

**ST. JOSEPH'S COLLEGE (AUTONOMOUS),  
DEVAGIRI, CALICUT**



**Syllabus  
for  
M.Sc. ZOOLOGY PROGRAMME**

**AS PER  
CHOICE BASED CREDIT AND SEMESTER SYSTEM PG 2019**

**(With effect from 2019 admission onwards)**

# Regulations for the Post-Graduate Choice Based Credit Semester System - 2019

## 1. SHORT TITLE

These regulations shall be called “**St. Joseph’s Regulations for Choice Based Credit Semester System for Post-Graduate Curriculum - 2019**” (SJCBCSSPG-2019)

## 2. SCOPE, APPLICATION & COMMENCEMENT

2.1 The regulations provided herein shall apply to all the Post Graduate programmes offered by St. Joseph’s College (Autonomous) Devagiri, Calicut

2.2 These regulations shall supersede all the previous regulations for the Post-graduate programmes.

## 3. DEFINITIONS

3.1 ‘**Academic Committee**’ means the Committee constituted by the Principal under this regulation to manage and monitor the running of the Post Graduate programmes, under SJCBCSSPG-2019.

3.2 ‘**Programme**’ means the entire course of study and Examinations (traditionally referred to as course).

3.3 ‘**Duration of Programme**’ means the period of time required for the conduct of the programme. The duration of post-graduate programme shall be four semesters.

3.4 ‘**Semester**’ means a term consisting of a minimum of 90 working days including examination days distributed over a minimum of 18 weeks each of 5 working days.

3.5 ‘**Course**’ means a segment of the subject matter to be covered in a semester (traditionally referred to as paper). All the courses need not carry the same weightage. The courses should define their learning objectives and learning outcomes. A course may be designed in such a way that it consists of lectures/ tutorials/laboratory work/ field work/ outreach activities/ project work/ vocational training/viva/ seminars/ term papers/assignments/ presentations/ self-study etc. or a combination of some of these.

3.6 ‘**Core course**’ means a compulsory course in a subject related to a particular PG Programme, which shall be successfully completed by a student to receive the degree.

3.7 ‘**Elective course**’ means a course, which can be substituted, by equivalent course from the same subject and a minimum number of courses are required to complete the programme.

3.8 **Audit Course** :These courses are mandatory for which the student can register without earning credits.

- 3.9 **Ability Enhancement Course** :This is one among the Audit courses which is mandatory for all programmes but not counted for the calculation of SGPA or CGPA. The object is to enhance the ability and skill in the concerned core area.
- 3.10 **Professional competency Course** :This is one among the Audit courses which is mandatory for a programme but not counted for the calculation of SGPA or CGPA. The objective is to get professional competency and exposure in the concerned core area.
- 3.11 **'Readmission'** is the act of admitting a student again after leaving the institution.
- 3.12 **'Improvement course'** is a course registered by a student for improving his/her performance in that particular course.
- 3.13 **'Department'** means any teaching Department offering a course of study in the college.
- 3.14 **'Parent Department'** means the Department which offers a particular postgraduate programme.
- 3.15 **'Department Council'** means the body of all teachers of a Department in a College.
- 3.16 **'Department Coordinator'** is a teacher nominated by Department Council to coordinate the continuous evaluation undertaken in that Department.
- 3.17 **'Student Advisor'** means a teacher/coordinator from the college nominated by the College Council / to look into the matters relating to SJCBS SPG-2019.
- 3.18 **'Credit'(C)** of a course is a measure of the weekly unit of work assigned for that course.
- 3.19 **'Letter Grade'** or simply **'Grade'** in a course is a letter symbol (e.g., A+,A,B+,B, etc (as mentioned in Clause 20.2 of this Regulation) which indicates a particular range of grade points which indicates the broad level performance of a student.
- 3.20 **Grade Point (G)** :It is a numerical weightage allotted to each letter grade on a Grading Scale.
- 3.21 **'Credit point'(P)** of a course is the value obtained by multiplying the grade point (G) by the Credit (C) of the course  $P=G \times C$ .
- 3.22 **'Semester Grade point average' (SGPA)** is the value obtained by dividing the sum of credit points obtained by a student in various courses taken in a semester by the total number of credits taken by him/her in that semester. The grade points shall be rounded off to two decimal places.

3.23 **'Cumulative Grade point average' (CGPA)** It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.

3.24 Words and expressions used and not defined in these regulations but defined in the Calicut University Act and Statutes shall have the meaning assigned to them in the Act and Statute.

#### **4. DURATION OF THE PROGRAMME**

4.1 The duration for completion of a four semester PG Programme is ***two years***.

The maximum period for completion is 4 years.

4.2 The duration of each semester shall be 90 working days, inclusive of examinations, spread over five months.

4.3 Odd semesters shall be held from June to October and even semesters from November to March subject to the academic calendar of the College.

## 5. SCHEME AND SYLLABUS

5.1 The detailed scheme and syllabus for each course shall be framed by the Board of Studies concerned and approved by the Academic Council based on this Common Regulation.

## 6. PROGRAMME STRUCTURE

- 6.1 Students shall be admitted to post graduate programme offered by the college.
- 6.2 The programme shall include three types of courses: **Core courses, Elective courses and Audit Courses.**
- 6.3 Comprehensive Viva-voce and Project Work / Dissertation shall be treated as Core Courses. Project Work is mandatory for all regular programmes and Comprehensive Viva-voce is optional and these shall be done in the end semester.
- 6.4 Total credit for the programme shall be 80 (eighty), this describes the weightage of the course concerned and the pattern of distribution as detailed below:
- i) Total Credit for Core Courses shall not be less than 60 (sixty) and not more than 68 (sixty eight).
  - ii) Total Credit for Elective Course shall not be less than 12 (twelve) and not more than 20 (Twenty).
  - iii) Total Credits for Comprehensive Viva-voce and Project Work combined together shall be 8 (eight) subject to a minimum of 4 (four) credit for Project Work.
  - iv) Total credit in each semester shall vary between 18 to 22.
  - v) No course shall have less than 2 credits and more than 5 credits.
- 6.5 Elective courses shall be spread over either in the Third & Fourth Semesters combined or in anyone of these Semesters (III / IV) only subject to the stipulations of the BoS concerned.
- 6.6 Study Tour / Field visit / Industrial visit / Trip for specimen collection may be conducted as a part of the Programme as per the stipulations of the BoS concerned.
- 6.7 **Audit Courses** : In addition to the above courses there will be two Audit Courses (**Ability Enhancement Course & Professional Competency Course**) with 4 credits each. These have to be done one each in the first two semesters. The credits will not be counted for evaluating the overall SGPA & CGPA. The colleges shall conduct examination for these courses and have to intimate /upload the results of the same to the University on the stipulated date during the III Semester. Students have to obtain only minimum pass requirements in the Audit Courses. The details of Audit courses are given below.

Semester	Course Title	Suggested Area	Details
I	Ability Enhancement Course (AEC)	Internship / Seminar presentation / Publications / Case study analysis / Industrial or Practical Training /Community linkage programme / Book reviews etc.	Concerned BoS can design appropriate AEC & PCC and evaluation criteria by considering the relevant aspects in the core area of the faculty under study.
II	Professional Competency Course (PCC)	To test the skill level of students liketesting the application level of different softwares such as SPSS/R/ Econometrics / Pythan/Any software relevant to the programme of study / Translations etc.	

6.8 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 programme.

6.9 For uniform identification a common guideline for Coding various courses are given in the last part of the Appendix.

Courses and Credit distribution summary:

<b>Sem ester</b>	<b>Course</b>	<b>TeachingHours</b>	<b>Credit</b>	<b>Total Credit</b>
I	Core Courses (Theory/Practical)		<ul style="list-style-type: none"> <li>• For Core course total credit can vary from 60 to 68.</li> </ul>	
II	Core Courses (Theory/Practical)			
III	(i) Core Courses(Theory/Practical) (ii) Elective Courses (Theory/Practical)			
IV	(i) Core Courses (Theory / Practical) Including : (a) Comprehensive Viva-voce (Optional) (b) Project Work /Dissertation (ii) Elective Courses (Theory/ Practical)			
<b>Total credit shall be</b>				<b>80</b>
I	<b>Audit Course I :</b> Ability Enhancement Course (AEC)	Not coming in the normal work load	4 (Not added for SGPA / CGPA)	4
II	<b>Audit Course II :</b> Professional Competency Course (PCC)		4 (Not added for SGPA / CGPA)	4

## 7. PROJECT WORK / DISSERTATION & COMPREHENSIVE VIVA-VOCE

- 7.1 There shall be 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.
- 7.2 For Regular students, **Project work is mandatory** for all faculties but **Comprehensive Viva-voce is optional**. Viva-voce related to Project work shall be one of the criteria for Project Work evaluation provided as per 18.6 of this regulation.
- 7.3 SDE/Private Registration students can opt for either Project Work or one Theory Course.
- Comprehensive Viva-voce is optional. These shall be in accordance with the decisions and stipulations of the concerned BoS.
- 7.4 If the SDE/Private registration students opt Project Work, it can be done only under the supervision of a working /retired teacher from a Govt /Aided College or a University teacher and prior approval/sanction from the SDE has to be obtained as per the stipulations of the concerned programme curriculum.
- 7.5 All students have to submit a Project Report/Dissertation in the prescribed structure and format as a part of the Project Work undertaken as per the stipulations of the concerned BoS.
- 7.6 There shall be **External and Internal evaluation for Project Work** and these shall be combined in the proportion of 4:1. In the case of Comprehensive Viva-voce, the conduct of **External Viva-voce is mandatory** but internal is optional, subject to the decision and stipulations of the BoS concerned.
- 7.7 Detailed course structure on Project work to be done, Viva-voce and Project Report preparation can be designed by integrating relevant aspects by the concerned Board of Studies of the Programme.
- 7.8 Details of evaluation of Project Work/Dissertation and Comprehensive Viva-voce are given under clause 18 of this regulation.

## 8. BOARD OF STUDIES AND COURSES

- 8.1 The PG Boards of Studies concerned shall design all the courses offered in the post- graduate programmes. The Boards shall design and introduce new courses, modify or re- design existing courses and replace any existing courses with new/modified/re-designed courses to facilitate better exposure and training for the students.



- 8.2 **The Syllabus** of a course shall include course code, the title of the course, the number of credits, maximum grade for external and internal evaluation, duration of examination hours, distribution of internal grade, model question paper and reference materials. The Board of Studies concerned has the liberty to decide whether the questions can be answered in Malayalam or not. Maximum efforts shall be made to maintain a uniform pattern while designing the courses, project, viva, practical etc. in the scheme and syllabus of various programmes coming under same faculty.
- 8.3 Code numbers for the courses can be given as per the general guidelines given in the 'Appendix' for a uniform identification.

## 9. ADMISSION

- 9.1 The admission to all PG programmes shall be as per the rules and regulations of the University/College.
- 9.2 The eligibility criteria for admission shall be as announced by the University from time to time.
- 9.3 Separate rank lists shall be drawn up for reserved seats as per the existing rules.
- 9.4 The college shall make available to all the admitted students the information regarding all the courses including electives offered with syllabus and credit for the entire course.
- 9.5 There shall be a uniform calendar prepared by the College for the Conduct of the programmes.
- 9.6 There shall be provision for inter collegiate and inter University transfer in the 2<sup>nd</sup> and 3<sup>rd</sup> semester within a period of two weeks from the date of commencement of the semesters.
- 9.7 There shall be provision for credit transfer subject to the conditions specified by the Board of Studies concerned.
- 9.8 There shall be provision for transfer from Regular stream to SDE/Private registration and SDE/Private Registration to Regular (under the same scheme and syllabus) in the Second and Third Semester within a period of two weeks or the period fixed by the University from the date of commencement of the academic year as per the existing rules and regulations for inter college transfer. Transfer of students from Autonomous colleges to SDE and SDE to Autonomous Colleges is also permitted.
- 9.9 There shall be a uniform **calendar** prepared by the College for the registration, Conduct / schedule of the courses, examinations and publication of results. The College shall ensure that the calendar is strictly followed.

## 10. READMISSION

- 10.1 There shall be provision for readmission of students.
- 10.2 For readmission, the vacancy should be within the sanctioned strength in the parent college. If there is no vacancy in the junior batch of the parent college, readmission can be taken in another college with the junior batch, if there is vacancy within the sanctioned strength in the concerned college.
- 10.3 This readmission is not to be treated as college transfer.

10.4 There should be a gap of at least one semester for readmission.

10.5 The candidate seeking readmission to a particular semester should have registered for the previous semester examination.

10.6 Readmission shall be taken within two weeks from the date of commencement of the semester concerned.

10.7 The Principal can grant readmission to the student, subject to the above conditions, and inform the matter of readmission to the Controller of Examinations within one month of such readmission.

10.8 If change in scheme occurs while readmission, provision for credit transfer will be subject to the common guidelines prepared by Board of Studies/ Faculty concerned.

10.9 This provision is applicable to SDE/Private Registration student also irrespective of vacancy and sanctioned strength.

## **11. REGISTRATION**

11.1 - A student shall be permitted to register for a programme at the time of admission.

11.2 - A student who registers for a programme shall complete it within 4 years.

11.3 - Students shall be normally permitted to register for the examination if they have required minimum attendance as per clause 12 of this regulation. If the student has a shortage of attendance in a semester, the student shall be permitted to move to the next semester and can write the examination for the entire courses of the semester in which shortage of attendance occurs as supplementary examination only after the completion of the entire programme. In such cases, a request from the student may be forwarded through the Principal of the college to the Controller of Examinations within two weeks of the commencement of the semester. There will not be any Repeat semester in SJCBCSSPG 2019.

11.4 - The students who have attendance within the limit prescribed as per clause 12 of this regulation, but could not register for the semester examinations, have to apply for token registration, within two weeks of the commencement of the next semester.

## **12. ATTENDANCE**

12.1 The students admitted in the PG programmes shall be required to attend at least 75 percent of the total number of classes (theory/practical) held during each semester. The students having less than prescribed percentage of attendance shall not be allowed to appear for the end semester examination.

12.2 Condonation of shortage of attendance for a maximum of 9 days (10% of the working days in a semester) in the case of single condonation and 18 days (20% of the working days in a semester) in the case of double condonation in a semester subject to a maximum of two times (for single condonation only) during the whole period of Post Graduate programme may

be granted by the University as per the existing procedures. In the case of double condonation, only one condonation shall be allowed during the entire programme.

- 12.3 Benefit of condonation of attendance will be granted to the students on health grounds, for participating in University Union activities, meeting of the University bodies /Govt. bodies and participation in other extracurricular activities on production of genuine supporting documents, with the recommendation of the Head of the Department concerned.
- 12.4 - A student who is not eligible for such condonation **shall observe the provisions as per clause 11.3** of this regulation. The principal should intimate the details of these candidates at the commencement of the next semester.
- 12.5 -Women students can avail maternity leave as per the existing university rules.

### 13. EXAMINATION

- 13.1 -There shall be End semester examination at the end of each semester.
- 13.2 -Practical examinations shall be conducted by the College at the end of each semester or at the end of even semesters as prescribed in the curriculum of the particular Programme. The number of examiners and other aspects of the practical examination shall be prescribed by the concerned Boards of Studies of the programmes.
- 13.3 - **Project Work / Dissertations** shall be evaluated at the end of the programme only. There shall be both Internal and External evaluation for the Project Work. The details of internal evaluation shall be framed by the concerned Boards of Studies.
- 13.4-Comprehensive Viva–Voce** shall be conducted at the end of the programme only.
- There shall be only External Comprehensive Viva–Voce conducted by the external examiners appointed by the College. The details of evaluation shall be framed by the concerned Boards of Studies.
- 13.5** -There shall be one end-semester examination of 3 hours duration for each theory course and the duration of practical course can be decided by the concerned BoS.

### 14. SCHEME AND SYLLABUS

- 14.1 -Distribution of courses/weightage for theory/practical among the semesters shall be equal as far as possible and the aggregate weightage for each semester shall be stipulated by the Boards of studies concerned.
- 14.2 -The detailed scheme and syllabus for each course shall be framed by the respective Boards of Studies concerned and approved by the Academic Council.

## 15. EVALUATION AND GRADING

- 15.1 **Evaluation:** The evaluation scheme for each course shall contain two parts; (a) Internal / Continuous Assessment (CA) and (b) External / End Semester Evaluation (ESE).
- 15.2 Of the total, 20% weightage shall 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**.
- 15.3 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.
- 15.4 **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 provided in clause **20.2** of this regulation.
- 15.5 **Evaluation of Audit Courses:** The examination and evaluation shall be conducted by the college itself either in the normal structure or MCQ model from the Question Bank and other guidelines provided by the BoS. The Question paper shall be for minimum 20 weightage and a minimum of 2 hour duration for the examination. The result has to be intimated / uploaded to the controller of examinations during the Third Semester as per the notification of the College.

## 16. INTERNAL EVALUATION / CONTINUOUS ASSESSMENT (CA)

- 16.1 This assessment shall be based on a predetermined transparent system involving periodic written tests, assignments, seminars and viva-voce in respect of theory courses and based on tests, lab skill and records/viva in respect of practical courses.
- 16.2 The criteria and percentage of weightage assigned to various components for internal evaluation are as follows:

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

*(The components and the weightage of the components of the practical (Internal) can be modified by the concerned BOS without changing the total weightage 10.)*

- 16.3 Grades shall be 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 shall be as per the Ten Point scale provided in clause **20.2** of this regulation.

- 16.4 There shall be no separate minimum Grade Point for internal evaluation.
- 16.5 To ensure transparency of the evaluation process, the internal assessment marks awarded to the students in each course in a semester shall be published on the notice board before 5 days of commencement of external examination.
- 16.6 There shall not be any chance for improvement of internal marks.
- 16.7 The course teacher shall maintain the academic record of each student registered for the course, which shall be forwarded to the Principal, after being endorsed by the Head of the Department.
- 16.8 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.
- 16.9 Each student shall be required to do **assignment /s** 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.
- 16.10 Every student shall deliver **Seminar / Presentation** as an internal component 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.
- 16.11 All the records of Continuous Assessment (CA) must be kept in the college and must be made available for verification, if asked for.

#### **17. EXTERNAL / END SEMESTER EVALUATION (ESE)**

- 17.1 The semester-end examinations in theory courses shall be conducted by the College with question papers set by external experts. The evaluation of the answer scripts shall be done by examiners based on a well-defined scheme of valuation.

- 17.2 After the external evaluation, only Grades are to be entered in the space provided in the answer script for individual questions and calculations need to be done only up to the Cumulative Grade Point (CGP) and all other calculations including grades are to be done by the examination wing of the College.
- 17.3 Students shall have the right to apply for photocopy or scrutiny as per rules within the time permitted for it.
- 17.4 The evaluation shall be done immediately after the examination preferably in a Centralized Valuation Camp.
- 17.5 The language of writing the examination shall be specified in the separate regulations for the programme by the concerned BoS.

**17.6 PATTERN OF QUESTIONS FOR EXTERNAL (ESE) :**

- 17.6.1 Questions shall 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 shall be given to each module based on content/teaching hours allotted to each module.
- 17.6.2 It has to be ensured that questions covering all skills are set. The setter shall also submit a detailed scheme of evaluation along with the question paper.
- 17.6.3 A question paper shall be a judicious mix of short answer type, short essay type /problem solving type and long essay type questions.
- 17.6.4 The question shall be prepared in such a way that the answers can be awarded A+, A, B, C, D, E Grades.
- 17.6.5 Weightage: Different types of questions shall be given different weightages to quantify their range given in the following model:

SI. No.	Type of Questions	Individual weightage	Total Weightage	Number of questions
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
<b>Total</b>			<b>30</b>	<b>18</b>

- 17.6.6 Questions should be asked as far as possible from all modules following a uniform distribution. However concerned BoS can change the pattern and type of questions subject to the condition that total weightage should be 30.
- 17.7 End Semester Evaluation in Practical Courses shall be conducted and evaluated by both Internal and External Examiners as per the stipulations of the concerned BoS. Duration and other aspects of practical external examinations shall be decided by the Boards of Studies concerned.

