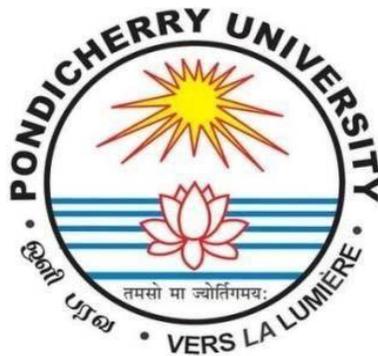


# **PONDICHERRY UNIVERSITY**

**(A CENTRAL UNIVERSITY)**



**NEP REGULATIONS**

**&**

**SYLLABUS & REGULATIONS FOR**

***B.Sc. (Honors) ZOOLOGY***

**(2023-24 onwards)**

[Affiliated Colleges]

# BACHELOR OF SCIENCE IN ZOOLOGY

## 1. DEFINITIONS

Terms used in the NEP Regulations shall have the meaning assigned to them as given below unless the context otherwise requires:

- i. **Credit:** A credit is the number of hours of instruction required per week for the given subject in a given semester of 16-18 weeks. One credit is equivalent to 15 hours of teaching (lecture or tutorial) or 30 hours of practice or field work or community engagement and service per Semester.
- ii. **Academic Year:** Means the year starting on 1st day of July and ends on the 30th day of June succeeding year.
- iii. **Residence time:** Means the time a student spends for attending classes in the College/Institution (either Online/Offline) as a full-time student and enrolled in any Academic programme of the Institution.
- iv. **Semester:** Means 18 weeks (90 Working days) of teaching-learning session of which two weeks shall be set apart for examinations and evaluation.
- v. **Grade:** Means a letter grade assigned to a student in a course for his/her performance at academic sessions as denoted in symbols of: O(Outstanding), A+(Excellent), A(Very good), B+(Good), B(Above average), C(Average), P(Pass), F(Fail) and Ab( Absent) with a numeric value of O=10, A+=9, A=8, B+=7, B=6, C=5, P=4, and F=0, Ab=0.
- vi. **Grade Point Average (GPA):** Means an average of the Grades secured by a student in all courses in a given academic session duly weighted by the number of credits associated to each of the courses.
- vii. **Cumulative GPA (CGPA):** Means the weighted average of all courses the student has taken in the entire programme of study.
- viii. **Common courses:** Means the set of courses that all students who are admitted are required to study; these courses include, Languages (English- Modern Indian languages), NEP specific courses viz. Understanding India, Environmental sciences/Education, Health and wellbeing/Yoga, and Digital & Technological solutions.
- ix. **Major Discipline Courses:** Means the core subjects mandatory for the Zoology discipline. These courses are common across all specializations of Zoology.

- x. **Minor Discipline Courses:** Means allied/elective/specialization specific subjects of Zoology discipline. Based on the set of Minor Discipline Courses the candidate study, specialization in zoology will be awarded. e.g. B.Sc. (zoology) with minor discipline courses in Botany and Chemistry will be awarded B.Sc. Zoology with Specialization in Botany and Chemistry.
- xi. **Credit Requirements:** For a Degree/Diploma/Certificate Programme means the minimum number of credits that a student shall accumulate to achieve the status of being qualified to receive the said Degree, Diploma/Certificate as the case may be.
- xii. **Exit option:** Means the option exercised by the student, to leave the Programme at the end of any given Academic year.
- xiii. **Lateral entry:** Means a student being admitted into an ongoing Programme of the University otherwise than in the 1<sup>st</sup> year of the programme.
- xiv. **Vocational Studies/Education:** Means set of activities for participation in an approved project or practical or lab, practices of application of scientific theories, studio activities involving students in creative artistic activities, workshop-based activities, field-based shop-floor learning, and Community engagement services, etc. **(These courses are expected to enable students to incorporate the learned skills in daily life and start up entrepreneurship.)**
- xv. **Skill-based learning/project:** Means activities designed to understand the different socio- economic contexts, first-hand understanding of the policies, regulations, organizational structures, processes, and programmes that guide the development process.
- xvi. **Work-based internship:** Means structured internships with Software Companies, Research and Higher Educational Institution Laboratories, Corporate offices, etc. which will further improve employability.

## 2. AWARD OF UG DEGREE/DIPLOMA/CERTIFICATE

Four years B.Sc. Degree programme shall have options for earning a UG Certificate/ Diploma/ Degree/ Degree with Honors based on the exit option exercised by the candidates.

## 3. DURATION OF THE COURSE

The Curriculum Framework designed by UGC for implementing NEP 2020 specifies that all Undergraduate (UG) degree programmes are to be for a period of either 3 years or 4 years leading to the award of UG Degree of UG(Hons)Degrees.

All UG courses shall focus on conceptual understanding and development of critical thinking in a given field of Study, incidentally the skills such as communication, teamwork, and leadership shall be embodied in Teaching-learning process to facilitate for career option in the given field of specialization.

#### 4. AGE LIMIT

The rules as applicable to other Under Graduate courses as prevailing in Pondicherry University.

#### 5. ELIGIBILITY FOR ADMISSION

Candidates for admission to B.Sc./B.Sc. (Hons.) Zoology shall require to have passed H.Sc. (or +2) or its equivalent with Botany/Zoology/Biology as one of the subjects of study, conducted by the Government of Tamil Nadu or any other equivalent system recognized by the Government of Puducherry based on the admission criteria laid down by Pondicherry University are eligible to apply.

#### 6. LATERAL ENTRY

As per NEP, students have a choice of entry into the Programme of study. UGC specifies that about 10% of seats over and above the sanctioned strength shall be allocated to accommodate the Lateral Entry students. The guidelines for lateral Entry are as follows:

1. Lateral Entry for II Year B.Sc. /B.Sc. (Hons.) Zoology:  
Student should complete **UG certificate in Zoology from** any University.
2. Lateral Entry for III Year B.Sc. /B.Sc. (Hons.) Zoology:  
Student should complete **UG Diploma course in Zoology** from any University.
3. Lateral Entry for IV Year B.Sc. (Hons.) Zoology:  
Student should complete **B.Sc. Zoology** from any University.

#### 7. PEDAGOGICAL APPROACHES

a) Lecture Courses	Regular classroom lectures by qualified / experienced Expert Teachers <ul style="list-style-type: none"><li>• These Lectures may also include classroom discussion, demonstrations, case analysis</li><li>• Use of Models, Audio-Visual contents, Documentaries, PPTs may supplement.</li></ul>
b) Tutorial Courses	Problem solving Exercise classes guided discussion, supplementary readings vocational training, etc.
c) Practical / Lab work	Practical Lab activity with Theoretical support Mini projects, Activity based engagement, Program executions, Data processing and presentation exercise.
d) Seminar Course	A course requiring student to design and participate in discussions, Group Discussions, Elocution and Debate, Oral Communication Paper presentations, Poster Presentation, Role play participation, Quiz competitions, Business plan preparation/presentation, etc.
e) Internship course	Courses requiring students to <i>Learn by Doing</i> in the workplace external to the educational Institutions. Internships involve working in Software Companies, Research and Higher Educational Institution Laboratories, Corporate Offices, etc. All Internships should be properly guided and inducted for focused learning.

f) Research Project	Students need to study and analyze the recent research publications from indexed/peer reviewed journals in their area of specialization. Outcome of the study and analysis need to be presented as a thesis or research report with necessary experimental results.
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## 8. ACADEMIC AUDIT OF COURSES

Internal Quality Assurance Cell at every institution is expected to supervise the implementation of NEP Regulations in these programmes. Availability of required number of Classrooms, Faculty rooms, Labs, Library facilities, Computer Centre and recruitment of Faculty members, allocation of funds for running the Science Labs/Computer Centre etc., is the responsibility of the College Administration.

## 9. COURSE STRUCTURE

All Academic Programmes offered under NEP shall be offered in terms of credits. Each course/subject in a given Programme of study shall carry certain number of credits which will be awarded on completion of the said course.

**12.1 EXIT OF THE COURSE:** NEP 2020 introduces the facility to breakdown the Programme of study at Undergraduate (UG) level after completion of every year of study. The students will be awarded the following:

1. Students who opt to exit after completion of first year will be awarded **UG Certificate in Zoology** provided they have earned a minimum of 42 credits and in addition, they have to complete work based vocational course/internship of 4 credits during the summer vacation of the first year.
2. Students who opt to exit after completion of second year will be awarded **UG Diploma in Zoology** provided they have earned a minimum of 84 credits and in addition, they have to complete work based vocational course/internship of 4 credits during the summer vacation of the Second year.
3. Students who opt to exit after completion of third year will be awarded **UG degree (B.Sc. in Zoology)**, provided they have earned a minimum of 124 credits.
4. Students who exit after completion of fourth year will be awarded either **B.Sc. (Hons.) Zoology**, provided they have earned a minimum of 164 credits or **B.Sc. (Hons. with Research) Zoology**, provided they have earned a minimum of 164 credits with Research Project.

## 10. MEDIUM OF INSTRUCTION

The medium of instruction for B.Sc. Zoology **shall be in English.**

## 11. Break up of Credits and Courses:

NEP Framework has specified the minimum number of credits that a Bachelor student has to earn in 3/4 year period. Table I specifies the number of credits and number of courses that a 3 year UG student and a four year UG (Hons) Degree student is expected to complete in 3 and 4-year duration respectively.

**TABLE-I**  
**BREAKUP OF CREDITS AND**  
**COURSES**

Sl. No.	Component	3 Year Degree	4 Year Hons Degree
1.	Major Disciplinary Courses	60 Credits (15 Courses of 4 credits each)	80 Credits (20 Courses of 4 credits each)
2.	Minor Disciplinary Courses	24 Credits (6 Courses of 4 Credits each)	32 Credits (8 Courses of 4 credits each)
3.	Multi-Disciplinary Courses	9 Credits (3 courses of 3 credits each)	9 Credits (3 courses of 3 credits each)
4.	Ability Enhancement Courses	12 Credits (4 courses of 3 credits each)	12 Credits (4 courses of 3credits each)
5.	Skill Enhancement Courses	9 Credits (3 courses of 3 credits each)	9 Credits (3 courses of 3 credits each)
6.	Common Value-added courses	8 Credits (4course of 2credits each)	8 Credits (4 course of 2 credits each)
7.	Winter Project / Internship Community Engagement	2 Credits (1 field-based course)	2 Credits (1 field-based course)
8.	Research Dissertation Project	-	12 Credits (Project report & background subjects)
9.	Total credits required	124 Credits	164 Credits

Every Undergraduate (UG) programme offered by a College shall confirm to the Structure specified by the UGC's Framework, 2023. A student of 3 year UG programme is mandated to complete a minimum of 124 credits and the student of 4 year Honors degree shall complete 164 credits. An UG student shall complete the following courses under different heads as listed below:

1. Major Disciplinary Courses
2. Minor Disciplinary Courses
3. Multi Disciplinary Courses
4. Ability Enhancement Courses
5. Skill Enhancement Courses
6. Value added/Common Courses
7. Internships and Community Service based projects

## 12. NEP Classification of Courses:

### i. Major Disciplinary courses (MJD): (60/80 Credits)

Major disciplinary courses are subject specific compulsory subjects that a student has to complete to obtain the UG / UG (Hons) Degree in the given discipline. Major disciplinary courses shall constitute 50% of the total credits.

All discipline specific major courses shall be designed for 4 credits each with one/two additional hours or guidance of teaching at Tutorials/Practicals. UG programmes may be offered in a single major discipline or in Multiple Major disciplines giving equal weightage in credits. For example, a B.Sc. course may be in a single discipline like B.Sc. (Maths) or with multiple major disciplines like B.Sc. (Maths, Physics & Chemistry).

#### i) Minor Disciplinary Course (MID): (24/32 Credits)

Minor disciplinary courses refer to those subjects which are Allied / Specialisation / Elective subjects to the Major discipline. These allied courses are expected to provide additional understanding of the subject in a specific focused area. For example, a B.A. (Political Science) student shall study allied subjects like Public Administration, Sociology as these subjects have inter linkages with the Major Disciplinary subjects.

#### ii) Multi-Disciplinary Courses (MLD): (9 Credits)

All undergraduate students are mandated to pursue 9credits worth of courses in such Multi-disciplinary areas/Courses out of 9/10 NEP defined subjects. Colleges may identify any 3 multiple disciplinary streams listed below based on availability of resources and manpower.

- a) Natural Sciences
- b) Physical Sciences
- c) Humanities / Social Sciences

Students are expected to learn basic/introductory courses designed by other departments for this purpose. Colleges may list any 3 introductory courses (one each in Natural Sciences, Physical Sciences, Humanities) for uniform adoption of all UG students.

#### iii) Ability Enhancement (AEC) courses: (8 Credits)

All Undergraduate (UG) students are mandated to complete at least 8 Credits worth of Courses which focus on Communication and Linguistic skills, Critical reading, and writing skills. These courses are expected to enhance the ability in articulation and presentation of their thoughts at workplace. Colleges may design these ability enhancement courses tuned to the requirements of given major discipline. E.g. A course in Business Communication is more appropriate in place of literature/prose/poetry.

