile emissions
- 1.8 Noise pollution-sources, effects and abatement.



2: WATER POLLUTION (40 hrs)

- 2.1. Organic pollution: (a) Origin and sources of organic pollutants, biodegradable and non- biodegradable- Domestic, Agricultural and Industrial sources.

Biochemical oxygen demand (BOD) - Kinetics of BOD tests- rate constant and its importance- Method of estimation

Chemical Oxygen Demand (COD) - Importance and method of estimation

Effects of organic pollution on aquatic systems, saprobicity system and indicator species. Importance in pollution assessment.
- 2.2. Eutrophication- natural and cultural sources and effects.
- 2.3. Biocides: Classification and types of Biocides- Fungicides, Pyrethroids and pesticides.

Effects of Biocides, Biological magnification, Toxic effects on non target organisms- hazards to man.
- 2.4. Heavy metals sources and effects of the following in the ecosystem and human population

Mercury - Inorganic and organic mercury compounds - Bioconversion of inorganic and organic mercury

Cadmium - itai - itai disease

Lead - Plumbism

Lesser metals - copper, zinc, selenium, chromium, molybdenum, beryllium and thallium.
- 2.5. Thermal pollution-sources, effects- cooling towers as control measures.
- 2.6. Oil spills-sources effects and control.
- 2.7. Hazards of Radioactive materials in the environment Biological effects of ionizing, radiations, nuclear waste disposal.
- 2.8. Carcinogens in the environment

Polycyclic aromatic hydrocarbons (b) Nitrosamines (c) Inorganic carcinogens-Asbestos, Metal dust (d)Carcinogens in food: Artificial sweeteners, disodium benzoate and other additives.
- 2.9. Water pollution abatement technology:

Primary, secondary and tertiary treatment systems (b) Principles of design and operation



of

screens (2) Grit chambers (3) Sedimentation tanks (4) Oxidation ponds and algal pond.

2.10. Design and operation of biological treatment systems: (1) Aerated lagoons (2)

Activated sludge process (3) Trickling filters (4) sludge digest.

2.11 Sewage and sewage treatment: composition, bacteriology of sewage treatment, stabilisation- properties of sewage, categories of sewage, use of effluents in irrigation

TERRESTRIAL POLLUTION (15 hrs)

3.1 Solid waste- garbage, rubbish, ashes, debris, street litter, agricultural waste, mining waste, industrial waste, e-waste etc.

3.2 Problems of solid waste disposal, consequences of solid pollution- Love canal episode as an example.

3.3 Solid waste disposal methods: Sanitary land fill, plasma gasification, deep well injection, incineration, recycling biogas

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**Semester: 4****Name of Course: SJZOL4E11- CAPTURE AND CULTURE FISHERIES****Credits: 4:0:0**

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Describe freshwater fisheries and aquaculture	PO1, PO4, PO5, PSO1	U	F, C	33
CO2	Analyse some of the basic techniques used in fishery management	PO1, PO4, PO5, PSO1	Z	F, C	15
CO3	Evaluate the characteristic of sewage and problems associated with sewage fed fish culture.	PO1, O3, PO4, PPO5, PSO1	E	F, C	7
CO4	Explain reproduction and genetic selection of fishes	PO1, PO3, PO4, PO5, PSO1	U	F, C	10
CO5	Understand different aquaculture practices	PO1, PO3, PO4, PO5, PO6, PSO1	U	F, C	25
Total Number of Hours					90

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create
***F-factual, C-conceptual, P-practical/procedural**



FOURTH SEMESTER ELECTIVE COURSE- FISHERY SCIENCE- II

SJZOL4E11 - CAPTURE AND CULTURE FISHERIES (90 Hours)

Introduction to Capture and Culture fisheries (10 hrs)

1.1. Marine fisheries - Crustaceans, Molluscs and fin fishes

Shrimps, Crabs and Lobsters Mussels, Oysters and Cephalopods, Sardine, Mackerel, Bombay duck, Pomfretes, Ribbon fishes and Tuna

Freshwater fisheries (5 hrs)

2.1. Major river systems and fisheries

2.2. Lakes and reservoir fishery

Estuarine fisheries (5 hrs)

3.1. Major estuaries and fisheries

Aquaculture (5 hrs)

4.1. History of aquaculture, scope and definition, importance of aquaculture, present state of aquaculture, future prospectus

4.2. Classification of aquaculture practices

Design and construction of aqua farms and hatcheries (5 hrs)

5.1. Pond design and construction

5.2. Farm design and layout

5.3. Pond preparation

5.4. Cage farms

5.5. Pens and enclosures

5.6. Design and construction of hatcheries

Transportation and acclimatization (3 hrs)

Nutrition and feeds (3 hrs)

7.1. Feeding habits and food utilization



7.2. Live feeds

7.3. Artificial feeds

Water quality management (3 hrs)

8.1. Water quality parameters

8.2. Techniques for monitoring

8.3. Strategies for monitoring

Fertilizers and chemicals in aquaculture (2 hrs)

Reproduction and genetic selection (10 hrs)

10.1. Reproductive cycles

10.2. Control of reproduction

10.3. Induced breeding

10.4. Use of hormone analogues

10.5. Cryo-preservation of gametes

10.6. Sex reversal

10.7. Genetic selection and hybridization

Control of weeds, pests and predators in aquaculture (2 hrs)

Aquaculture practices (25 hrs)

12.1. Integrated fish farming - paddy cum fish culture, duck cum fish culture, pig cum fish culture

12.2. Polyculture

12.3. Culture of shrimps

12.4. Culture of prawns

12.5. Culture of crabs

12.6. Culture of edible oysters, pearl oysters and mussels

12.7. Culture of sea weeds

12.8. Culture of fresh water fishes - Indian major carps and exotic carps

12.9. Culture of cold water fishes - trout and mahaseer



12.10. Culture of brackish water fishes - mullets, milk fish and *Etroplus*

Preparation and maintenance of aquarium (5 hrs)

13.1. Types of aquaria

13.2. Preparation and maintenance

13.3. Equipments

13.4. Water chemistry

13.5. Aquarium fishes and plants

Pathology (7 hrs)

14.1. Major fish diseases - viral, bacterial, fungal

14.2. Protozoan infections

14.3 Control and treatment.

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**Semester: 4****Name of Course: SJZOL4E11 Wildlife Biology II: Wildlife Conservation****Credits: 4:0:0**

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Discuss types of forests and different wildlife habitat	PO1, PO4, PO5, PO6 PSO1	U	F, C	22
CO2	Evaluate principles of wildlife conservation biology and how they are used to manage wildlife and solve environmental problems	PO1, PO2, PO3, PO4, PO5, PO6, PSO1	E	F, C	13
CO3	Analyse different protected areas and their significance in conservation	PO1, PO2, PO3, PO4, PO5, PO6, PSO1	Z	F, C	18
CO4	Understand variety of laws and regulations that influence how natural resources are used and protected	PO1, PO2, PO3, PO4, PO5, PO6, PSO1	U	F, C	33
CO5	Analyse the impacts of land use and environmental management decisions on ecosystems and society	PO1, PO2, PO3, PO4, PO5, PO6, PSO1	Z	F, C	4
Total Number of Hours					90

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural**



FOURTH SEMESTER ELECTIVE COURSE: WILDLIFE BIOLOGY- II SJZOL4E11 - WILDLIFE CONSERVATION (90 Hours)

Conservation - Scope and History (8 hrs)

- 1.1 History of conservation in India- Status of wildlife in India (Past and Present)
- 1.2 Values of Wildlife - conservation values & ethics
- 1.3 Causes of depletion of Wildlife resources - habitat loss, construction of dams, collection for trophies, hunting, poisoning, poaching and other developmental activities.
- 1.4 Why conserve? The ecological, genetic, economic and Philosophic reasoning.
- 1.5. Man and Wildlife conflict - crop depredation, cattle lifting, human encounters case studies in Kerala (Brief account only), control and management.

Wildlife Habitat (14 hrs)

- 2.1 Forest types - classification by Champion & Seth, mention major plant species of Indian forests.
- 2.2 (a).Deforestation - reasons for deforestation- shifting cultivation, illicit felling and encroachment, grazing and lopping, forest fire, industrial development, mining, plant diseases, insect pest, human settlements.
- (b). Afforestation & Reforestation.
- 2.3 Grasslands, Mangroves and Sacred groves (Mention conservation and management)
- 2.4 Forestry (Social, Production, Plantation and Protection)
- 2.5 Hydel projects and their impacts (mention habitat fragmentation, loss of forest corridors & isolation of Wildlife population), case studies in Kerala.
- 2.6 In Situ and Ex situ conservation (Gene banking, conservation and exchange)
- 2.7 National River Conservation Programme (NRCP)

Tribals and Wildlife (4 hrs)

- 3.1 Tribal groups in Kerala
- 3.2 Role of tribals in Wildlife conservation - Joint Forest Management
- 3.3 Ecodevelopment Projects



Exotic and pet animals (4 hrs)

- 4.1 Introduction of Exotic animals (Flora and Fauna) in India: Principles and problems
- 4.2 Illegal Wildlife Trade and Pet Trade in India- Major trade centres, routes and related issues.