## 18. EVALUATION OF PROJECT WORK / DISSERTATION

- 18.1 There shall be External and Internal evaluation with the same criteria for Project Work done and the grading system shall be followed as per the specific guidelines and stipulations of the concerned BoS.
- 18.2 One component among the Project Work evaluation criteria shall be Viva-voce (Project Work related) and the respective weightage shall be 40%.
- 18.3 Consolidated Grade for Project Work is calculated by combining both the External and Internal in the Ratio of 4:1 (80% & 20%).
- 18.4 Details regarding the conduct of external and internal evaluation, criteria for evaluation and other aspects relating to the same can be taken by the concerned Boards of Studies and shall be specified in the Programme curriculum.
- 18.5 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 report. **There shall be no improvement chance for Project Work.**
- 18.6 The External and Internal evaluation of the Project Work shall be done based on the following criteria and weightages as detailed below:

Sl. No	Criteria	% of wightage	Weightage External	Weightage Internal	Remarks
1	Relevance of the topic and Statement of problem	60%	8	2	Concerned Boards of Studies may conveniently divide this criteria in to various relevant categories and can assign suitable titles provided that the total weightage should be 24 and 6 for External and Internal.
2	Methodology & Analysis		8	2	
3	Quality of Report & Presentation		8	2	
4	Viva-voce	(40%)	16	4	Mandatory criteria
<b>Total Weightage</b>		<b>100%</b>	<b>40</b>	<b>10</b>	

## 19 - CONDUCT OF COMPREHENSIVE VIVA-VOCE

- 19.1 There shall be External and Internal Comprehensive Viva-voce; while the External Conduct of the Viva-voce is mandatory and the Internal conduct of the viva-voce will be optional subject to the decision and stipulation of the concerned BoS.
- 19.2 The concerned Boards of Studies shall design the structure, criteria, details of appointment of Board of examiners (both external and internal) and other relevant aspects of its evaluation.
- 19.3 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 viva-voce, they will be treated as failed in that attempt and the student may re appear for the same next time in accordance with the University exam stipulations. **There shall be no improvement chance for Comprehensive viva-voce.**

## 20 - DIRECT GRADING SYSTEM

- 20.1 Direct Grading System based on a 10 – Point scale is used to evaluate the performance (External and Internal Examination of students)
- 20.2 For all courses (Theory & Practical)/Semester/Overall Programme, Letter grades and **GPA/SGPA/CGPA** are given on the following way :
- a) First Stage Evaluation for both Internal and External done by the Teachers concerned in the following Scale :

Grade	Grade Points
<b>A+</b>	<b>5</b>
<b>A</b>	<b>4</b>
<b>B</b>	<b>3</b>
<b>C</b>	<b>2</b>
<b>D</b>	<b>1</b>
<b>E</b>	<b>0</b>



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%***

20.3 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.

20.4 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.

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

20.4.2 **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.

## 20.5 Semester Grade Point Average (SGPA) – Calculation

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.

(SGPA= Total Credit Points awarded in a semester / Total credits of the semester)

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**.

**Model calculation is given in the Annexure :**

## 20.6 Cumulative Grade Point Average (CGPA) - Calculation

**After the successful completion of the programme, Cumulative Grade Point Average (CGPA) is calculated using the formula**

**Cumulative Grade Point Average (CGPA) = Total Credit points awarded in all semesters/Total credits of the programme)**

The **SGPA** and **CGPA** shall be rounded off to 3 decimal points.

## 21. GRADE CARD

21.1 The College shall issue to the students grade card on completion of each semester, which shall contain the following information :

- Name of College
- Name of University
- Title of PG Programme
- Semester concerned
- Name and Register Number of student
- Code number, Title and Credits of each Course opted in the semester including Audit Courses
- Letter grade in each course in the semester
- The total credits, total credit points and SGPA in the Semester (corrected to three decimal places)

The final Grade card issued at the end of the final semester shall contain the details of all courses taken during the entire programme, including those taken over and above the prescribed minimum credits for obtaining the degree. The final grade card shall show CGPA (corrected to three decimal places), percentage of marks (corrected to two decimal places) and the overall letter grade of a student for the entire programme. The final Grade card will also contain the list of Audit courses.

## 22. AWARD OF DEGREE

22.1 The successful completion of all the courses with **P** Grade shall be the minimum requirement for the award of the degree

### 23. POSITION CERTIFICATE

- 23.1 The University publishes list of top 10 positions for each programme after the publication of the programme results. Position certificates shall be issued to candidates who secure positions from 1st to 10<sup>th</sup> in the list. The position list shall be finalised after the result of revaluation.
- 23.2 The position list shall be prepared in the order of merit based on the CGPA scored by the students. Grace Grade points awarded to the students shall not be counted for fixing the position.

### 24. GRIEVANCE REDRESSAL COMMITTEE

- 24.1 **Department Level Committee:** The college shall form a Grievance Redressal Committee in each department comprising of course teacher, one senior teacher and elected representative of Students (Association Secretary) as members and the Head of the Department as Chairman. The committee shall have initial jurisdiction over complaints against Continuous Assessment.
- 24.2 **College Level Committee:** There shall be a college level grievance redressal committee comprising of student adviser, two senior teachers , two staff council members (one shall be elected member) and elected representative of students (College Union Chairperson) as members and the Principal as Chairman. This committee shall address all grievances relating to the internal assessment grades of the students.

### 25. TRANSITORY PROVISION

- 25.1 Notwithstanding anything contained in these regulations, the Academic Council shall, for a period of three years from the date of coming into force of these regulations, have the power to provide by order that these regulations shall be applied to any programme with such modifications as may be necessary.

### 26. REPEAL

- 26.1 The Regulations now in force in so far as they are applicable to programmes offered by the College and to the extent they are inconsistent with these regulations are hereby repealed. In the case of any inconsistency between the existing regulations and these regulations relating to the Credit Semester System in their application to any course offered in a College, the latter shall prevail.

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### APPENDIX

1. *First Phase Evaluation can be done at 6 point scale by assigning the respective Grade Points as detailed below (done by the concerned teacher/examiner)*

<b>Grade</b>	<b>A+</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>
<b>Grade Point</b>	<b>5</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>0</b>

2. Calculation of CGPA, SGPA & CGPA based on the Direct Grading system using 10 Point Scale as detailed below :

Letter Grade	GradeRange	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	0	Incomplete
Ab	0	-	Absent

**Phases for Evaluation :**

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

1. Evaluation of all individual External Theory courses and Internal evaluation
2. Evaluation of Project Work External and Internal
3. Evaluation of External and Internal Practical Courses
4. Evaluation of External and Internal Comprehensive Viva-voce

**II Phase - GPA Calculation - To be done by the College**

1. Consolidation of External and Internal for Theory Courses (Calculation of GPA)
2. Consolidation of External and Internal for Project Work (Calculation of GPA)
3. Consolidation of External and Internal for Practical Courses (Calculation of GPA)
4. Consolidation of External and Internal for Comprehensive Viva-voce (Calculation of GPA)

**III Phase - SGPA Calculation - To be done by the College**

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

### III Phase - CGPA Calculation - To be done by the College

Calculation of Consolidated Grade Point Average.  
(Grade) of a Programme.

This is the consolidated net result

#### Model Calculation of Grade :

#### Calculation of overall Grade for one Course (GPA) - Theory External

#### First Phase Evaluation (Done by the concerned Teacher/Examiner)

:

#### I - Theory - External :

Type of Question	Qn.No	Grade Awarded	Grade Point	Weightage	Weighted Grade Point	Calculation
Short Answer type	1	A+	5	2	10	Overall Grade of the theory paper = Sum of Weighted Grade Points / Sum of the weightage <b>115/30 = 3.83 = Grade A+</b>
	2	-	-	-	-	
	3	A	4	2	8	
	4	C	2	2	4	
	5	-	-	-	-	
	6	A	4	2	8	
	7	-	-	-	-	
Medium Essay type	8	B	3	3	9	
	9	A+	5	3	15	
	10	-	-	-	-	
	11	-	-	-	-	
	12	-	-	-	-	
	13	A	4	3	12	
	14	B	3	3	9	
Long Essay type	15	A+	5	5	25	
	16	-	-	-	-	
	17	-	-	-	-	
	18	B	3	5	15	
<b>TOTAL</b>				<b>30</b>	<b>115</b>	

*Note :1) The total weightage for external evaluation is 30, (2) Maximum Weighted Grade Point (WGP) is 150 (30 X 5), (3) Same way all theory courses can be evaluated.*

## II - Theory-Internal :

Components	Weightage (W)	Grade Awarded	Grade Point(GP)	WGP=W *GP	Overall Grade of the course
Examination /Test	2	A	4	8	<b>WGP/Total weight = 22/5 =4.40</b>
Seminars / Presentation	1	A+	5	5	
Assignments	1	A	4	4	
Viva-voce	1	A+	5	5	
<b>Total5</b>				<b>22</b>	<b>O</b>

Maximum weight for Internal evaluation is 5. Therefore Maximum Weighted Grade Point (WGP) is **25 (5 X 5)**.

## III - Project - External :

Components	Weightage (W)	Grade Awarded	Grade Point(GP)	WGP=W *GP	Overall Grade of the course
Relevance of the topic and Statement of problem	8	A	4	32	<b>WGP/Total weight = 160/40 =4</b>
Methodology & Analysis	8	B	3	24	
Quality of Report & Presentation	8	A+	5	40	
Viva-voce	16	A	4	64	
<b>Total40</b>				<b>160</b>	<b>A+ - Grade</b>

Project - Internal :

Components	Weightage (W)	Grade Awarded	Grade Point(GP)	WGP=W *GP	Overall Grade of the course
Relevance of the topic and Statement of problem	2	A	4	8	<b>WGP/Total weight = 38/10 = 3.8</b>
Methodology & Analysis	2	B	3	6	
Quality of Report & Presentation	2	A	4	8	
Viva-voce	4	A	4	16	
<b>Total10</b>				<b>38</b>	<b>A+ - Grade</b>

**Second Phase Evaluation (Done by the College) :**

**V - Theory - Consolidation of Grade (GPA) (Internal + External) :**

The external grade awarded for the Course 1 is 'A' with a Grade point of 3.83 and its internal is 'O'. with a Grade Point of 4.40. The consolidated grade for the course Course 1 is as follows.

Exam	Weightage	Grade awarded	Grade Points (WGP / TOTAL WEIGHTAGE)	Weighted Grade Point
External	4	A+	3.83	15.32
Internal	1	O	4.40	4.40
<b>Total5</b>				<b>19.72</b>
Grade of a course (GPA)	GPA=Total weighted Grade Points/Total weight <b>19.72/5 =3.94 = Grade A+</b>			

**VI - Project Work - Consolidation of Grade (GPA) (Internal + External) :**

Exam	Weightage	Grade awarded	Grade Points (WGP / TOTAL WEIGHTAGE)	Weighted Grade Point
External	4	A+	4	16
Internal	1	A+	3.8	3.80
<b>Total5</b>				<b>19.8</b>
Grade of a course (GPA)	GPA=Total weighted Grade Points/Total weight <b>19.8/5 =3.96 = A+ Grade</b>			

**Third Stage Evaluation :**

**CALCULATION OF SGPA (To be done by the College) :**

Course code	Title of the course	Credits (C)	Grade Awarded	Course Grade Points (G)	Credit Points (CP=CXG)	SGPA
<b>I - SEMESTER</b>						
001	Course 1	4	O	4.25	17	SGPA = Total Credit Points /Total Credits = 80.16/20 = <b>4.01</b> <b>Grade - A+</b>
002	Course 2	4	A+	3.9	15.6	
003	Course 3	4	A	3.45	13.8	
004	Course 4	4	A	3.64	14.56	
005	Course 5	4	O	4.8	19.2	
<b>TOTAL</b>		<b>20</b>			<b>80.16</b>	
<b>II - SEMESTER</b>						
006	Course 6	4	A+	3.88	15.52	SGPA = Total Credit Points /Total Credits = 73.08/20 = <b>3.65</b> <b>Grade - A</b>
007	Course 7	4	A+	3.75	15	
008	Course 8	4	A	3.3	13.2	
009	Course 9	4	A	3.56	14.24	
010	Course 10	4	A+	3.78	15.12	
<b>TOTAL</b>		<b>20</b>			<b>73.08</b>	
<b>III - SEMESTER</b>						
011	Course 11	4	A	3.45	13.8	SGPA = Total Credit Points /Total Credits = 74.04/20 = <b>3.70</b> <b>Grade - A</b>
012	Course 12	4	A+	3.8	15.2	
013	Course 13	4	O	4.8	19.2	
014	Course 14	4	A	3.58	14.32	
015	Course 15	4	B+	2.88	11.52	
<b>TOTAL</b>		<b>20</b>			<b>74.04</b>	
<b>IV - SEMESTER</b>						
016	Course 16	4	A+	3.85	15.4	SGPA = Total Credit Points /Total Credits = 76.08/20 = <b>3.80</b> <b>Grade - A+</b>
017	Course 17	4	A	3.6	14.4	
018	Course 18	4	A	3.47	13.88	
019	Course 19	4	A+	3.8	15.2	
020	Course 20	4	O	4.3	17.2	
<b>TOTAL</b>		<b>20</b>			<b>76.08</b>	



**Fourth Stage Evaluation :**

**CALCULATION OF CGPA (To be done by the College) :**

*CGPA for the above case :*

Semester	Credit of the Semesters	Grade Awarded	Grade point (SGPA)	Credit points
I	20	A+	4.01	80.20
II	20	A	3.65	73.00
III	20	A	3.70	74.00
IV	20	A+	3.80	76.00
<b>TOTAL80</b>				<b>303.20</b>

**CGPA (Total credit points awarded / Total credit of all semesters) = 303.20 / 80 = 3.79**  
**( Which is in between 3.50 and 3.99 in 10-point scale)**  
**Therefore the overall Grade awarded in the programme is - 'A+'**

**GUIDELINES FOR CODING VARIOUS COURSES :**

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

1. First Digit **F** indicates syllabus revised in 2019
2. **Second, Third and Fourth digits** indicate the Programme (ENG for English, MCM for M.Com, CHE for chemistry, PHY for physics, MLM for Malayalam, etc)
3. **Fifth digit** is the Semester indicator which can be given as 1,2,3 &4 respectively for I,II,III& IV Semester (MCM1, CHE2 Etc).
4. **Sixth digit** will be the Course Category indicator as detailed below :

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

5. **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)
6. If the number of courses in one category is only one (eg : Viva, Project etc.), assign the course serial number as 01.
7. Examples :

SI No	Code	Details
1	FMCM1C01	M.Com I Sem Core Course No1
2	FCHE2A02	Chemistry II Sem Audit Course No.2
3	FENG4V01	English IV Sem Viva No. 1
4	FMLM3E02	Malayalam III Sem Elective No. 2
5	FPHY4P01	Physics IV Sem Project Work No. 1

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**CURRICULUM AND SYLLABUS FOR  
M. Sc. ZOOLOGY COURSE  
FIRST SEMESTER- THEORY COURSES**

<b>Code No. &amp; Title of the Course</b>	<b>Credits</b>	<b>External Weightage</b>	<b>Internal Weightage</b>
FZOL1C01- Biochemistry	4	30	5
FZOL1C02- Biophysics and Biostatistics	4	30	5
FZOL1C03- Systematics and Evolution	4	30	5

**SECOND SEMESTER- THEORY COURSES**

<b>Code No. &amp; Title of the Course</b>	<b>Credits</b>	<b>External Weightage</b>	<b>Internal Weightage</b>
FZOL2C04- Cell & Molecular Biology	4	30	5
FZOL2C05- Ecology and Ethology	4	30	5
FZOL2C06- Developmental Biology and Endocrinology	4	30	5

**FIRST & SECOND SEMESTER- PRACTICAL COURSES**

<b>Code No. &amp; Title of the Course</b>	<b>Credits</b>	<b>External Weightage</b>	<b>Internal Weightage</b>
FZOL2L01- Biochemistry, Biophysics & Biostatistics	4	30	5
FZOL2L02- Systematics, Evolution, Ecology & Ethology	4	30	5
FZOL2CL03- Cell & Molecular Biology, Developmental Biology & Endocrinology	4	30	5

### THIRD SEMESTER- THEORY

Code No. & Title of the Course	Credits	External Weightage	Internal Weightage
FZOL3C07- Physiology	4	30	5
FZOL3C08- Immunology & Cytogenetics	4	30	5
FZOL3C09- Microbiology & Biotechnology	4	30	5

### FOURTH SEMESTER – THEORY

Code No. & Title of the Course	Credits	External Weightage	Internal Weightage
FZOL4E10 - Environmental Biology I: Man, Environment & Natural Resources	4	30	5
FZOL4E11- Environmental Biology II: Environmental Pollution	4	30	5
FZOL4E12- Environmental Biology III: Environmental Conservation	4	30	5

### THIRD & FOURTH SEMESTER- PRACTICAL COURSES

Code No. & Title of the Course	Credits	External Weightage	Internal Weightage
FZOL4L04- Physiology, Immunology, Microbiology, Biotechnology & Microtechniques & Histochemistry	4	30	5
FZOL4L05- Environmental Biology I	4	30	5
FZOL4L06- Environmental Biology II & III	4	30	5
FZOL4P13 - Project Work	4	30	5
FZOL4V14 - VIVA- VOCE	4	30	5

1. Total number of theory courses	12	Total number of practical courses	6
Credit for each theory course	4	Credit for each practical course	4
Total credits for theory course	48	Total credits for practical courses	24

1. Project work: Credits-8 (4 credits for dissertation and 4 credits for viva-voce)  
(Project report / dissertation shall be presented by Power point software)
2. Practical Examination shall be conducted at end of second and fourth semester.
3. Two hours per week under practical work may be allotted during the third and fourth semesters for the project work.
4. The teacher who gives guidance to project work can select any topic from the syllabi including the elective course and the topic shall be assigned to each student. The research work on this topic shall be carried out by each student under the supervision of the teacher. The report of the research work shall be submitted by each student in the form of a Dissertation which shall be submitted for the evaluation a day prior to the date of viva-voce pertaining to the dissertation. A declaration by the student to the effect that the dissertation submitted by him/ her has not previously been formed the basis for the award of any degree or diploma and a certificate by the supervising teacher to the effect that the dissertation is an authentic record of work carried out by the student under his/ her supervision are to be furnished in the dissertation.
5. Weightage for each core and elective theory course shall be 30 for the external examination and 5 for the internal theory examination.
6. Weightage for each external core and elective practical course shall be 30 for the external examination and 5 for the internal core and elective practical examination.
7. Theory examination question paper shall contain 7 short answer questions (Answer any four) with weightage 2each , 7 short essay questions (Answer any four) with weightage 3 each and 4 essay questions (Answer any two) with weightage 5 each.

8. Weightage for the external practical examination can be distributed as follows:

<b>With submission</b>		<b>Without submission</b>	
Major question (1No.)	: Weightage 10	Major (1 number)	: Weightage 12
Minor question (2 Nos.)	: 6+7= 13	Minor (2 Nos.)	: 2x5 =10
Spotters (2 Nos.)	: 2x1= 2	Spotters (4Nos.)	: 4x1.25 = 5
Submission (slides)	: 2	Record	: 3
Record	: 3	Total	: 30
Total	: 30		

9. No submission is required for the practical in elective course.
10. A candidate has to submit the following at the time of practical examination related to FZOL4C04
- Whole mount : 4 numbers
  - Slides: Histology : 4 numbers
  - Slides: Histochemistry : 2 numbers (To test the presence of carbohydrate and protein)
- 1 If a candidate fails to submit the field study / tour report, no weightage for the record be awarded.
  - 2 Project report should be presented using power point option. Credit given for project is limited to maximum 4 and project and general viva -voce is limited to 4.
  - 3 A minimum of two test papers for each course have to be conducted and the average shall be counted for internal evaluation in each semester.
  - 4 One seminar for each course is compulsory.

<b>Criteria for the evaluation of dissertations</b>	<b>Weightage</b>
1. Introduction, review of literature etc.	2
2. Objectives and relevance of the study	3
3. Methodology	5
4. Results	6
5. Discussion and interpretation	5
6. Conclusions	3
7. Involvement of the student	2
8. Style and neatness of the dissertation	1
9. References	3
Total	30

<b>Criteria for the Viva-voce</b>	<b>Weightage</b>
<b>A. Presentation of project work- (POWER POINT Presentation)</b>	
1. Quality and correctness of slides	3
2. Time management	2
3. Way of presentation	3
4. Clarity of presentation	4
5. Communication skill	4
6. Answers to questions	4
Subtotal	20
<b>B. General Viva-voce:</b>	
7. Knowledge of the student	3
8. Communications	3
9. Answers to questions	4
Subtotal	10
Grand Total	30

**MODEL QUESTION PAPER PG ZOOLOGY**

**I/II/III/IV SEMESTER M.Sc. DEGREE EXAMINATION (SJCSS), Month & Year**

Branch: Zoology

Course Code: Course Name

Time : 3hrs

MaximumWeightage:30

**Part A**

(Answer **any four** questions. Weightage **2** for each question)

1. .
2. .
3. .
4. .
5. .
6. .
7. .