**a) English /Language**

<b>Ability Enhancement Course</b>	
I. English Language a. English Language & Literature – 1 and 2 b. Functional English–1&2 c. Communicative English–1&2	II. Indian Language (two courses) a. Indian language & Literature –1 and 2 b. Functional language–1 &2 c. Communicative language-1&2

**iv) Skill Enhancement Course: (9 Credits)**

These courses focus at imparting practical skills with hands-on Training. In order to enhance the employability of students, Colleges are expected to design such courses that they deem fit for their students for better employment/entrepreneurship/career development, etc. Colleges may also outsource the Skill Enhancement Courses to AICTE approved agencies for conducting short term Training Workshops, Skill India initiatives of GOI and approved Trades by Skill development of corporation are to be considered. Short term courses.

**v) Value Added Common courses (VAC): (8 Credits)**

Under NEP, the UGC has proposed for 6 to 8 credits worth of common courses which are likely to add value to overall knowledge base of the students. These courses include:

- a) Understanding India
- b) Environmental Studies
- c) Digital Technologies
- d) Health, Wellness, Yoga Education, Sports & Fitness

The course structure and coverage of topics are suggested by UGC in its draft documents, University has hosted the Syllabus of the above courses in the University Website for reference of the colleges/Students.

**vi) Summer Internship (2 to 4 Credits)**

As per the UGC guidelines all UG students should be exposed to 4 to 6-week Summer Internship in an industrial organizations / Training Centres / Research Institution, etc. Such Summer Internship is to be conducted in between 4<sup>th</sup> Semester and 5<sup>th</sup> semester. A review of report and award of grade based on Work based learning by students is to be recorded during the 5<sup>th</sup> Semester.

**a) Community Engagement and Service (CES) (2 Credits)**

All UG students are also mandated to participate in a 15 days community engagement activity during their winter vacation between 3<sup>rd</sup> and 4<sup>th</sup> Semesters. This Community engagement activity is expected to expose the students to social problems of neighbourhood village students may prepare a report on the activities carried out for a award of 2 credits.

### 13. EVALUATION:

#### Total Marks: 100

All Credit courses are evaluated for 100 marks. Internal Assessment component is for 25 marks and the End Semester University exam is for 75 marks. In case of Practicals, Project work, etc., it is 50:50 marks for Internal and End-Semester Exams.

#### Breakup of Internal Assessment Marks:

Total Internal Assessment mark for a theory subject is 25 marks. The breakup is:

a)	Mid Semester Exam (one) -20 Marks
b)	Percentage of Attendance-5 Marks
<b>Total - 25Marks</b>	

Marks for Attendance are as follows:

Below75%	0
75%-80%	1
80%-85%	2
85%-90%	3
90%-95%	4
95%-100%	5

#### Internal Test Scheme:

Principal of the College schedules the Mid-Semester Exam for all courses during 8/9<sup>th</sup> week of start of classes. All faculty members are expected to conduct this Mid-Semester exam for 1.30 hr duration and evaluate, upload the marks to Controller of Examinations of University. Colleges are also requested to preserve the answer books of Mid-Semester exams until declaration of results by the University.

Internal Assessment marks for Practicals / Project work / Internships subjects:

Faculty member in-charge of Lab practicals shall evaluate the practical subjects for 50 marks. The breakup is as follows:

a) Observation note / Demo note/ Work dairy / etc.	20
b) Practical Record/ Internship Report / etc.	30
<b>Total</b>	<b>50</b>

#### End-Semester University Exam:

Controller of Examinations (COE) of Pondicherry University schedules the End-Semester exams for all theory and practical subjects based on University calendar.

A detailed Exam Time Table shall be circulated to all Colleges at least 15 days before the start of exams mostly during 15/16<sup>th</sup> week of the Semester. Question Papers shall be set externally based on BOS approved syllabus. All students who have a minimum of 70% attendance are eligible to attend the end-semester exams. The breakup of end semester marks:

a) Theory subjects: (Sec A, Sec B and Sec C) Questions from all units of syllabus	75marks
b) Practical/Internship Project Work subjects (Based on Practical Exams/Presentation/Viva)	50marks

#### Consolidation of Marks and passing Minimum:

Controller of Examinations of the University consolidates the Internal Assessment marks uploaded by the Colleges and marks secured by students in end-semester examination. The total marks will be converted into letter grades as shown in the following Table 2. As per NEP Regulations, the passing minimum is 50% marks (IA + End semester put together) However, Pondicherry University considers 40% marks as pass during first 3 years of study and students who secured less than 50 will be awarded 'P' (Pass Grade)

#### Arrear Exam:

A student who failed to secure 40% marks in aggregate is declared as Failed and he is eligible to take up supplementary examination by registering to the said course in the following Semester. All other candidates who failed due to shortage of attendance, those who are seeking to improve the grade shall repeat the course.

#### Letter Grades and Calculation of CGPA:

Total Marks Secured by a student in each subject shall be converted into a letter grade. UGC Framework has suggested a Country wide uniform letter grades for all UG courses. The following Table shows the seven letter grades and corresponding meaning and the grade points for calculation of CGPA.

**TABLE-2**

<b>Equivalent Grade</b>	<b>Letter</b>	<b>Meaning</b>	<b>Grade Points for Calculation of CGPA</b>
	O	Outstanding	10
	A+	Excellent	9
	A	Very Good	8
	B+	Good	7
	B	Above Average	6
	C	Average	5
	P	Pass	4
	F	Fail	0
	Ab	Absent	0

In order to work out the above letter grades, the marks secured by a student (Total of IA and Semester End) would be categorized for relative grading.

The ranges of marks for each grade would be worked as follows:

Highest marks in the given subject = X  
 Cut of marks for grading purpose =50marks  
 Passing mark (for 3 years of UG) =40  
 Number of grades (excepting P grade) (O, A+, A, B+, B, C)=6  
 Range of marks =K

$$K = \frac{x - 50}{G}$$

The following table given the range of marks and letter grades. According to K value, one of the following grading schemes will be followed.

(i) If  $K \geq 5$ , then the grades shall be awarded as given in Table II.

<b>Table II</b>		
<b>Range of Marks in%</b>	<b>Letter Grade Points for</b>	<b>Letter Grade Points for</b>
X to (X-K) +1	O	10
(X-K) to(X-2K) +1	A+	9
(X-2K) to (X-3K) +1	A	8
(X-3K) to (X-4K) +1	B+	7
(X-4K) to (X-5K) +1	B	6
(X-5K) to 50	C	5
40 –49	P	4
Below 40	F	0
Absent (Lack of Attendance)	Ab	0

(ii) If  $K < 5$ , then the grades shall be awarded as given in Table III.

<b>Table III</b>		
<b>Range of Marks in%</b>	<b>Letter Grade Points for</b>	<b>Letter Grade Points for</b>
80-100	O	10
71-79	A+	9
66-70	A	8
61-65	B+	7
56-60	B	6
50-55	C	5
40-49	P	4
Below40	F	0
Absent (lack of attendance)	Ab	0

Calculation of Semester Grade Point average and CGPA:

Semester Grade Point Average (SGPA) is calculated by taking a weighted average of all grade points secured by a candidate from all subjects registered by him/her in the given Semester. The weights being the number of credits that each subject carry.

Cumulative Grade Point Average (CGPA) CGPA shall be calculated as the weighted average of credits that course carries and the value of Grade points averaged for all subjects.

Computation of SGPA and CGPA

The following procedure shall be followed to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

The SGPA is the ratio of the sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student,

$$\text{i.e. SGPA}(S_i) = \frac{\sum(C_i \times G_i)}{\sum C_i}$$

Where  $C_i$  is the number of credits of the  $i^{\text{th}}$  course and  $G_i$  is the grade point scored by the student in the  $i^{\text{th}}$  course.

(i) *Example for Computation of SGPA where candidate has not failed in any course.*

Semester	Course	Credit	Letter Grade	Grade point	Credit Point (Credit x Grade)
I	Course1	3	A	8	3X8=24
I	Course2	4	B+	7	4X7=28
I	Course3	3	B	6	3X6=18
I	Course4	3	O	10	3X10=30
I	Course5	3	C	5	3X5=15
I	Course6	4	B	6	4X6=24
		20			139
	SGPA				139/20=6.95

(ii) *Example for Computation of SGPA where candidate has failed in one course.*

Semester	Course	Credits	Letter Grade	Grade point	Credit Point (Credit x Grade)
I	Course1	3	A	8	3X8=24
I	Course2	4	B+	7	4X7=28
I	Course3	3	B	6	3X6=18
I	Course4	3	O	10	3X10=30
I	Course5	3	C	5	3X5=15
I	Course6	4	F	0	4X0=00
		20			115
	SGPA				115/20=5.75

(ii) Example for Computation of SGPA where candidate has failed in

Semester	Course	Credit	Letter Grade	Grade point	Credit Point (Credit x Grade)
I	Course1	3	A	8	3X8=24
I	Course2	4	B+	7	4X7=28
I	Course3	3	F	0	3X0=00
I	Course4	3	B	6	3X6=18
I	Course5	3	C	5	3X5=15
I	Course6	4	F	0	4X0=00
		20			85
	SGPA				85/20=4.25

two courses.

The CGPA shall also be calculated in similar way as shown in examples (i), (ii) and (iii) of SGPA for all subjects taken by the students in all the semesters. However, if any student fails more than once in the same subject, then while calculating CGPA, the credit and grade point related to the subject in which the student fails in multiple attempts will be restricted to one time only. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

In case of audit courses offered, the students may be given (P) or (F) grade without any credits. This may be indicated in the mark sheet. Audit courses will not be considered towards the calculation of CGPA.

### **DECLARATION OF RESULTS:**

Controller of Examinations (COE) of the University shall declare the results of given UG programme following the CGPA secured by students by the end of 6<sup>th</sup> Semester and 8<sup>th</sup> Semester.

### **PASS CLASSES**

Range of CGPA	Result
9.0 above	First Class with distinction
6.0 above	First Class
5.0 Below 5.99	Second Class
4.0 4.99	Pass Class

## 14. CURRICULUM

FIRST SEMESTER							
S.No	Component	Course Code	Title of the Course	Credits	Hours/Week		
					L	T	P
1	MJD 1		Biology of Invertebrates-I (theory & practical)	4	3		2
2	MID 1		Wildlife Conservation (Theory & Practical) (or) Fundamentals of Zoology (Theory & Practical) (or) Zoonotic Diseases of Humans and Animals (Theory & Practical)	4	3		2
3	MLD 1		Natural Sciences (Hosted in the University Website)	3	4		
4	AEC 1		English I	3	3		3
5	SEC 1		Aquaculture (or) Sericulture (or) Ecotourism	3			4
6	VAC 1	XX1VA01	Understanding India	2	4		
7	VAC 2	YY1VA02	Environmental Studies	2	4		
<b>Total</b>				<b>21</b>	<b>30 Hours</b>		

SECOND SEMESTER							
S.No	Component	Course Code	Title of the Course	Credits	Hours/Week		
					L	T	P
1	MJD 2		Biology of Invertebrates – II (Theory & Practical)	4	3	1	2
2	MID 2		Public Health and Hygiene (Practical & Theory) (or) Basic Immunology (Theory & Practical) (or) Value Added Products of Animals (Practical & Theory)	4	4		
3	MLD 2		Physical Sciences (Hosted in the University website)	3	4		
4	AEC 2		Indian Language I	3	3		3
5	SEC 2		Vermitechnology (Theory & Practical) (or) Dairy Production Technology (Theory & Practical) (or) Ornamental Fish Culture (Theory & Prac.)	3			4
6	VAC 3	XX2VA03	Digital Technologies	2	4		
7	VAC 4	CS2VA04	Health & Wellness/Yoga Education	2	4		
<b>Total</b>				<b>21</b>	<b>30 Hours</b>		

<b>THIRD SEMESTER</b>							
S.No	Component	Course Code	Title of the Course	Credits	Hours/Week		
					L	T	P
1	MJD 3		Biology of Vertebrates (Practical & Theory)	4	3	1	2
2	MJD 4		Comparative Anatomy of Vertebrates (Theory & Practical)	4	3	1	2
3	MID 3		Economic Zoology (Practical & Theory) (or) Agricultural Entomology (Theory & Practical) (or) Food, Nutrition and Health (Practical & Theory)	4	4		
4	MLD 3		Humanities/Social Sciences (Hosted in the university website)	3	2		2
5	AEC 3		English II	3	3		3
6	SEC 3		Apiculture (Theory & Practical) (or) Medical Laboratory Technology (Theory & Practical) (or) Public Health Management	3			4
<b>Total</b>				<b>21</b>	<b>28 Hours</b>		

<b>FOURTH SEMESTER</b>							
S.No	Component	Course Code	Title of the Course	Credits	Hours/Week		
					L	T	P
1	MJD 5		Cell Biology (Theory & Practical)	4	3	1	2
2	MJD 6		Ecology And Ecosystems (Theory & practical)	4	4		
3	MJD 7		Genetics (Theory & Practical)	4	3	1	2
4	MID 4		Genetic Engineering (or) Microbiology (Theory & Practical) (or) Environmental Biotechnology	4	4		
5	AEC 4		Indian Language II	3	3		3
6	Project	1	Community Engagement and Service	2			6
<b>Total</b>				<b>21</b>	<b>30 Hours</b>		