Protected Areas (18 hrs)

- 5.1 National parks and Sanctuaries: Important National Parks and Sanctuaries in India with special importance to Kerala - characteristics features, importance, declaration, formation, management, protection and administration.
- 5.2 Marine Sanctuaries and National Parks of India: Gulf of Mannar, Gulf of Kutch & Andaman.
- 5.3 Important Bird Sanctuaries of India: Bharatpur, Ranganathitoo, Thatekkad and Vedan Thangal.
- 5.4. Man and Biosphere reserves (MAB) in India - concept, importance, ecological features and management (Brief Account). Nilgiri biosphere reserve (NBR) and Agastyanam Biosphere reserve. Mention other biosphere reserves in India.

Wildlife - Laws and Regulation (5 hrs)

- 6.1 Wildlife administration and legislation: administrative set up (central and state level), statutory bodies,
- 6.2. Wildlife Protection Act -1972 with its latest amendments.
- 6.3. Indian Forest act (Brief Account only).

Red Data Book (3 hrs)

- 7.1 Red data book on animals.
- 7.2 IUCN criteria and definition regarding extinct (EX), extinct in the wild (EW), critically endangered (CD), low risk (LR), data deficient (DD) & not evaluated animals (NE). The problems in the application of criteria in the wild.

Government and Voluntary Organizations (10 hrs)

- 8.1 Role of Government and voluntary organization in wildlife conservation (IBWL, IUCN,



ICF, WWF, BNHS, WPS, MNHS, TRAFFIC, CITES, NBA etc.)

8.2 Environmental Education and UN conferences on Environmental Issues

8.3 Resource depletion and Sustainable development

8.4 Earth Summit and World summit

Conservation Schemes (15 hrs)

9.1 Project Tiger

9.2 Project Hangul

9.3 Crocodile breeding project

9.4 Gir Lion Project

9.5 Project Sangai

9.6 Project Elephant

9.7 Sea turtle project

9.8 Snow Leopard Project.

Ecological Principles of Conservation (5 hrs)

10.1 Concept of minimum viable area

10.2 Minimum viable population

10.3 Compression hypothesis

10.4 Stable limit cycle

10.5 Fragmentation and isolation of habitats - role of corridors

10.6 Environmental and demographic stochasticity

10.7 Effective population size.

10.8 Genetic isolation (Island Biogeography theory) and genetic viability

Ecotourism (4 hrs)

11.1 Tourism and Wildlife - Importance of Tourism in Wildlife conservation - tourism requirements, visitor impact, visitor management - control and safety rules.

11.2 Ecotourism, role of ecotourism in sustainable development.



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**Semester: 4**

Name of Course: SJZOL4E12- Entomology III: Agricultural , Medical & Forensic Entomology

Credits: 4:0:0

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Discuss various types economically useful insect pests and its significance.	PO1, PO4, PO5, PO6 PSO1	U	F, C	30
CO2	Analyse the principles of Insect pest management	PO1, PO3, PO4, PO5, PSO1	Z	F, C	15
CO3	Analyse chemical Control of insects.	PO1, PO3, PO4, PO5, PSO1	Z	F, C	20
CO4	Evaluate the impact of insecticides in Environment	PO1, PO3, PO4, PO5, PO6, PSO1	E	F, C	10
CO5	Understand forensic entomology and its applications	PO1, PO3, PO4, PO5, PSO1	U	F, C	5
Total Number of Hours					90

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create

***F-factual, C-conceptual, P-practical/procedural**



FOURTH SEMESTER THEORY ELECTIVE

COURSE- ENTOMOLOGY-III

SJZOL4E12- AGRICULTURAL, MEDICAL & FORENSIC ENTOMOLOGY

(90 Hours)

1: Insect Pests (10 Hrs)

- 1.1. Types of damage to plants by insects (Injury by chewing insects, piercing and sucking insects, internal feeders, subterranean insects, to stored products and indirect effect of feeding)
- 1.2. Classification of insect pests (Regular pests, Occasional pests, Seasonal pests, persistent pests, sporadic pests, major pests, minor pests, potential pests, key pests)
- 1.3. Causes for insect assuming pest status
- 1.4. Concepts of Economic levels, Economic injury levels, Economic threshold level
- 1.5. Pest surveillance and forecasting pest outbreak
- 1.6. Estimation of damage caused by insects to crops

2: Insect pests of crops (20 Hrs)

- 2.1. Identification, life history, damage and control of major pests of:
 - 2.1.1. **Paddy** (17 major pests including stem borers, army worm, rice thrips, gall midge, mealy bug, BPH, green & white leaf hoppers, rice caseworm, rice leaf roller, rice hispa, rice earhead bug, root weevil, rice grass hoppers)
 - 2.1.2. **Sugarcane** (Major pests including shoot, internode & top borers, white grub, leaf hopper, sugarcane scale, mealy bug, whiteflies, Termites, Black winged bug)
 - 2.1.3. **Cotton** (Major pests - Aphid, leaf hopper, thrips, whitefly, Pink spotted and American boll worms, stem weevil, Red and Dusky cotton bugs, leaf roller)
 - 2.1.4. **Coconut** (7 pests - Rhinoceros beetle, red palm weevil, black-headed caterpillar, white grub, Scale insect, Lace wing bug, coconut skipper)
 - 2.1.5. **Pulses** (8 pests - Gram pod borer, plume moth, red gram pod fly, pod borer, spotted pod borer, Blue butterflies, bean aphid, white fly)
 - 2.1.6. **Common vegetables**
 - 2.1.6.1. **Brinjal** (shoot & fruit borer, stem borer, spotted leaf beetle, grey weevil,



Pumbkin beetle)

2.1.6.2. **Tomato** (serpentine leaf miner, fruit borer)

2.1.6.3. **Gourds** (fruiflies, snake gourd semilooper, spotted beetle, Pumbkin beetle)

2.1.6.4. **Bhendi** (Earias, leaf hopper, Red cotton bug, Grampod borer)

2.1.6.5. **Cruciferous vegetables** (diamond black moth, cabbage borer, leaf webber, Cabbage green semilooper, Cabbage aphid)

2.1.7. Fruit trees

2.1.7.1. **Mango** (hopper, flower webber, Leaf webber, gall midges, Nut weevil, stem borer, red tree ant)

2.1.7.2. **Cashew** (tree borers, Hairy caterpillar, Tea mosquito bug, Apoderus, Leaf miner)

2.1.7.3. **Banana** (rhizome weevil, banana aphid, spittle bug)

2.1.7.4. **Citrus** (Fruit sucking moth, citrus butterfly)

2.1.8. Spices

2.1.8.1. **Pepper** (pollu beetle, shoot borer, Marginal gall thrips)

2.1.8.2. **Cardamom** (cardamom thrips, rhizome borer, cardamom whitefly, hairy caterpillars, *Eupterote* and *Pericallia*)

2.1.8.3. **Turmeric and Ginger** (Leaf roller, shoot borer)

2.2. Identification, nature of damage & control of Insect pests of Stored Products: rice weevil, sweet potato weevil, lesser grain borer, tobacco beetle, drug store beetle, pulse beetle, Angoumois grain moth, potato tuber moth, Red flour beetle, rice moth)

Principles of Insect pest management (15 Hrs)

Ecology based pest management

3.1. Prophylactic methods

3.2. Curative or direct methods

3.2.1. Cultural methods

3.2.2. Mechanical methods

3.2.3. Physical methods

3.2.4. Legal methods



3.3. Biological control

- 3.3.1. History of biological control, Ecological basis of biological control.
- 3.3.2. Natural enemies (Parasites, Parasitoids, Predators), Feasibility of biocontrol.
- 3.3.3. Applied biological control (Conservation and Enhancement, Importation and Colonization, Mass culture and release).
- 3.3.4. Importance of systematics, Advantages and disadvantages of biological control.
- 3.3.5. Important biocontrol projects undertaken in India by employing parasites and predators.

4. **Autocidal control**- Sterile male technique and other methods, Chemosterilants, Methods of sterilization, Application, Dynamics, Advantages and disadvantages. Examples of autocidal control.

3.5. **Insect growth regulators** (IGRs) – Brief note on Insect growth hormones and mimics (JH mimic & ecdysone agonists) and chitin synthesis inhibitors as insect control agents,

3.6. **Behavioural (pheromonal) control**- (Brief note on Trail, Alarm, Aggregation and sex pheromones and the behaviour produced, Mode of application, Pest management with pheromones, Advantages and disadvantages, Examples).