**Part B**

(Answer **any four** questions. Weightage **3** for each question)

8. .
9. .
10. .
11. .
12. .
13. .
14. .

**Part C**

(Answer **any two** questions. Weightage **5** for each question)

15. .
16. .
17. .
18. .



## Programme Specific Outcome

<b>PSOs</b>	<b>PROGRAMME SPECIFIC OUTCOMES</b>
PSO1	Student will be able to develop knowledge and understanding of living organisms at several levels of biological organization from the cellular through molecular to whole organisms level and at ecosystem level in an evolutionary perspective
PSO2	Student will be able to acquire knowledge related to concepts like ecology, evolution, taxonomy, biochemistry, molecular biology etc. and apply the knowledge in new situations
PSO3	The student will develop skills in experimental techniques in the subjects of study
PSO4	The student will be able to develop scientific way of thinking and scientific attitude pertaining to the concepts in ecology, evolution, taxonomy, biochemistry, molecular biology etc

**FIRST SEMESTER  
FZOL1C01: BIOCHEMISTRY**

Contact Hours: 90 hrs(5hr/wk)

Credits: 4

COs	COURSE OUTCOMES
CO1	The student will describe the importance of various chemical interactions in the biological system
CO2	The Student develops the ability to analyse the structure, classification, and biochemical properties of carbohydrates from other organic molecules
CO3	The student develops the ability to describe classification, structural organization, and purification techniques of proteins.
CO4	The student acquire knowledge regarding the classification and functions of lipids and fatty acids
CO5	The student develops appreciation on the mechanisms of enzyme action, inhibition, and acquire knowledge regarding classification of enzymes that facilitate the functioning of enzymes
CO6	The student develops appreciation on Watson and Crick model of DNA
CO7	The student will explore various anabolic and catabolic pathways of biomolecules such as glucose, nucleic acids, amino acids and lipids.
CO8	The student develops a conceptual knowledge regarding the principles of energetics in biological systems

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 (12 hrs)
  - 2.1. Monosaccharides
    - 2.1.1. Classification with examples-
    - 2.1.2. Structure of glucose, fructose, galactose, mannose, ribose and deoxy ribose
    - 2.1.3. Methods of representation of sugars (Ball and stick, projection formula and perspective formula)
    - 2.1.4. Isomerism - Structural isomerism (functional group isomerism) and stereo isomerism (optical isomerism)- mention epimer, anomer and enantiomer with examples
    - 2.1.5. Mutarotation

- 2.1.6. Reactions - Oxidation (by acids, metal hydroxides and H<sub>2</sub>O<sub>2</sub>), dehydration (by acid) and reduction (by alkali), reactions with alanine and phenyl hydrazine
- 2.1.7. Derivatives - ascorbic acid, acetal and hemiacetal, ketal and hemiketal, glycosides - glycosidic bond
- 2.1.8. Biological roles of monosaccharides
- 2.2. Disaccharides
  - 2.2.1. Structure and biological roles of Maltose, Sucrose, Lactose, Cellobiose and Trehalose
  - 2.2.2. Biosynthesis of trehalose and lactose
- 2.3. Polysaccharides
  - 2.3.1. Homopolysaccharides - Structure and biological roles of cellulose, starch, glycogen, inulin and chitin
  - 2.3.2. Mode of action of amylase on homopolysaccharides (starch and glycogen)
  - 2.3.3. Heteropolysaccharide - Structure and biological roles of hyaluronic acid, chondroitin, chondroitin sulphate, keratin sulphate, heparin and agar-agar
- 3. Proteins (9 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. -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 -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 (8 hrs)
  - 4.1. Classification of lipids -Simple lipids (fats, oils and waxes), compound lipids (phospholipids, glycolipids, lipoproteins and sulpholipids) and derived lipids.

- 4.2. Brief account of the chemistry of sterols, terpenes and carotenoids.
- 4.3. Acid number, saponification number, Iodine number, Polenske number and Reichert-Meissl number of lipids , Rancidity
- 4.4. 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
- 4.5. Prostaglandins - Chemical nature and functions.
- 4.6. Fatty acids - definition; essential fatty acids
- 4.7. Classification with examples- Saturated, unsaturated, hydroxyl and cyclic fatty acids
- 4.8. Nomenclature of fatty acids - Genevan system
5. Nucleic acids (5 hrs)
  - 5.1. Structure of nitrogen bases and nucleotides
  - 5.2. Structural organization of DNA (Watson -Crick model)
  - 5.3. Characteristic features of A-, B- C- and Z-DNA
  - 5.4. Structural organization of t-RNA; brief note on micro-RNA
  - 5.5. Biological roles of nucleotides and nucleic acids
- Unit - II - Enzymes (15 hrs)
  - 1.1. Classification- (I.U.B. system)
  - 1.2. Specificity of enzyme action
  - 1.3. Mechanism of enzyme action: Formation of enzyme substrate complex- Gibbs free energy of activation; Michaelis-Menten theory, Fischer's template theory and Koshland's induced fit theory. Electrostatic, hydrogen and Van der Waal's bonds in Enzyme-substrate complex.
  - 1.4. Enzyme kinetics - Michaelis-Menten equation - derivation; significance of  $K_m$  and  $V_{max}$  Values.
  - 1.5. Lineweaver-Burk equation and double reciprocal plot of enzyme reaction.
  - 1.6. Enzyme inhibition - Competitive, non-competitive and uncompetitive inhibition (distinguish kinetically), suicide inhibition and feedback inhibition
  - 1.7. Allosteric enzymes - positive and negative modulators
  - 1.8. Factors influencing enzyme action
  - 1.9. Iso-enzyme, ribozyme, co-enzymes and zymogens
  - 2.0. Classification, Structure and functions of Vitamins.

## 2.1. Vitamins as co-enzymes

### Unit - III - Bioenergetics

(5 hrs)

- 1.1. Laws of thermodynamics and biological system, Enthalpy, Entropy, Free energy concept
- 1.2. Energy of activation, Standard free energy change
- 1.3. Role of ATP as a free energy carrier in the biological system

### Unit - IV - Metabolism and biosynthesis of biomolecules

(15 hrs)

#### 1. Carbohydrate metabolism

- 1.1. Glycolysis - (PFK as pacemaker - Hexokinase conformation and change by glucose), Fate of pyruvic acid
- 1.2. Metabolism of 2, 3 DPG as regulator of oxygen transport
- 1.3. Citric acid cycle; Pyruvate dehydrogenase complex and ketoglutarate dehydrogenase complex
- 1.4. Electron transport system and oxidative phosphorylation; Redox potential, Chemiosmotic hypothesis; inhibitors of electron transport chain
- 1.5. Gluconeogenesis, Glycogenesis, Glycogenolysis; regulation of glycogen synthesis and breakdown
- 1.6. Pentose phosphate pathway (HMP pathway) and its significance.
- 1.7. Uronic acid pathway
- 1.8. Metabolism of Fructose and Galactose

#### 2. Amino acid metabolism

(5 hrs)

- 2.1. Biosynthesis and degradation of - glutamic acid, phenyl alanine, methionine, tryptophan, isoleucine, histidine, valine, Glutathione, Creatine and Creatinine
  - Fate of amino acids in the body
  - Nitrogen balance
  - Transamination, Decarboxylation and deamination reactions in the biological system.
  - Proteinuria, Hyperhomocysteinaemia, Edema and High sensitive C-reactive protein

3. Lipid metabolism (8 hrs)
- 3.1. Oxidation of fatty acids
  - 3.2. Biosynthesis of fatty acids
  - 3.3. Biosynthesis of cholesterol
4. Nucleic acid metabolism (6 hrs)
- 4.1. Biosynthesis and degradation of purines and pyrimidines

**References:**

1. David L Nelson & Michael M Cox Lehninger, Principles of Biochemistry, VI<sup>th</sup> edition, (2013) Mac Millan
2. Robert Harper's Biochemistry, (2012) 29<sup>th</sup> Edition, K. Murray, Daryl K. Granner, Peter, A. Mayes and Victor, W. Rodwell Appleton and Lange, Prentice Hall of India Private limited, New Delhi,
3. Lubert Stryer,(2011) Biochemistry, VII<sup>th</sup> edition, W.H. Freeman & Co.
4. Oser, B.L, (1965) Hawk's Physiological Biochemistry, Mc Graw Hill Book Co.
5. Eric E. Conn, Paul K. Stumpf, George Bruening, Roy H. Doi, (latest ) Outlines of Biochemistry, V<sup>th</sup> edition, John Wiley & Sons, Inc, (2007).
6. Deb, A.C.(2004) Fundamentals of biochemistry, New Central Book Agency (P) Ltd.
7. Keith Wilson and John Walker (2008) Principles and techniques of Biochemistry and Molecular biology - 6<sup>th</sup> edn, Cambridge University Press
8. Voet, D. and Voet, J.G. & Pratt (2012), Principles of Biochemistry, John Wiley & Sons
9. Zubay, G (1997 .), Biochemistry, Mc Graw – Hill Publications
10. Devlin,T.M. (2010), A Text of Biochemistry with clinical correlations, John Wiley & Sons

**FIRST SEMESTER**  
**FZOL1C02: BIOPHYSICS AND BIOSTATISTICS**

Contact Hours: 90 hrs(5hr/wk)

Credits: 4

COs	COURSE OUTCOMES
CO1	The student develops conceptual knowledge regarding the basic principles of physics involved in biological processes
CO2	The student appreciate the biological aspects and implications of sound energy
CO3	The student will be able to differentiate various ionizing radiations and to understand a comparative account of their biological effects
CO4	The student may familiarize with various biophysical and electrophysiological methods
CO5	The student gain conceptual knowledge on the principles of microscopy and apply
CO6	The student explore the possibilities of the applications of separation techniques.
CO7	The student will describe gravity 'G' force and its multi-faceted applications
CO8	The student will explore and appreciate nano technology as a highly promising arena in biological investigations
CO9	The student skills in various methods of data collection, tabulation and presentation of data for biological research
CO10	The student develops ability to apply measures of central tendency and dispersion in biological research, and various types of probability distribution
CO11	The student analyze and apply parametric and non parametric tests and its applications in biological research
CO12	The student learn how to apply different types of ecological indexes in biological research

Section-A-Biophysics (55 hrs)

1. Colloidal System (3 hrs)

1.1 Crystalloids and Colloids,

1.2 Properties of colloids-Adsorption, Brownian movement ,

Tyndall phenomena, Electosmosis, Cataphoresis, Coagulation

1.3 Forms of colloids, Suspensions and Emulsions, preparation and properties of emulsions

2. Diffusion and Osmosis (5 hrs)

2.1. Fick's laws and diffusion coefficient.

2.2. Gibb's Donnan equilibrium

2.3. Application of diffusion processes in biology:

2.4. Osmosis, Osmotic concentration, Osmotic pressure and osmotic gradient.

- 2.5. Vant Hoff's laws
- 2.6. Haemolysis. : Osmotic and Nonosmotic
- 2.7. Electrolytic and ionic balance in biological fluid
- 3. P<sup>H</sup> (2 hrs)
  - 3.1. Dissociation of water
  - 3.2. Dissociation of a weak acid
  - 3.3. Henderson Hasselbalch equation
  - 3.4. Electrometric determination of p<sup>H</sup>
  - 3.5. P<sup>H</sup> value calculation
  - 3.6. Buffer Solutions-theory, buffers used in biology
- 4 . Bioacoustics (5 hrs)
  - 4.1. Characteristics of sound \
  - 4.2. Physical basis of hearing
  - 4.3. Physical organization of ear
  - 4.5. Physical aspects of sound transmission in the ear.
  - 4.6. Audible sound frequency
  - 4.7. Pitch reception and theories
  - 4.8. Infrasonic and ultrasonic sounds
  - 4.9. 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 - physical and biological
  - 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
  - 5.7. Incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines
  - 5.8. Autoradiography
- 6. Biophysical methods (5 hrs)
  - (Brief account of the following)



- 6.1. Molecular analysis using—using UV / visible
- 6.2. Fluorescence,
- 6.3. Circular dichroism
- 6.4. NMR and Electron Spin Resonance (ESR) spectroscopy
- 6.5. Structure determination using X-ray diffraction
- 6.6. Analysis using light scattering.
- 6.7. Mass Spectrometry
- 6.8. 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, f MRI, CAT.
- 8. Principles and applications of (8 hrs)
  - 8.1. Microscopy
  - 8.2. Resolving powers of different microscopes
  - 8.3. Fluorescent, Interference , scanning and transmission electron microscopes (SEM &TEM)
  - 8.4. Different fixation and staining techniques for EM, (freeze-etch and freeze fracture methods for EM-image processing methods in microscopy)
  - 8.5. Laser and its applications in Biology
- 9. Separation Techniques (10 hrs)
  - 9.1. Chromatography (Adsorption, Partition and Ion exchange chromatography )
  - 9.2. Column chromatography
  - 9.3. Paper chromatographhy
  - 9.4. Thin- layer chromatography
  - 9.5. Gel-filtration,
  - 9.6. Gas chromatography,
  - 9.7. Affinity chromatography,

- 9.8. HPLC
- 9.9. Electrophoresis
- 9.10. Paper electrophoresis
- 9.11. Disc electrophoresis
  - PAGE, Two dimensional PAGE, Highvoltage Electrophoresis
- 9.12. Immuno electrophoresis.
- 9.13. Isoelectric focusing.
- 9.14. Flow cytometry
- 10. Influence of gravity (3 hrs)
  - 10.1. Human body posture in the gravitational field
  - 10.2. Influence of G force
  - 10.3. Force 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. Roles of nanotechnology in environmental management.
- Section -B –BIOSTATISTICS** (35 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. Data: (5 hrs)
  - 2.1 Types of data: classification based on Source of data, Compilation, Variable, Nature
  - 2.2 Methods of data collection and classification:-  
Advantages and disadvantages of census and sampling method,

Class intervals- exclusive and inclusive method  
Frequency curve (types. skewness, kurtosis, ogive)

3. Sampling (2 hrs)
- 3.1 Random sampling
    - Simple Random Sampling
    - Stratified Random Sampling
    - Systematic Random Sampling
    - Cluster Sampling
    - Multistage Sampling
  - 3.2 Non Random Sampling
    - Convenience sampling
    - Purposive sampling
    - Quota sampling
  - 3.3 Sample Size
4. Statistical Methods: Measures of central tendency and dispersal (problems to be discussed) (6 hrs)
- 4.1. Mean, (raw data, discrete series and continuous series)
  - 4.2 Standard deviation, (raw data, discrete series and continuous series)
  - 4.3 Standard error,
  - 4.4 Degrees of freedom
5. Probability distributions (4 hrs)
- 5.1 Basic concepts and definition:
  - 5.2 Laws of probability
  - 5.3 Probability distribution: -
    - Binomial, Poisson and Normal
6. Statistical inference (problems to be discussed) (9 hrs)
- 6.1 Difference between parametric and non-parametric statistics;
  - 6.2 Testing of hypothesis
  - 6.3 Errors
  - 6.4 Confidence interval; levels of significance, Critical region;
  - 6.5 Normality test
  - 6.6 t-test: Types,
    - Paired t-test

Unpaired t-test

6.9 chi-square test,

1. Goodness of fit

2. Contingency Chi-square

3. Homogeneity Chi-square

6.9 F-test, ANOVA

One –way

Two- way classification

6.10 Kruskal-Wallis, Mann-Whitney

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

7.1 Types of correlation

7.2 Methods to measure correlation Scatter diagram

i. Karlpearson's coefficient of correlation

ii. Spearman's correlation

7.3 Types of regression analysis

7.4 Regression equations

7.5 Difference between regression and correlation analysis

## **REFERENCES -**

### **BIOPHYSICS**

1. Ackerman, E. (1962).Biophysical Science. Prentice Hall Inc.
2. Alonso, A and Arrondo, J.L.R (2006) - Advanced techniques in Biophysics, Springer
3. Alok Srivastava and Ipsita Roy-(2009)-Bio-Nano- Geo Sciences- The future challenge- Ane Books Ltd.
4. Baker, E.J and Silverton, R.E. (1978) - Introduction to medical laboratory technology, ELBS
5. Bengt Nolting ( 2006), Methods in modern Biophysics, Springer.
6. Daniel, M (2002), Basic Biophysics for Biologists. Agro Botanics, Bikaner
7. Das, D. (1991) Biophysics and Biophysical Chemistry, Academic Publishers Calcutta.
8. Ernster, L (1985), Bioenergetics, Elsevier, New York.
9. Frank H. Stephenson (2006)- Calculations for Molecular Biology and

- Biotechnology-A guide to Mathematics in the laboratory-Academic Press- An imprint of Elsevier.
10. Hoppe, W, Lohmann,W, Markl,H and Ziegler,H (1983) ,Springer Verlag,New York.
  11. Keith Wilson and John Walker (2008), Principles and techniques of Biochemistry and Molecular biology - 6<sup>th</sup> edn, Cambridge University Press
  12. Marshall, A.G. (1978) Biophysical Chemistry, Principles, Techniques and Applications-John Wiley and Sons NewYork
  13. Mohan P. Arora-(2007), Biophysics -Himalaya Publishing House.
  14. Muralidharan.V.S. and Subramania, A (2010)- Nanoscience and Technology- Ane Books Ltd.
  15. Narayan, P (2000) Essentials of Biophysics. New age international
  16. Nagini.S (2009)- Instant Biochemistry-Ane Books Ltd.
  17. Roy, R.N(1996)-A text book of Biophysics-New central book Agency Calcutta.
  18. Srivastava, P.K (2006)-Elementary Biophysics, An introduction. Narosa publishing house New Delhi
  19. Viswanathan. B(2009)-Nano Materials- Narosa Publishing House.

## BIOSTATISTICS

1. Agarwal, B.L. (1996) Basic statistics, New Age International(P) Ltd. Publishers, New Delhi.
2. Bailey, N.T.J. (1981) Statistical methods in Biology. Hodder and Stongtton, London.
3. Campell, R.C. (1978), Statistics for biologists. Blacker and Sons Publishers, Bombay.
4. Gupta, C.B. and Gupta, V. (2002) Statistical methods. Ika's Publishing House, New Delhi.
5. Rostogi, V. B. (2009) Fundamentals of Biostatistics. Ane's Students Edition New Delhi
6. Magurran AE. 2004. Measuring Biological Diversity. Blackwell Publishing
7. Stephen W,Looney(2008) Methods in Molecular Biology-Biostatistical Methods-Springer International Edition
8. Zar, J.H.(2003) Biostatistical Analysis - Fourth edition. Pearson Education. Delhi.