<b>FIFTH SEMESTER</b>							
S.No	Component	Course Code	Title of the Course	Credits	Hours/Week		
					L	T	P
1	MJD 8		Animal Physiology	4	3	1	2
2	MJD 9		Developmental Biology	4	3	1	2
3	MJD 10		Biochemistry and Molecular Biology	4	3	1	2
4	MID 5		Toxicology (or) Forensic Entomology (or) Tools and Techniques	4	4		
5	MJD 11		Summer Internship	4			6
<b>Total</b>				<b>20</b>	<b>28 Hours</b>		

<b>SIXTH SEMESTER</b>							
S.No	Component	Course Code	Title of the Course	Credits	Hours/Week		
					L	T	P
1	MJD 12		Endocrinology (Theory & Practical)	4	3	1	2
2	MJD 13		Biotechnology (Theory & Practical)	4	3	1	2
3	MJD 14		Evolution and Ethology (Theory & Practical)	4	3	1	2
4	MJD 15		Public Health Entomology (Theory & Practical)	4	4		
5	MID 6		Vectors and Diseases (or) Reproductive Biology (or) Medical Microbiology	4	4		
<b>Total</b>				<b>20</b>	<b>26 Hours</b>		

<b>SEVENTH SEMESTER (Honors)</b>							
S.No	Component	Course Code	Title of the Course	Credits	Hours/Week		
					L	T	P
1	MJD 16		Immunology (Theory & Practical)	4	3		2
2	MJD 17		Biostatistics and Bioinformatics	4	3		2
3	MJD 18		Fishery Biology (Theory & Practical)	4	3		2
4	MID 7		Environmental Pollution and Human Health (Theory & Practical) (or) Life Style Diseases and Management (Theory & Practical) (or) Nanobiology	4	3		2
5	MID 8		Animals and Human Welfare (or) Neurobiology (or) IPR, Biosafety and Bioethics	4	4		
<b>Total</b>				<b>20</b>	<b>25 Hours</b>		

<b>EIGHTH SEMESTER B.Sc. Zoology (Hons)</b>							
S.No	Component	Course Code	Title of the Course	Credits	Hours/Week		
					L	T	P
1	MJD 19		Bio-Instrumentation and Techniques (Theory & Practical)	4	3	1	2
2	MJD 20		Research Methodology	4	3	1	2
3	MJD 21		Comparative Physiology (Theory & Practical)	4	3	1	
4	MJD 22		Advanced Biotechnology	4	3	1	
5	MJD 23		Reproductive Physiology (Theory & Practical)	4	3	1	
<b>Total</b>				<b>20</b>	<b>24 Hours</b>		

**EIGHTH SEMESTER – B.Sc. Zoology  
(Hons with Research Project)**

S.No	Component	Course Code	Title of the Course	Credits	Hours/Week		
					L	T	P
1	MJD 19		<b>Bio-Instrumentation and Techniques (Theory &amp; Practical)</b>	4	3	1	2
2	MJD 20		<b>Research Methodology</b>	4	3	1	2
3	MJD 24		<b>Research Project</b>	4			
4	MJD 25		<b>Project Report</b>	4			
5	MJD 26		<b>Project Viva-voce</b>	4			
<b>Total</b>				<b>20</b>	<b>24 Hours</b>		

## **SEMESTER -I**

### **MJD-1: BIOLOGY OF -INVERTEBRATES -I**

#### **Objectives:**

1. To understand Biodiversity, Habitat, Adaptation organization and taxonomic status of invertebrates.
2. Explaining the basic aspects of classification, structural and functional details of Invertebrates.

#### **Course outcome**

Foster an awareness of the diversity of life on Earth. Learn about various biological diversity levels by looking at the Lower non-chordate fauna's systematic classification. Become familiar with animal taxonomy identification. Recognize the importance of invertebrate fauna in evolution.

#### **Syllabus:**

##### **Unit-I**

**[12 hrs]**

General principles of animal taxonomy, Binomial nomenclature, Whitaker's five kingdom concept, Classification of animal kingdom.

Phylum Protozoa: General characteristic features of Protozoa up to classes with suitable example. Type study: Paramecium, Protozoan parasites of man.

Phylum Porifera: General characteristic features of Porifera up to order up to classes with suitable example. Type study: leucosolenia

##### **Unit-II**

**[08 hrs]**

Phylum Cnidaria: General characteristic features of Cnidaria up to up to classes with suitable example. Type study: Obelia

Phylum Ctenophora: General characteristic features of Ctenophora up to up to classes with suitable example.

##### **Unit-III**

**[08 hrs]**

Phylum Platyhelminthes: General characteristic features of Platyhelmines up to classes with suitable example. Type study: Tape worm

**Unit-IV****[09 hrs]**

Phylum Ashelminthes: General characteristic features of Ashelminthes up to classes with example. Type study: Ascaris, Parasitic namatodes of Man-Mode of infection, treatment and preventive measures.

**Unit-V****[08 hrs]**

Phylum Annelida: General characteristic features of Annelida up to classes with suitable example. Type study: Nereis

**Reference Books**

1. Kotpal, R. L.,2000, Modern Text Book of Zoology –Invertebrates, 8th Revised dition(Reprint), Rastogi Publications, Meerut – 250 002.
2. Ayyar, E.K. and T.N. Ananthkrishnan, 1992.Manual of Zoology Vol. 1 (Invertebrate), Part I & II.S. Viswanathan (Printers and Publishers) Pvt Ltd., Madras, 991p.
3. Jordan, E.L. and P.S. Verma, 2010, Invertebrate Zoology, S. Chand & Co Ltd., Ram Nagar, New Delhi.
4. Hyman volume I to VI, 1955, McGraw Hill Co. New York.
5. Barnes R.D (1992) Invertebrate Zoology IV Edn. Holt saunders International Edn.

## MJD-1: BIOLOGY OF -INVERTEBRATES-I PRACTICAL

### SPOTTERS:

#### A- Classify giving reasons up to order:

1. Paramecium
2. Scypha
3. Aurelia
4. Fasciola
5. Ascaris
5. Leech

#### B- Draw labeled sketches:

6. L.S. Sponge
7. Obelia medusa
8. Physalia
9. Ephyra larva
10. Cercaria larva
11. Miracidium larva
12. Redia Larva

#### C- Comment on Biological significance:

13. Entamoeba
14. Paramecium – Conjugation
15. Plasmodium
16. Obelia colony
17. Taenia – Mature proglottid
18. Ascaris
19. Heteroneries

#### D – Relate structure and function:

19. Sponge – Spicules
20. Taenia – Scolex
21. Nereis- Parapodium

### I. DISSECTION

1. Earthworm - Nervous system

### II. MOUNTING

1. Earth worm- Body setae and Penial setae
2. –Neries Parapodium.

## **MID-1: WILDLIFE CONSERVATION**

### **UNIT-1: CONCEPT OF BIODIVERSITY, HUMAN-WILD LIFE INTRACTION**

**[5 HRS]**

Definition, Levels, Values, Measurement of Biodiversity; Concept of Wildlife. Man-animal conflict in India; Human-wildlife Coexistence; Eco-tourism; Wildlife Crimes, Sustainable Utilization of Biodiversity Resources.

### **UNIT-2: CONSERVATION OF BIODIVERSITY**

**[12 HRS]**

Factors causing biodiversity degradation, Concept of species extinction. In situ conservation (Biosphere Reserves, National Parks, Wildlife Sanctuaries, Conservation Reserves, Community reserves, Sacred Habitats), Ex-situ conservation (Botanical & Zoological Gardens, Gene Banks, Seed And Seedling Banks, Pollen Culture, Tissue Culture and DNA banks, Butterfly Gardening); Concept of Biodiversity Hotspots and Mega-diversity Country. Traditional Ecological Knowledge and documentation of local biodiversity.

### **UNIT-3: BIODIVERSITY AND WILDLIFE RESOURCES IN INDIA**

**[8 HRS]**

Biodiversity of Indian subcontinent, Bio-geographical region in India, India as a mega diversity nation; India's National Biodiversity Action Plan, Biodiversity hotspot in India; Species conservation projects in India (Tiger, Rhino, Lion, Turtles, Crocodiles, Birds, Coral reefs).

### **UNIT-4: ESTIMATION OF WILDLIFE AND ITS HABITAT**

**[8 HRS]**

Species Census methods; Species sampling method (Quadrat, Line Transect, Belt Transect, Pit fall, Mark-Recapture technique, Radio-telemetry etc.); Ethics in Field Studies. Methods of recording field observations; Essential Field kit and its usage; Data analysis.

### **UNIT-5: NATIONAL AND INTERNATIONAL PROTECTION MEASURES; WILDLIFE PHOTOGRAPHY**

**[12 HRS]**

**Wild Life Protection** - Indian Wildlife (Protection) Act, 1972, Concept of Schedule in Wildlife Protection; Indian Biodiversity Act 2002; IUCN Red list of Threatened Species; The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

**Wildlife Photography** - Basic Principles; Fundamentals of camera lenses and accessories; Learning to see, Finding the best subject, Positioning the subject, Utilizing colour, lines, shapes, patterns and texture; Techniques for photographing mammals, birds, fish, insects, reptiles, and amphibians; Composition on landscape photography; Ethics; Legalities.

## **Suggested Reading**

1. Krishnamurthy, K. V. 2003. Textbook of Biodiversity. Science Publication.
2. Groom, M. J., Meffe, G. R. and Carroll, C. R. 2006. Principles of Conservation Biology, Sinauer Associates, Inc., USA.
3. Rangarajan M. (2001) India's Wildlife History. Permanent Black, New Delhi, India.
4. M.Kato. The Biology of Biodiversity, Springer.
5. J.C. Avise. Molecular Markers, Natural History and Evolution, Chapman & Hall, New York.
6. E.O. Wilson. Biodiversity, Academic Press, Washington.
7. G.G. Simpson. Principle of animal taxonomy, Oxford IBH Publishing Company.
8. E. Mayer. Elements of Taxonomy.
9. E.O. Wilson. The Diversity of Life (The College Edition), W.W. Northem & Co. o
10. B.K. Tikadar. Threatened Animals of India, ZSI Publication, Calcutta.

## **MID-1: WILD LIFE CONSERVATION PRACTICAL**

Field work and educational excursion in an ecosystem:

1. Practical aspects of wildlife biology will be covered viz., identification & characterization of floral and faunal diversity in any wildlife habitats (Mountain, Hill, Forest etc.) of India.
2. Participants will be required to undertake exercises in habitat description, mapping and evaluation, estimation of wildlife populations.
3. The participants will be given hands-on training to analyse the data collected in the field using software with field report.
4. Basic techniques on Wildlife Photography

## MID-1: FUNDAMENTALS OF ZOOLOGY

### (For other Majors as Allied)

**Objectives:** Students will be able to identify the major group of organisms with an emphasis on animals and be able to classify them within a phylogenetic framework.

Students will be able to compare and contrast the characteristics of animals that differentiate them from other forms of life.

### **Programmes Outcomes:**

Students gain knowledge and skills in the fundamentals of Animal Sciences, understand the complex interaction among various living organisms.

#### **UNIT I:** (8 Hrs)

General classification of Animal kingdom- general characteristics of Invertebrate, Chordates and Vertebrata.

#### **UNIT II:** (9 Hrs)

Protozoan parasites of human (Entamoeba, Trypanosoma), Canal system in sponges, Polymorphism in coelenterates, Helminth parasites of human (Tapeworm, Ascaris), Coelom and its significance.

#### **UNIT III:** (8 Hrs)

Respiration in Arthropods. Metamorphosis in Insects. Economic importance of mollusca. water vascular system in Echinodermata, Larval forms in Echinodermata.

#### **UNIT IV:** (10 Hrs)

Life cycle and retrogressive metamorphosis in Ascidia. Life cycle of Amphioxus. Life cycle of Balanoglossus and affinities.

#### **UNIT V:** (10 Hrs)

Accessory respiratory organ in Fishes, Migration of Fishes. Parental care of Amphibia. Poisonous snakes of India. Flight adaptation in birds. Placenta in Mammals.

### **Suggested Readings:**

1. Ekambaranatha Ayyar, M and Ananthakrishnan, T.N. 1993, Outlines of Zoology, Vol.I and II, Viswanathan and Co. Madras.
2. Jordan, E.K. and P.S. Verma, 1993. Chordate Zoology, 12th edition, S. Chand & Co. Ltd., Ram Nagar, New Delhi.
3. Text book of Invertebrata – N.Arumugam et al., (2008) Saras Publications Nagerkovil 4. P.S. Dhami and J.K. Dhami – Invertebrate Zoology – S.Chand and Co. New Delhi.
5. Invertebrate Zoology – R.L.Kotpal, (2005) Rastogi Publications, Meerat.