3.7. **Insect attractants**: definition, types of attractants, applications in insect pest management, examples, advantages and disadvantages.

3.8. **Insect repellents**: definition, desirable features of good repellent, types of repellents, applications in insect pest management, examples, advantages and disadvantages.

3.9 **Insect antifeedants**: definition, examples, applications in insect pest management, advantages and disadvantages

3.10. **Microbial control** of crop pests by employing Bacteria, Virus and Fungi
Classification of entomophagous Bacteria, Virus, Fungi, Mode of action, formulation, Application, Examples

3.11. **Integrated Pest Management**- Definition, IPM in Agroecosystem, Kinds of pest, (Key pests, Occasional pests, Potential pests, Migrant pests) Establishing the need to take action, Guidelines for developing IPM, Tactics in IPM, IPM of Rice



Unit 4: Chemical Control (20 Hrs)

- 4.1. Insecticide formulation (Brief note on Emulsifiable concentrates, Watermiscible liquids, Wettable powders, Water soluble powders, Oil solutions, Flowable powders, Aerosoles, Granulars, Fumigants, Ultra-low volume concentrates, Fogging concentrates, Dusts, Poison baits and Slow release insecticides)
- 4.2. Classification of insecticides.
 - 4.2.1. Based on mode of entry.
 - 4.2.2. Based on mode of action.
 - 4.2.3. Based on chemical nature
- 4.3. Chemistry, toxicology & mode of action of following class of insecticides; mention examples for each class.
 - 4.3.1. Synthetic Organic compounds.
 - 4.3.1.1. Organochlorine insecticides.
 - 4.3.1.1.1. DDT.
 - 4.3.1.1.2. BHC.
 - 4.3.1.1.3. Cyclodiene group (special reference to endosulfan; examples: heptachlor, aldrin).
 - 4.3.1.2. Organophosphorous insecticides (examples: TEPP, Dichloros, monocrotophos, parathion).
 - 4.3.1.3. Carbamates (special mention of carbofuran; examples: Carbaryl, aprocarb)
 - 4.4. Inorganic compounds as insecticides - arsenic compounds, fluorides, sulphur compounds
 - 4.5. Fumigants – definition, examples, methods of fumigation, hazards of fumigation, advantages and precautions
 - 4.6. Botanical insecticides- chemical properties, mode of action and toxicity of the following: Nicotine, Rotenone, Pyrethrum and Neem
 - 4.7. Synthetic pyrethroids – definition, uses as insecticides, mode of action (examples: Pyrethrin, allethrin)
 - 4.8. Insecticide synergists – definition, types of synergism, mode of action & examples

Insecticides and Environment (10 hrs)



5.1. Insecticide resistance -Genetic, Physiological and biochemical mechanism

5.2. Pesticides and the environment- its impact on wildlife and human health

5.3. Microbial and environmental degradation of pesticides

Medical entomology (10 hrs)

6.1. Insect vectors of human diseases and their biology: (Malaria, Lymphatic filariasis, Dengue, Chikungunya, Zika, Yellow fever, West Nile virus, River Blindness, African sleeping sickness, American sleeping sickness, Kala Azar, Plague, Typhus): Mosquitoes (*Anopheles*, *Aedes*, *Culex*, *Mansonia*); Sand fly, Flea, Assassin bug, Black fly, Tse Tse fly, Head louse.

6.2. Mosquito control- Larval and adult control-Chemical, Biological and environmental.

6.3. Insects related to Myiasis

6.4. Poisonous insects: Bees, wasps and ants- Anaphylaxis.

6.5. Maggot therapy (Use of maggots in treatment.

Forensic Entomology (5 hrs)

7.1 : Introduction to Forensic entomology

7.2 : Insects used in forensic entomology (Dipterans and

coleopterans) 7.3: Succession of insect fauna on a cadaver.

7.4. Methods of forensic entomology: Detection of time of death, mode of death and place of death. Case histories (at least 3).

7.5. Forensic entomology in India.

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**Semester: 4****Name of Course: SJZOL4E12- Environmental Biology III: Environmental Conservation****Credits: 4:0:0**

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Describe different types of habitats and the significance of habitat conservation.	PO1, PO2, PO3, PO4, PO5, PO6 PSO1	U	F, C	25
CO2	Understand biodiversity of India and global hotspots	PO1, PO2, PO3, PO4, PO5, PO6, PSO1	U	F, C	20
CO3	Evaluate the strategies of conservation	PO1, PO2, PO3, PO4, PO5, PO6, PSO1	E	F, C	20
CO4	Analyse the benefits of different environmental conservation projects	PO1, PO2, PO3, PO4, PO5, PO6, PSO1	Z	F, C	25
Total Number of Hours					90

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural**



FOURTH SEMESTER THEORY

ELECTIVE COURSE: ENVIRONMENTAL BIOLOGY-III

SJZOL4E12 - ENVIRONMENTAL CONSERVATION (90 Hours)

Habitat Conservation (25 hrs)

1.1. Forest Ecology

1.1.1. Major vegetation types - dry and moist deciduous, semi evergreen, evergreen, and montane evergreen forests

1.1.2. Tropical rain forests; geography, climate; precipitation; features of plants- leaves, root, bark.

1.1.3. Shola forests (Cloud forests) ; global distribution; fog precipitation; cloud stripping; water shed function; fauna; vegetation.

1.1.4. Montane shola grass land matrix

1.1.5. Mangroves

1.2. Deforestation and its consequences

1.2.1. Need for scientific management and conservation of forests
1.2.2- Social forestry and agro forestry

1.3. Habitat destruction, Fragmentation and Degradation, causes and consequences

1.4. Wetlands and waterfowl conservation

1.4.1. Ramsar convention aims and objectives, Ramsar sites in Kerala

1.4.2. Coastal zone management

1.4.2.1. Special features of CRZ

1.4.2.2. Coastal Zone Management plan and its objectives

1.4.2.3. Categorization of the Coastal Zone; „Setback line“: Coastal Zone Management

1.4.3. Indicative list of ecologically sensitive areas (ESA)

1.4.3. Coral reefs: list of major coral reefs; conservation problems

1.4.4. Ocean acidification; Ocean Warming and Coral Bleaching;

1.4.5. Coral tourism; water pollution; sedimentation; coral mining;

Biodiversity conservation (20 hrs)



- 2.1. The richness of biodiversity
- 2.2. The importance of biodiversity (Direct and indirect values)
- 2.3. Reasons for high species diversity in the tropics.
- 2.4. Biodiversity of India
- 2.5. The threatened biodiversity with special reference to critically endangered vertebrates from India.
- 2.6. Loss of biological diversity and Causes of extinction.
- 2.7. Endemism
- 2.8. Keystone species and Keystone resources—
- 2.9. Exotic species introductions, invasive species, disease and over exploitations
- 2.10. Global hotspots - hotspots in India,- Western ghats and Sreelanka, Indo Burma, and Eastern Himalayas.
- 2.11. Biological control and Integrated Pest Management.
- 2.12. Organic farming and its importance

Strategies of conservation (20 hrs)

- 3.1. Concept of minimum viable area and minimum viable population
- 3.2. National Parks, aims and objectives -Briefly mention the important national parks in India with special reference to Kerala (Eravikulam, Silent valley, Mathikettan chola, Anamudi chola and Pambadum chola National parks from Kerala)
- 3.3. Sanctuaries-Major sanctuaries in India and mention the sanctuaries in Kerala.
- 3.4. Biosphere Reserves –Their aims and objectives, briefly mention them-with special reference to Kerala
- 3.5. Conservation strategies at the global level-Role of World conservation union, CITES, WWF and other international conventions and protocols
- 3.6. IUCN categories of threatened animals and red data book.
- 3.7. Wildlife management in India; Role of Government and non governmental agencies. Briefly mention wildlife protection act 1972 and its amendments and schedules
- 3.8. Endangered species -strategies of conservation with special reference to India - Project Tiger, Project Elephant, Project hangul, Operation Rhino. Crocodile breeding



- project, Project Sangai, Gir lion project, Himalayan Musk deer project.
- 3.9. Ex situ conservation -Zoo, Aquarium, Seed bank, Gene bank, Pollen bank etc.
- 3.10. In situ conservation. - National parks, sanctuaries, Biosphere reserves, community reserves and other protected areas.
- 3.11. Traditional Ecological Knowledge (TEK)-
- 3.11.1. Introduction and need for its conservation
 - 3.11.2. Economic benefits
 - 3.11.3. Social implications-sacred groves, sacred landscape, sacred species
 - 3.11.4. TEK and sustainable development.