**FIRST SEMESTER**  
**FZOL1C03: SYSTEMATICS AND EVOLUTION**

Contact Hours: 90 hrs(5hr/wk)

Credits: 4

COs	COURSE OUTCOMES
CO1	The student develops skills in the identification and taxonomic classification of organisms based on their characters
CO2	The student will be able to describe different levels of taxonomy
CO3	Aware about Place, importance, applications and goals of taxonomy
CO4	Learn about purpose of classification, use of classification, theories of biological classification and types classification
CO5	Explain taxonomic procedures like Taxonomic collections, Curation, Recording of field data, storage of collection, labelling and cataloguing of collection Identification- methods of identification, Use of keys, Taxonomic descriptions, Taxonomic and ecological publication and their difference.
CO6	The student will acquire knowledge regarding Species concept and the taxonomic diversity within species, different kinds of species, sub species and other infra specific categories, hybrids
CO7	Recognize the importance of Zoological nomenclature, International Code of Zoological Nomenclature
CO8	Interpret Principle of priority, Homonymy and Synonymy and Different kinds of types in descriptive taxonomy
CO9	Use new trends in Systematics especially Chemo and Serotaxonomy, Cytotaxonomy, Numerical taxonomy, Cladistics, Molecular systematics and DNA bar coding vs traditional taxonomy
CO10	Recognize the ethics related to taxonomic collections and publication
CO11	Realize the taxonomic impediments
CO12	Describe the mechanism of natural selection and the evolutionary mechanisms
CO13	Explain tempo of evolution
CO14	Describe molecular evolutionary theories like Neutral theory of molecular evolution, Molecular clocks- genetic equidistance- human mitochondrial molecular clock and Phylogenetic relationships
CO15	Recognize Evolutionary trends in Biochemical evolution and primates evolution
CO16	An enhanced knowledge about the Mechanism of natural selection
CO17	The student develops conceptual understanding on Hardy-Weinberg law, founder principle, bottleneck effect and genetic drift, process of Isolating mechanisms-Prezygotic and Postzygotic isolating mechanisms; speciation-allopatric, peripatric-parapatric-heteropatricsympatric speciation; ecotypes etc.
CO18	The student develops appreciation about the major processes involved in the Co-evolution; Microevolution, Macroevolution et
CO19	The process involved in the Gradualism and punctuated equilibrium along with anagenesis and cladogenesis will be acquired
CO20	An enhanced level of conceptual learning regarding Neutral theory of molecular evolution; molecular divergence; molecular drive, Molecular clocks- genetic equidistance- human mitochondrial molecular clock , Phylogenetic relationships- DNA barcoding vs traditional taxonomy etc
CO21	An elevated understanding of the Biochemical evolution- Collapse of Orthogenesis along with Stages in primate evolution ; African origin for modern humans, Y-chromosomal Adammitochondrial Eve, the process of Communication, speech, language and self awareness in Primates etc

## Section A. Systematics (45 hours)

1. Definition and basic concepts in Systematics and Taxonomy (4 hrs)
  - 1.1 historical resume of systematics
  - 1.2 Levels of Taxonomy -Alpha, beta, gamma taxonomy
  - 1.3 Place, importance and applications of taxonomy
  - 1.4 Goals of taxonomy
2. Classification (4 hrs)
  - 2.1 Practice of classification- purpose of classification
  - 2.2 Use of classification- storage of data, recovery of data
  - 2.3 Theories of biological classification- hierarchy of categories
  - 2.4 Types of classification—evolutionary & phylogenetic classification - typological classification, phenetic classification, omnispective classification, horizontal and vertical classification
  - 2.5 Components of classification
3. Taxonomic procedure (8 hrs)
  - 3.1. Taxonomic collections- types of collections, value of collections
  - 3.2. Curation- preservation of collection in field and laboratory
  - 3.3. Recording of field data, storage of collection, labelling and cataloguing of collections
  - 3.4. Identification- methods of identification
    - 3.4.1. Use of keys- kinds of keys, their merits and demerits
  - 3.5. Taxonomic descriptions: presentation of findings
  - 3.6. Kinds of taxonomic publications
    - 3.6.1. Taxonomic and ecological publication and their difference
4. Species concepts (7 hrs)
  - 2.1. Species category- different species concepts: typological, Nominalistic, biological, evolutionary, recognition, ontological (theoretical) and operational (epistemological species concepts)
  - 2.2. Taxonomic diversity within species, different kinds of species, sub species and other infra specific categories, hybrids.
5. Taxonomic characters (4 hrs)

- 5.1 Different kinds of taxonomic characters
- 5.2 Functions of taxonomic characters.
- 5.3 Taxonomic characters and classification
- 5.4 Taxonomic characters and evolution
- 6. Zoological nomenclature (5 hrs)
  - 6.1 International Code of Zoological Nomenclature, development of Code of Zoological Nomenclature: its operative principles, interpretation and application of important rules in the formation of scientific names of various taxa.
  - 6.2 Principle of priority
    - 6.2.1 Homonymy and Synonymy
  - 6.3 Type method and its significance
    - 6.3.1 Different kinds of types in descriptive taxonomy
- 7. Newer trends in systematics (4 hrs)
  - 7.1 Chemo and serotaxonomy
  - 7.2 Cytotaxonomy
  - 7.3 Numerical taxonomy
  - 7.4 Cladistics
  - 7.5. Molecular systematics
  - 7.6 DNA bar coding vs traditional taxonomy
- 8. Ethics in taxonomy (3 hrs)
  - 8.1 Ethics related to collections
    - 8.1.1 Credit
    - 8.1.2 Lending and borrowing of specimens
    - 8.1.3 Loan of material
    - 8.1.4 Exchange of materials
    - 8.1.5 Collaboration and co-operation with co-workers
    - 8.1.6 Use of language
  - 8.2. Ethics related to taxonomic publications
    - 8.2.1 Authorship of taxonomic papers
    - 8.2.2 Correspondence
    - 8.2.3 Suppression of data
    - 8.2.4 Undesirable features of taxonomic papers



- 8.3 Taxonomists and user communities
9. Taxonomic impediments (4 hrs)
- 9.1 Impediments to build up taxonomic collections and maintenance
  - 9.2 Shortage of man power
  - 9.3 Lack of funding for taxonomic research
  - 9.4 lack of training in taxonomy
  - 9.5 Lack of Library facilities
  - 9.6 Impediments in publishing taxonomic work
  - 9.7 Solutions to overcome the impediments
    - 9.7.1 International co-operation
    - 9.7.2 Development of Taxonomic centres
  - 9.8 Need for efficient international networking
  - 9.9 The desired end product

### **Section B. Evolution (45 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 sex characteristics-sexy son hypothesis-good genes hypothesis.
2. The Mechanisms (10 hrs)
- 2.1. Origins of unicellular and multi cellular organisms; Major groups of plants and animals; Origin of eukaryotic cells; Evolution of unicellular eukaryotes;
  - 2.2. Population genetics - populations, gene pool, gene frequency; Hardy-Weinberg law, founder principle, bottleneck effect and genetic drift as factors in speciation.
  - 2.3. speciation-allopatric- peripatric-parapatric-heteropatric- sympatric speciation;
  - 2.4.Co-evolution; Microevolution, Macroevolution. Convergent homoplasy) -divergent-parallel evolution.
3. Tempo of evolution (8 hrs)
- 3.1. Gradualism Vs punctuated equilibrium.
  - 3.2. Anagenesis Vs Cladogenesis.
4. Molecular evolution (10 hrs)
- 4.1. Neutral theory of molecular evolution; molecular divergence; molecular drive.
  - 4.2. Molecular clocks- genetic equidistance- human mitochondrial molecular clock.

- 4.3. Phylogenetic relationships- Homology; Homologous sequences of proteins and DNA  
- orthologous and paralogous; parsimony analysis; nucleotide sequence analysis;.
5. Evolutionary trends (10 hrs)
- 5.1. Biochemical evolution- Collapse of Orthogenesis.
- 5.2. Stages in primate evolution including Homo: dry and wet nosed primates,  
prosimians and simians. Y-chromosomal Adam-mitochondrial Eve.
- 5.3. Communication, speech, language and self awareness in primates.

**References:**

**A. Systematics**

1. David, M. H, Craig Moritz and Barbara K. M. (1996) Molecular Systematics. Sinauer Associates, Inc.
2. David, M. S. (2009) DNA barcoding will frequently fail in complicated groups: an example in wild potatoes. American Journal of Botany 96(6): 1177-1189. Downloadable from [www.vcr.uwisc.edu/spoonerlab/.../BarCodes%20and%20Wild%20Potatoes.pdf](http://www.vcr.uwisc.edu/spoonerlab/.../BarCodes%20and%20Wild%20Potatoes.pdf)
3. Kapoor, V.C (1998) Theory and practise of animal taxonomy. Oxford & IBH ,Publi., Co. New Delhi
4. Kipling, W. W; Brent, D.M. and Quentin, D. W. (2005) The Perils of DNA Barcoding and the Need for Integrative Taxonomy. Syst. Biol. 54(5):844-851, Downloadable from [sysbio.oxfordjournals.org/cgi/reprint/54/5/844.pdf](http://sysbio.oxfordjournals.org/cgi/reprint/54/5/844.pdf)
5. Mayr, E (1969) Principles of Systematic Zoology . McGraw Hill Book Campny, Inc., New York

6. Narendran, T.C (2008) An introduction to Taxonomy . Zoological survey of India.
7. Sneath P.H. A. (1973): Numerical Taxonomy: The Principles and Practice of Numerical Classification, W H Freeman & Co.

### **B: Evolution**

1. Coyne, J.A. and Allen, O.H. (2004) Speciation. Sinauer Associates Inc., Massachusetts, USA.
2. David, M. H, Craig Moritz and Barbara K. M. (1996) Molecular Systematics. Sinauer Associates, Inc.
3. Douglas Futuyma (2013): Evolution, Sinauer associates Inc.
4. Gould, S. J. (1997) Ontogeny & Phylogeny, Belknap press. Harvard University Cambridge.
5. Kipling, W. W, Brent, D.M. and Quentin, D. W. (2005) The Perils of DNA Barcoding and the Need for Integrative Taxonomy. Syst. Biol. 54(5):844-851, Downloadable from [sysbio.oxfordjournals.org/cgi/reprint/54/5/844.pdf](http://sysbio.oxfordjournals.org/cgi/reprint/54/5/844.pdf)
6. McHenry, H.M. (2009) "Human Evolution". in Michael Ruse & Joseph Travis. Evolution: The First Four Billion Years. Cambridge, Massachusetts: The Belknap Press of Harvard University Press. p. 265.
7. Motoo Kimura (1983) The neutral theory of molecular evolution. Cambridge University Press.
8. J. Philip Grime, Simon Pierce ( 2011) : The Evolutionary Strategies that Shape Ecosystems;; Wiley-Blackwell
9. Roderick D.M, Page and Edward, C. H. (2000) Molecular Evolution: A Phylogenetic Approach: Blackwell science.
10. Strikberger, M.W. (2005) Evolution, Jones and Bartett Publishers, London.
11. Veera Bala Rastogi ( 2014) : Organic evolution: Medtec publishers
12. Wallace Arthur (2011) Evolution: A Developmental Approach; Wiley-Blackwell

**PRACTICALS**  
**BIOCHEMISTRY**  
**(Part of Practical Course FZOL2L01)**

**Hr/Week:2 hrs**

1. Actual acidity and titrable acidity of a strong and a weak acid.
2. Comparison of the buffering capacities of two buffers of same pH
3. Qualitative tests for carbohydrates
  - a) Qualitative tests for monosaccharides (Glucose and fructose)
  - b) Qualitative tests for disaccharides (Lactose, Maltose & Sucrose)
  - c) Qualitative tests for polysaccharides (Dextrin & Starch)
  - d) Identification of unknown carbohydrates (Glucose, Fructose, Lactose, Maltose, Sucrose, Dextrin & Starch) by suitable tests.
4. 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
5. Qualitative tests for proteins
  - a) Colour reactions with proteins (Albumin, Casein, Peptones & gelatin)
  - b) Precipitation reactions with proteins (Albumin, Casein, Peptones & gelatin)
  - c) Identification of unknown protein (Albumin, Casein, Peptones & gelatin)
6. Qualitative tests for non-protein nitrogenous substances (urea, uric acid and creatinine)
7. Identification of unknown carbohydrates, protein and non-protein nitrogenous substances from a given solution.
8. Quantitative estimation of proteins
  - a) Estimation of proteins by Biuret method
  - b) Isolation of casein from cow's milk

9. Quantitative estimation of non-protein nitrogenous substances
  - a) Quantitation of blood urea by diacetyl monoxine method
  - b) Determination of urine creatine by alkaline picrate method
10. Quantitative estimation of lipids
  - a) Estimation of total serum cholesterol by Zak's method
  - b) Saponification number of oils - coconut oil & ground nut oil.
  - c) Iodine number of fats

**References:**

1. Plummer David, T.( latest) An introduction to practical biochemistry -Tata Mc Graw-Hill, New Delhi
2. Oser, B.L., (1965) Hawk's Physiological Biochemistry, McGraw Hill Book Co.
3. Sadasivan, S. and Manickam, A., (2005), Biochemical methods, New Age International, New Delhi.
4. Keith Wilson and John Walker (2008), Principles and techniques of Biochemistry and Molecular biology - 6th edn, Cambridge University Press
5. Jayaraman, J.(latest.) Laboratory Manual in Biochemistry, Wiley Eastern Ltd.

## **BIOPHYSICS & BIOSTATISTICS** **(Part of Practical Course FZOL2L01)**

### **Biophysics**

**Hr/Week:2 hrs**

1. pH meter and measurement of pH
2. Paper chromatography of amino acids, mixtures, identification of unknown amino acids and sugars.
3. Gel filtration chromatography (Separation of starch from glucose)
4. Thin layer chromatography of amino acids and sugars.
5. Serum electrophoresis.
6. Determination of absorption coefficient and concentration of unknown solutions by calibration curve using a coloured solution.
7. Absorption spectrum of a coloured solution (KMnO<sub>4</sub>)
8. Drawings using Camera lucida

### **Biostatistics**

**Hr/Week:2 hrs**

1. Preparation of frequency table with given data
2. Diagrammatic presentation of census data in Kerala in the form of bar diagrams and pie diagrams. (prepare same graph in Excel and keep print )
3. Graphic presentation of population distribution in the form of histogram, frequency polygon and frequency curve. (prepare same graph in Excel and keep print)
4. Computation of measures of central dispersion anthropometric data of School children. (prepare same in Excel and keep print outs and add steps for excel)
5. Simulation of binomial and poisson distributions
6. Estimation of mean number of children per family(data from at least 10 families nearby campus ) (prepare same in Excel and keep print and add steps for excel)
7. 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 print and add steps for excel)

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

## **SYSTEMATICS & EVOLUTION** **(Part of Practical Course FZOL2L02)**

### **Systematics**

**Hr/Week:2 hrs**

1. Collection, Preservation and curation of specimens
2. Identification of animals (Fishes/insects/any other) up to family/ generic / species level- minimum 15 specimens.
3. Preparation of dichotomous (simple bracket) keys; minimum ten sets from the identified specimens.

### **Evolution**

**Hr/Week:2 hrs**

1. Exercises in convergent evolution.
2. Exercises in divergent evolution.
3. Gene and Genotype frequency estimation.
4. Hardy Weinberg Equilibrium and relative frequency estimation.

### **Reference**

John T (2002) Practical statistics for environmental and biological scientists john wiley and sons.

**SECOND SEMESTER**  
**FZOL2C04: CELL AND MOLECULAR BIOLOGY**

Contact Hours: 90 hrs(5hr/wk)

Credits: 4

COs	COURSE OUTCOMES
CO1	The student will acquire knowledge regarding the mechanism of DNA replication- both chromosomal and extra chromosomal, enzymes involved, models of replication, inhibitors and the significance of DNA replication.
CO2	The student learn to know the safeguard systems of DNA, restriction enzymes and their significance, mechanisms involved in damage and repair of eukaryotic DNA and its importance.
CO3	Learn to explain the general features of genetic code, special features of the genetic code in mitochondria, and variations in genetic code.
CO4	The student gain in-depth knowledge regarding the structural organization of mRNA in prokaryotes and eukaryotes, the mechanism of transcription, translation, post transcriptional and translational modifications, structure, biogenesis and role of ribosomes in protein synthesis; and RNA editing.
CO5	The student will gain knowledge regarding the regulation of gene expression in Phages, Bacteria, and in Eukaryotes; recent research findings like antisense RNA strategies and role of si RNA, piRNAs and mi RNA in the regulation of eukaryotic gene expression and their applications.
CO6	The components, organization and special features of eukaryotic genome, interrupted genes and their evolution; concept of gene families, and molecular evolutionary clock.
CO7	Introduction to transposition mechanisms in prokaryotes and eukaryotes, and their significance.
CO8	Molecular mechanisms of genetic recombination models, and significance.
CO9	Special features of microbial genetics, and organelle genome, their replication and mapping.
CO10	The student gain an in depth knowledge regarding the events and regulation of cell cycle, its alteration and causes of cancer. Genes involved in the regulation of cancer and modern therapeutic interventions like immunotherapy and gene therapy

1. Genomes

(5 Hrs)

- 1.1 Genomes of prokaryotes and eukaryotes
- 1.2 Special features of eukaryotic genomes – Unique, moderately repetitive and highly repetitive DNA sequences
- 1.3 Re-association kinetics of the above types of DNA
- 1.4 Cot value and complexity of the genomes
- 1.5 Satellite DNA and selfish DNA
- 1.6 Organisation of human genome (brief account), human genome mapping
- 1.7 Organelle genomes : Mitochondrial and chloroplast genomes



- 1.8 Special features of yeast and human mitochondrial genomes
  
- 2. Replication of DNA (8 Hrs)
  - 2.1 Semiconservative and semi discontinuous synthesis, Okazaki fragments
  - 2.2 Replicon, replication origin and terminus of E.coli and Yeast, replication fork, extra chromosomal replicons, fidelity of replication
  - 2.3 Enzymes and accessory proteins involved in replication – Helicases, Topoisomerases, Primase, SSB, DNA polymerases and DNA ligases.
  - 2.4 Priming mechanisms, Primer removal, Primosome and Replisome
  - 2.5 Replication of the ends of eukaryotic chromosome – role of telomerase
  - 2.6 Models of DNA replication – Rolling circle model and looped rolling circle model, D-loop model,  $\theta$ -model
  - 2.7 Inhibitors of DNA replication – Inhibitors of nucleotide biosynthesis, DNA polymerase inhibitors, DNA template damaging agents and DNA Topoisomerase inhibitors
  
- 3. Systems that safeguard DNA (6 Hrs)
  - 3.1 Restriction enzymes : Significance, Classification and nomenclature of restriction enzymes
  - 3.2 Modification enzymes : Significance, operation of restriction and modification in bacteria
  - 3.3 DNA damages and repair
    - 3.3.1 DNA – major types of damages and their causes
    - 3.3.2 Repair mechanisms in bacteria and eukaryotes – direct reversal, mismatch repair, base excision repair, nucleotide excision repair, recombination repair, SOS response, and non homologous end joining repair
  
- 4. Transcription in prokaryotes and eukaryotes (8 Hrs)
  - 4.1 RNA polymerases of prokaryotes, eukaryotes, phages and organelles
  - 4.2 Initiation, elongation and termination of transcription
  - 4.3 Structural organization of monocistronic and polycistronic transcription units

- 4.4 Promoters, enhancers, silences and insulators.
- 4.5 Transcription factors, activators and repressors, DNA binding domains of transcription activators
- 4.6 Post transcriptional modification of hnRNA – capping, poly (A) tailing, spliceosome assembly and splicing, trans splicing and RNA editing
- 4.7 Nucleocytoplasmic transport of the processed mRNA
- 5. Genetic code (5 Hrs)
  - 5.1 Characteristic features of the genetic code
  - 5.2 Degeneracy of the code, start and stop codons, wobble hypothesis, isoacceptor tRNAs
  - 5.3 Special features of genetic code in mitochondria, mitochondrial RNAs
  - 5.4 Variations in the genetic code in Mycoplasma and Tetrahymena
  - 5.5 Point mutations that alter the genetic code – missense, nonsense and frame shift
  - 5.6 Suppressor mutations, suppressor genes and suppressor tRNAs
- 6. Ribosome : The site of protein synthesis (4 Hrs)
  - 6.1 Composition, topography, active centres and biogenesis of ribosome, reconstitution experiments, r-protein mutants
  - 6.2 Methods to study ribosome structure- Immune electron microscopy, cross linking; active centres, affinity labelling
  - 6.3 Organization of rRNA transcription unit, processing of pre-rRNA, role of snoRNAs
  - 6.4 Biogenesis; nucleolate mutants in *Xenopus laevis*
- 7. Translation in prokaryotes and eukaryotes (7 Hrs)
  - 7.1 Activation of amino acids and amino acylation of tRNA, amino acyl tRNA synthetases
  - 7.2 Process of initiation elongation and termination of translation in prokaryotes and eukaryotes; initiation, elongation and termination factors
  - 7.3 Translational proof-reading
  - 7.4 Translational inhibitors in prokaryotes and eukaryotes – role of tetracycline, streptomycin, neomycin, chloramphenicol, erythromycin,

- puromycin and diphtheria toxin
- 7.5 Post-- translational modification of proteins: protein folding (role of chaperones) and biochemical modifications
8. Regulation of gene expression at transcription and translation level (10 Hrs)
- 8.1 Regulation of gene expression in bacteria and phages
- 8.1.1 Structure and mechanism of regulation of tryptophan, arabinose and galactose operons
- 8.1.2 Regulation of gene expression in phages - alternate patterns of gene expression for control of lytic and lysogenic cycle in  $\lambda$  phage
- 8.2 Regulation of gene expression in eukaryotes
- 8.2.1 Transcription regulation by chromatin remodelling
- 8.2.2 Effects of chromatin modification on transcription - acetylation, methylation and phosphorylation
- 8.2.3 Role of activators and repressors on transcription
- 8.2.4 Transcription regulation by the arrangement of genes in a cluster
- 8.2.5 Regulation of translation by alternate pathways of transcript splicing
- 8.2.6 Anti sense RNA strategies for regulating gene expression
- 8.2.7 si RNA and mi RNA in regulation, piRNAs
9. Interrupted genes (3 Hrs)
- 9.1 Organisation and special features of interrupted genes
- 9.2 Evolution of interrupted genes
10. Gene families (6 Hrs)
- 10.1 Concept of a gene family, types of gene families
- 10.2 Simple multigene family - organisation of rRNA gene in *Xenopus*
- 10.3 Complex multigene family - organisation of histone genes in sea urchin and tRNA genes in *Drosophila*
- 10.4 Developmentally controlled complex multigene family e.g., globin gene
- 10.5 Organisation of globin genes and its expression pattern in Man
- 10.6 Evolution of globin genes
- 10.7 Concept of an evolutionary clock