## MID-1: FUNDAMENTALS OF ZOOLOGY PRACTICAL

1. Prawn Digestive -Nervous system
2. Cockroach Digestive - Nervous system
3. Earth worm - Body setae
4. Mosquito - Mouth parts
5. Prawn – Appendages
6. Spotters: Amoeba, Paramecium, Entamoeba, Sycon, *Obelia*, Aurelia, *Fasciola*, *Taenia*, Ascaris – Male & Female, Leech, Fresh water mussel, star fish, Amphioxus, Ichthyophis, Cobra, Pigeon (feathers) and Rabbit.

## MID-1: ZOO NOTIC DISEASES OF HUMANS AND ANIMALS

### Course Objectives:

Students should be able to:

- Recognize and comprehend the zoonotic potential of diseases presented after successfully completing the course.
- Recognize the epidemiology of zoonotic illnesses that pose a serious threat to public health.
- Explain the role zoonotic illnesses play in public health.
- Specify the path(s) by which the main zoonotic illnesses are transmitted.
- Enumerate notable achievements in zoonotic disease public health (and provide justification for each success).
- List the main zoonotic disease prevention and control strategies for both individuals and populations.
- Enumerate the groups that are most susceptible to the particular zoonotic illnesses that will be covered in the course.
- Recap the variations between industrialized and developing nations with respect to zoonotic disease prevalence and risk (and the reasons for these disparities)

### Course outcome

The following competencies are reinforced or gained primarily via this course: Providing an account of the genetic, physiological, and psychological elements that influence an individual's vulnerability to negative health consequences after being exposed to environmental risks. The ability to analyse and interpret epidemiologic data; a description of methods for identifying, preventing, and controlling environmental hazards that endanger human health and the environment; and the application of epidemiologic knowledge and technique in a relevant field or applied setting.

### Unit: I

[08 hrs]

Principles of Zoonoses, Human Viral Diseases: Rabies, AIDS and Covid-19.

Zoonotic Viral Diseases of Human: Encephalitis Influenza, Lymphocitic, Choriomeningitis, Monkey pox.

### Unit: II

[10 hrs]

Zoonotic Bacterial Diseases of Human: Rat-bite fever, Staphylococcosis, Vibriosis, Yersiniosis Anthrax, Cat Scratch Disease, Leptospirosis, Tuberculosis, Brucellosis, Salmonellosis, Botulism. Bacterial Diseases Animals: Pasteurellosis, Psittacosis, Listeriosis, Q fever.

**Unit: III****[10 hrs]**

Vector Borne Bacterial Diseases: Lyme disease, Rocky Mountain spotted fever, Ehrlichiosis, Leishmaniasis, Plague, and Tularemia. Vector borne parasitic diseases: Chikungunya, Dengue and severe dengue, Yellow fever, Zika virus, Malaria, Japanese encephalitis, Lymphatic filariasis, Leishmaniasis.

**Unit: IV****[09 hrs]**

Protozoans Parasitic diseases of Human: Babesiosis, Cryptosporidiosis, Giardiasis, Toxoplasmosis, Round Worm Infections, Tapeworm Infections, Trichinosis, TSEs: BSE, Chronic Wasting Disease, Scrapie.

**Unit: V****[08 hrs]**

WHO, CDC, NCDC, NCVBDC, ICMR, VCRC, NIRT, NIP, NIP, NIMR, NARFBR, VIDRL, NIV, NLEP, NTEP, NARI.

**References:**

- Handbook of Zoonoses: Identification and Prevention by J. L. Colville and D. L. Berryhill. 2007 ISBN: 978-0-323-04478-3.
- Human-Animal Medicine: Clinical Approaches to Zoonoses, Toxicants and Other. Shared Health Risks by Rabinowitz and Conti. 2009 ISBN: 978-1416068372.

**MID-1: ZOONOTIC DISEASES OF HUMANS AND ANIMALS -PRACTICAL**

1. Identification of vectors.
2. Identification Bacterial diseases.
3. Identification of Viral diseases
4. Identification of Protozoan parasites
5. Institute Models: CDC

## SEC-1

### **A) AQUACULTURE**

**About the course:** This course will give the students an understanding of the principles of aquaculture, including production systems, water quality, nutrition, spawning, larval culture and culture methodologies with special reference to fish, and prawns. The course will include an opportunity to conduct hands-on activities related to culture and husbandry of animals.

**Learning outcomes:** After completing this course the learners will be able to

- understand the aquaculture systems
- Understand conditioning factors and how they can be manipulated
- Describe water depuration mechanisms
- Understand the environmental impacts of aquaculture

#### **Unit I: Freshwater Aquaculture Systems**

**13 Lectures**

Aquaculture concept, Culture systems: Freshwater prawn culture, fish culture in paddy fields, Brackish water culture, Mariculture: Oyster culture, Crab culture, Lobster culture, mussel culture, culture of Eels, Culture of aquatic weeds. Composite fish culture: Definition and various patterns. Mixed fish farming in India. Techniques of composite culture. Culture of buffalo fish. Culture of Catfishes. Culture of miscellaneous fishes. Crayfish culture.

#### **Unit II: Preparation and management of fish culture ponds**

**13 Lectures**

Nursery ponds. Predatory and Weed fishes and their control. Fish toxicants. Fertilization. Aquatic insects and their control. Fish food organisms and their production. Supplementary feeding. Transport of fish seed and Brood fish. Causes of mortality in transport. Methods for packaging and transport. Open systems. Closed systems. Use of chemicals in live fish transport. Anesthetic drugs. Antiseptics and Antibiotics.

#### **Unit III: Fish Pathology**

**13 Lectures**

Parasitic infections. Fungus infections. Protozoan diseases. nematode diseases. Non-parasitic diseases. Rearing ponds, Stocking ponds. Fish breeding: Natural and artificial. Harvesting: Fishing techniques, preservation & processing of fish. Freshwater prawn culture. Introduction. Breeding characteristics. Juvenile prawn migration. Seasonal & regional distribution of seeds. Identification of juveniles. Controlled breeding. Culture: Ponds, Monoculture. Mixed culture.

#### **Unit IV: Technologies in Fisheries Development**

**13 Lectures**

Role of hard water in the culture of *Macrobrachium* species. Fertilization & feeds. Pearl culture: Introduction, Pearl-producing mollusks, pearl formation, collection of oysters, rearing of oysters, insertion of the nucleus, harvesting of pearls, composition & quality of the pearl. Recirculation technology,

**Unit-V: Geographic Information System (GIS) technology**, Passive Acoustics in fisheries, Use of Information Communication Technology (ICT) in fishes: production aspects, marketing aspects.

#### **Recommended readings**

1. Jingran, V. G. (1983) Fish and fisheries of India, Hindustan pub. corp. New Delhi.
2. Hute, M. and Kahn, H. (2000) Textbook of fish culture, Blackwell Scientific Publication, Australia.
3. Srinivasulu, M., Reddy, K.R.S., Rao, S. (1999) Textbook of Aquaculture, Discovery Publishing House New Delhi.
4. Yawn Mehta, Fisheries & Aquaculture Biotechnology (2011) Campus Books International, Prahalad street, Ansari Road, DurgaGanj, New Delhi.

## SEC-1

### **B) SERICULTURE**

<b>Unit I.</b>	<b>7</b>
Scope and history of sericulture, Systematic position of Silkworm, Species of silkworm, Biology and life history of mulberry silk worm <i>Bombyxmori</i> .	
<b>Unit II.</b>	<b>8</b>
Sericulture Industry. Major steps and requirements of sericulture, Species of Mulberry, Types of Mulberry plantation.	
<b>Unit III.</b>	<b>14</b>
Rearing of silkworm - steps in rearing, grainage management-supply of seed to rearers and commercial rearing-spinning of cocoons-marketing of cocoons, post cocoon processing-stifling, reeling and spinning. Silk and chemical nature	
<b>Unit IV.</b>	<b>6</b>
Diseases of Silkworm - causative agents, symptoms and counter measures of maggot disease, fabrine, polyhedrosis, flacherie, green muscardine.	
<b>Unit V.</b>	<b>10</b>
Economic importance of silk- Status of sericulture industry in India- National sericulture projects (NSP)-Central silk board (CSB)-Silk development and Research – Stations and Regional Silk Research institutions.	

### **Suggested Readings**

1. A Text Book of Sericulture. Dr. HFM. Raj.
2. A Text Book on Sericulture. Rearing and Management. Dr. Jyoti Das.
3. Economic Zoology. Sukhla and Upadhaya. Rastogi Publication.
4. An Introduction to Sericulture. Dr. G. Ganga and Dr. J. Sulochana Shetty. Oxford and IBH publishing. New Delhi.
5. A hand Book of Sericulture and Silk Production. PrabhaShekar and Martin Hardingha.

## SEC-1

### **C) ECOTOURISM**

**About the course:** This course is designed to provide students with an understanding of the management and planning of ecotourism opportunities. The course will give students to the concept of ecotourism and its economic, cultural, and environmental impacts at different scales. Students will learn the methods through which ecotourism can be marketed and managed, together with its potential adverse impacts.

**Learning outcomes:** Upon successful completion of this course, the student should be able to:

- Identify and manage for ecological impacts on soil, water, vegetation, and wildlife resulting from recreation and tourism development;
- Understand ecological impacts and ecotourism management approaches in a variety of ecosystems under diverse landowners;
- Ability to analyze the environmental and social consequences of ecotourism management strategies and decisions;
- Understand management tools to reduce visitor-related impacts that occur ecotourism areas (impacts of outdoor recreation include impacts to soil, vegetation, water, wildlife, air, soundscape, night sky, historical/cultural resources, visitor experiences, and facilities/services).

#### **Unit I: Baseline information about Ecotourism**

**13 Lectures**

History of ecotourism and its definitions. Types of Tourism: Extreme tourism and Mass tourism. Why is mass tourism NOT eco-friendly? Evolution and characteristics of ecotourism, relevance of responsible tourism. World Ecotourism Summit- policies and formulations How ecotourism development can benefit future generations. Ecotourism as a tool of capacity building and conservation.

#### **Unit II: Ecotourism as an Industry**

**13 Lectures**

Ecotourism is a growth sector within the tourism industry. Tourist resorts. Environmental, socio-cultural, and economic impacts of ecotourism. Viewpoints on tourism industry and major constituents, Tourism organizations – international, national, state level and private sector, Importance of tourism statistics. Tourism industry in India, Ecotourism in Kerala possibilities and problems.

**Unit III: Management functions and practices in tourism****[12 Lectures]**

Tourism policies and planning, Involvement of local bodies and officials in tourism, Coordination between tourists and hosts, Tourism products and operations, Tourist sites and attractions. Managing personnel in tourism, Managerial practices in tourism, Tourism services and management, Seasonality and destination in tourism, and Preparation of maps and charts.

**Unit IV: Marketing ecotourism****[ 13 Lectures]**

Tourism marketing- definition, concepts, and features Advertising and publicity in tourism. Role of media in tourism, Tourism writing. Communication skills and tourism Ecotourism and competing resource users. International and domestic tourism markets, Marketing research and analysis, Tourism forecasting and use of technology in tourism marketing, Airlines, Travel Agency, hotel accommodation, tour packages marketing etc.

**Recommended readings**

1. Mowforth, M., & Munt, I. (2009). Tourism and sustainability (3rd Edition). London, UK: Routledge.
2. Newsome, D., Moore, S.A., & Dowling, R.K (2002). Natural area tourism. Bristol, UK: Channel View. (Publications.
3. Weaver, D. (2008). Ecotourism (2nd Edition). Hoboken, NJ: JS Wiley. Staff :Dr.Julian Clifton

## **SEMESTER - II**

### **MJD-2: BIOLOGY OF INVERTEBRATES II**

#### **Unit-I:**

Phylum Onychophora: General characteristic features of Onychophora up to classes with suitable example. Type study: Velvet worm

#### **Unit-II:**

Phylum Arthropoda: General characteristic features of Arthropods up to classes with suitable example. Type study: Cockroach

#### **Unit-III:**

Phylum Mollusca: General characteristic features of Mollusca up to classes. Type study: Pila

#### **Unit-IV:**

Phylum Echinodermata: General characteristic features of Echinodermata up to order. Type study: Sea star

#### **Unit-V:**

Phylum Hemichordata: General characteristic features of Hemichordata up to order. Type study: Balanoglossus

#### **Reference Books**

1. Kotpal, R. L., 2000, Modern Text Book of Zoology –Invertebrates, 8th Revised edition(Reprint), Rastogi Publications, Meerut – 250 002.
2. Ayyar, E.K. and T.N. Ananthkrishnan, 1992. Manual of Zoology Vol. 1 (Invertebrate), Part I & II. S. Viswanathan (Printers and Publishers) Pvt Ltd., Madras, 991p.
3. Jordan, E.L. and P.S. Verma, 2010, Invertebrate Zoology, S. Chand & Co Ltd., Ram Nagar, New Delhi.
4. Hyman volume I to VI, 1955, McGraw Hill Co. New York.
5. Barnes R.D (1992) Invertebrate Zoology IV Edn. Holt saunders International Edn.