Environmental Impact (25 Hrs)

- 4.1. Aims and uses of preparing Environmental Impact Statement (EIS)
- 4.2. Aims and objectives of Environmental Impact Assessment (EIA),
- 4.3. Environmental management systems-ISO-14000 standards
- 4.4. Cost benefit analysis of environmental protection incorporating, environmental costs and benefits of designing projects.
- 4.5. Development and displacement of rural communities, ethical and socio - economic problems, Disappearing culture and traditions, Impact on environment. Urban environment and new problems.
- 4.6. Ecotourism - Importance of Ecotourism, visitor impact, visitor management, control and safety rules – threats to local culture, ecolodges. Economic & Ecological effects of ecotourism
- 4.7. Restoration of ecology and degraded rural landscape- Illustrate with case studies from India.
- 4.8. Environmental protection movements – Global, national, and local, historical, present social pressure group agencies like Green and Chipco movement, Narmada Bachao

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**Semester: 4****Name of Course: SJZOL4E12- Fishery Science III: Harvesting, Post-harvesting Technology & Marketing****Credits: 4:0:0**

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Evaluate different harvesting methods and significance of different techniques	PO1, PO4, PO5, PO6, PSO1	E	F, C	22
CO2	Analyse different post-harvest technology	PO1, PO3, PO4, PO5, PO6, PSO1	Z	F, C	61
CO3	Understand various fishery management and international marketing.	PO1, PO3, PO4, PO5, PO6, PSO1	U	F, C	6
Total Number of Hours					90

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural**



FOURTH SEMESTER THEORY ELECTIVE COURSE - FISHERY

SCIENCE – III

SJZOL4E12 – HARVESTING, POST HARVESTING TECHNOLOGY AND MARKETING (90 hrs)

PART- I. HARVESTING

Commercial fishing method (1 hr)

- 1.2. Brief history of commercial fishing
- 1.3. Introduction to materials for construction of nets and rope

Crafts and gears for harvesting (21 hrs)

2.1. Towed or dragged gear

2.1.1. Bottom trawling

- 2.1.2. Beam trawl
- 2.1.3. Otter trawl
- 2.1.4. Side trawling
- 2.1.5. Stern trawling
- 2.1.6. Bottom pair trawling
- 2.1.7. Mid water (pelagic) trawling
- 2.1.8. Targeted and selective trawling
- 2.1.9. Turtle excluder device (TED)
- 2.1.10. Dredging

2.2. Encircling gear

- 2.2.1. Beach seining
- 2.2.2. Purse seining
- 2.2.3. Seine nesting

2.3. Static gear

- 2.3.1. Gill nets
- 2.3.2. Trap nets
- 2.3.3. Long lines
- 2.3.4. Pots and traps



2.4. Other gears

2.4.1. Squid jigging

2.4.2. Net fishing

2.4.3. Harpooning

2.5. Fish aggregating devices (FAD)

2.6. Echo-sounder and sonar

2.7. Catch per unit effort and economic consideration of vessel operations.

2.8 Onboard handling and processing

Part-II- POST HARVEST TECHNOLOGY

Chemical composition of fish (2 hrs)

3.1. Chemical composition of fish muscle

3.2. Significance of proteins and lipids

3.3. Nutritive value of fish muscle over red meat

Post-mortem changes in fish muscle (4 hrs)

4.1. Pre-rigor mortis and post mortem changes

4.2. Physical and biochemical changes associated with the post mortem changes

4.3. Importance of post mortem changes in fish processing

4.4. Problems associated with post mortem changes and solutions

Fish spoilage mechanisms (4 hrs)

5.1. Microbial spoilage

5.2. Enzymatic spoilage

5.3. Biochemical spoilage

Handling of fresh fish (3 hrs)

6.1. Icing and icing methods

6.2. Different types of ice - block ice, flake ice and dry ice

6.3. Handling - on board chilling and use of refrigerated sea water (RSW)

6.4. Fish landing platforms



6.5. Hygienic handling of fish on board and on shore

Methods (Techniques) of processing/preservation and their products (10 hrs)

7.1. Drying

7.2. Salting

7.3. Smoking

7.4. Freezing - plate freezers, blast freezers and individual quick freezing (IQF)

7.5. Battered and breaded products

7.6. Accelerated freeze drying (AFD)

7.7. Immersion freezing and cryogenic freezing

7.8. Canning

7.9. Irradiation

7.10. Assessment of capacity of plate, blast and IQF freezers

Processing of shrimps (3 hrs)

8.1. Commercially important prawns and shrimps of India

8.2. Pre-processing of prawns and shrimps into different varieties - peeled and devined (PD), peeled and undeined (PUD), head-less shrimps (HI), head on shrimps (HON)

8.3. Grades of shrimps

8.4. Cooked shrimps

8.5. IQF shrimp

Processing of lobsters (3 hrs)

9.1. Commercially important lobsters of India

9.2. Pre and processing lobsters into different varieties of products

9.3. Grades of packing

Processing of cephalopods (3 hrs)

10.1. Commercially important cephalopods (squids and cuttlefish) of India

10.2. Pre-processing of cephalopods into different varieties

10.3. Grades of packing



Processing of fish (4 hrs)

- 11.1. Commercially important fishes of India
- 11.2. Fish filleting
- 11.3. Surimi
- 11.4. IWP products, grades for fish products

Fishery by-products (9 hrs)

- 12.1. Body oil, liver oil and sauces
- 12.2. Shark fins, fin rays, fish maws/isinglass
- 12.3. Fish silage, chitin and chitosan
- 12.4. Fermented fishery products

Fish processing plant and cold storage (2 hr)

- 13.1. The pre-processing and processing plant, cold storage – general conditions relating to premises ,building, equipment, general conditions of hygienic of plant and workers, conditions of storage of frozen products
- 13.2. Requirements for registration with MPEDA, approval of processing plant by FIA allotment code

Quality control (7 hrs)

- 14.1. Fundamental aspects of quality
- 14.2. Major quality problems in sea foods
- 14.3. Quality of water and ice-chlorination and use of UV rays
- 14.4. Microbiology
- 14.5. Microbial hazards of sea foods - *E. coli*, *Salmonella*, *V. cholerae*, *Staphylococcus*
- 14.6. Inspection systems
- 14.7. Brief introduction to the quality control concepts of HACCP, ISO and IQM (total quality management)

Packing and export of seafood (4 hrs)

- 15.1. Methods of packing of various sea food products for export



15.2. Identification marks

15.3. In house stuffing and transport in refrigerated containers

Fishery education, research, development and export promotion agencies (3 hrs)

16.1. Objectives and activities of the following institutions (very brief) – CIFT,
CMFRI, CIRNET, NIO, FSI, CIBA, FIA, MPEDA

16.2. Objectives of fishery extension

16.3. Qualities for fishery extension workers

16.4. Organizations of extension programs

Part- III- FISHERY MANAGEMENT AND INTERNATIONAL MARKETING

Fishery management (2 hrs)

17.1. Marketing of fish in India

17.2. Fisherman and fisherman co-operatives

International marketing (4 hrs)

18.1. Scope and importance.

18.2. Major sea food products and markets of India.

18.3. Documents required for export - letter of credit, invoice, bill of landing etc.

18.4. Buyers and buyers agents

18.4.1. Trade promotion

18.4.2. Role of trade promotion offices and embassies

18.4.3. Seafood trade fairs

18.4.4. Trade promotion visits

18.4.5. Value added products and its marketing.

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**Semester: 4****Name of Course: SJZOL4E12- WILDLIFE MANAGEMENT****Credits: 4:0:0**

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Explain Wildlife Management & habitat management	PO1,PO2, PO3, PO4, PO5, PO6 PSO1	U	F, C	23
CO2	Analyse different population estimation techniques and methods	PO1, PO5, PO6, PSO1	Z	F, C	35
CO3	Evaluate Prey predator, Wetland, Zoo, Healthcare and disease management programmes	PO1, PO2, PO3, PO4, PO5, PO6, PSO1	E	F, C	6
Total Number of Hours					90

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural**



FOURTH SEMESTER THEORY ELECTIVE
COURSE: WILDLIFE BIOLOGY - III
SJZOL4E12- WILDLIFE MANAGEMENT (90 Hours)

1. Wildlife Management (5 hrs)

Concepts and Principles

Policies and laws in wildlife management

Habitat and management (18 hrs)

2.1. Components of habitat (Physical and Biological), Mention different types of habitats.

2.2. Habitat Evaluation Procedures (HEP).

2.3. Habitat Suitability Index (HSI)

2.4. Environmental Impact Assessment (EIA).

2.5. Concept of herbivory, frugivory and carnivory (predation).

2.6. Food selection and patterns of habitat utilization.

2.7. Forest and fire: Impacts of fire on vegetation succession, effects of fire on soil, forest development and wildlife, Fire prevention, fire detected system, fire control and suppression procedures in India and developed nations.