## 10.8 Pseudogenes

11. Transposons (8 Hrs)
- 11.1 Definition, features and types
  - 11.2 Mechanism of transposition, consequences of transposon activity
  - 11.3 Transposons in bacteria – IS elements, Composite transposons,
  - 11.4 Phage Mu as a transposon
  - 11.5 Transposons in eukaryotes –Controlling elements in Maize, P elements in *D. melanogaster*, Tc1/Mariner elements
  - 11.6 Retroposons – Ty elements, Copia elements, LINEs, SINEs, Alu family
  - 11.7 Processed pseudogenes
12. Molecular mechanisms involved in recombination of DNA (5 Hrs)
- 12.1 Genetic recombination – Site specific recombination , non-homologous recombination and 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 (4 Hrs)
- 13.1 Structural organisation of *Escherichia coli*
  - 13.2 Methods of genetic transfer in bacteria– transformation (in *Streptococcus pneumoniae*), conjugation and sexduction, transduction
  - 13.3 Brief note on mapping genes by interrupted mating (in bacteria)
14. Cell cycle (4 Hrs)
- 14.1 Cell cycles in vivo
  - 14.2 Control of cell cycle – role of protein kinases, check points, kinase inhibitors and cellular responses
15. Molecular Biology of cancer (7 Hrs)
- 15.1 Characteristics of transformed cells
  - 15.2 Gene mutations in cancer and genetic rearrangements in progenitor cells
  - 15.3 Oncogenes, proto oncogenes and tumor suppressor genes

- 15.4 Virus induced cancer
- 15.5 Cancer and the cell cycle
- 15.6 Cancer and apoptosis
- 15.7 Interactions of cancer cells with normal cells
- 15.8 New therapeutic interventions in cancer – Immunotherapy and gene therapy
- 15.9 Impairment of signalling mechanism in tumorigenesis : Role of oncogenes and oncoproteins, NIDDM and cancer
- 15.10 Cancer as a disease of development: Context dependent tumors, Cancer stem cells and the epithelial-mesenchymal transition, cancer and epigenetic gene regulation, developmental therapies for cancer (Brief account)

## REFERENCES

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J. D. (2002). Molecular Biology of the Cell. Garland, NY
2. Brown T. A. (2000). Essential Molecular Biology. II Ed. Oxford OUP.
3. Brown T. A. (2006). Genomes 3. Garland Science, New York.
4. Clark, David P. (2005). Molecular Biology. Amsterdam, Elsevier.
5. Jones & Bartlett Learning (2013) GENES XI 5 wall street Barlington, MA 01803978-443-5000
6. Karp, G. (2013). Cell and Molecular Biology.(7<sup>th</sup> Edition) John Wiley, New York
7. Karp, G. (2002). Cell and Molecular Biology. John Wiley, New York
8. Klinemith, L. J. and Kish, V. M. (1995). Principles of Cell and Molecular Biology. 2nd Ed. Harper Collins College Publishers.
9. Lewin, Benjamin. (2013). Genes XI<sup>th</sup> edn. Jones, Bartlet.Inc.
10. Lewin, Benjamin. (2009). Genes,X<sup>th</sup> edn.. Jones, Bartlet Inc.
11. Lodish, H., Baltimore, D., Berk , A., Zipursky, S. L., Matsudaira , P. and Darnell, J. (1995) Molecular Cell Biology, Scientific American Books, New York.
12. Malcinski, G. M. and Freifelder, D. (1998). Essentials of Molecular Biology.

- 3rd Ed. Jones and Bartlett Publishers.
13. Mayers, R. A. (Ed) (1995). Molecular Biology and Biotechnology: A Comprehensive Desk Reference. VCH Publishers, Inc., NY.
  14. Nelson D. L. Cox, M. M. and Lehninger, A. L. (2007). Principles of Biochemistry, IV Ed. Freeman and Co, NY.
  15. Panno, Joseph (2005). Gene Therapy. Facts on file. New York.
  16. Scott F Gilbert (2014). Developmental Biology. Xth edition. Sinauer Associates
  17. Sinden, Richard R. (2006). DNA structure and function. California, Academic press.
  18. Snustad, D. P. and Simmons, M. J. (2000). Principles of Genetics. 2nd Ed. John Wiley & Sons Inc.
  19. Synder, L. and Champness, W. (1997). Molecular Genetics of Bateria. ASM Press Washington DC.
  20. Watson J. D., Gilman M., Witkowski, J. and Zoller, M. (1992). Recombinant DNA, II Edition, Scientific American Books, W.H.Freeman and Company.
  21. Strachan, T. and Read, A. P. (2003). Human Molecular Genetics, III ed, John-Wiley & Sons NY.

**SECOND SEMESTER  
FZOL2C05: ECOLOGY AND ETHOLOGY**

Contact Hours: 90 hrs(5hr/wk)

Credits: 4

COs	COURSE OUTCOMES
CO1	The student develops ability to differentiate between the concepts of Habitat, Niche
CO2	The student explain the concepts of, Ecosystem energetic sand Mineral cycling
CO3	The student learn to appreciate nature's way to maximize efficiency in utilization of energy and resources; to reduce competition.
CO4	The student will be able describe the characteristics of population growth and species interaction
CO5	The student will explain the components of Ecological community, the process of Ecological succession, Biomes etc
CO6	The student will appreciate the complexity of relationship between organisms.
CO7	The student will be able to describe the characteristics of various biogeographically realms, and Indian biodiversity
CO8	The student will be able to give explanation to the differential distribution of organisms across the world
CO9	The student will describe the characteristics of various biogeographically realms, and Indian biodiversity
CO10	The student will explain the concept of Carbon credit, Carbon trading etc
CO11	The student will learn to analyse various aspects of Green building technology and interlinking of rivers.
CO12	The student learn to appreciate the richness of Indian biodiversity and various strategies of Wildlife conservation
CO13	The student will be able to describe the components of animal behaviour, factors of motivation and conflict behaviour, properties of instinctive behaviour, types of learning, adaptiveness of behaviour, importance of biological rhythms and parental care, influence of hormones on behaviour
CO14	The student develops appreciation about the importance of nature watch and field study

Part-A-ECOLOGY (65 hrs)

1. Natural history of Indian subcontinent (3 hrs)

1.1 Major habitat types of the subcontinent

1.2 Geographic origins and migrations of species

1.3 Seasonality of the subcontinent

2. Habitat and niche (3 hrs)

2.1 Concept of habitat and niche

2.2 Niche width and overlap

2.3 Fundamental and realized niche

- 2.4 Resource partitioning
- 2.5 Character displacement
- 5. Ecosystem (9 hrs)
  - 3.1 Structure and function
  - 3.2 Ecosystem energetic
  - 3.3 Primary production
  - 3.4 Energy flow models
  - 3.5 Mineral cycling (CNP)
  - 3.6 Trophic levels, Food chain, food web and secondary production
  - 3.7 Decomposers and detritivores
- 4. Population Ecology (7 hrs)
  - 4.1 Characteristics of a population
  - 4.2 Methods of estimating population density of animals, ranging patterns through direct, indirect and remote observations
  - 4.3 Sampling methods in the study of behaviour, habitat characterization
  - 4.4 Ground and remote sensing methods
  - 4.5 Population growth curves, Life tables, survivorship curves, population regulation, Life history strategies, r and k selection, Demes and dispersal, interdemec extinctions, age structure of populations
  - 4.6 Growth and regulation of human population
- 5. Species interaction (6 hrs)
  - 5.1. Types of interactions, interspecific competition
  - 5.2. Herbivory, Carnivory, Pollination, Symbiosis;-mutualism, commensalisms and proto co- operation
- 6. Community Ecology (7 hrs)
  - 6.1. Nature of communities
  - 6.2. Characteristics of a biotic community
  - 6.3. Species diversity and its measurements, Alpha diversity: Simpson's Diversity Index -Shannon index -Fisher's Alpha - Rarefaction; Beta diversity - Sorensen's similarity index-Whittaker's measure; Gamma diversity
  - 6.4. Latitudinal gradients in diversity
  - 6.5. Edges and ecotones.



7. Ecological succession (4 hrs)
- 7.1. Types, mechanisms, changes involved
  - 7.2. Concept of Climax
  - 7.3. Facilitation, inhibition, tolerance of communities
  - 7.4. Influence of human activities on succession
  - 7.5. Restoration ecology and theory of succession
8. Biogeography (6 hrs)
- 8.1. 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
9. Theory of island biogeography (4 hrs)
- 9.1. Theory - Influencing factors -
  - 9.2 Applications in conservation biology- species-area relationship -single large or several small (SLOSS) - development of habitat corridors
10. Biogeographical zones of India (4 hrs)
- (a) 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.
11. Applied Ecology (8 hrs)
- 11.1. Carbon credit, Carbon trading, Blue Carbon
  - 11.2 Green building technology and its ecological importance.
  - 11.3 Discuss the benefits and disadvantages of the idea of (brief)
    - a. Inter linking of major rivers of India,
    - b. Sethusamudram ship canal project.
    - c. Gadgil (WGEEP) and Kasturirangan report on Western Ghat
12. Conservation Biology
- 12.1. Principles of conservation
  - 12.2. Major approaches to management,
  - 12.3. Biodiversity with special reference to India-status monitoring and documentation, major drivers of biodiversity change

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

- Part B. ETHOLOGY (25 hrs)
1. Introduction (3 hrs)
- 1.1 Ethology as different from the other schools studying animal behaviour like behaviourism.
- 1.2 Behaviour as a reaction to stimuli - sign stimuli, social releasers, Ethograms, super normal stimuli, stimulus filtering.
2. Motivating factors (3 hrs)
- 2.1 General factors in motivation; Studies of motivation in guppies;
- 2.2 mating systems-parental investment and reproductive success
3. Conflict behaviour- stress-displacement activities- Ritualization. (2 hrs)
4. Instinctive behaviour & reflex action, neural basis of sleep and arousal-
5. Learning. Neural basis of learning, memory, cognition, sleep and arousal;
- Biological clocks (3 hrs)
5. Adaptiveness of behaviour (3 hrs)
- JP Scott's categories of behaviour.
6. External stimulus - circadian rhythms (3 hrs)
- 6.1- Proximate and Ultimate factors
- 6.2-Types of orientation-reafference theory of Von Holst & Mittel Steadt.
- 6.3-Navigation & migration
7. Parental care -Mating systems, Parental investment and Reproductive success; Development of behavior; Social communication; Social dominance; Use of space and territoriality; domestication and behavioural changes; Social behaviour of termites & Primates; (4 hrs)
9. Evolution and adaptiveness of behaviour-Altruism, Kin selection, inclusive fitness, selfish gene theory, cultural transmission of behaviour (4 hrs)

## REFERENCES

### ECOLOGY

1. Ahluwalia and sunitha malhorta-Environmental Science-Ane Books Pvt.Ltd

2. Allan Beebi and Anne Maria Brennan-2006- First Ecology-Ecological principles and environmental issues-Oxford university press
3. Archbold, O. W. Ecology of World Vegetation. New York, NY: Chapman and Hall, 1995.
4. Begon,Harper,Townsend- Ecology-Individuals,Populations,and communities- Blackwell Science,Second edition
5. Brewer Richard-The Science of Ecology-Saunders college publishing
6. Chapman J.L and Reiss. M.J- Ecology principles and applications-Cambridge law price editions
7. Charles J .Krebs- Ecology. The experimental analysis of distribution and abundance
8. David Quammen. 1997. The Song of the Dodo: Island Biogeography in an Age of Extinctions. Scribner. ISBN 0-684-82712-3
9. Dick Neal- Introduction to population Biology- Cambridge University Press
10. Eugene P.Odum- Fundamentals of Ecology- W.B.Saunders Company
11. MacArthur, R. H. and Wilson, E. O. 1967. The Theory of Island Biogeography. Princeton, N.J.: Princeton University Press.
12. Magurran, A. E. 2004. Measuring biological diversity. Oxford: Blackwell Publishing. ISBN 0- 632-05633-9
13. May and Mc Lean- Theoretical Ecology principles and applications- Oxford university press
14. Whittaker, Robert H. Communities and Ecosystems New York: MacMillan Publishing Company, Inc., 1975.

## **ETHOLOGY**

1. Chris Barnard (2003) : Animal Behaviour: Mechanism, Development, Function and Evolution, Publisher: Pearson Education.
2. David McFarland (1999) : Animal Behaviour: Psychobiology, Ethology and Evolution, 3rd Edition. Publisher: Pearson Education.
3. David Mcfarland (2006) A Dictionary of Animal Behaviour. Publisher: Oxford University Press.
4. Goodenough, J; McGuire B. and Robert, W. (1993) Perspectives on Animal

- Behaviour. John Wiley and Sons, Lond.
5. Graham Scott (2004) Essential Animal Behaviour. Publisher: Wiley-Blackwell
  6. Lenher, P. (1996) Handbook of Ethological methods. Cambridge Univ.Press, Lond.
  7. Manning, A. (1967) An Introduction to Animal Behaviour. Edward Arnold Pub., London.
  8. Manning, A. and Dwakins, M.S. (1995) An Introduction to Animal Behaviour. Cambridge Univ. Press, Lond.
  9. Scott, J.P. (1972) Animal Behaviour. Publisher: Univ of Chicago

**SECOND SEMESTER**  
**FZOL2C06: DEVELOPMENTAL BIOLOGY & ENDOCRINOLOGY**

Contact Hours: 90 hrs(5hr/wk)

Credits: 4

COs	COURSE OUTCOMES
CO1	The student will gain knowledge on basic concepts in development.
CO2	The student will explain the process of gametogenesis, fertilization and embryonic development.
CO3	The student will appreciate the genetic, cellular and molecular basis of development.
CO4	The student will describe the process of ageing and mechanisms.
CO5	The student realize the impact of environment on development.
CO6	Describe different classes of chemical messengers and their physical characteristics
CO7	Explain how the secretion of hormone is regulated through positive and negative feedback mechanisms
CO8	Summarize the anatomy, regulation, and physiological functions of the hormones of the hypophysis, thyroid, parathyroid, pancreas adrenal, hypothalamus and adrenal glands
CO9	Describe the anatomy of male and female reproductive systems including hormonal functions and pathophysiology

Part- A - DEVELOPMENTAL BIOLOGY

1. Introduction: Basic concepts of development (6hrs)
  - 1.1 Potency
  - 1.2 Commitment
  - 1.3 Specification - autonomous, conditional, syncytial
  - 1.4 Determination
  - 1.5. Morphogenetic gradients
  - 1.6 Imprinting
  - 1.7 Mutants and transgenics in analysis of development
  - 1.8 The stem cell concept-Stem cell vocabulary, Stem cell potency, Progenitor cells, Adult stem cells, Stem cell niches, Mesenchymal stem cells, Multipotent adult stem cells, Pluripotent Embryonic stem cells, Stem cell therapy.
2. Gametogenesis, fertilization and early development (10hrs)
  - 2.1 Production of gametes- Spermatogenesis and Oogenesis, Ultrastructure of gametes
  - 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 (10hrs)

- 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

### 4. Cell to cell communication in Development (7 hrs)

- 4.1 Cell adhesion- Differential cell affinity, The thermodynamic model of cell interactions
- 4.2 Cadherins and cell adhesions
- 4.3 Cell migration (brief)
- 4.4 Cell signaling –Induction and competence, Reciprocal induction, Epithelial - mesenchymal interactions
- 4.5 Paracrine factors

Signal transduction cascades (Fibroblast growth factors and the RTK pathway, The JAK-STAT pathway, The Hedgehog family, The Wnt family, The TGF $\beta$  super family, cell death pathways )

5. Differential Gene Expression in Development (8 hrs)

- 5.1 Evidence for genomic equivalence
- 5.2 Differential gene transcription-Promoters and Enhancers,DNA methylation. Transcription factors, Silencers and Insulators.
- 5.3 Differential RNA processing- X chromosome inactivation- dosage compensation,
- 5.4 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.
- 5.5 Post translational regulation of gene expression.
- 5.6 Models of cell differentiation- hematopoiesis, myogenesis, differentiation of neural crest cells.
- 5.7 Reversibility of patterns of gene activity- cell fusion, transdifferentiation.

6. Sex Determination (3 hrs)

- 6.1 Chromosomal sex determination, The Mammalian pattern, Primary sex determination in Mammals, The ovary pathway- Wnt 4 and R-spondin 1, The testis pathway, Secondary sex determination in Mammals
- 6.2 Hormonal regulation of the sexual phenotype
- 6.3 The genetic analysis of the secondary sex determination.
- 6.4 Environmental sex determination- Temperature dependent sex determination in Reptiles, Location dependent sex determination.

6. Metamorphosis, Regeneration and Aging (8 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 aging, Genes and aging, DNA repair enzymes, Aging and the insulin signaling cascade, The mTOR pathway, Chromatin modification, Wear and tear, Oxidative damage, Mitochondrial genome damage, genetically programmed aging .

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

8. Developmental Mechanisms of Evolutionary change-

Heterotopy, Heterochrony, Heterometry, Heterotypy. ( Brief) (2 hrs)

### **References - Developmental biology**

1. Balinsky, B. I. An introduction to Embryology.
2. Berril, N. J. Developmental biology.
3. Deuchar, E. M. Cellular interactions in animal development.
4. Gilbert, S. F. Developmental Biology. Sinauer Associates, 10<sup>th</sup> edition
5. Hodge, R. Developmental Biology: From a Cell to an Organism.
6. Hopper, A. S. & N. H. Hart. Foundation of animal development.
7. Lash, J & J. R. Whittaker. Concepts of development.
8. Muller, W. A. Developmental biology. Springer.
9. Snustad, D. P., J. M. Simmons & J. B. Jenkins. Principles of Genetics. Wolpert, L. Principles of Development. Oxford university press, 2<sup>nd</sup> edition



## **Part B Endocrinology (35 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. Physical characteristics of hormones - latency, post-secretory modification and half- life
  - 1.5. Physiological roles of hormones.
  - 1.6. Control of hormone secretion.
2. General mechanisms of Hormonal action (4 hrs)
  - 2.1. Cell signalling
  - 2.2. Receptors and transducers;
    - 2.2.1. types of receptors- g protein coupled receptors, steroid receptors and nitric oxide receptors,
    - 2.2.2. Regulation of receptor number, receptor activation
  - 2.3. Second messengers of hormone action- cAMP, cGMP, inositol triphosphate, diacylglycerol ,
  - 2.4. Receptor signal transduction
  - 2.5. Eicosanoids and hormone action
3. 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 - Endocrinology**

1. Bentley, P. J. Comparative vertebrate endocrinology
2. Bern, H. A. Text book of comparative endocrinology
3. Bolander, F. F. 2006. Molecular endocrinology, Academic press, New Delhi.
4. Ganong, W. F. 2005. Review of medical physiology, Mc Graw Hill, New Delhi.
5. Hadley, M. E. 2000. Endocrinology, Pearson education, Inc., New Delhi.
6. Harris, G. W. 1995. Neural control of the pituitary gland, Edward Arnold, London.
7. Hazelwood, R. 1990. The endocrine pancreas, EnglewoodCliffs, Prentice Hall, NJ.
8. Horrbin, D. F. Essentials of Biochemistry, endocrinology and nutrition.
9. Prakash Lohr. Hormones and human health
10. Nelson R. J. Introduction to behavioural endocrinology
11. Norris D. O. 2005. Vertebrate endocrinology.
12. Vinzen, G. Et al, 1992. Adrenal cortical steroid hormones, Englewood Cliffs, Prentice Hall, NJ.