## MJD-2: BIOLOGY OF INVERTEBRATES– II PRACTICAL

### I. DISSECTION

1. Prawn- Nervous system
2. Cockroach - Digestive system
3. Cockroach Nervous system

### II. MOUNTING

1. Mouth parts of Mosquito
2. Sting apparatus of Honey bee
3. Prawn appendages
4. Cockroach mouth parts

### III – SPOTTERS

#### A- Classify giving reasons up to order:

1. Velvet worm
2. *Penaeus*
3. *Lamellidens*
4. *Pila*
5. *Asterias*

#### B- Draw labeled sketches:

1. *Mysis* larva
2. *Alima* larva
  
3. *Bipinnaria* larva

#### C- Comment on Biological significance:

1. *Peripatus*
2. *Limulus*
3. Nauplius larva
4. Zoea larva
5. *Chiton*
6. *Sepia*
7. *Octopus*
8. *Loligo*
9. Sea anemone on Hermit crab
10. *Balanoglossus*

#### D – Relate structure and function:

1. *Penaeus* – *Petasma*
2. Honey bee – Sting apparatus
3. Mosquitos – Mouth parts
4. Scorpion – Book – lung
5. Starfish – *Pedicellaria*
6. Starfish - Tube foot

## MID-2 PUBLIC HEALTH AND HYGIENE

### **UNIT – I Concepts of Public Health and Hygiene: [9 Hrs]**

Nutrition and health- Malnutrition and Over nutrition, Nutritional Deficiencies, Vitamin deficiencies.

### **UNIT – II Environment and Health Hazards: [8 Hrs]**

Need of Water Purification, Adulteration of Food, Undesirable Changes in Air, Radiation effects, e- waste, Solid waste and Excreta disposal.

### **UNIT-III Communicable diseases and their control measures: [10 Hrs]**

Air Borne Disease : Tuberculosis, Influenza Food and water Borne Disease : Amoebiasis, Jaundice Vector Borne Disease : Malaria, Dengue Contact Disease : Venereal disease and AIDS.

### **UNIT – IV Non – communicable diseases and their preventive measures: [9 Hrs ]**

Hypertension, Coronary Heart Diseases, , Diabetes, Obesity and Tumour Haemophilia and Sickle Cell Anaemia, Occupational health Hazards

### **UNIT – V Health Education in India: [9 Hrs]**

Ill Effects of Smoking, Alcoholism and drug abuse WHO programmes, Government and voluntary Organizations – vaccination and awareness programme. First Aid- Precautions and awareness on Personal hygiene.

### **Suggested Readings:**

1. Park and Park, 1995: Text book of preventive and social medicine – Banarsidas Bhanot Publ. jodhpur- India.
2. Verma, S. 1998: Medical zoology, Rastogi Publ.- Meerut- India
3. Jatin V. Modi and Renjith S. Chawan. Essentials of Public Health and Sanitation –Part I- IV
4. Murray, C. J. L. and A.D. Lopez. (1996). The Global Burden Of Disease. World Health Organization.
5. Park, J.E. and Park, K. Textbook of Community Health for Nurses.

## **MID-2 PUBLIC HEALTH AND HYGIENE PRACTICAL**

1. Identification of Parasites
2. Identification of disease causing vectors
3. Occupational Health Hazards
4. Estimation of Haemoglobin
5. Demonstration of ECG
6. Estimation of BMI
7. Vitamins and Deficiency diseases
8. Visit to a hospital to study solid waste management and report submission

BIOLOGY OF NON-CHORDATES - II

BIOLOGY OF NON-CHORDATES – II PRACTICAL

## MID-2 BASIC IMMUNOLOGY

Objectives: To study the process which help to maintain the organisms internal environment, when challenged with foreign substances.

To understand the basics in Immunology

### Unit: I

Introduction-Scope of immunology- Historical perspectives - Immunohaematology- blood groups, blood transfusion, Rh-incompatibilities; Types of immunity- innate and acquired immunity.

### Unit: II

Anatomy of lympho-reticular system- primary and secondary lymphoid organs; Cells of the immune system.

### Unit: III

Antigens- Types, properties, antigenic determinants, haptens, adjuvants. Immunoglobins- types, structure and properties, Monoclonal and polyclonal antibodies; Antigen-antibody interactions. Vaccines- types, toxoids, antitoxins.

### Unit: IV

Immune responses- Primary and secondary immune response- Cell mediated and humoral immune responses, Immune responses against tumors, Immunologic tolerance and disorders, autoimmune diseases.

### Unit: V

Complement system- Classical and alternate pathway, MHC-classes, Hypersensitivity reactions – types and diseases. Types of grafts, graft Vs host reactions.

### References

1. Ivan M. Roit 1994. Essential Immunology-Blackwell scientific publications, oxford.
2. Janis kuby 1993. Immunology II edition. W.H. Frumen and company, New york.
3. William E. Paul 1993. Fundamental immunology. II edition Raven press, New york.
4. Ian R. Tizard, 1995, Immunology: An Introduction, 4th edition, Saunders College Publishing,
5. Chakravarthy, A.K. (1996) – Immunology, Tata Mc Graw Hill Publishing Co. Ltd., New Delhi.

## **MID-2 BASIC IMMUNOLOGY PRACTICAL**

1. Human Blood grouping [ABO and Rh]
2. Study of prepared slides of primary and secondary lymphoid organs.
3. Thymus
4. Spleen
5. Bone marrow
6. Lymph node.
7. Peyer patches
8. Bursa fabricus
9. T – cell
10. **B-** cell
11. MALT
12. GALT

## **MID-2: VALUE ADDED PRODUCTS OF ANIMALS**

### **Unit-I:**

**9 Hrs**

Value added products of honey – Bee Wax, Bee propolis, Bee Venom, Bee Pollen, etc. Fermented honey (mead), honey paste for dressing wounds, honey jelly, honey caramels, creamed honey, comb honey, honey beer, honey fruit syrup, honey with fruits and nuts and honey gums their manufacture.

### **Unit -II:**

**9 Hrs**

Value added products of fishes – Fish protein concentrate, fish oils- fish liver oil and body oil, squalene from shark liver oil, fish gelatin, fish glue, fish maws and isinglass, fish wafers, fish silage, fish skin leather, shark cartilage, fertilizer from fish waste, chitin and chitosan, surumi, roe, ambergris-ready to cook and ready to eat products.

### **Unit -III:**

**9 Hrs**

Different kinds of goat meat products-Curried goat, Goat Sausage, Goat Hamburger - Curried goat burrito; Organ products for food and pharmaceuticals. Meat Products: Canned meat, Frozen meat, Cooked and Refrigerated meat, Dried and preserved meat, Cured meat, Prepared meat products, Production methods for Intermediate moisture and dried meat products,

### **Unit -IV:**

**9 Hrs**

Poultry Products: Poultry meat processing operations in detail along with equipment used – Packaging of poultry products, refrigerated storage of poultry meat, by products – eggs, egg products, Whole egg powder, Egg yolk products, their manufacture, packaging and storage.

### **Unit -V:**

**9 Hrs**

Milk Products: Testing and grading of raw milk. Pasteurized, standardized, toned, double toned, sterilized, homogenized, reconstituted, recombined and flavoured milks. Preparation of cultured milks, cultures and their management, yoghurt, Dahi, Lassi and Srikhand. Milk products such as Cream, Butter, Ghee, Khoa, Cheese, condensed, evaporated, dried milk and baby food, Ice cream and Kulfi, butter milk, lactose and casein.

**Suggested Readings:**

1. Krell,1996. Value-added products from beekeeping.FAO agricultural services bulletin no.124, FAO, United Nations,Rome.<http://www.fao.org/docrep/woo76Eoo.htm>.
2. La Bell, F. 1988. Honey :Traditional food finds new uses.Food Process.11:111-114.
- 3.Spottel,W.1950. (Honey and dried milk). J.A. Barth,Leipzig, Germany,p.323.
4. Gopakumar, K.1997. Tropical Fishery Products. Oxford & IBH Publications.
5. Chandran, K.K., 2000. Post Harvest Technology of Fish and Fish Products. Daya publishing House, New Delhi.

## **MID-2: VALUE ADDED PRODUCTS OF ANIMALS PRACTICAL**

1. Different Types of Honey bees
2. Beehive architecture
3. Economically important freshwater and marine water fishes.
4. Identification of Breeds of Goat.
5. Identification of Poultry Breeds.
6. Breeds of Cattle
7. Value added Products related to syllabus-Samples

## SEC-2 VERMITECHNOLOGY

### UNIT – I: [ 8 Hrs]

Definition, Scope of vermiculture. Soil: major types (red soil, black soil, alluvial soil). Taxonomy & Classification of earthworms. Biology of Earthworms.

### UNIT – II: [9 Hrs]

Types of earthworms: Endemic and exotic species of earthworms. Diversity and abundance of earthworms in Puducherry regions. Physical, chemical and biological changes caused by earthworms in soil drilospheres and vermicasts.

### UNIT – III: [9 Hrs]

Vermicomposting- Vermicomposting materials, Vermicomposting methods Small scale and large scale. Factors affecting vermicomposting - pH, moisture, temperature. Vermiculture unit - materials required and maintenance.

### UNIT – IV: [9Hrs]

Harvesting of Vermicomposting - quality, properties and advantages over chemical fertilizers, packaging, Transport & marketing. Collection of vermiwash and its applications. Prospects of Vermiculture as self employment venture.

### UNIT – V: [9 Hrs]

Natural enemies of earthworms- Pests, parasites and pathogens affecting earthworms. Economic importance of earthworms- bait, food and medicine and agriculture. Recycling of food wastes through Vermicomposting.

### Suggested Readings:

1. Edwards, C.A., and Bother, B. 1996: Biology of Earthworms – Chapman Hall Publ. Co., London.
2. Ismail, S.A. 1997. Vermitechnology. The biology of Earthworm. Orient Longman, India, 92 pp.
3. Ranganathan, L.S. – 2006 – Vermicomposting technology – from soil health to human health.
4. Talashikar, S.C. 2008: Earthworms in Agriculture – Agrobios – India.
5. Gupta, P.K. 2008: Vermicomposting for sustainable agriculture [2nd edition] – Agrobios – India.
6. Himadri Panda. 2022. The Complete Technology Book on Vermiculture and Vermicompost (Earthworm). Asia Pacific Business Press Inc. Asia Pacific Business Press Inc.

## **SEC-2 VERMITECHNOLOGY PRACTICAL**

1. Major types of soil (red soil, black soil, alluvial soil)
2. Study of morphological characters of earthworm
3. Identification of Common Earthworm species (*Eisenia fetida* and *Eudrilus eugeniae*)
4. Demonstration of digestive system of earthworm (demonstration only)
5. Earthworm body setae mounting
6. Natural enemies of earthworms- Pests, parasites and pathogens affecting earthworms
7. Preparation of Vermicomposting methods (Open, method, Pit methods, Silpaulin method)
8. Preparation & Collection of Vermiwash
9. Harvesting of Vermicomposting
10. Economic importance of earthworms (bait, food and medicine and agriculture)

## **SEC-2 DAIRY PRODUCTION TECHNOLOGY**

**About the course:** The course is designed to give an account of different breeds of dairy cattle, their characteristics and performance, the factors affecting their health, and the technologies that help artificial insemination and genomic testing.

**Learning outcomes:** After completing the course, the students will be able to

- learn about protein metabolism and nutritional recommendations for various stages of the lactating mother and diet preparation techniques.
- acquire the skills to manage a dairy farm or to start one with adequate inputs.

### **Unit-I: Planning and maintaining desired cattle breed**

**[6 HRS]**

History and future of Dairy Industry, Major dairy markets of the world, Distribution map of dairy farming areas/ major milk-producing regions in India. Dairy Products and their nutritive value. Milk, cheese, yoghurt, gluten, etc;

### **Unit-III Planning and maintaining desired cattle breed**

**[12 HRS]**

Dairy farm planning Management. Challenges in setting up a dairy farm. Environment and facilities: Expertise, Animals Dairy herd health and production; Managing Dairy Cattle. Breed selection: Breeds of cattle and buffalo, Native cow varieties, Indian exotic breeds, popularity and performance; Forage Production and Pasture Management. Nutritional requirements and sources of feed: Temperate and tropical grasses. Feed composition– nutrients for milk production, Water Energy, Protein, Fibre, Energy and digestibility, and Vitamins.

### **Unit-II: Housing and Maternity Management**

**[10 HRS]**

Housing of Dairy Cattle. Dairy and shed design. Cooling strategies, Cow comfort Management; Cleaning Management. Animal signs Management. Dairy herd Management and growth; Cow health and reproductive performance. Breeding Dairy Cattle. Artificial insemination and conception; Maternity management, The Lactation Cycle. Calf management, Calf diseases; Common management procedures. Vaccination, dehorning, weaning etc.

**Unit-III: Milk Products Management****[8 HRS]**

Milk products: Cheese, yogurt, gluten etc. Milking Management. Gathering cow for milking; Milking machines for smallholders; cleaning and sanitizing dairy equipment; Milking procedure. Dry cow therapy; Milk filtration Management. Milking Hygiene; Post-harvest milk quality.