2.8. Impacts of pollution on forest and wildlife, Environmental sanitation.

2.9 Vegetation profile: Techniques for estimation of plant abundance, frequency, dominance and importance value index, Preparation of vegetation profile, various techniques for assessment of vegetation cover

Wildlife population estimation (12 hrs)

3.1. Direct Count: - Total count, Drive count, Time area counts and transect Count-

Indirect Count: - Call count, Track count and Pellet count/dungcount

3.2. Abundance estimation techniques for mammals, birds, reptiles and amphibians.

3.3. Capturing and Marking Techniques: - Live trapping of birds and Mammals, Chemical immobilization, methods of marking captured birds and mammals, Peterson or Lincoln Index method.

3.4. Determination of Age and sex in animals and birds



Modern Methods of Wildlife study (15 hrs)

- 4.1 Wildlife photography: Still and Videography, recording of calls, study of animal evidences.
- 4.2 Remote sensing, GIS, Radar in wildlife research.
- 4.3 Radio telemetry: Importance, scope and methodology
- 4.4 Genetics in wildlife management- Pedigree analysis and karyotyping techniques

Food habit analysis (8 hrs)

- 5.1 Sampling method: Direct and indirect methods, qualitative and quantitative methods
- 5.2. Kinds of study materials, preservation and analytical procedures.

Prey predator management (5 hrs)

- 6.1. Foraging behaviour, optimal foraging theory, group foraging, depredation, forage poisoning

Wetland Management (10 hrs)

- 7.1. Study of Waterfowl, waterfowl management, Habitat manipulation, food production, water development and cover improvement.
- 7.2. Management of Indian Cranes. Endangered and Non-endangered crane, crane conservation, migration, impact of pollution on wetland birds. Conventions related to Wetland management.
- 7.3. Ramsar sites in India, Conventions on wetlands
- 7.4. Pheasants and Pheasant management- Pheasants of Himachal Pradesh, Pheasantry.

Zoo management (10 hrs)

- 8.1. Basic consideration for designing a modern zoo,
- 8.2. Functions of a modern zoo,
- 8.3. Zoo layout and exhibition of animals,
- 8.4. Zoo services
- 8.5. Zoo sanitation
- 8.6. Captive breeding,
- 8.7. Safari parks



8.8. Moonlit zoo

Healthcare and disease management (7 hrs)

9.1 Disease monitoring and control, surveillance of disease.

9.2 Viral, bacterial, rickettsial, mycoplasmal, and protozoan disease.

9.3 Nutritional deficiency disease, worm infestation and related disease, Zoonosis.

References

- Aaron, N.M. (1973): Wildlife ecology. W.H. Freeman Co. San Francisco, USA. Abbassi and Ramaswami (1999): Biotechnological methods of pollution.
- Barret, E.C and Anton Micallef (1991): Remote Sensing for Hazard Monitoring and Disaster Assessment, Taylor and Francis, London.
- Canter, L.W. and Graw, M.C.(1996). Environmental Impact Assessment, Hill publication, New York.
- Chang Kang, Tsung. (2002): Introduction to Geographic information system.Tata McGraw-Hill Publishing Company Limited. New Delhi
- Choudary, Suahant and Malik, Pradeep. A guide to chemical Restraint of WildAnimals. Nataraj Publishers, Dehradun
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- Gopal, Rajesh (1992): Fundamentals of Wildlife Management, Justice Home,Allahabad, India.
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- Lilleand, T.M, and Kieffer, R.W. Remote Sensing and image Interpretation. John Wiley and Sons.
- Negi, S.S. (1993): Biodiversity and its conservation in India. Indus Publishing Co., New Delhi.
- Negi, S.S. (2007). Manual for Wildlife Management in India.
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- Robinson W.L and Eric G. Bolen (1984): Wildlife ecology and management. Mac Millen Publishing Co. New York.
- Rodgers W.A (1991): Techniques for wildlife census in India.
- Sabbins, F.E., Freeman.(1959). Remote sensing: Principles and Applications.
- Saharia V.B. (1982): Wildlife of India



- Samar Singh .(1986).Natural heritage
- Sanayal, Ram Bramha (1995): A Handbook of the Management of Animals in Captivity.
- Schaller (1978): The deer and Tiger.
- Sharma B.K. and Kaur, H. (1996): Environmental chemistry. Goel Publishing House, Meerut.
- Sharma, B.D. (1999): Indian wildlife resources: Ecology and development. Daya publishing House, Delhi.
- Singh, S.K (2005): Textbook of Wildlife Management. IBDC.Lucknow
- Singh, Samar (1987): Conserving India's Natural Heritage. Nataraj Publication.
- Teague R.D. (Ed), (1980): A manual of wildlife ecology
- Conservation, The wildlife society Washington D.C.
- Tikkader (1994): Threatened animals of India.
- WII.(1983). A Guide to chemical restraints of wild animals.Technical report II.



Core Courses practical

Semester: 4

Name of Course: SJZOL4L04-Immunology, Developmental biology, Endocrinology, Biotechnology, Microbiology and Micro techniques

Credits: 4:0:0

COCO	Statement	PO/ PSO	CLKC	
CO1	Understand the structural and functional features of Organs of immune system.	PO1, PO5, PSO4	U	F,C,P
CO2	Prepare and analyse the serum sample and also the various components of blood.	PO1, PO3, PO5, PSO4	Z	F,C,P
CO3	Compare the early developmental process of frog embryo upto gastrula stage.	PO1, PO2, PO3, PO5, PO6, PSO4	A	F,C,P
CO4	Acquire skills to analyse the different developmental stages of chick embryo upto 72 hours.	PO1, PO3, PO5, PSO4	C	F,C,P
CO5	Compare and differentiate various types of larval forms according to their special features.	PO1, PO5, PSO4	Z	F,C,P
CO6	Enumerate the different types of placenta and its functions in mammals.	PO1, , PO5 PSO4,	U	F,C,P
CO7	Construct and analyze the electrophoretogram from genetic material of different sample.	PO1, PO5 PSO4,	C	F,C,P
CO8	Practice different staining methodologies for microorganisms and categories them according to their features.	PO1, PO5 PSO4,	C	F,C,P
CO9	Prepare and differentiate various types of tissues after corresponding staining procedures.	PO1, PO3, PO5, PSO4,	E	F,C,P

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create

***F-factual, C-conceptual, P-practical/procedural**



Elective Courses practical (opted)

Semester: 4

Name of Course SJZOL4L05-Human Genetics I & II

Credits: 4:0:0

COCO	Statement	PO/ PSO	CLKC	
CO1	Understand sterilization, medium preparation methods	PO1, PO5, PSO4	U	F,C,P
CO2	Design the cell culture protocol for the karyotyping of the human chromosomes from the blood samples	PO1, PO3, PO5, PSO4	C	F,C,P
CO3	Construct a karyotype and identify the genetic condition of the sample provided.	PO1, PO2, PO3, PO5, PO6, PSO4	C	F,C,P
CO4	Estimate the blood parameters using the spectrophotometer and evaluate the clinical significance of the samples provided	PO1, PO3, PO5, PSO4	Z	F,C,P
CO5	Differentiate the fetal and adult hemoglobin from the sample provided	PO1, PO5, PSO4	Z	F,C,P
CO6	Identify the organ system disease conditions from the analysis of the clinical conditions observed in the photograph or karyotype.	PO1, PO2, PO3, PO5, PO6, PSO4,	U	F,C,P
CO7	Identify the human development stage based on the characteristics of the given specimen.	PO1, PO3, PO5, PO6, PSO4,	U	F,C,P
CO8	Critically evaluate the ART and prenatal diagnostic tools applications in the clinical conditions.	PO1, PO2, PO3, PO5, PO6, PSO4,	E	F,C,P

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural**

**Semester:****Name of Course SJZOL4L06- Human Genetics III****Credits: 4:0:0**

COCO	Statement	PO/ PSO	CLKC	
CO1	Construct the pedigree based on the available clinical information and provide the counselling as the genetic service to the condition.	PO1, PO2, PO3, PO5, PO6, PSO4	C	F,C,P
CO2	Understand the basics operational knowledge of diagnostic tools PCR, electrophoresis etc.	PO1, PO5, PSO4	U	F,C,P
CO3	Differentiate the dermatoglyphic patterns in different individuals using ink and print method.	PO1, PO5, PSO4	Z	F,C,P
CO4	Estimate the gene and allele frequency of the population based on the analysis of the available data provided.	PO1, PO2, PO3, PO5, PO6, PSO4	E	F,C,P
CO5	Test the blood group based on cross matching method and identify the blood group of the sample provided.	PO1, PO2, PO3, PO5, PO6, PSO4	Z	F,C,P

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural**



THIRD SEMESTER CORE PRACTICALS

SJZOL4L04-Immunology, Developmental biology, Endocrinology, Biotechnology, Microbiology and Micro techniques

THIRD SEMESTER PRACTICALS

SJZOL4L04 – IMMUNOLOGY

Study of cells of immune system.
Histology of organs of immune system.
Bleeding of animals and preparation of serum.
Separation of lymphocytes.
Demonstration of agglutination reaction.
Immunoelectrophoresis.
Demonstration of ELISA technique.
Production of antibodies.
Preparation of antiserum.
Titration of antiserum.