**SECOND SEMESTER PRACTICALS**  
**FZOL2L01: BIOCHEMISTRY, BIOPHYSICS & BIOSTATISTICS**

Credits: 4

COs	COURSE OUTCOMES
CO1	The student develops skills to perform and compare the importance of pH in biological processes.
CO2	The student familiarize with qualitative tests to identify and distinguish various carbohydrates.
CO3	The student learn to conduct qualitative analysis to identify proteins and nonprotein nitrogenous substances.
CO4	The student acquire skills to perform quantitative tests for carbohydrates, lipids, proteins and non- protein nitrogenous substances.
CO5	The student familiarize with the instruments/ techniques in biophysics; PH meter, Paper chromatography, TLC, Gel electrophoresis
CO6	The student learn the applications of colorimetry in quantitative analysis
CO7	The student gather knowledge regarding collection, grouping and graphical representation of data with special emphasis on Microsoft Excel.
CO8	The student learn to calculate measures of dispersion and their applications in data analysis.
CO9	Familiarising with data interpretation in statistics; ANOVA, Correlation and Regression analysis

**SECOND SEMESTER PRACTICALS**  
**FZOL2L02: SYSTEMATICS, EVOLUTION,  
 ECOLOGY AND ETHOLOGY**

Credits: 4

COs	COURSE OUTCOMES
CO1	The student may gather basic knowledge regarding Collection and Identification of animals up to species level
CO2	Scientific handling of specimens collected, preservation and museum curation
CO3	The student may gather basic knowledge regarding convergent and divergent evolution
CO4	carryout experiments of laboratory standards to estimate water quality parameters including BOD COD hardness and PH, Salinity, Phosphates nitrates
CO5	Students able to determine the water holding capacity and moisture of soil sample
CO6	Determine the transparency of water by using Secchi- disk
CO7	Able to calculate the diversity of different habitat
CO8	Able to recognise the behavioural response of Jungle babbler and bonnet macaques

**SECOND SEMESTER PRACTICALS**  
**FZOL2L03: CELL AND MOLECULAR BIOLOGY,**  
**DEVELOPMENTAL BIOLOGY & ENDOCRINOLOGY**

**Credits: 4**

COs	COURSE OUTCOMES
CO1	The student develops practical knowledge to isolate genomic DNA from animal tissues.
CO2	The student acquire hands own training in the Quantification of DNA, RNA and Proteins by colourimetric methods
CO3	Understand the preparation of polytene chromosome of drosophila larva and study of meiotic stages using grass hopper testis
CO4	The student gain knowledge about the identification of different developmental stages of frog.
CO5	The student will identify common larval forms..
CO6	The student gain skills in the vital staining technique.
CO7	The student will be able to perform the whole mount preparation of different developmental stages of chick embryo.
CO8	The student will be trained to do the mounting of various larval forms.
CO9	The student learn the stages of insect development.
CO10	The student compare morphological and histological details of different types of placenta in mammals.
CO11	The student appreciate the effects of hormones in amphibian metamorphosis

1. Cell fractionation and isolation of mitochondria, nucleus and nucleolus
2. Isolation of DNA from liver/spleen/thymus
3. Isolation of bacterial plasmids
4. Isolation of RNA from yeast
5. Estimation of DNA by diphenyl amine method/UV absorption
6. Estimation of RNA by orcinol method/UV absorption
7. Estimation of protein by Lowry's method
8. Maintenance of E.coli culture (suspension and surface cultures) and quantitative evaluation of a given sample of culture by dilution and plating.
9. Preparation of salivary gland polytene chromosome from Drosophila larva
10. Study of meiotic stages using grass hopper testes.
11. Preparation of chromosome spread using mice/rat/guinea pig bone marrow.
12. Analysis of metaphase chromosomes from rat/mouse bone marrow or any other suitable material by means of G banding.
13. Preparation of human karyotype from photographs of chromosome spreads – Normal and abnormal
14. Preparation of restriction fragments and their separation by electrophoresis

## **Part 2 - Developmental Biology & Endocrinology**

1. Induced ovulation in fish.
2. Identification of different developmental stages of frog - Egg, blastula, gastrula, neurula, tadpole external gill and internal gill.
3. Vital staining of chick embryo.
4. 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.
5. Tracing the development of stained parts. Candling, identification of blastoderm, window preparation - staining using stained agar strips and following the development.
6. Preparation of stained temporary/permanent mounts of larvae.
7. Experimental analysis of insect development - *Drosophila*.
8. Regeneration studies in frog tadpole tail.
9. Demonstration of sperm of rat/calotes/frog.
10. Morphological and histological studies of different types of placenta in mammals.
11. Hormones in Amphibian metamorphosis - Thyroxine/Iodine solution.
12. Culture of early chick embryo in vitro.
13. Study of invertebrate/vertebrate larval forms (minimum 7).
14. Observation of the mid-sagittal sections and cross sections of the chick embryo through head/ heart region of 24, 48 & 56 hours of incubation.

## Reference for Practicals

1. Adamstone, E. B. & Waldo Shumway (1954). 3 Ed. A Laboratory Manual of Vertebrate Embryology. John Wiley & Sons, Inc.
2. Roberts Rugh (1961). Laboratory Manual of Vertebrate Embryology. Indian Ed., Allied Pacific Pvt. Ltd.
3. Browden, L. W., Erikson, C. A., & Jeffery, R. W. (1991). Developmental Biology. 3 Ed., Saunders College Publi., Philadelphia.
4. Zarrow, M. X., Yochim, J. M., Mc Carthy, T. L. & Sanborn, R. C. (19964). Experimental Endocrinology: A source book of basic Techniques. Academic Press, New York.
5. Thomas, J. A. (1996). Endocrine methods. Academic press, New York.
6. Humason, G. L. (1962). Animal Tissue techniques. W. H. Freeman & Co.

**ECOLOGY AND ETHOLOGY**  
**(Part of Practical Course FZOL2L02)**

**Part A Ecology**

1. Identification, qualitative and quantitative estimation of marine plankton
2. Estimation of BOD in polluted water sample.
3. Estimation of COD in water sample
4. Estimation of salinity, phosphates, chlorides and silicates and nitrates in water samples
5. Separation and identification of soil arthropods using Berlese funnel.
6. Determination of moisture content of soil sample.
7. Determination of water holding capacity of soil sample.
8. Testing the transparency of water using Secchi disc
9. Determination of primary productivity in pond water using light and dark bottle.
10. Determination of Shannon diversity index, Simpson's diversity index
11. Paper strip test for H<sub>2</sub>S
12. Study of termitorium / ant colony
13. 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)
14. 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 undertaken. 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**

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

2. Study of circadian rhythm
3. Chemo reception and behaviour in flies -finding the tarsal threshold for sugar
4. Behavioural reaction to moisture and light using isopods.

### **References**

1. NC Aerry 2010- A manual of environmental analysis . Ane books private limited.
2. Goodenough, J; McGuire B. and Robert, W. (1993) Perspectives on Animal Behaviour. John Wiley and Sons, Lond.
3. Manning, A. (1967) An Introduction to Animal Behaviour. Edward Arnold Pub., London.



**THIRD SEMESTER  
FZOL3C07: PHYSIOLOGY**

**Contact Hours: 90 hrs(5hr/wk)**

**Credits: 4**

COs	COURSE OUTCOMES
CO1	The student create an awareness among the society to promote balanced lifestyle and improve people's diet
CO2	The student will be able to explain the role of nutrition in health
CO3	Discuss the physiology of various organ systems in the body
CO4	The student will be able to differentiate the structure and functions of various organs in the human body
CO5	The student will describe different functional areas of cerebral cortex
CO6	The student will describe the cardiac cycle
CO7	The student will be able to discuss the physiology and mechanisms of respiration
CO8	The student will Identify and define neuro-anatomical structures
CO9	The student will summarize the various neurological disorders
CO10	Discuss different types of excretory organs in different animal groups
CO11	Explain the role of excretory system in the regulation of water balance, acid base balance and electrolyte balance
CO12	Identify the symptoms of life style diseases and suggest ways to control them
CO13	Explain the environment's influence on the physiological function and performance of living organisms

1. Nutrition:

(12 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. Digestion of carbohydrate, protein & lipids- Brief note on the role of salivary glands, liver, pancreas and intestinal glands in digestion
- 1.5. Absorption of carbohydrates, lipids, amino acids, water, electrolytes, vitamins and minerals in GIT
- 1.6. Movements of GI tract: deglutition, gastric motility and emptying, intestinal motility and defecation
- 1.7. The role of hormones and neurotransmitters in the control of gastrointestinal motility
- 1.8. Energy balance and obesity-causes and consequences
- 1.9. BMR and its significance (Ref. 4)

2. Excretory system (12 hrs)

- 2.1 Introduction: Brief description of different types of excretory organs in different animal groups
- 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
- 2.6 Composition (normal & abnormal) and characteristics of urine
- 2.7 Physiology of micturition
- 2.8 Renal clearance - definition, concept and significance; clearance value of urea, creatinine, phosphate, potassium, chloride and sodium

3. Respiratory system: (13 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
- 3.8 Transport of gases
  - 3.8.1 Transport of oxygen and carbon dioxide

3.8.2 Oxygen dissociation curve - factors affecting binding of oxygen to haemoglobin ( $PO_2$ ,  $PCO_2$ , CO, pH, body temperature, diphosphoglyceric acid level, foetal haemoglobin and also myoglobin)

3.9 Neural and chemical regulation of respiration

#### 4. Nervous system

(18 hrs)

4.1 Introduction: Basic details of neurons and action potential

4.2 Gross neuroanatomy of the brain (histology & neural pathway not expected unless otherwise specified)

4.2.1. Cerebral cortex- Motor cortex: mention functional areas (including specialized areas) and their motor functions

4.2.2. Cerebral cortex- Association areas, their sub areas and their functions; Wernicke's area and its intellectual function

4.2.3. Memory - definition, types of memory (positive and negative memory), brief note on the mechanism of short term, intermediate long term and long term memory, consolidation of memory

4.2.4. Brain stem - List the components (medulla, pons, mesencephalon, reticular and vestibular nuclei) and functions

4.2.5. Cerebellum- mention parts and functions

4.2.6. Basal ganglia - mention components and functions

4.2.7. Limbic system; structure and functions (emotion and motivation)

4.3. Gross neuroanatomy of the spinal cord

4.3.1. Spinal cord - structural organization

4.3.2. Reflex action - reflex arc, muscle spindle, Golgi tendon organ

4.3.3. Types of reflexes- monosynaptic reflex (e.g., Muscle stretch reflex, negative stretch reflex), polysynaptic reflex (e.g., withdrawal reflex)

4.4. Diseased states of brain - brief description of epilepsy, depression, schizophrenia, Alzheimer's disease, Senile

dementia & Parkinson's disease

5. Special senses (13 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 circuitry 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) (4 hrs)

6.1.1. Mechanoreceptors and their stimulation

6.1.2. Pain receptors and their stimulation

6.1.3. Thermal receptors and their stimulation

7. Cardiovascular system (8 hrs)

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. ECG - Principle and application
- 7.7. Neural and chemical regulation of heart function
- 7.8. Blood volume and blood pressure
- 7.9. Physiological anatomy of coronary blood flow, coronary blood flow and its control
- 7.10. Ischemic heart disease - mention causes and example
- 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 in controlling interstitial fluid protein concentration, interstitial fluid volume and interstitial fluid pressure
- 9. Environmental physiology
  - 9.1. Thermoregulation
    - 9.1.1. Comfort zone, normal body temperatures (oral, skin & core), heat production & heat loss, factors affecting body temperature, lethal temperature
    - 9.1.2. Temperature regulating mechanisms (hot & cold), mention the role of hypothalamus, thyroid and adrenal glands
    - 9.1.3. Acclimatization

## REFERENCES

1. Arthur C.Guyton & John E. Hall (2003): Textbook of Medical Physiology, Saunders (An imprint of Elsevier).
2. William F.Ganong (1999): Review of Medical Physiology, Lange Medical Publications (Appleton & Lange).
3. Jain A.K. (2009): Text Book of Physiology (Vol. I & II), Avichal Publishing Company, New Delhi.
4. Deb, A.C. (2002): Fundamentals of Biochemistry (2002): New Central Book Agency (P) LTD, India.
5. Prosser & Brown, Comparative Animal Physiology
6. William S. Hoar, Comparative Animal Physiology
7. Kunt-Schmidt-Nielsen: Animal Physiology, Adaptation and Environment.
8. Jensen D. (1976): Principles of Physiology, Appleton Century Crafts, N.Y.
9. Lonco, G.N. (1993): Physiological Animal Ecology. Longman Scientific and Technical, Essex.
10. Caer BL-Haw's Physiological chemistry, 14<sup>th</sup> Edn. Tata McGraw Hill Pub. Co. New Delhi.
11. Shepherd, G.M: Neurobiology-Principles of Neural Science, E. Kandel & P. Schwartz.
12. Campbell et al. (1984): Clinical Physiology, 5<sup>th</sup> Edn. Blackwall Scientific Publications, Oxford.
13. Pragnelli, C.V & Farhi, L.E. (1989): Physiological function of special Environment-Springer verlag, N.Y.
14. Davie IV & Lewid S.M.- Practical Haematology, 6<sup>th</sup> Edn. Churchill, Livingstone, Edinburgh.

**THIRD SEMESTER**  
**FZOL3C08: IMMUNOLOGY & CYTOGENETICS**

**Contact Hours: 90 hrs(5hr/wk)**

**Credits: 4**

COs	COURSE OUTCOMES
CO1	An in depth knowledge in the process of immune cell synthesis and maturation, antigen receptor structure and the mechanisms of antigen recognition by B-cell and T-cells.
CO2	The student will explore the Structure and diversity of immunoglobulins, antigens and its classification, production and clinical uses of monoclonal antibodies and antigen antibody interactions.
CO3	Mechanisms of humoral and cellular immunity, immune cell receptor and intracellular signal cascades related to immune system activation and response.
CO4	The student explore the fundamentals of Immune effector mechanisms, chemical signaling through cytokines, its therapeutic uses and cytokine related diseases.
CO5	The student gain conceptual knowledge regarding key principles, procedure and applications of different Immunetechniques used in the biomedical field and to develop new methods and techniques on the basis of the earned knowledge.
CO6	The complement system and its components, hypersensitivity and allergic responses, diseases related to hypersensitivity, autoimmune disorders and complement deregulation.
CO7	The student will appreciate the scientific principles behind vaccination, types of vaccines and their role in fighting diseases.
CO8	The student will be able to describe the mechanisms of autoimmunity and immune deficiency diseases

**A. Immunology (67 hrs)**

1. Introduction (9 hrs)
  - 1.1. Innate and adaptive immunity, types and attribute of adaptive immunity
  - 1.2. Cells and organs (primary, secondary and tertiary) of the immune system
  - 1.3. Antigens, Antigenicity, immunogenicity and Haptens, Adjuvants
  - 1.4. Factors influencing immunogenicity
  
2. Antibodies (8 hrs)
  - 2.1. Structure, Different Classes and functions of Antibody Molecules
  - 2.2. Generation of Antibody diversity
    - 2.2.1. Organisation of immunoglobulin gene
    - 2.2.2. Light chain (V-J-C) and Heavy chain (V-D-J-C) rearrangement.
    - 2.2.3. Mechanism of rearrangement
    - 2.2.4. Class switching
  - 2.3. Monoclonal antibodies-Hybridoma Technology and Applications
  - 2.4. Antibody Engineering

3. Antigen-Antibody Interactions (8 hrs)
- 3.1. Strength of Antigen Antibody Interactions
  - 3.2. Cross reactivity, precipitation reactions, agglutination reactions, agglutination inhibition reactions.
  - 3.3. Immunotechniques -Detection of molecules using ELISA, RIA, Western Blot, Immunoprecipitation, immunoelectrophoresis, Immunodiffusion reaction (Mancini and Ouchterlony method), Immunofluorescence, Flowcytometry (FACS).
4. Generation of B Cell & T cell response (10 hrs)
- 4.1. Humoral & Cell mediated response- Primary and secondary response, Generation of CTLs, NK cell mediated cytotoxicity, ADCC
  - 4.2. B & T cell receptors ( $\alpha\beta$ ,  $\gamma\delta$ ) and CD<sub>3</sub> Complex
  - 4.3. Properties of B cell & T cell Epitopes
  - 4.4. Activation and differentiation of B and T cells
5. Immune effector Mechanisms (12 hrs)
- 5.1. Cytokines & Antagonists, Properties and function, therapeutic applications.
  - 5.2. Complement System
    - 5.2.1. Components
    - 5.2.2. Complement activation and regulations (classical, alternate and lectin pathways, MAC formation)
    - 5.2.3. Functions
  - 5.3 Toll -like receptors
  - 5.4. Inflammation
    - 5.4.1. Acute and chronic inflammation.
    - 5.4.2. Neutrophil and lymphocyte extravasation
    - 5.4.3. Mediators of inflammation
  - 5.5. Hypersensitivity reactions
    - 5.5.1. Type I, II and III hypersensitivity reactions
    - 5.5.2. Delayed type hypersensitivity
6. Major Histocompatibility Complex (MHC) (6 hrs)
- 6.1. General organisation and inheritance of MHC
  11. MHC genes & molecules



12. Cellular distribution of MHC molecules
13. Antigen processing and presentation -Endogenous and Cytosolic pathways.  
Presentation of non peptide bacterial antigens.

7. Immune system in Health and Diseases (12 hrs)

- 7.1. Immune responses during bacterial (Tuberculosis) parasitic (malaria) and viral (HIV) infections.
- 7.2. Autoimmune diseases
  - 7.2.1. Organ specific (Hashimotos thyroiditis, Autoimmune anaemia, Good Patures syndrome, Insulin dependent diabetes mellitus; Graves disease; Myasthenia gravis)
  - 7.2.2. Systemic autoimmune disease (SLE, Multiple sclerosis, Rheumatoid arthritis)
  - 7.2.3. Treatment of autoimmune disease.
- 7.3. Primary Immunodeficiency diseases (Bruton's disease, Di-george Syndrome & Severe combined immunodeficiency (SCID))
- 7.4. Secondary immunodeficiency Diseases (AIDS). Origin, means of infection, course of infection, structure and types of HIV, Acute infection, seroconversion, Window period, Chronic latent phase- Lymph adenopathy, Crisis phase, viral multiplication, mutation, diagnosis, antiretroviral therapy and AIDS vaccine.
- 7.5. Vaccines-
  - 7.5.1. Passive immunisation
  - 7.5.2. Active immunisation (herd immunity)
    - 7.5.2.1. Whole organism vaccine- Attenuated and Inactivated vaccine- advantages and disadvantages.
    - 7.5.2.2. Purified macromolecule Recombinant Vector, DNA vaccines, synthetic peptide vaccines and multivalent vaccines

8. Transplantation immunology (4 hrs)

- 8.1. Immunologic basis of graft rejection
- 8.2. General and specific immunosuppressive therapy
- 8.3. Transplantation antigens

## References:

1. Adul K Abbas and Andrew H Lichtman (2003). Cellular and Molecular Immunity (fifth edition). Elsevier Science, USA.
2. Carpenter. Immunology and Serology
3. Das Gupta, Modern Immunology
4. Godkar, P.B. (1998): A Text Book of Medical Laboratory Technology, Bhalani Bhalani Publishing House Mumbai
5. Hay & Hudson -Practical Immunology.
6. Janis Kuby (1997): Immunology. WH Freeman, New York
7. Joshi. K. R and Osamo N.O (1994). Immunology. Agro Bios Publishers, Jodhpurr
8. Peter Parham (2004). The immune System (2<sup>nd</sup> Edition), Garlands, New York
9. Roit, Essentials of Immunology.
10. Shetty. N (1993) Immunology Wiley Eastern Ltd, New Delhi
11. Weir-Hand book of Experimental Immunology (Volume 1,2&3).

### B. Cytogenetics (23 hrs)

1. Cellular communication (7 hrs)
  - 1.1 Regulation of hematopoiesis
  - 1.2 General principles of cell communication
  - 1.3 Cell-cell interactions – cell adhesion and roles of different adhesion molecules
  - 1.4 Extracellular matrix: Basal membrane and Laminin, Collagen, Proteoglycan, Fibronectin
  - 1.5 Interaction of cells with extracellular matrix: Integrins. Focal adhesion and hemidesmosomes.
  - 1.6 Interaction of cells with other cells: Selectins, Immunoglobulins, Cadherins, Adherens.
2. Cell signaling (10 hrs)
  - 2.1 Signal transduction
  - 2.2 Concept of cell-signaling
  - 2.3 Signaling through cell surface receptors: G protein linked receptors;

signaling via cAMP, PKA, IP3, Ca<sup>2+</sup>/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

2.4 Receptor desensitization

2.5 Signaling by nitric oxide, carbon monoxide

2.6 Signaling network

3. Apoptosis and its significance (6 hrs)

3.1 Necrosis; Programmed and induced cell death

3.2 Process of apoptosis: Initiation, Execution: cytochrome C, caspases, Phagocytosis

3.3 Regulation of apoptosis - Extracellular and Intracellular

3.4 Apoptosis in *Caenorhabditis elegans*, *Drosophila*, mammals and bacterial population

3.5 Mechanism of cell death

3.6 Genes involved in apoptosis

## Reference

1. Becker, W. M., Reece, J. B. and Poenie, M. F. (1999; 2000). *The World of the Cell*, 4<sup>th</sup> edition, Benjamin/Cummings Publishing Co.
2. Benjamin Lewin (2008). *Genes IX*. Jones & Bartlett Learning Publishers, New York.
3. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter(2002). *Molecular Biology of the Cell*. 4th Edition, Garland Science, New York.
4. De Robertis, E. D. P. and De Robertis, Jr. E. M. F. (1996). *Cell and Molecular Biology*, Eighth Edition, B.I. Waverly Pvt Ltd, New Delhi.
5. Karp, G. (2002). *Cell and Molecular Biology*. John Wiley, New York.
6. Kleinsmith, L. J. and Kish, V. M. (1995). *Principles of Cell and Molecular Biology (SecondEdition)*. Harper Collins College Publishers, New York.
7. Peter Snustad, D. and Michael J. Simmons (2000). *Principles of Genetics*. 2nd

Ed. John Wiley & Sons Inc.