**Unit-IV: Business Prospects, Biosecurity****[9 HRS]**

Dairy business profit strategies. Common disorders in Dairy Cattle; Managing Dairy Facilities for sick and lame cows. Mastitis, metabolic disorders, hypomagnesemia, ketosis and fatty liver, Ruminal acidosis, metritis; Hoof management. Manure handling. Cow Longevity; Dairy buffalo Production Management, Biosecurity; Farm level economics affecting productivity and profitability.

**Recommended readings**

1. Klaus, A. J. (2015) Dairy Farming: The Beautiful Way
2. Leitch, A. (2018) The Dairy Farm: Dairy Cattle Methods, and Dairy Farm Management

**SEC-2 DAIRY PRODUCTION TECHNOLOGY PRACTICAL**

1. Visit to dairy plant: ghee refinery, butter manufacturing unit, powder plant, cheese factory, ice-cream unit, casein making unit
2. Demonstration of manufacture of products in lab/at dairy plant/ through video aids- cream, butter, ghee, khoa, channa, paneer, curd/dahi, yoghurt, chakka, shrikhand, cheese, ice cream, kulfi, dried and condensed milk products: milk powder- skim milk, whole milk, whey, condensed milk and dairy by-product (skim milk, casein, caseinate, whey concentrate, powder, lactose, ghee residues)
3. Sensory evaluation of milk and milk products

## **SEC-2 ORNAMENTAL FISH CULTURE**

Objectives:

To impart training on Aquarium fish keeping technology to create knowledge on self-employment opportunity

### **UNIT – I**

Importance and scope of ornamental fish culture – Economic potential, commercial and aesthetic value of ornamental fish culture, trends in ornamental fish farming in the world and in India. Taxonomy of important freshwater and marine ornamental fish of indigenous and exotic species.

### **UNIT – II**

Popular ornamental fishes: Beta, Colisa, Macropodus, Trichogaster leeri, T. italics microlepis, Zebra fish. Gold fish varieties: Koi, Puntius, tetra, Glass fish, cichilids, angel fish, molly, guppy. Marine species: Hippocampus, scat, Biology, habits and patterns of reproduction of Gold fish and Zebra fish.

### **UNIT – III**

Fish farms - mass production of fancy fishes, preparations for breeding – breeding behaviour of chosen fishes: carp, fighter fish – induced breeding – food and feeding – live feeds: rotifers, tubifex and artificial feeds.

### **UNIT –IV**

Disease management: Common bacterial, viral, fungal, protozoan and crustacean infections - treatment and control.

### **UNIT –V**

Aquarium design, Construction and preparation: size, shape, substrate, ornamental aquatic plants. Construction and functions of Bio-filters; aerators – accessories for fish tanks – hood and light, nets, suction tube and maintenance of water quality: controlling ammonia build up, pH, feeding regimes.

### **Suggested Readings.**

1. Baradach, JE, JH Ryther and WO Mc Larney (1972). Aquaculture. The Farming and Husbandry of Freshwater and Marine Organisms. Wiley Interscience, New York.
2. Jameson, J.D. and R.Santhanam (1996). Manual of ornamental fisheries and farming technology. Fisheries College and Research Institute, Thoothukudi.
3. Mitchell Beazley, 1998. The complete guide to tropical aquarium fish care. Read and Consumes Book Ltd., London.
4. Jameson, J.D. Alangara Meen Valarpu (in Tamil). National Book House, New Delhi.
5. Mill Dick, 1993: Aquarium fish, DK Publ.Co,Inc. New York –USA

## **ORNAMENTAL FISH CULTURE PRACTICAL**

1. Identification of Common freshwater aquarium fishes
2. Identification of Common marine ornamental fishes
3. Identification of plants and décor materials for aquarium
4. Identification, symptoms and treatment of diseases of aquarium fishes
5. Field visit: Visit to ornamental/aqua farms (Tour report submission)

## **SEMESTER - III**

### **MJD-3: BIOLOGY OF VERTEBRATES**

**Course Outcome:** Create appreciation on diversity of life on earth. Understand different levels of biological diversity through the systematic classification of invertebrate fauna. Familiarize taxa level identification of animals. Understand the evolutionary significance of invertebrate fauna.

#### **Unit - I** **[7 hrs]**

Origin, General characters and classification of Chordata upto classes. Protochordata- Salient features of Cephalochordata , Affinities of Cephalochordata. Salient features of Urochordata. Structure and life history of Herdmania. Retrogressive metamorphosis –Process and Significance.

#### **Unit - II** **[7 hrs]**

Cyclostomata, General characters, Comparison of Petromyzon and Myxine. Pisces: General characters of Fishes. Scoliodon: External features, Digestive system, Respiratory system, Structure and function of Heart and Brain. Migration in Fishes. Types of Scales. Dipnoi.

#### **Unit - III** **[15 hrs]**

General characters of Amphibia. Classification of Amphibia up to orders with examples. Rana hexadactyla: External features, Digestive system, Respiratory system, Structure and function of Heart and Brain. Reptilia: General characters of Reptilia, Classification of Reptilia upto orders with examples. Calotes: External features, Digestive system, Respiratory system, Structure and function of Heart and Brain. Identification of Poisonous snakes and Skull in reptiles.

#### **Unit - IV** **[7 hrs]**

Aves, General characters of Aves. Columba livia: External features, Digestive system, Respiratory system, Structure and function of Heart and Brain. Migration in Birds. Flight adaptation in birds.

#### **Unit - V** **[9 hrs]**

General characters of Mammalia. Classification of Mammalia upto sub - classes with examples. Comparison of Prototherians, Metatherians and Eutherians. Dentition in mammals. Placenta in mammals. Aquatic Mammals, adaptive radiation in mammals.

## Reference books

1. J.Z. Young, 2006. The life of vertebrates. (The Oxford University Press, New Delhi). 646 pages. Reprinted
2. Arumugam, N. Chordate Zoology, Vol. 2. SarasPublication. 278 pages. 200 figs.
3. A.J. Marshall, 1995. Textbook of zoology, Vertebrates. (The McMillan Press Ltd.,UK). 852 pages. (Revised edition of Parker & Haswell, 1961).
4. M. EkambaranathaAyyar, 1973. A manual of zoology. Part II. (S. ViswanathanPvt.Ltd., Madras).
5. P.S. Dhami & J.K. Dhami, 1981. Chordate zoology. (R. Chand & Co.). 550 pages. Gurdarshan Singh & H. Bhaskar, 2002. Advanced Chordate Zoology. Campus Books, 6 Vols. 1573 pp., tables, figs.
6. A.K. Sinha, S. Adhikari & B.B. Ganguly, 1978. Biology of animals. Vol. II. Chordates. (New Central Book Agency, Calcutta). 560 pages.
7. R.L.Kotpal, 2000. Modern textbook of zoology, Vertebrates. (Rastogi Publ., Meerut). 632 pages.
8. E.L. Jordan & P.S. Verma, 1998. Chordate zoology. (S. Chand & Co.). 1092 pages.
9. G.S. Sandhu, 2005. Objective Chordate Zoology. Campus Books, vii, 169 pp.
10. Sandhu, G.S. & H. Bhaskar, H. 2004. Textbook of Chordate Zoology. Campus Books, 2 vols., xx, 964 p., figs.
11. Veena, 2008. Lower Chordata. (Sonali Publ.), 374 p., tables, 117 figs.

## **MJD-3: BIOLOGY OF VERTEBRATES PRACTICAL**

### **PROCHORDATES**

1. Balanoglossus and its T. S. through proboscis,
2. Ascidia
3. Herdmania
4. Amphioxus
5. T.S. of Amphioxus through pharynx and intestine.
6. Cyclostomata: Petromyzon
7. Ammocoete larva
8. Myxine.

### **PISCES:**

#### **Cartilaginous Fishes**

1. Narcine
2. Trygon
3. Pristis
4. Myxobatias

#### **Bony Fishes**

1. Zebrafish
2. Hippocampus
3. Muraena
4. Ostracion
5. Tetradon
6. Pleuronectus
7. Diodon
8. Echeneis (Any Six) – (Locally available).

#### **Ornamental fishes:**

1. Siamese
2. Koi
3. Oscar
4. Betta Sp
5. Neon tetra
6. Guppies
7. Goldfish
8. Angelfish
9. Rainbow fish
10. Mollies (Locally available any five aquarium fishes).

#### **Accessory respiratory organs**

1. Sacco branchus,
2. Clarias
3. Anabas.

**Amphibia:**

1. Rana
2. Bufo
3. Ambystoma
4. Axolotllarva
5. Necturus
6. Ichthyophis

**Reptilia:**

1. Turtle
2. Tortoise
3. Calotes
4. Chameleon
5. Varanus

**Snakes:**

1. Dryophis
2. Ratsnake
3. Brahmini
4. Cobra
5. Krait
6. Russell's viper
7. Hydrophis (Any Five).

**Aves:**

1. Beak
2. Feet modifications in the following examples:
3. Duck
4. Crow
5. Sparrow
6. Parrot
7. Kingfisher
8. Eagle or Hawk. (Any five).

**Mammalia:**

1. Mongoose
2. Squirrel
3. Pangolin
4. Hedge Hog
5. Rat
6. Loris. (Any five).

**Mounting of scale –**

1. Placoid.
2. Ctenoid
3. Cycloid Scales.

Skeletal System in Frog/ Pigeon/ Rabbit/Rat

Skull, vertebrae, girdles and limb bones (Except hands and feet).

**NOTE:** Field Visit / Study Tour

## **MJD-4 : COMPARATIVE ANATOMY OF VERTEBRATES**

### **Course learning objective:**

- ✓ This course aims to provide the undergraduate students a thorough knowledge of structural details and comparative account of the different organ systems of the body from lower to higher vertebrates, and protochordates, thus enabling them to appreciate the incredible vertebrate diversity.
- ✓ The course furnishes an understanding of evolutionary basis of morphological and anatomical differences as well as similarities that occur among vertebrates.
- ✓ It helps students propose possible homology between structures, and understand how they evolved as the vertebrates dwelled different habitats.
- ✓ The structural modifications of digestive, circulatory, respiratory and skeletal system relates to the distribution of animals in their different comfort zones of habitat and ecological niches.
- ✓ The understanding of anatomical details of organ systems of mammals like rat and mice aims to give the basic information for their use in experimental and research studies in different branches of Zoology like Immunology, Medical Zoology and Reproductive Biology etc.

### **Course learning outcome:**

Upon completion of the course, students should be able to:

- ✓ Explain comparative account of the different vertebrate systems
- ✓ Understand the pattern of vertebrate evolution, organisation and functions of various systems.
- ✓ Learn the comparative account of integument, skeletal components, their functions and modifications in different vertebrates.
- ✓ Understand the evolution of heart, modification in aortic arches, and structure of respiratory organs used in aquatic, terrestrial and aerial vertebrates; and digestive system and its anatomical specializations with respect to different diets and feeding habits.
- ✓ Learn the evolution of brain, sense organs and excretory organs to a complex, highly evolved form in mammals.
- ✓ Learn to analyze and critically evaluate the structure and functions of vertebrate systems, which helps them to discern the developmental, functional and evolutionary history of vertebrate species.
- ✓ Understand the importance of comparative vertebrate anatomy to discriminate human biology.

### **Unit 1: Phylum Chordata and Sub-phylum Vertebrata**

**10 hrs**

Origin of Chordates, Classification of Vertebrates and specialty of respective classes, Fishes – Migration, Amphibians – Parental care, Reptiles – Extinct reptiles, Birds – Palate in Birds, Mammals – New world and Old world Monkeys.

**Unit 2: Integumentary and Skeletal System****8 hrs**

General structure and functions of Integument, Vertebrate integument and its derivatives: Structure and functions (glands, scales, horns, claws, nails, hoof, feather and hair), Skeletal system in vertebrates, Comparative account of (i) Jaw suspensorium, (ii) Limbs and Girdles.

**Unit 3: Digestive and Respiratory System****7 hrs**

Alimentary canal and associated glands, Dentition, Comparative account of respiratory organs – Skin, gills, lungs and air sacs, Accessory respiratory organs.

**Unit 4: Circulatory and Urinogenital System****9hrs**

General plan of circulation, Composition of blood in different classes, Evolution of heart and aortic arches, Succession of kidney, Evolution of urinogenital ducts.

**Unit 5: Nervous System and Sense Organs****11 hrs**

Comparative account of brain, Nervous System – Central, Peripheral and Autonomic, Classification of receptors, Comparative account of Sensory Receptors, Comparative account of Sense organs.

**Suggested Readings:**

- Ekambaranatha Ayyar & T.N. Ananthakrishnan (1995) *A manual of Zoology*, Vol – II, (part I & II) S. Viswanathan Pvt. Ltd. Chennai.
- Jordan, E.L. & P.S. Verma (2000) *Chordate Zoology*, S. Chand & Co. New Delhi.
- Kotpal, R. L., *Modern Text Book of Zoology – Vertebrates*, Revised Edition (Reprint), Rastogi Publications, Meerut – 250 002.
- Kardong, K.V. (2005). *Vertebrate's Comparative Anatomy, Function and Evolution*. IV Edition. McGraw-Hill Higher Education.
- Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of the Vertebrates*. IX Edition, The McGraw-Hill Companies.
- Leiem C.F., Bermis W.E, Walker, W.F, Grande, L. (2001). *Functional anatomy of the vertebrates, An evolutionary perspective*. III Edition, Brookes/Cole, Cengage Learning.
- Young, J. Z., 2004, *The Life of Vertebrates*, 3<sup>rd</sup> Edition, Oxford University Press, London.  
Parker and Hanswell, 2004, *Text Book of Zoology, Vol II (Chordata)*, A.Z.T, B.S. Publishers and Distributors, New Delhi – 110 051.