References

Talwar, G.P. and Gupta, S.K. (2002). A hand book of practical and clinical immunobiology. 2nd ed. CBS Publishers, India.
Wilson. K. and Walker, J. (1995). Practical Biochemistry- Principles and Techniques. Cambridge University Press.

THIRD SEMESTER PRACTICALS



SJZOL4L04- Developmental Biology & Endocrinology

Induced ovulation in fish.

Identification of different developmental stages of frog - Egg, blastula, gastrula, neurula, tadpole external gill and internal gill stage.

Vital staining of chick embryo.

Preparation of temporary/permanent whole mounts of chick embryo of the following stages to study the extent of development of the circulatory and nervous system in detail in 20, 24, 33, 48 & 72 hours of incubation.

Tracing the development of stained parts. Candling, identification of blastoderm, window preparation - staining using stained agar strips and following the development.

Preparation of stained temporary/permanent mounts of larvae.

Experimental analysis of insect development - *Drosophila*.

Regeneration studies in frog tadpole tail.

Demonstration of sperm of rat/calotes/frog.

Morphological and histological studies of different types of placenta in mammals.

Hormones in Amphibian metamorphosis -

Thyroxine/Iodine solution.

Culture of early chick embryo in vitro.

Study of invertebrate/vertebrate larval forms (minimum 7).

Observation of the mid-sagittal sections and cross sections of the chick embryo through head/ heart region of 24, 48 & 56 hours of incubation.

References

Adamstone, E. B. and Waldo Shumway (1954). 3 Ed. A Laboratory Manual of Vertebrate Embryology. John Wiley & Sons, Inc.

Roberts Rugh (1961). Laboratory Manual of Vertebrate Embryology. Indian Ed., Allied Pacific Pvt. Ltd.

Browden, L. W., Erikson, C. A., and Jeffery, R. W. (1991). Developmental Biology. Ed., Saunders College Publi., Philadelphia.



Zarrow, M. X., Yochim, J. M., Mc Carthy, T. L. and Sanborn, R. C. (1964).

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Thomas, J. A. (1996). Endocrine methods. Academic press, New York.

Humason, G. L. (1962). Animal Tissue techniques. W. H. Freeman & Co.



THIRD SEMESTER PRACTICAL

SJZOL4L04 BIOTECHNOLOGY

Isolation of plasmid DNA.

Isolation of total RNA from
tissues

Separation of DNA by electrophoresis.

Bacterial transformation.

PCR

Cell immobilization.

SJZOL4L04 – MICROBIOLOGY

Selective isolation and enumeration of bacteria.

Bacterial staining technique

Simple staining of bacteria.

Negative staining

Hanging drop technique.

Gram staining.

Endospore staining.

Turbidity test for contamination of milk.

Preparation of media and sterilization.eg: Nutrient agar, mac conkey agar,

Cultivation of yeast and molds

Bacteriological analysis of water e.g., fecal pollutants.

Antibiotic sensitivity test.

Maintenance of *E. coli* culture (shake and surface cultures) and quantitative evaluation (number of cells/ml) of a given sample of culture by dilution and plating.



THIRD SEMESTER PRACTICALS

SJZOL4L04 - MICROTECHNIQUE AND HISTOCHEMISTRY

Preparation of stained and unstained whole –mounts.

Identification of the various tissues of animals in serial sections prepared using nuclear and cytoplasmic stains.

Processing a few types of tissues for the histochemical staining-Staining of serial sections to show the presence of

Carbohydrates by PAS method

Proteins by Mercuric bromophenol blue method

Fats by Sudan Black B method

DNA by Feulgen Technique.

Submission:

Stained/unstained Whole mounts	– 4 numbers
Double stained serial histology slides	- 4 numbers
Histochemical slides	- 2 numbers

References

Ausubel, F.M., Brebt R, Kingston, R.E., Moore, D. D., Seidman, J. G., Smith, J.A. and Struht, K. (2002): Short protocols in Molecular Biology. John Wiley & Sons, Inc.

Sambrook, J. & Russel, D.W. (2001): Molecular cloning: A laboratory Manual. CSHL Press, NY Kannan, N. (2003). Lab Manual in General Microbiology. Panima Publishing Company,India.

Cappuccino,J.G. and Sherman,N. (2007). Microbiology-A laboratory Manual Benjamin-Cummings Publishing Company.USA.



FOURTH SEMESTER PRACTICALS

ELECTIVE COURSE -HUMAN GENETICS PAPER 1

SJZOL4L05 - CLINICAL GENETICS

Sterilization, medium preparation.

Peripheral blood lymphocyte culture.

Banding - G banding, C banding, NOR banding.

Karyotyping and reporting - Normal, Down, Edward, Klinefelter, Patau, Turner.

Experiments with Spectrophotometer- blood urea, serum creatinine, BUN.

Study of hematological disorders- Bleeding time, Clotting time, Prothrombin time. Detections of HbF, HbA.

Study of organ system diseases by charts, photographs etc.- Thalassemia, Hemophilia,

DMD, Neurofibromatosis, Huntington's chorea, Pituitary dwarfism, Congenital adrenal hyperplasia.

FOURTH SEMESTER PRACTICALS

HUMAN GENETICS -II

SJZOL4L05 DIAGNOSTIC GENETICS

(Practical classes to be conducted during fourth semester)

Clinical tests for inborn errors of metabolism

Urine spot test for Mucopolysaccharides

Urine spot test for Cystinuria and Homocystinuria

Lysosomal Enzyme assays (Arylsulfatase A and B)

Estimation of serum cholesterol, proteins, triglycerides, lipids

Stages of human development-

(Demonstration with video or with slides, models or charts, visits to labs Cleavage, 2 cells, 4 cells, 8 cells, 16 cells, 32 cells, Morula, Blastula, Gastrula, Organogenesis

Developmental features of human fetus- first lunar month to tenth lunar month Human birth defects-Spina bifida, Meningocele, neural tube defect

ART- IVF, ICSI, GIFT, ZIFT, Semen



analysis PGD- FISH, PCR based
analysis Amniocentesis, CVS - demo by
video

References:

Devlin, T.M. (1994): Text book of Biochemistry with clinical correlations (3rd edn.).
Emery, A.E.H. and Rimoin, D.L. (1983): Principles and Practice of Medical Genetics, Vol. II, Churchill Livingstone, Chap.99.
Weatherall, D.J. and Clegg. (1981): The Thalassaemia Syndromes (Ed.

FOURTH SEMESTER PRACTICALS

ELECTIVE COURSE - HUMAN GENETICS – III SJZOL4L06 - CANCER GENETICS AND GENETIC SERVICES

Problems in genetic counseling
Agarose gel electrophoresis
Preparation of human genomic DNA
Blood grouping and cross matching
Experiments with PCR
Estimation of CA/MN on cells
SCE -sister chromatid exchange
Micro Nucleus Assay
Study of Ph1 chromosome, FISH in genetics, bcr-abl gene fusion, PMLRARA fusion
Qualitative and quantitative analysis of Ig, ELISA, Western blotting.
Experiments with ELISA Reader- FSH, LH, T3, T4, TSH, Testosterone
Study of radiation induced chromosomal aberrations
Study of dermatoglyphic features
Calculation of gene frequencies of dominant and recessive autosomal alleles.