8. Purves W. K., Orians G. H. and Heller H. C. (1995). *Life: The Science of Biology*, 4<sup>th</sup> Edition. Sinauer Associates, Sunderland.
9. Robert H. Tamarin (2002). *Principles of Genetics*, 7th Edition, Tata McGraw-Hill Education Pvt Ltd, New Delhi.
10. Sheeler, Philip and Donald, E. Bianchi. (1987) *Cell and Molecular Biology*. III Ed. John Wiley.
11. 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.

**THIRD SEMESTER**  
**FZOL3C09: MICROBIOLOGY & BIOTECHNOLOGY**

Contact Hours: 90 hrs(5hr/wk)

Credits: 4

COs	COURSE OUTCOMES
CO1	The student learn the features of various types of cloning vectors
CO2	The student explore different steps involved in molecular cloning
CO3	The student will describe the techniques involved in the production of molecular probes, Genomic and CDNA library
CO4	The student evaluate and compare various types of PCR techniques
CO5	The student will analyze techniques involved in isolation, sequencing and synthesis of genes
CO6	The student explore and appreciate the applications of biotechnology in animal health care, agriculture and environmental protection
CO7	The student get familiar with the biotechnological techniques involved in animal cell tissue culture, gene silencing and cloning
CO8	The student ethical and social implications of biotechnology
CO9	The student understand taxonomy, structure, nutrition, growth of various microbes
CO10	The student analyze various types of microbial diseases and its control measures
CO11	The student appreciates beneficial effects of microbes

**Part-A-MICROBIOLOGY (45 Hours)**

1. Introduction- (3 Hrs)

- 1.1 History and scope of microbiology
- 1.2 Spontaneous generation concept
- 1.3 Recognition of the role of microbes in diseases
- 1.4 Composition of the microbial world
- 1.5 Turning points in microbial research
- 1.6 Microorganisms and the evolution of the earth
- 1.7 Modern age of micro biology

2. Microbial Taxonomy and Phylogeny (4 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 Manuel (mention major groups)

3. Bacterial cell structure and function (6 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 (3 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, pure cultures and pure culture techniques
5. Microbial growth (5 hrs)
  - 5.1. Growth curve -synchronous growth
  - 5.2. Continuous culture
  - 5.3. Factors influencing microbial 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 measurements
6. Utilization of energy (4 hrs)
  - 6.1. Biosynthetic process-peptidoglycan synthesis, amino acid synthesis
  - 6.2. Non synthetic processes -Bacterial motility and transport of nutrients
7. Viruses (4 hrs)
  - 7.1. General structural properties
  - 7.2. Types: DNA viruses, RNA viruses, and enveloped viruses
  - 7.3. Virus-host interactions- lytic cycle and lysogenic cycle.
8. Microbial diseases (4 hrs)
  - 8.1. Human diseases caused by bacteria- Streptococcal diseases, Typhoid, Cholera, tetanus, Leprosy, tuberculosis and Pneumonia.
  - 8.2. Human diseases caused by viruses- AIDS, Small pox, Rabies, Measles, Swine Flu, Bird flu, SARS, NE, NIPAH
  - 8.3. Fungal diseases- Candidiasis
9. Control of microorganisms (5 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's, Cephalosporins, Chloramphenicol, Tetracyclines
- 9.3. Microbial drug resistance
- 10. Microbial fermentation (4 hrs)
  - 10.1. Lactic fermentation Homolactic and heterolactic fermenters, Mention dairy products, cheese, Yogurt, kefir etc.
  - 10.2. Alcoholic fermentation-Alcoholic beverages
- 11. Environmental microbiology (3 hrs)
  - 11.1. Aquatic microbes
  - 11.2. Microbiological analysis of drinking water
  - 11.3. Waste water- microbial characteristics and treatment
  - 11.4. Microbial Bioremediation, Biofertilizers, and Bioinsecticides
  - 11.5. Biogas plants.

### **Part-B-BIOTECHNOLOGY (45 Hrs)**

- 1. Introduction (1 hr)  
Definition, branches, scope and importance
- 2. Genetic engineering (4 hrs)
  - 2.1. Cloning vectors –
    - 2.1.1. Properties of a good cloning vector
    - 2.1.2. Types - plasmids (pBR322, pBR 327, pUC); phages (lambda phage, M13);  
cosmids, Phagemids, viruses, BAC, YAC and MAC.
  - 2.2. Shuttle vectors and expression vectors
  - 2.3. Enzymes for r DNA technology- Restriction enzymes and ligases
- 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 (2 hrs)
  - 4.1. Production
  - 4.2. Labelling
  - 4.3. Applications
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, FISH and GISH, Chromosome walking
6. Polymerase Chain Reaction (2 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 (brief notes) (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 (3 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 (2 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
- 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. Intellectual property rights (2 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 - (2 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

## References:

### Part- B- Biotechnology

1. Alphey - DNA sequencing-Bios Scientific publishers-
2. Bernard R. Glick & Jack J. Pasternak-Molecular Biotechnology-Principles and applications of recombinant DNA- ASM press Washington D.C.
3. Charles Hardin (2008): Cloning, Gene expression, and Protein purification- Experimental procedures and process rationale - Oxford University Press.
4. Chatterji, A.K. -Introduction to environmental biotechnology-Prentice Hall of India
5. Colin Ratledge and Bjorn Kristiasen-Basic Biotechnology - Cambridge University press.
6. Dominic, W.C. Wong-The ABCs of gene cloning-Springer international edition
7. Dubey, R.C. -A text book of biotechnology-S. Chand & Co.
8. Gupta. P.K. -Elements of biotechnology-Rastogi publications.
9. Singh, B.D.-Biotechnology-Kalyani publishers.
10. Sobti, R.C. & Suparna, S .Pachauri-Essentials of Biotechnology-Ane Books Pvt.Ltd.
11. Wilson & Walker (2008): Principles and techniques of Biochemistry and Molecular biology- Cambridge low price editions.

### Part-A - Microbiology

12. Gandhi-Microbiology and Immunology notes and cases-Blackwell publishing
13. Hans G. Schlegel (2008): General Microbiology-Cambridge low price editions
14. Kanika Sharma-Manual of microbiology tools and techniques-Ane's student edition-Ane books Pvt. Ltd
15. Monica Cheesbrough - District laboratory practice in tropical countries, Part I

and II - Cambridge low price editions

16. Mansi- Fermentation, Microbiology and Biotechnology-Taylor and Francis
17. Pelczar, M.J, Reid, R.D. & Chan, E.C.S-Microbiology-TMH edition
18. Prescott, Harley and Klein- Microbiology, IVth ed. McGraw-Hill
19. Rao, A.S.-Introduction to microbiology-Prentice Hall of India.
20. Tortora, Funke and Case - Microbiology : An Introduction Eight edition-pearson education, Veerbala Rastogi-Fundamentals of Molecular biology-Ane books
21. Wise-Bioinstrumentation and Biosensors-Taylor and Francis.

**FOURTH SEMESTER**  
**FZOL4E10: ENVIRONMENTAL BIOLOGY I: MAN,**  
**ENVIRONMENT & NATURAL RESOURCES**

Contact Hours: 90 hrs(5hr/wk)

Credits: 4

COs	COURSE OUTCOMES
CO1	The student will describe the concepts related to Weather and Climate
CO2	The student will explain the general features of Human population
CO3	The student will identify the different types and Functions of Ecosystems
CO4	Explain the human impact on ecosystems and sustainable development
CO5	Enumerate the various types and relevance of renewable and non-renewable natural resources
CO6	The student learn the concepts of Water management and conservation

1. Weather and climate: (15 hrs)
  - 1.1. Atmosphere- structure and composition; Local winds: Sea and land breezes; Polar easterlies, Westerlies; Trade winds; Jet streams
  - 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), Stratocumulus (Sc), Stratus (St), and Cumulonimbus (Cb).
2. 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, causating factors of the following: cloud burst, debris flow, landslides, internal erosion and soil piping

2.4. Physical evidence for climatic change - Historical and archaeological evidence- Glaciers - Vegetation -Ice cores -Dendroclimatology- Pollen analysis-Sea level change

3. Human population (10 hrs)

2.6 Exponential growth - geometric growth or geometric decay- Malthusian growth model

2.7 Population momentum age structure - population pyramid, age structure diagram Types of population pyramid - Young and aging populations - youth bulge

2.8 Current trends in global population with reference to developed and developing countries

2.9 Population explosion -Baby boom - History of population growth Projections of population growth, Demographic transition Carrying capacity - Human population in India

4. 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

4.5 Primary production, factors affecting & measurements of primary production

4.6 Ecological efficiencies- ratios within and between trophic levels,

4.7 Energy flow in an ecosystem,- Lindmann's work, Single channel, Y shaped and universal energy flow models

4.8 Place of man in the food chain, Human expropriation of primary production, Nutrient cycling, selection, diversity, decomposition and stability.

4.9 Development of ecosystems, Types and factors controlling, changes in the trends of ecological attributes,

4.10 Relevance of ecosystem development concept to human ecology and evolution of ecosystems

4.11 Human impact on ecosystems, Human settlements, Human cultural evolution, Environmental crisis,

- 4.12 Environmental protection and sustainable development, Creating sustainable cities suburbs and towns,
- 4.13 Meeting human needs while protecting the environment.
5. 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.Culture fisheries, briefly mention the common species and culture methods
- 5.4.Aquaculture. economically important crustaceans, mussels, oysters, clams and sea weeds.(Brief)
- 5.5.Fishery resources of Kerala with special reference to fresh water ornamental species.
- 5.6.Marine products - Food value of fish, Fish meal, fish body oil, Fish liver oil, Fish maw and other products.
- 5.5 Forest products -major and minor products of both plant and animal origin,
- 5.6 Economically important insects and their products-Honey, Lac and Silk.
- 5.7 Plantation, crops, and their products and uses (Tea, coffee, Rubber, Coconut, Cashew nut, Cardamom)
- 5.8 Mineral resources with special reference to India. Their over exploitation and environmental problems citing case studies from India.
- 5.9 Water as a resource -Characteristics of water. Major water compartments. Hydrological cycle. Water management and conservation - Rain water harvesting techniques. Surface and ground water resources of Kerala
6. Energy resources
- 6.1. Conventional energy sources (coal, Oil and natural gas and oil shale)
- 6.2. Non conventional energy sources -solar energy, wind energy, geothermal energy, hydropower, biomass, biogas, Tidal energy, Energy from waste, Hydrogen, and Nuclear energy.
- 6.3. Energy crisis

**References:**

1. Ahluwalia & Sunita Malhotra-Environmental Science-Ane books Pvt. Ltd

2. Ananthakrishnan, T.N. - Bioresource Ecology- Oxford and IBH.
3. Andrewartina- Intriduction to the study of animal population-University of

Chicago Press

4. Bailey J.A.-Principles of wildlife management -John Wiley and sons, New York
5. Beebi & Ann Maria (2006): First Ecology-Oxford university press
6. Bouis M.E. Conservation biology- the science scarcity and diversity. Binarer Associates Inc. Publishers, Sunderland, Massachusetts.
7. Chiras, D. (2001): Environmental science, Jones and Bartlet publishers Collar, N.J. Crooby, M.J. and Shatters field, A.J. (1994): Birds to watch - The world list of threatened birds, Cambridge U. K. bird life international (Bird life conservation series 4) Cunningham &Cunningham 2003- Principles of Environmental Science:, Tata McGraw Hill
8. Dempster- Animal population Ecology- Academic press
9. Ehrlich and Ehrlich- Ecoscience- W.H. Freeman and Co.
10. Emlen, J.M Population biology. The co- evolution of population dynamics and behaviour- M c Millan publishing company New York, London.
11. Emlaw, J.M. Ecology an evolutionary approach.
12. Franco K.G-- Man and the changing environment
13. Irewarth Horn, An introduction to climate- Mac Graw-Hill
14. Krebs, C., Ecology, Harper and Row publishers, New York
15. Lutgens, Frederick, K. and Edward J. Tarbuck (1995): The Atmosphere, Prentice Hall, 6<sup>th</sup> ed., pp 14-17, ISBN 0-13-350612-6
16. National Academy of Sciences (NAS). 2001. "Climate Change Science: An Analysis of Some Key Questions", National Academies Press. 42 pp.
17. Odum H. T. System ecology, an Introduction- John wilsy & Sons, New york.
18. Owen O. S. Natural resources conservation, An Ecological Approach- Mc Millan.
19. Percel, J.P. (1968) Wet evergreen forest of the western ghats of India- Pondicherry- India-Institute Francis de Pondicherry.
20. Pidwirny, M. (2006). "Causes of Climate Change". Fundamentals of Physical Geography, 2<sup>nd</sup> Edition. <http://www.physicalgeography.net/fundamentals/7y.html>
- Intergovernmental Panel on Climate Change (IPCC), 2001. "Working Group I Third Assessment Report." Cambridge University Press. Cambridge, UK. 881 pp.
21. Preston, Heuveline and Guillot (2001): Demography: Measuring and Modelling Population Processes
22. Puri et al.- Forest Ecology- Oxford university press



23. Ramakrishnan, P. S.-Ecology and sustainable development-National book trust  
India
24. Raymond Dasman- Environmental Conservation- John Wiley
25. Sagrayia, K. P. - Forest and Forestry- National Book Trust, New Delhi
26. Smith R.I. - Elements of ecology- Harper and Row publishers, New york.
27. Turk and Turk-Envoronmental Science- Saunders.
28. UN population estimates and projections, database query, August2009".  
Esa.un.org. 2009-03-11. <http://esa.un.org/unpp/>.

**FOURTH SEMESTER**  
**FZOL4E11: ENVIRONMENTAL BIOLOGY II:**  
**ENVIRONMENTAL POLLUTION**

Contact Hours: 90 hrs(5hr/wk)

Credits: 4

COs	COURSE OUTCOMES
CO1	Acquire in depth knowledge about the common pollutants in our environment and their interactions with ecosystem components
CO2	Perform qualitative and quantitative analysis of various primary and secondary pollutants in the environment
CO3	Gain insight on the multi-dimensional impact produced by various pollutants on health, environment and materials of the ecosystem
CO4	Apply appropriate abatement techniques for various air, water and terrestrial pollutants present in the ecosystem
CO5	Comprehend the rules and regulations implemented by various governmental institutions

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)
- (a) Oxides of Carbon, Hydrocarbons
  - (b) SO<sub>2</sub>, H<sub>2</sub>S, Mercaptans
  - (c) Oxides of Nitrogen, Ammonia
  - (d) Ozone
- 1.4 Sampling and sizing of particulate matter.  
 Sample collection - settlement, filtration, particle count, evaluation by optical microscopy, particle size analysis - projected diameter and statistical diameter (Ferete's diameter and Martin's diameter).
- 1.5 Interaction of air pollutants in the atmosphere  
 Secondary pollutants, photochemical-smog, Acid rain, green house effect, Ozone depletion.
- 1.6 Effect of air pollution:
- (a) On materials, buildings, metals etc.
  - (b) On vegetation

(c) On weather and atmospheric conditions

(d) On human health- a brief survey of major air pollution episodes.

1.7 Air pollution- abatement technology, basic principles of design and working of: (a) 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

1.9 Air Act.

1.10 Air Quality Standards

## 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.

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

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

(d) 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

(a) Mercury - Inorganic and Organic mercury compounds - Bioconversion of inorganic and organic mercury

(b) Cadmium - itai - itai disease

(c) Lead - Plumbism

(d) 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 ionising radiations, Nuclear waste disposal.
- 2.8. Carcinogens in the environment
  - (a) 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 (1) screens (2) Grit chambers (3) Sedimentation tanks (4) Oxidation ponds and (5) 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
- 2.12. Water Act, and Water quality standards.
- 3. TERRESTRIAL POLLUTION (15 hrs)
  - 3.1 Solid waste- Sources and types garbage, rubbish, ashes, debris, street litter, agricultural waste, mining waste, industrial waste, e-waste etc. hazardous waste
  - 3.2 Problems of solid waste disposal,
  - 3.3 consequences of solid pollution-Love canal episode as an example.
  - 3.4 Solid waste disposal methods: Composting, Sanitary land fill, plasma gasification, deep well injection, incineration, Pyrolysis
  - 3.5 ,Generation of biogas from biodegradable organic wastes
  - 3.6 Recycling of solid wastes

## References:

1. Ahluwalia & Sunita Malhotra (2009): Environmental Science-Ane books Pvt.Ltd
2. Ananthakrishnan T.N.- Bioresource Ecology- Oxford and IBH
3. Chiras, D. (2001) : Environmental science, Jones and Bartlet publishers
4. Ciaccio - Water and Water Pollution.Hand book- Vol. I- V- Marcel- Dekker
5. Cunningham & Cunningham (2003): Principles of Environmental Science:, Tata McGraw Hill
6. Dehre, F. W. - Toxicity of heavy metals in the environmental Volume I & II MarcelDekker
7. Eddy and Metcalf- Waste water engineering- Tata Mc Graw Hill
8. Ehrlich and Ehrlich- Ecoscience- W.H.Freeman and Co.
9. Hodges- Environmental Pollution- Holt, Rinehart and Winstone
10. Hussain, S.K. Text Book of water supply and Sanitary Engineering- Oxford IBH
11. Irewarth Horn, An introduction to climate- Mac Graw-Hill
12. Irving Sax- Industrial Pollution- Holt, Rinehart and Rinhold Co.
13. Jain, R.A.- Environmental Impact Analysis- Academic Press
14. Leeper- Managing heavy metals on land Marcel- Dekker
15. Mellanby - Pesticides and Pollution- Collins
16. Namerow, N.I. - Scientific stream analysis - Mc Graw Hill
17. Namerow, N.L.- Scientific stream analysis - Mc Graw Hill
18. Nemerow, N.I.-Industrial Water Pollution-Addison, Wesly.
19. Premins- Air Pollution -Mac Graw-Hill.
24. Ravera - Biological Aspects of fresh water pollution- Pergamon
25. Schroeder - Water and Waste water treatment- Mc Graw Hill
20. Smith & Smith- Minamata-Holt, Rinchart & Winston.
26. Stem et al. - Fundemantals of Air Pollution- Academic Press.
27. Turk and Turk-Envoronmental Science- Saunders
28. Wilson - Hand book of Solid waste mangement - Van Nostrand publishers

**FOURTH SEMESTER**  
**FZOL4E12: ENVIRONMENTAL BIOLOGY III:**  
**ENVIRONMENTAL CONSERVATION**

Contact Hours: 90 hrs(5hr/wk)

Credits: 4

COs	COURSE OUTCOMES
CO1	The student gain knowledge on the important approaches and practices in biodiversity conservation and management
CO2	The student evaluate ecological, evolutionary, economical importance of various biodiversity components
CO3	Develop skills in planning management of bioresources
CO4	The student develops appreciation of the major conservation strategies & programmes implemented by national and international agencies and their role in biodiversity conservation
CO5	The student will be able to identify and categorise organisms based on the degree of threat and under the need for their conservation
CO6	Acquire insight towards and environmental friendly and sustainable life

1. 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

Ramsar convention aims and objectives, Ramsar sites in Kerala

Coastal zone management

Special features of CRZ

Coastal Zone Management plan and its objectives

Categorization of the Coastal Zone; 'Setback line': Coastal

## Zone Management

Indicative list of ecologically sensitive areas (ESA)

1.5 Coral reefs: list of major coral reefs; conservation problems

1.6 Ocean acidification; Ocean Warming and Coral Bleaching;

1.7 Coral tourism; water pollution; sedimentation; coral mining;

2. Biodiversity conservation (40 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 birds and Mammals 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. Unesco world heritage site- sites of ecological importance of India.

2.12. Biological control and Integrated Pest Management.

2.13. Organic farming and its importance

3 Strategies of conservation

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

3.4.1.1 Conservation strategies at the global level-Role of World

conservation union, CITES, WWF, TRAFFIC, Ramsar Convention, UNFCCC (Kyoto Protocol), Convention on Biological Diversity (CBD), Conservation International (CI), Operation Wallacea, REDD.