## COMPARATIVE ANATOMY OF VERTEBRATES PRACTICAL

### Any Six of the Following Practicals:

1. Study of placoid, cycloid and ctenoid scales of fish through permanent slides/photographs.
2. Study of different types of feathers of birds.
3. Disarticulated skeleton of Frog, Varanus, Fowl, Rabbit (Skull, Limb bones, Vertebral Column, Sternum, Girdles, Ribs).
4. Carapace and plastron of turtle/tortoise.
5. Mammalian skulls: One herbivorous and one carnivorous animal.
6. Study of digestive, circulatory and urinogenital system of frog/rat through videos on dissection or through virtual dissections.
7. Study of anatomical details of any two organs (brain, heart, lung, kidney, eye and ear) through videos.
8. Visit to Zoological Park, Biodiversity Park or Sanctuary.

### Suggested Readings:

- Ekambaranatha Ayyar & T.N. Ananthakrishnan (1995) *A manual of Zoology*, Vol – II, (part I & II) S. Viswanathan Pvt. Ltd. Chennai.
- Jordan, E.L. & P.S. Verma (2000) *Chordate Zoology*, S. Chand & Co. New Delhi.
- Kotpal, R. L., *Modern Text Book of Zoology – Vertebrates*, Revised Edition (Reprint), Rastogi Publications, Meerut – 250 002.
- Kardong, K.V. (2005). *Vertebrate's Comparative Anatomy, Function and Evolution*. IV Edition. McGraw-Hill Higher Education.
- Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of the Vertebrates*. IX Edition, The McGraw-Hill Companies.
- Leiem C.F., Bermis W.E, Walker, W.F, Grande, L. (2001). *Functional anatomy of the vertebrates, An evolutionary perspective*. III Edition, Brookes/Cole, Cengage Learning.
- Young, J. Z., 2004, *The Life of Vertebrates*, 3<sup>rd</sup> Edition, Oxford University Press, London.  
Parker and Hanswell, 2004, *Text Book of Zoology, Vol II (Chordata)*, A.Z.T,B.S. Publishers and Distributors, New Delhi – 110 051.

## MID-3: ECONOMIC ZOOLOGY

### UNIT – I Aquaculture

Definition, scope, and significance of Aquaculture, Prawn culture, Pearl culture, Edible Oyster culture.

### UNIT – II Pisciculture

Basic concept on mono and composite fish culture (Carp culture); Fish diseases caused by *Ichthyophthirius multifiliis*, *Trichodinia* sp. and *Ichthyobodo* sp., symptoms and control; Maintenance of aquarium.

### UNIT – III Sericulture

Different species and economic importance of silkworm, Mulberry and Non-mulberry Sericulture (Eri, Muga, Tussar), Sericulture techniques.

### UNIT – IV Apiculture

Different species of Honeybee, types of beehives - Newton and Lang troth, Bee Keeping equipment, Methods of extraction of honey (Indigenous and Modern) and its processing, Products of apiculture industry (Honey, Bees Wax, Propolis, Royal jelly, Pollen etc.) and their uses.

### UNIT – V Agricultural Crop Pest and Management

Bionomics of crop pests of rice (*Leptocorisa acuta*); sugarcane (*Pyrilla perpusilla*); vegetable (*Raphidopalpa foveicollis*); and stored grain (*Corcyra cephalonica*); Pest Management Strategies (Physical, Chemical & Biological)

### Reference Books

1. Atwal, A.S. (1993) Agricultural Pests of India and Southeast Asia. Kalyani Publishers, New Delhi.
2. Shukla, G.S. and Upadhyay, V.B.: Economic Zoology, 4e, 2002, Rastogi.
3. D. B. Tembhare. (2017) Modern Entomology. Published by Himalaya Publishing House (ISO 9001: 2008 Certified).
4. Dawes, J. A. (1984). The Freshwater Aquarium, Roberts Royee Ltd. London.
5. S.S. Khanna and H.R. Singh. A Textbook of Fish Biology & Fisheries Published by Narendra Publishing House.3rdEdition. (ISBN13: 9789384337124).
6. Dokuhon, Z.S. (1998). Illustrated Textbook on Sericulture. Oxford & IBH Publishing Co., Pvt. Ltd. Calcutta.

### **MID-3: ECONOMIC ZOOLOGY PRACTICAL**

1. Study of aquatic organisms - prawns, oysters and fishes (any three) through museum specimens in the laboratory with details on their classification, distribution and specialized features.
2. Study of different species of aquarium fishes (Goldfish, Guppy, Swordtail fish) and maintenance of aquarium in lab/indoor.
3. Study of major crop pests of rice (*Leptocorisa acuta*), sugarcane (*Pyrilla perpusilla*), vegetable (*Raphidopalpa foveicollis*) and stored grain (*Corcyra cephalonica*) belonging to different orders.
4. Study of *Bombyx mori*, its life cycle and economic importance.
5. Study of the life history of honeybee, *Apis cerana indica* and *Apis mellifera* from specimen/ photographs - egg, larva, pupa, adult (queen, drone, worker).
6. Study of artificial hive (Langstroth/Newton), its various parts and beekeeping equipment.
7. Project report on life cycle of any one crop pest or on a product obtained from apiculture industry.
8. Field study/lab visit to an apiary/honey processing unit/sericulture institute/aquarium shop/fish farm/pisciculture unit.

### **MID-3: AGRICULTURAL ENTOMOLOGY**

#### **UNIT-I: Introduction**

[9 hours]

History of entomology in India, evolution of insects as a most successful group in the animal kingdom, classification of insects up to the orders mention important families, morphology of insects-Head, thorax, abdomen, wings, genitalia, appendages, types of mouth parts and its structures, sampling methods for insect population

#### **UNIT-II: Insect pest and pest out break**

[7hours]

Definition of pest, categories of pests, parameters of insect population levels, causes of insect outbreak, accidental introduction of pests from foreign countries, resurgence, and pest resurgence, methods of collection and sampling of insect populations.

#### **UNIT-III: Major crops pests in India**

[11 hours]

Distribution, damage, bionomics and management of various insect pests-Paddy Pests-Thrips, brown plant hopper, gall midges, yellow stem borer, leaf roller; Wheat Pests-Aphids, Armyworm, Ghujhia weevil, gram pod borer, termites; finger millet- pink stem borer, white stem borer, root aphid, cut worm, white grub; Coconut pests- Rhinoceros beetle, red palm weevil, black headed caterpillar, eriophyid mite, slug caterpillar; Cotton pests-leaf hopper, cotton aphids; thrips, whitefly, mealy bug; Mango pests- stemborer, nut weevil, fruitfly, flower gall midges, leaf webber, flower webber and leaf caterpillar; Pest of sugar cane-Pyrilla perpusiella

#### **UNIT-IV: Biological and Chemical control of pests**

[9 hours]

History, principles and scope of biological control; important groups of parasitoids, predators and pathogens; principles of classical biological control- importation, augmentation and conservation. Mass production of quality biocontrol agents- techniques, formulations, economics, field release/application and evaluation. Successful biological control projects, analysis, trends and future possibilities of biological control.

#### **UNIT-V: Integrated pest management (IPM)**

[9 hours]

Definition and concept, Principles of pest management and history, Ecological methods of pest management-physical, mechanical and cultural, Pest management through botanicals, behavioural modification and radiation technology, Host plant resistance and biological components of IPM. Biotech approaches, AESA and IPM case studies in field crops. IPM in paddy, cotton and Mango.

## References

1. Ananthakrishnan, T. N. (Ed.). (1992). Emerging Trends in Biological Control of Phytophagous Insects. Oxford & IBH publishing Co. Pvt. Ltd., New Delhi.
2. Ananthakrishnan, T. N. (1984). Biology of Gall Insects. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Apple, J. L. and Smith, R. R. (1976). Integrated Pest Management. Plenum Press, New York.
3. Atwal, A. S. (1986). Agricultural Pests of India and South East Asia. Kalyani Publishers, Ludhiana.
4. Banerjee, B. (1988). An introduction to Agricultural Acarology - Biology and control of mite pests in the tropics. S.K. Dutta Associated Publishing Co., 8798/7, Shidipura, Karolbagh, New Delhi.
5. Bucherl, W. and Buckley, E. (Eds). (1971). Venomous Animals and Their Venoms. Academic Press New York, London.
6. Claussen, C. P. (1962). Entomophagous Insects. Haner Publishing Co.,
7. David, B. V. and Ananthakrishnan, T. N. (2004). General and Applied Entomology Second Edition. Tata McGraw Hill Publishing Company Limited, New Delhi.
8. Debach, Paul (1964). Biological Control of Insect Pests and Weeds. Chapman & Hall.
9. Dent, D. (1991). Insect Pest Management, CAB International, UK.
10. Evans, G. O. (1992). Principles of Acarology, CAB International, U.K.
11. Kilgore. W. W. and Douth, R. L. (1967). Pest Control. Academic Press, London
12. Krantz, G. W. (1978). A manual of Acarology, D.S.U. Book Stores, Corvallis, Oregon.
13. Nair. M. R. G. K. (1975, 1996). Insect & Mites of Crops in India. ICAR, New Delhi
14. Pedigo, L. P. (1996). Entomology & Pest Management Practice. Hall India Pvt. Ltd., New Delhi.
15. Ramakrishna Ayyer, R. V. (1963). A Handbook of Economic Entomology of South India. Govt. of Madras publication.

## **MID-3: AGRICULTURAL ENTOMOLOGY PRACTICAL**

### **I. Spotters**

1. Spodoptera
2. Rhinoceros beetle
3. Eriophyid mite
4. Batocera
5. Pyrilla
6. Earias vittella
7. Helicoverpa
8. Mealy bug
9. Lady bird beetle
10. Zamboni flies

### **II. Different methods of insect sampling**

1. Sweep net
2. Sticky traps
3. Light traps
4. Pit fall traps
5. Malaise trap
6. Pan trap

**III. Collect any five crop pests available in your locality, make an insect box and submit it individually.**

**IV. Study the life cycle of any two insect pests.**

**V. Visit the paddy fields and collect and identify pests and their natural enemies; Make a record.**

### **MID-3: FOOD, NUTRITION AND HEALTH**

**Course Objective:** The prime focus is to provide the students with a basic understanding of the relationship between food, nutrition and health. It is important to understand this link and change eating habits in accordance to one's age, pregnancy, lactation and physical activity. Mental health is also affected largely by our lifestyle. Apart from physical activity, the intake of the required vitamins, minerals and antioxidants also nourish the brain. Malnutrition is the main cause of impairment of growth in young children and infants and leads to diseases like Marasmus. Moreover, food hygiene including food and water-borne infections along with food spoilage has also been covered in this course.

**Course Learning Outcome:** Upon the completion of the course, students will be able to:

- Have a better understanding of the association of food and nutrition in promoting healthy living.
- Think more holistically about the relationship between nutrition science, and social and health issues.
- Move on to do post-graduation studies and apply for jobs as food safety officers, food analysts, food inspectors, food safety commissioners or controllers for jobs in organizations like FSSAI.
- Specialize in various fields of nutrition.

#### **Unit I: Basic concept of food and nutrition**

**[10 hrs]**

Food Components and food nutrients, Concept of a balanced diet, nutrient needs and dietary patterns for various groups- adults, pregnant and nursing mothers, infants, school children, adolescents and elderly. Food Pyramid, Nutritional anthropometry- BMI, waist-to-hip ratio, skin-fold test and bioelectrical impedance; interpretation of these measurements.

#### **Unit II: Nutritional Biochemistry**

**[8 hrs]**

Carbohydrates, Lipids, Proteins, their dietary source and role Vitamins- their dietary source and importance Minerals- their biological functions. Dietary Fibres - Definition, their dietary source and nutritional importance. Elementary idea of Probiotics, Prebiotics, and Organic Food.

#### **Unit III: Health and deficiency**

**[7 hrs]**

Definition and concept of health, Major nutritional Deficiency diseases- (kwashiorkor and marasmus), Deficiency disorders, their causes, symptoms, treatment, prevention and government programmes, if any.

#### **Unit IV: Life style disease and social health problems**

**[8 hrs]**

Life style related diseases- hypertension, diabetes mellitus, Atherosclerosis and obesity- their causes and prevention through dietary and lifestyle modifications, Social health problems- smoking, alcoholism, drug dependence and Common ailments- cold, cough, and fevers, their causes and treatment.

**Unit V: Food hygiene****[12 hrs]**

Food and Waterborne infections; Bacterial infection: Cholera, typhoid fever, dysentery; Viral Infection: Hepatitis, Poliomyelitis; Protozoan infection: amoebiasis, giardiasis; Parasitic infection: taeniasis and ascariasis their transmission, causative agent, sources of infection, symptoms and prevention; Brief account of food spoilage: Causes of food spoilage and their preventive measures.