Elective Courses practical

(Remaining available options as elective courses)

Semester: 4

Name of Course: SJZOL4L05 Entomology 1 & II

Credits: 4:0:0

COCO	Statement	PO/ PSO	CLKC	
CO1	Evaluate the morphology and taxonomy of insects	PO1, PO2, PO3, PO5, PO6, PSO4	E	F,C,P
CO2	Examine the anatomy and physiology of insects	PO1, PO2, PO3, PO5, PO6, PSO4	U	F,C,P

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create

*F-factual, C-conceptual, P-practical/procedural

Semester: 4

Name of Course: SJZOL4L05 Environmental Biology I & II

Credits: 4:0:0

COCO	Statement	PO/ PSO	CLKC	
CO1	Estimate air, radiation and heavy metal pollution of different samples as given in syllabus	PO1, PO2, PO3, PO4 PO5, PO6, PSO4	E	F,C,P
CO2	Analyse water and terrestrial pollution of different samples as given in syllabus	PO1, PO2, PO3, PO4, PO5, PO6, PSO4	Z	F,C,P

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create

*F-factual, C-conceptual, P-practical/procedural

**Semester: 4****Name of Course: SJ ZOL4L05 Fishery Science I & II****Credits: 4:0:0**

COCO	Statement	PO/ PSO	CLKC	
CO1	Acquire skills to separate and analyse different physiological systems, scales of fishes.	PO1, PO2, PO3, PO5, PO6, PSO4	C	F,C,P
CO2	Determine the amylase, protease and lipase activities in different parts of alimentary canal of fish	PO1, PO2, PO3, PO4, PO5, PO6, PSO4	E	F,C,P
CO3	Determine the rate of ammonia and urea excretion in fishes	PO1, PO2, PO3, PO4, PO5, PO6, PSO4	Z	F,C,P

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural****Semester: 4****Name of Course: SJZOL4L05 Wildlife Biology I & II****Credits: 4:0:0**

COCO	Statement	PO/ PSO	CL	KC
CO1	Develop skills to dissect out the arterial system of bird	PO1, PO2, PO5, PO6, PSO4	C	F,C,P
CO2	Examination and identification of different adaptive features of different animals as given in syllabus	PO1, PO2, PO3, PO5, PO6, PSO4	E	F,C,P
CO3	Identify the samples related to wildlife biology	PO1, PO2, PO5, PO6, PSO4	U	F,C,P

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural****Semester: 4**

**Name of Course: SJZOL4L06 Entomology III****Credits: 4:0:0**

COCO	Statement	PO/ PSO	CL	KC
CO1	Observe and identify insect pests of different crops and animals as given in the syllabus	PO1, PO4, PO5, PO6, PSO4	A	F,C,P
CO2	Develop skills to rear insect pests, Parasitoids and Predators in laboratory	PO1, PO2, PO3, PO4, PO5, PO6, PSO4	C	F,C,P
CO3	Analyse the impact of insecticide application in a field.	PO1, PO2, PO3, PO4, PO5, PO6, PSO4	U	F,C,P
CO4	Observe and collect insect pollinators, parasitoids and predators, scavengers and weed killers	O1, PO2, PO3, PO4, PO5, PO6, PSO4	A	F,C,P

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural****Name of Course: SJZOL4L06 Environmental Biology III****Credits: 4:0:0**

COCO	Statement	PO/ PSO	CL	KC
CO1	Analyse different soil and sediment parameters from different sources.	PO1, PO2, PO4, PO5, PO6, PSO4	Z	F,C,P
CO2	Evaluate the count of selective microbes in soil samples	PO1, PO2, PO4, PO5, PO6, PSO4	E	F,C,P
CO3	Analyse the impact of insecticides on soil and water ecosystem	PO1, PO2, PO3, PO4, PO5, PO6, PSO4	Z	F,C,P

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural**

**Name of Course: SJZOL4L06 Fishery Science III****Credits: 4:0:0**

COCO	Statement	PO/ PSO	CL	KC
CO1	Identification of fishing craft, gears, gear material and fishery byproducts.	PO1, PO2, PO5, PO6, PSO4	U	F,C,P
CO2	Preparation of culture media and analyse the bacterial colony using staining procedure.	PO1, PO2, PO3, PO5, PO6, PSO4	Z	F,C,P
CO3	Estimation of different compounds and molecules in different organs of fishes.	PO1, PO2, PO5, PO6, PSO4	E	F,C,P
CO4	Observe & Analyse the functioning of any fishery research institutes, fish hatcheries, fish landing centers, boat building yards, aqua-farms etc.	PO1, PO2, PO3, PO4, PO5, PO6, PSO4	C	F,C,P

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural****Name of Course: SJZOL4L06 Wildlife Biology III****Credits: 4:0:0**

COCO	Statement	PO/ PSO	CL	KC
CO1	Analyse digestive enzymes of the gut of different animals.	PO1, PO2, PO4, PO5, PSO4	Z	F,C,P
CO2	Analyse the morphometry and adaptive of various animals as listed in syllabus	PO1, PO2, PO3, PO5, PSO4	Z	F,C,P
CO3	Estimation of uric acid in birds and reptiles	PO1, PO2, PO5, PSO4	Z	F,C,P
CO4	Apply various methods of population study as listed in syllabus	PO1, PO2, PO3, PO4, PO5, PO6, PSO4	A	F,C,P

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create***F-factual, C-conceptual, P-practical/procedural**



THIRD SEMESTER PRACTICALS ELECTIVE

COURSE- ENTOMOLOGY –I SJZOL4L05 -

MORPHOLOGY & TAXONOMY

Study of the sclerites of head and thorax of different Orders of insects: Grasshopper, Cockroach, Housefly, Honeybee.

Study of the different types of antennae- prepare permanent slides of at least 5 types of antennae (To be submitted during practical examination) .

Adaptive radiation of pterygote mouth parts (Adult & Larval)

Adaptive radiation of pterygote legs- prepare permanent slides of at least 5 types of legs.

Wings: their shape variation in the venation of pterygote wings.

Study of different types of genitalia.

Mounting of stinging apparatus – Honeybee

Morphological studies of different castes of social insects- Honeybee, Ants and Termites

Studies of (a) Honey bee and hives (b) Termitarium and termites.

Dissection of alimentary canal and associated glands- Oryctes grub, Iphita and Cricket

Dissection of reproductive system in insects- Iphita, Cockroach and grasshopper.

Dissection of nervous system- Oryctes grub, Iphita and Cricket.

Dissection of stomatogastric nervous system (oesophageal, sympathetic, single recurrent nerve and paired recurrent nerves in Cockroach.

Preparation of dichotomous keys of the following orders up to families. Each order should contain a minimum of 5 species: Orthoptera, Hemiptera, Hymenoptera, Lepidoptera and Coleoptera.

References

- Borror, D.J. and DeLong, D. H. (1964). An Introduction to the study of Insects. Holt Reineheart and Winston, New York.
- Pedigo, L.P.(1996).Entomology and Pest Management Practice. Hall India Pvt. Ltd, New Delhi.
- Mani. M.S. (1962). General Entomology. Oxford and IBH, New Delhi.
- Nair, K.K., Ananthakrishnan, T.N. and David, B.V. (1976). General and applied Entomology. Tata Mc Graw Hill , New Delhi.



THIRD SEMESTER PRACTICALS ELECTIVE COURSE: ENVIRONMENTAL BIOLOGY –I

SJZOL4L05 - AIR POLLUTION, RADIATION BIOLOGY AND HEAVY METALS

A. AIR POLLUTION

I. Air samplers – Simple, Handy and High volume air samplers.

Monitoring of the following pollutants in ambient and polluted air:

- Dust fall
- Suspended particulate matter
- Sulphation rate using lead peroxide candle.
- Sulphur dioxide
- Nitrogen dioxide
- Ammonia

Study on the effect of SO₂ on vegetation

B. RADIATION BIOLOGY

Demonstration of UV induced lipid peroxidation in tissue homogenates

Effect of Vitamin E on UV induced lipid peroxidation

C. HEAVY METALS

I. Estimation of the following metals in effluent and sediment samples

- Zinc- Zincon method
- Chromium (Hexavalent) - Diphenylcarbazide method

References

- Aery, N.C.-Manual of Environmental Analysis- Ane Books Pvt.Ltd
- Greenberg *et al*-Methods for the examination of water and waste water-APHA publishers Washington D.C.
- Indian standard methods for measurement of air pollution-ISI - New Delhi
- Indian standard method of sampling and test for industrial effluents Part III-ISI New Delhi
- Michael –Ecological methods for field and Lab investigations-Tata Mc Graw-Hill
- Sawyer and Mc Carty-Chemistry for environmental engineering –Mc Graw Hill Publisher.



THIRD SEMESTER PRACTICALS ELECTIVE

COURSE - FISHERY SCIENCE - I

SJZOL4L05 - TAXONOMY, BIOLOGY, PHYSIOLOGY & ECOLOGY

- Identification of common and local fishes
- Dissection of accessory respiratory organs
- Dissection of urinogenital system
- Dissection of arterial system
- Mounting of internal ear
- Study of different types of scales
- Determination of haemoglobin content in fish blood
- 8. Determination of amylase, protease and lipase activities in different parts of alimentary canal of fish
- Determination of rate of ammonia and urea excretion in fishes.
- Age determination of fishes using scales and otolith.

THIRD SEMESTER PRACTICALS ELECTIVE

COURSE: WILDLIFE BIOLOGY-I

SJZOL4L05 - BIODIVERSITY AND BIODATA

- Dissections.
- Arterial system of bird (Pigeon/quail/chicken)
- Flight muscles.
- Perching mechanism - pigeon
- Examination and identification of poisonous and non poisonous snakes
- Examination and identification of different types of feathers.
- Examination and identification of horns and antlers.
- Examination and identification of scales of reptiles, birds, and modified hairs of pangolin and porcupine.
- Mapping distribution of bird fauna and identification of distinct biotic regions. 7 Scats / pellet analysis – significance (Population estimation).