3.4.2 IUCN categories of threatened animals and red data book.

3.4.3 Wildlife management in India; Role of Government and non governmental agencies. Briefly mention wildlife protection act 1972 and its amendments and schedules

3.4.4 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.

3.4.5 Ex situ conservation -Zoo, Aquarium, Seed bank, Gene bank, Pollen bank

3.5 In situ conservation.- National parks, sanctuaries, Biosphere reserves, Community reserves and other protected areas. Traditional Ecological Knowledge (TEK)-

3.6.1 Introduction and need for its conservation

3.6.2 Economic benefits

3.6.3 Social implications-sacred groves, sacred landscape, sacred species

3.6.4 TEK and sustainable development.

4. 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,



ecologies. 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.
- 4.9. Marine debris, Great Pacific Ocean/Indian Ocean garbage patches; Asbestos and health hazards;

**References:**

1. Ahluwalia & Sunita Malhotra-Environmental Science-Ane books Pvt.
2. Alan Beebi & Ann Maria-First Ecology-2006-Oxford university press
3. Ananthakrishnan, T.N. - Bioresource Ecology- Oxford and IBH.
4. Bailey, J.A.- Principles of wildlife management -John Wiley and sons, New York
5. Bandopadhyaya Jaya J. et al- Indian environment Crises and response- Natraj publishers Dehradun
6. Barbs, S.K. and Hughes, K.N. An introduction to marine ecology- Blackwell Scientific Publication
7. Bouis, M.E. - Conservation biology- the science scarcity and diversity. Sinaur Associates.
8. Chiras, D. (2001): Environmental science, Jones and Bartlet publishers
9. Cunningham & Cunningham (2003): Principles of Environmental Science:, Tata McGraw Hill
10. Dempster- Animal population Ecology- Academic press 11. Ehrlich and Ehrlich- Ecoscience- W.H. Freeman and Co.
11. Emlen, J.M. Population biology. The co- evolution of population dynamics and behaviour-Mac Millan publishing company New York
12. Irewarth Horn, An introduction to climate- Mc Graw-Hill
13. Jain R.A.- Environmental Impact Analysis- Academic Press
14. Kikkawag & Anderson B J Community ecology- Pattern and process- Blackwell Scientific publications
15. Krebs, C. - Ecology, Harper and row publishers, New York
16. Odum H. T. System ecology, an Introduction- John Wiley & Sons, New York
17. Owen O. S. Natural resources conservation, An Ecological Approach- Mac

Millan.

18. Ramakrishnan, P.S.-Ecology and sustainable development-National book trust  
India
19. Primack- Essentials of Conservation Biology fifth edition-Sinauer associates
20. Puri et al.- Forest Ecology- Oxford university press
21. Raymond Dasman- Environmental Conservation- John Wiley
22. Sagrayia, K.P. - Forest and Forestry- National Book Trust, New Delhi
23. Smith R.I. Elements of ecology- Harper and Row publishers, New York.
24. Turk and Turk-Environmental Science- Saunders College Publishing

**FOURTH SEMESTER PRACTICALS**  
**FZOL4L04: PHYSIOLOGY, IMMUNOLOGY, MICROBIOLOGY,**  
**BIOTECHNOLOGY AND MICROTÉCHNIQUES**

**Credits: 4**

COs	COURSE OUTCOMES
CO1	The student gain practical knowledge regarding the methods of analysis of enzyme activity and its dependent factors
CO2	The student will compare the effects of biotic and abiotic factors on aquatic life
CO3	The student gain a thorough practical knowledge related to the analysis of various blood parameters
CO4	The student gain hands on training on various immune-techniques
CO5	Students may gain a thorough knowledge regarding the immune components and production of antiserum in animals
CO6	The student gather hands own experience in isolation, staining and counting of bacteria
CO7	The student gain better knowledge regarding various sterilization techniques and bacterial culture
CO8	The student gain skills for Isolation of pure colonies of bacteria
CO9	The student is able to analysis the presence of bacteria in water samples
CO10	The student secure hands own training to isolate plasmid DNA and RNA from bacteria and other tissues
CO11	The student know how to separate DNA /RNA by electrophoresis
CO12	The student acquire practical knowledge to work with PCR machine in order to amplify DNA and experience on cell immobilization
CO13	The student attain skills in Tissue fixation and staining
CO14	Student will demonstrate the differential staining
CO15	Gain the knowledge on stained and unstained whole mounts

**PHYSIOLOGY (2 Hr/wk)**

**(Practical classes to be conducted during third semester)**

1. Kymograph: working principle and applications
2. Effect of different substrate concentration, pH and temperature on human salivary amylase activity. Colorimetric method, plot graphs.
3. Qualitative demonstration of digestive enzymes in cockroach - amylases, lipases, proteases, invertases and controls.
4. Digestion in a vertebrate and calculation of peptic value.
5. Influence of temperature and pH on the ciliary activity in fresh water mussel/mytilus using silver foil. Plot graphs
6. Determination of respiratory quotient - estimation of O<sub>2</sub> consumption by an aquatic animal.
7. Determination of the rate of salt loss and gain in an aquatic animal (fish or crab).
8. Estimation of urea and ammonia in human Urine. Titrimetric method.

9. Rate of glucose - absorption - calculation of Cori coefficient
10. Estimation of haemoglobin of Fish/Man - Sahli's method.
11. Blood volume determination by dye dilution method (Vertebrate)
12. Blood: clotting time, bleeding time, rouleaux formation, preparation of haemin crystals.
13. Enumeration of RBCs in human blood.
14. Determination of lactic acid in muscle tissue.
15. Differential count of human WBCs
16. Haematocrit and ESR of human blood.
17. WBC total count

### **References**

1. Oser B. L., Hawk's Physiological chemistry, McGraw Hill Book Company
2. Hill R.W., Wyse G.A. (1989), Animal Physiology 2<sup>nd</sup> edition. Harper Collins Publishers
3. Schmidt-Nielsen, K. (1997), Animal Physiology, adaptation and environment, Cambridge university Press
4. G. K. Pal and Pravati Pal (2001) Text Book of Practical Physiology. Orient Longman

### **IMMUNOLOGY (2 Hr/wk)** **(Practical classes to be conducted during Third semester)**

- 5.1. Study of cells of immune system.
- 5.2. Histology of organs of immune system.
- 5.3. Bleeding of animals and preparation of serum.
- 5.4. Separation of lymphocytes.
- 5.5. Demonstration of agglutination reaction.
- 5.6. Immuno Electrophoresis.
- 5.7. Demonstration of ELISA technique.
- 5.8. Production of antibodies.
- 5.9. Preparation of antiserum.
- 5.10. Titration of antiserum

**MICROBIOLOGY (2 Hr/wk)**  
**(Practical classes to be conducted during Third semester)**

- 6.3. Selective isolation and enumeration of bacteria.
- 6.4. Bacterial staining technique
  - Simple staining of bacteria.
  - Negative staining
  - Hanging drop technique.
  - Gram staining.
  - Endospore staining.
- 6.5. Turbidity test for contamination of milk.
- 6.6. Phosphate activity of milk.
- 6.7. Microbial filters and their application.
- 6.8. Preparation of media and sterilization.eg: Nutrient agar, mac conkey agar,  
Sterilization by wet and dry heat, disinfection.
- 6.9. Cultivation of yeast and molds
- 6.10. Isolation of pure colonies of bacteria.
- 6.11. Growth curve of yeast - monitoring progress of microbial culture.
- 6.12. Bacteriological analysis of water e.g., fecal pollutants.
- 6.13. Anaerobic culturing.
- 6.14. Antibiotic sensitivity test.

**BIOTECHNOLOGY (2 Hr/wk)**  
**(Practical classes to be conducted during Third semester)**

1. Isolation of plasmid DNA.
2. Isolation of total RNA from tissues
3. Separation of DNA by electrophoresis.
4. Bacterial transformation.
5. PCR
6. Cell immobilization.

**MICROTECHNIQUE AND HISTOCHEMISTRY (2 Hr/wk)**  
**(Practical classes to be conducted during Third semester)**

1. Preparation of stained and unstained whole -mounts.
2. Identification of the various tissues of animals in serial sections prepared using Nuclear and cytoplasmic stains.
3. Processing a few types of tissues for the histochemical staining-Staining of serial Sections to show the presence of
  - a) Carbohydrates by PAS method
  - b) Proteins by Mercury Bromophenol Blue method
  - c) Lipids by Sudan Black B method
  - d) DNA by Feulgen Technique.

Submission:

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

**References:**

1. 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.
2. Sambrook, J. and Russel, D.W. (2001): Molecular cloning: A laboratory Manual. CSHL Press, New York.

**FOURTH SEMESTER PRACTICALS**  
**ELECTIVE COURSE**  
**FZOL4L05: ENVIRONMENTAL BIOLOGY I:**  
**WATER POLLUTION**

(Practical classes to be conducted during Fourth semester)

**Hrs/Week: 4**

**Credits: 4**

COs	COURSE OUTCOMES
CO1	Students will attain skills in the determination of various parameters such as dissolved solids, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, ammonia nitrogen, nitrite nitrogen and sulphate in waste water samples

Waste water characterization - determination of the following parameters in waste water samples

1. Turbidity - Nephlo meter or Secchi disc method
2. Odour
3. Dissolved solids - gravimetric method
4. Suspended methods - gravimetric method
5. Dissolved oxygen (modified Winkler method)
6. Biochemical oxygen demand - Dilution method
7. Chemical oxygen demand - Dichromate digestion
8. Ammonia nitrogen - Indophenol blue method
9. Nitrite nitrogen - Azo dye method
10. Nitrate nitrogen -Phenol disulphonic acid method
11. Sulphate
12. Inorganic phosphates - APHA method
13. Hardness EDTA titration Method
14. Residual chlorine
15. Species diversity indices and indicator species
16. Primary production
  - a) Light and dark bottle method
  - b) Chlorophyll method.

## References:

1. Greenberg et.al-Methods for the examination of water and waste water- APHA publishers Washington D.C.
2. Indian standard methods for measurement of air pollution-ISI - New Delhi
3. Indian standard method of sampling and test for industrial effluents Part III- ISI New Delhi
4. Michael -Ecological methods for field and Lab investigations-Tata Mc Graw-Hill
5. NC Aery-Manual of Environmental Analysis- Ane Books Pvt.Ltd
6. Sawyer & Mc Carty-Chemistry for environmental engineering -Mc Graw Hill Publishers
7. Trivedi & Goel-Practical methods in Ecology and Environmental Sciences- Environmental publications Karad



**FOURTH SEMESTER PRACTICALS**  
**ELECTIVE COURSE**  
**FZOL4L06: ENVIRONMENTAL BIOLOGY II & III**  
 (Practical classes to be conducted during Fourth semester)

**Credits: 4**

COs	COURSE OUTCOMES
CO1	The student acquire practical knowledge regarding air samplers
CO2	The student gain knowledge regarding the analysis of pollutants in air and effluents
CO3	The student develop skill for Soil and Sediment Analysis
CO4	The student gain indepth knowledge regarding environmental pathogens and their bioassays

**ENVIRONMENTAL BIOLOGY II: (3hr/wk)**  
**AIR POLLUTION, RADIATION BIOLOGY AND HEAVY METALS**

**A. AIR POLLUTION**

Air samplers - Simple, Handy and High volume air samplers.

Monitoring of the following pollutants in ambient and polluted air:

1. Dust fall
2. Suspended particulate matter
3. Sulphation rate using lead peroxide candle.
4. Sulphur dioxide
5. Nitrogen dioxide
6. Ammonia
7. Study on the effect of SO<sub>2</sub> on vegetation

**B. RADIATION BIOLOGY**

1. Demonstration of UV induced lipid peroxidation in tissue homogenates
2. Effect of Vitamin E on UV induced lipid peroxidation

**C. HEAVY METALS**

Estimation of the following metals in effluent and sediment samples

1. Copper-Biquinoline method
2. Zinc- Zincon method
3. Chromium (Hexavalent) - Diphenylcarbazide method

**References:**

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

**ENVIRONMENTAL BIOLOGY III: (3hr/wk)**  
**SOIL & SEDIMENT ANALYSIS**  
(Practical classes to be conducted during Fourth semester)

**A. Soil and Sediment Analysis**

1. Collection and Preservation
2. Redox potential.
3. Alkalinity.
4. P<sup>H</sup>
5. Exchangeable calcium and magnesium
6. Sodium and potassium.
7. Available phosphorous.
8. Ammonia Nitrogen
9. Chlorides
10. Organic Matter -Walkley Black Method
11. Sulphates

**B. Environmental Microbiology**

12. Standard plate count of soil and water samples
13. MPN of total coliforms
14. MPN of faecal coliforms

**C. Bioassay Studies and Insecticides**

15. Fish/Daphnia bioassay test to find out the toxicity of heavy metals/pesticides
16. Calculation of LC50 or TLm
17. Determination of the concentration of the following insecticides in water:
  - a) DDT
  - b) Methyl parathion
18. Inhibition of acetylcholine esterase by organophosphates/ carbamate insecticides(demonstration only)

**References:**

1. Aery, A.C.-Manual of Environmental Analysis- Ane Books Pvt. Ltd
2. Greenberg et.al-Methods for the examination of water and wastewater-APHA publishers Washington D.C.
3. Indian standard methods for measurement of air pollution-ISI - New Delhi
4. Indian standard method of sampling and test for industrial effluents Part III-ISINew Delhi
5. Michael -Ecological methods for field and Lab investigations-Tata Mc Graw- Hill
6. Sawyer & Mc Carty-Chemistry for environmental engineering -Mc Graw HillPublishers
7. Trivedi & Goel-Practical methods in Ecology and Environmental Sciences- Environmental publications Karad.

**AUDIT COURSE\***  
**FZOL1A01: ABILITY ENHANCEMENT COURSE**

**Credits: 4**

- |   |                           |                              |
|---|---------------------------|------------------------------|
| I. Research                                 | (2 hrs)                   |                              |
| 1. Definition                               |                           |                              |
| 2. Characteristics                          |                           |                              |
| 3. Objectives                               |                           |                              |
| 4. Research and Scientific method           |                           |                              |
| 5. Research Ethics                          |                           |                              |
| II. Types of Research                       | (8 hrs)                   |                              |
| 1. Descriptive vs. Analytical Research      |                           |                              |
| 2. Applied vs. Fundamental Research         |                           |                              |
| 3. Quantitative vs. Qualitative Research    |                           |                              |
| 4. Conceptual vs. Empirical Research        |                           |                              |
| III. Research Methodology:                  | (8 hrs)                   |                              |
| 1. An Introduction                          |                           |                              |
| 2. Research Process                         |                           |                              |
| 3. Basic Overview                           |                           |                              |
| 4. Formulating the Research Problem         |                           |                              |
| 5. Defining the Research Problem            |                           |                              |
| • Research Questions                        |                           |                              |
| • Research Methods vs. Research Methodology |                           |                              |
| IV. Literature Review                       | (2 hrs)                   |                              |
| 1. Review Concepts and Theories             |                           |                              |
| V Hypothesis                                | (5 hrs)                   |                              |
| 1. Sources of Hypothesis                    |                           |                              |
| 2. Characteristics of Hypothesis            |                           |                              |
| 3. Role of Hypothesis                       |                           |                              |
| 4. Tests of Hypothesis                      |                           |                              |
| VI. Data Collection                         | (5 hrs)                   |                              |
| 1. Observation Method                       |                           |                              |
| 2. Interview Method                         |                           |                              |
| 3. Questionnaires                           |                           |                              |
| 4. Case Study Method                        |                           |                              |
| VII Ecological sampling techniques          | (20 hrs)                  |                              |
| a) Capture sampling methods                 |                           |                              |
| a) Direct sampling methods                  | b) Mark recapture methods | c) Indirect sampling methods |
| • Beating tray                              | • Mutilation methods      | • Pug marks                  |
| • Kite net                                  | • Pigment markings        | • Scats                      |
| • Sweep net                                 | • Collars, bands or rings | • Pellets                    |
| • Plankton net                              |                           | • Voice calls                |
| • Sticky trap                               |                           | • Nest tracking              |
| • Pitfall tap                               |                           | • Remote sensing             |
| • Light trap                                |                           |                              |

- Mammal trap
  - Kick sampling
  - Pooter
  - Extractions
  - Flootation
  - Tullgren funnel
  - Snap trap
  - Box trap
  - Mist net
  - Cannon nets
  - Immobilizers
  - Hand capture
  - Baermann funnel
2. Hand sorting of arthropods
- VII. Processing and Analysis of Data (5 hrs)
1. Processing Operations
  2. Statistics in Research
  3. Descriptive Statistics
  4. Inferential Statistics
  5. Elements / Types of Analysis
- VIII. Structure and skill of Writing a (10 hrs)
1. Article
  2. Essay
  3. Research Paper
  4. Research Project
  5. Legislation Drafting
  6. Judgment Writing
  7. Thesis
  8. Dissertation
  9. Book
  10. Reviews - Book Review; Case Review
- IX .Citation Methods (5 hrs)
1. Foot Note
  2. Text Note
  3. End Note
  4. Bibliography
- X. Citation Rules (5 hrs)
1. Blue Book
  2. OSCOLA
  3. MLA
  4. APA
  5. Chicago
- XI Working in Laboratory (5 hrs)**
1. Good laboratory practice; Safety and bio- and radio- hazards, disposal of biological and chemical wastes
  2. Accuracy of liquid transfer
  3. Preparation of Reagents, chemicals, buffers
  4. General safety and precautions

## 5. Handling of Instruments in the CIF

### Reference

1. Introduction to Ecological Sampling (Chapman & Hall/CRC Applied Environmental Statistics) 1st Edition: Bryan F.J. Manly and Jorge A. Navarro Alberto
2. Research Methodology in the Medical and Biological Sciences 1st Edition: Petter Laake, Haakon Benestad, and Bjorn R. Olsen
3. Introduction to Biostatistics: A Guide to Design, Analysis and Discovery. Ronald Forthofer and Eun Lee. ISBN: 9781483296746

**AUDIT COURSES\***  
**FZOL2A02: PROFESSIONAL COMPETENCY COURSE**

**Credits: 4**

**SPSS AND PAST**

**I. Introduction to SPSS and PAST**

1. Preparation of frequency table with given data
2. Diagrammatic presentation of census data in Kerala in the form of bar diagrams and pie diagrams. (prepare same graph in SPSS and keep print )
3. Graphic presentation of population distribution in the form of histogram, frequency polygon and frequency curve. (prepare same graph in SPSS and keep print)
4. Computation of measures of central dispersion anthropometric data of School children. (prepare same in Excel and keep print outs and add steps for SPSS)
5. Simulation of binomial and poisson distributions
6. Estimation of mean number of children per family(data from at least 10 families nearby campus ) (prepare same in Excel and keep print and add steps for SPSS)
7. 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 print and add steps for SPSS)
8. Regression analysis and correlation analysis of a data of heights and weight of a group of students. (prepare same in Excel and keep print outs and add steps for SPSS)
9. Diversity analysis by using PAST  
Species diversity and its measurements, Alpha diversity: Simpson's Diversity Index -Shannon index -Fisher's Alpha - Rarefaction; Beta diversity -Sorensen's similarity index-Whittaker's measure; Gamma diversity

**II. Word processing software and their applications:**

1. Basics of MS Office Word, Open Office Writer
2. Creating, editing, saving and printing text documents
3. Font and paragraph formatting

4. Simple character formatting
5. Inserting tables, smart art, page breaks
6. Using lists and styles
7. Working with images
8. Using Spelling and Grammar check
9. Understanding document properties
10. Mail Merge

### **III. Spread sheet software and their applications:**

1. Spreadsheet basics: MS Office Excel, Open office Calc
2. Creating, editing, saving and printing spreadsheets
3. Working with functions & formulas
4. Modifying worksheets with colour & autoformats
5. Graphically representing data : Charts & Graphs
6. Speeding data entry : Using Data Forms
7. Analyzing data : Data Menu, Subtotal, Filtering Data
8. Formatting worksheets
9. Securing & Protecting spreadsheets

### **IV. Presentation software and their applications:**

1. MS Office Powerpoint and Open Office Impress
2. Opening, viewing, creating, and printing slides
3. Applying auto layouts
4. Adding custom animation
5. Using slide transitions
6. Graphically representing data : Charts & Graphs
7. Creating Professional Slide for Presentation.

### **Reference**

1. Basic Computer Knowledge: John Monyjok Maluth (2016)
2. Open Office Basic: An Introduction: Prof James Steinberg (2012)
3. OpenOffice.org For Dummies: Gurdy Leete, Ellen Finkelstein, Mary Leete. (2003)