Study of the dental formula of various mammals.

Study of mammal necropsy procedures

Spotters: Pug marks, teeth like lophodont, carnassial dentition, nest of birds,

Hair of mammals, feathers, spines, nails, claws, horns, antlers, and other item

related to wildlife biology.

FOURTH SEMESTER PRACTICALS ELECTIVE

COURSE- ENTOMOLOGY III

SJZOL4L06 - AGRICULTURAL, MEDICAL AND FORENSIC ENTOMOLOGY

Field observation, identification and collection of insect pest of paddy, coconut, sugarcane, cotton, pulses, vegetables, fruit trees spices and forest trees.

Field observation, identification and collection of insect pest of Man and domestic animals

Field observation, identification and collection of insect damages to crops

Study of life histories of insect pests

Laboratory rearing of insect pests (any two)

Observation of laboratory rearing of Parasitoids and Predators

Identification of insecticide appliances

Field study of insecticide application

Field study to observe and collect insect pollinators, parasitoids and predators, scavengers and weed killers

Estimation of LD 50 values for some insect pests

Field report- Each student shall submit a field report consisting of the areas visited like paddy fields, coconut groves, sugarcane fields, cotton fields, fields of pulses and vegetables, fruits, parasitoids and predator breeding stations, beekeeping stations, sericulture institutes, Toxicology laboratories etc.

(The field report with the dated signature of the teacher concerned and duly certified shall be submitted at the time of practical examination along with practical record. No marks shall be awarded for the record without field report).



References

- Atwal, A.S. (1988). Agricultural pests of India and South East Asia. Kalyani Publishers, New Delhi.
- Kottle, D.S. (1995). Medical and Veterinary Entomology. CAB International.
- Mike Service. (2008). Medical Entomology for students. 4th ed. Cambridge University Press, U K.
- Thacker, J.R.M. (2002). An Introduction to Arthropod Pest control. Cambridge University Press.
- Tonapi, G.T. (1994). Experimental Entomology. An aid to Field and Laboratory.
- Trigunayat, M.M. (2002). A Manual of practical Entomology. Scientific Publishings. Jodhpur.

FOURTH SEMESTER PRACTICALS ELECTIVE COURSE: ENVIRONMENTAL BIOLOGY-III SJZOL4L06 – SOIL AND SEDIMENT ANALYSIS

A. Soil and Sediment Analysis

Collection and Preservation

Redox potential.

Alkalinity

PH

Exchangeable calcium and magnesium

Sodium and potassium

Available phosphorous.

Ammonia Nitrogen

Chlorides

Organic Matter –Walkley Black Method

Sulphates

Environmental Microbiology

Standard plate count of soil and water samples

MPN of total coliforms

MPN of fecal coliforms

Bioassay Studies and Insecticides

Fish/Daphnia bioassay test to find out the toxicity of heavy metals/pesticides



Calculation of LC50 or TLm

Determination of the concentration of the following insecticides in water: a)

DDT b) Methyl parathion

Inhibition of acetylcholine esterase by organophosphates/ carbamate insecticides
(demonstration only)

References

Aery, A.C.-Manual of Environmental Analysis- Ane Books Pvt. Ltd

Greenberg,*et.al.*Methods for the examination of water and waste water- APHA
publishers Washington D.C.

Indian standard methods for measurement of air pollution-ISI – New Delhi

Indian standard method of sampling and test for industrial effluents Part III-ISI New Delhi

Michael –Ecological methods for field and Lab investigations-Tata Mc Graw- Hill

Sawyer and Mc Carty-Chemistry for environmental engineering –Mc Graw Hill Publishers

Trivedi and Goel-Practical methods in Ecology and Environmental Sciences-
Environmental publications Kara.

FOURTH SEMESTER PRACTICALS ELECTIVE COURSE – FISHERY SCIENCE– III

SJZOL4L06 – HARVESTING POST HARVESTING TECHNOLOGY AND MARKETING

Identification of fishing craft, gears and gear material from models, drawings and
photographs

Study of processing of commercially important fin fishes and shell fishes.

Identification of different fishery byproducts

Identification of different mechanisms used in fish processing.

Staining of bacteria

Preparation of culture media

Study of bacterial culture

Laboratory technique to detect pathogenic bacteria of public health, significance of *E. coli*, *Salmonella*, and *Staphylococcus*

Preparation of scoring key to identify different stages of fish spoilage



Estimation of ash and water content of fish muscle

Estimation of total amino acid in fish muscle

Estimation of trimethyl amine

Extraction of liver and body oil

Study of canning and refrigeration

Study Tour

A study tour not less than ten days duration (Need not be at a stretch) to fishery research institutes such as CIFT, CMFRI, CIFNET, IFP, etc, fish hatcheries, fish landing centers, boat building yards, aqua-farms etc. The field reports with dated signature of the teacher concerned and duly certified should be submitted at the time of examination.

FOURTH SEMESTER PRACTICALS ELECTIVE COURSE: WILDLIFE BIOLOGY-III SJZOL4L06 -WILD LIFE MANAGEMENT

Qualitative analysis of digestive enzymes of the gut. (Herbivores/ Carnivores/Omnivores).

Measurements (Morphometry) for systematic study. Total length, body length, tail length, various dimensions of the skull etc. of mammals, birds, reptiles, amphibians and fishes.

Quantitative estimation of uric acid in birds and reptiles.

Identifying features of the beaks and feet of common birds. Students are expected to identify from photographs / Xerox.

Assessment of the age of mammals using their teeth.

Measurement of temperature, light, rainfall, humidity, transpiration and wind speed.

Collection and quantitative and qualitative analysis of soil fauna.

Territory mapping. Quadrature sampling, Line transect, Line intersect, Point prime methods of population study. Pellet counting for deer population of elephant dung in a sanctuary.

Spotters: Various item related to wildlife biology.



Study Tour

A study tour of not less than 10 days duration (need not to be at a stretch) to sanctuaries, National Parks, Zoos, Research Institutes and other places of ecological importance. The field report with the dated signature of the teacher concerned and duly certified should submit at the time of examination. Slides should be submitted at the time of examination during IV semester.



CORE COURSE: PROJECT WORK & VIVA

Semester: 4

Name of Course SJZOL4P07- Project Work

Credits: 4:0:0

COCO	Statement	PO/ PSOCL	KC	
CO1	Understand that detail planning is necessary for the successful and safe experimentation	PO1, PO2, PO3, PO5, PO6, PSO4	U	F,C,P
CO2	Convert scientific questions into hypothesis that can be tested experimentally	PO1, PO2, PO3, PO5, PO6, PSO4	A	F,C,P
CO3	Prepare and present recorded results accurately and in an understandable form	PO1, PO2, PO3, PO4, PO5, PO6, PSO4	C	F,C,P
CO4	Identify the general characteristics of experiments that will yield valid scientific conclusion	PO1, PO2, PO3, PO5, PO6, PSO4	A	F,C,P
CO5	Design appropriate experiments to test hypothesis and evaluate the strength and weakness of experiments and their design	PO1, PO2, PO3, PO5, PO6, PSO4	C	F,C,P
CO6	Reach conclusions that are supported by the experimental results.	PO1, PO2, PO3, PO4, PO5, PO6, PSO4	E	F,C,P

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create

***F-factual, C-conceptual, P-practical/procedural**



Semester: 4

Name of Course SJZOL4V08- Viva Voce (Project-2 + General-2)

Credits: 4:0:0

COCO	Statement	PO/ PSO	CL	KC
CO1	Prepare comprehensively to answer questions from all the courses of four semesters.	PO1, PO2, PO3, PO5, PO6, PSO4	E	F, C, P
CO2	Attain Oral Presentation skills by answering questions in precise and concise manner.	PO1, PO2, PO3, PO5, PO6, PSO4	C	F, C, P
CO3	Gain confidence and inter-personal skills	PO1, PO2, PO3, PO5, PO6, PSO4	E	F, C, P

R-remember, U-understand, A- apply, Z- analyze, E- evaluate, C- create

***F-factual, C-conceptual, P-practical/procedural**



MODEL QUESTION PAPER

I/II/III/IV SEMESTER M.Sc. DEGREE EXAMINATION (CUCSS), Month & Year

Branch: Zoology

Course Code: Course Name

Time : 3hrs

Maximum Weightage:30

I. Answer any 4 of the following (Short Answer type questions)

(Weightage-2)

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.

4 x 2 = 8

II. Answer any 4 of the following (Short essay type questions)

(Weightage-3)

- 8.
- 9.
- 10.
- 11.
- 12.
- 13.
- 14.

4 x 3 = 12

III. Answer any 2 of the following (Long essay)

(Weightage-5)

- 15.
- 16.
- 17.
- 18.

2 x 5 = 10