**Recommended Books:**

- Shashi Goyal & Pooja Gupta. Food, Nutrition and Health (ISBN: 9788121940924)
- Linda Tapsell. Food, Nutrition and Health. I Edition, Oxford (ISBN: 978-0195518344)
- Avantina Sharma. Principles of Therapeutic Nutrition and Dietetics.. CBS Publishers and Distributors Pvt. Ltd.
- Elia M et al. (eds) Clinical Nutrition. Wiley-Blackwell, A John Wiley & Sons Ltd.
- Gibney MJ et al. (eds) (2009) Introduction to Human Nutrition. Wiley-Blackwell A John.

### **MID -3: FOOD, NUTRITION AND HEALTH-PRACTICAL**

1. To detect adulteration in a) Ghee b) Sugars c) Tea leaves and d) Turmeric
2. Estimation of Lactose in milk and diagnosis of lactose intolerance by measuring hydrogen gas during expiration.
3. Ascorbic acid estimation in food by titrimetric
4. Estimation of Calcium in foods by titrimetric
5. Study of the stored grain pests from slides/photographs (*Sitophilus oryzae*, *Trogoderma granarium*, *Callosobruchus chinensis* and *Tribolium castaneum*): their identification, habitat and food sources, damage caused and control. Preparation of temporary mounts of the above stored grain pests.
6. Visit to food testing lab /or any agency of food standards
7. Project work
8. Undertake computer aided diet analysis and nutrition counseling for different age groups.
9. Identify nutrient rich sources of foods (fruits and vegetables), their seasonal availability and price.
10. Study of nutrition labeling on selected foods

### **SEC-3: APICULTURE**

#### **Unit 1: Biology of Bees**

**[8 Hrs]**

Historical background of apiculture, classification, and biology of honey bees, Social organization of bee colonies, behavioral patterns (bee dance, swarming).

#### **Unit 2: Rearing of Bees**

**[13 Hrs]**

Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth; Bee Pasturage; Selection of beespecies for apiculture – Apisceranaindicia, Apismellifera; Beekeeping equipment methods of extraction of honey (Indigenous and Modern) & processing; Apiary management - Honey flow period and lean period, effects of pollutants on honeybees.

#### **Unit 3: Diseases and Enemies**

**[6 Hrs]**

Bee diseases control and preventive measures: enemies of bees and their control.

#### **Unit 4: Bee Economy**

**[8 Hrs]**

Products of the apiculture industry (Honey, Bees Wax, Propolis, Royal jelly, Pollen etc.) and their uses; Modern methods in employing artificial Beehives for cross-pollination in horticultural gardens- stationary and migratory beekeeping.

#### **Unit5: Entrepreneurship in Apiculture**

**[10 Hrs]**

Bee-keeping industries – Recent advancements, employment opportunities, economics in small and large-scale beekeeping, the scope for women entrepreneurs in the beekeeping sector, study of development programs and organizations involved in beekeeping in India.

#### **Recommended readings**

- Singh, S. (1962). Beekeeping in India, Indian Council of Agricultural Research, New Delhi.
- Mishra, R.C. (1995). Honeybees and their management in India. Indian Council of Agricultural Research, New Delhi.
- Prost, P. J. (1962). Apiculture. Oxford and IBH, New Delhi.
- Rahman, A. (2017). Beekeeping in India. Indian Council of Agricultural Research, New Delhi.
- Gupta, J.K. (2016). Apiculture, Indian Council of Agricultural Research, New Delhi.

### SEC-3: APICULTURE PRACTICAL

1. Study of the life history of honey bees: *Apis cerana indica*, *Apis mellifera*, *Apis dorsata*, *Apis florea*, *Melipona* sp. from specimen/ photographs - Egg, larva, pupa, adult (queen, drone, worker).
2. Study of morphological structures of honey bees through permanent slides/photographs– mouthparts, antenna, wings, sting apparatus, and temporary mount of legs (antenna cleaner, mid-leg, pollen basket).
3. Study of the natural beehive and identification of queen cells, drone cells, and brood.
4. Distinguishing characters of workers of three bee species.
5. Importance of site selection for beekeeping.
6. Study of an artificial hive (Lang troth/Newton), its various parts, and beekeeping equipment: draw diagrams of bee boxes proportionate to the body size and measure the body length and wing size.
7. Preparation of mount of pollen grains from flowers.
8. Diagnosis of honeybee diseases: Protozoan diseases, Bacterial diseases, Viral diseases (one each)-symptoms, nature of damage and control.
9. Identification of honeybee enemies: Predators-Insects and non-insects.
10. Video demonstration of wax extraction and preparation of comb foundation sheets.
11. Analysis of honey – purity, physical and biochemical parameters (any two constituents).
12. Study of bee pasturage – visit to fields/gardens/orchards to study the bee activity (role in pollination, nectar collection, videography of honeybee activity) and preparation of herbarium of nectar and pollen-yielding flowering plants (floral mapping).
13. Visit to an apiary/honey processing unit/institute and submission of a report.

### **SEC-3: MEDICAL LABORATORY TECHNOLOGY**

**Unit-I:** [9 Hrs]

Scope of Medical Laboratory Technology Basic tools used in medical laboratory Code and conduct for medical laboratory personnel, Safety measures in the laboratory. Cleaning and sterilization heat, moist heat, cold, and UV radiation. Disposal of biomedical wastes.

**Unit-II:** [10 Hrs]

Blood collection procedures Capillary method, venous blood, estimation of hemoglobin. WBC total count- differential count; RBC-total count, platelet count. packed cell volume (PCV), Erythrocyte Sedimentation Rate (ESR), Blood grouping, Blood transfusion and blood banking.

**Unit-III:** [8 Hrs]

Biochemical Analysis: Blood sugar and cholesterol estimation,Urine - Physical characteristics and Composition and examinations. Analysis of sputum and fecal matter for Infection.

**Unit-IV:** [10 Hrs]

Screening of Parasites: Clinical diagnosis of diseases: Bacterial diseases: Tuberculosis and Typhoid. Viral diseases: AIDS and Polio. Protozoan diseases: Amoebiasis and Malaria. Nematodes diseases: Filariasis and Ascaris.

**Unit-V:** [8 Hrs]

Diagnostic methods X-Ray, EGC, EEG,CT, MRI,PET, Echo recording, Histopathological techniques - neoplastic tissue.

**Suggested Readings:**

1. K.M.Samual&M.K.G.Iyyarstsans. (1984). Clinical lab techniques-4th edition.
2. Dr.K.N.Sachdev, Jaypee Brothers. (1988). Clinical Pathology and Bacteriology. Medical Publisher.
3. Kania Mukherjee. Medical laboratory Techniques-Vol-I,II& III. 4th edition. Tata Mc Graw hill Publishing company.
4. RamnikSood,M.D.(2006). Medical laboratory Techniques-5 thJaypeebrothers medical publishers.
5. G.K.Pal and Pravati Pal .Text book of practical physiology- Universities Press.

### **SEC-3: MEDICAL LABORATORY TECHNOLOGY PRACTICAL**

1. Measurement of pulse rate
2. Measurement of blood pressure
3. Demonstration of ECG
4. Estimation of Hemoglobin by Sahli's Method
5. Total RBC count.
6. Total leucocyte count
7. Differential leucocyte count.
8. Visit to a clinical laboratory and report submission
9. Blood Grouping
10. Identification of Parasites.

## **SEC-3: PUBLIC HEALTH MANAGEMENT**

### **Learning outcomes**

- An understanding of the theoretical issues related to healthcare policies
- An understanding of various governmental programs and institutions/organizations at national and international levels
- Acquaintance with the challenges faced by Public Health Administration Teaching Learning methods. The pedagogy comprised conventional lecture methods supplemented with class room interactions, discussions, tutorials, quizzes, seminars and assignments to be used to deliver the course.

### **UNIT – I (15hrs)**

Introduction: Public Health Administration – Nature, Significance and Scope; Sustainable Development Goals (SDGs) and Public Health; World Health Organization (WHO) –structure, functions and role in Asia

### **UNIT – II (15hrs)**

Institutional Framework of Health Administration at the national level: Union Ministry of Health and Family Welfare – organization, functions and role; Healthcare Programmes in India – Family Welfare Programme; Reproductive Child Healthcare; Immunization Programme; National Health Mission (NHM)

### **UNIT – III (15hrs)**

Institutional Framework of Health Administration at the state level: Organization, functions, and role of the Department of Health; Health Programmes at the state level; Administration of Primary Healthcare at the local level.

### **UNIT – IV (15hrs)**

Other Healthcare Institutions: National Institute of Health and Family Welfare –structure, function, and role; Medical Council of India – structure, functions, and role; Challenges of Public Health Administration

### **Recommended Readings:**

- Ahmad, Alia and Lalitha, N (Eds.) (2013) An Institutional Perspective on Provision of Health Care in India and Bangladesh. Academic Foundation: New Delhi
- Ballabh, C (2007) Health Care Services in Hospital. Alfa Publication: New Delhi
- Banerjee, Baratati (Ed.) (2017) DK Taneja's Health Policies & Programmes in India (15<sup>th</sup> Edition). Jaypee Brothers Medical Publishers: New Delhi
- Bergerhoff, Petra; Lemann, Dieter; Novak, P (Eds.) (1990) Primary Health Care: Public Involvement, Family Medicine, Epidemiology and Health Economics. Springer-Verlag: Berlin and Heidelberg.
- Burci, Gian Luca and Vignes, Claude-Henri (2004) World Health Organization. Kluwer Law International: London/New York

- Ghosh, B (1948) A Treatise on Hygiene and Public Health. Scientific Publishing Company: Calcutta
- Hanlon, John H (2008) Principles of Public Health Administration. C V Mosley Co. Mahal:
- Kishore, Jugal (2016) National Health Programs of India, National Policies and Legislations related to Health (12th Edition). Century Publications: New Delhi
- Rout, Himanshu Sekhar (Ed.) (2011) Health Care Systems: A Global Survey. New Century Publications: New Delhi
- Sanjivi, K S (2007) Planning India's Health. Orient Longman: University of California
- World Health Organization (2017) World Health Statistics 2017: Monitoring Health for the SDGs. Sustainable Development Goals: World Health Organization: USA

# SEMESTER – IV

## MJD-5: CELL BIOLOGY

### **Unit 1: Overview of Cells and Cell Membrane** [9 hrs]

History of cell biology; Cell Theory; Overview and difference between Prokaryotic and Eukaryotic cells; Ultra structure of an Animal Cell. Plasma membrane – Ultra structure, chemical composition, models (Bilayer, Unit membrane, fluid mosaic) and functions. Various models of plasma membrane structures, Transport across membranes: active and passive transport, facilitated transport. Phagocytosis, pinocytosis, exocytosis.

### **Unit 2: Cellular Components** [13 hrs]

Mitochondria – Ultrastructure, Composition and Functions; Semi-autonomous nature, Endo-symbiotic hypothesis. Respiratory chain, Chemiosmotic hypothesis and ATP Synthase. Endoplasmic Reticulum – Ultrastructure, Composition and Functions; Vesicular transport from ER to Golgi apparatus. Golgi apparatus – Ultrastructure, Composition and Functions; Protein sorting and transport from Golgi apparatus. Vesicular transport: Coated Vesicles; Lysosomes; Peroxisomes.

### **Unit 3: Nucleus** [7 hrs]

Ultrastructure of Nucleus: Nuclear envelope, Nuclear pore complex. Transport of molecules across nuclear membrane. Chromatin – euchromatin, heterochromatin and packaging, nucleosome, nucleolus. Giant chromosome – polytene and lampbrush.

### **Unit 4: Cell Division** [6 hrs]

Cell cycles – Mitosis and Meiosis; Stages and Features. Cell cycle regulation – Various check points and the role of cyclins and Cdks.

### **Unit 5: Cell Signalling and Cancer** [10 hrs]

Cell Ageing and Overview of Apoptosis – programmed cell death. Cell Signalling through G-protein coupled receptor (GPCR) and role of secondary messengers: cAMP and protein kinase. Biology and elementary knowledge of development and causes of cancer. Salient features of transformed cells. Tumor viruses,. Overview on cell lines, HeLa cells, CHO cell.

### **Reference Books**

1. Verma, P.S., and V.K. Agarwal, 1995, Cell and Molecular Biology, 8th edition, S. Chand & Co., New Delhi-110 055,567.
2. De Robertis, E.D.P. and E.M.F. De Robertis, 2006, Cell & Molecular Biology, 8th Edition, Indian Reprint.
3. Rastogi, S.C., 2010, Cell and Molecular Biology, Second Edition. New Age International (p) Ltd., New Delhi.
4. Powar, C.B.,1989, Essentials of Cytology, Himalaya Publishing House, Bombay, 368p.

5. Becker, W. M., Kleinsmith, L. J., Bertni, G. P. (2009). *The World of the Cell* (7th Ed.). Pearson Benjamin Cummings Publishing, San Fransisco.
6. Cooper, G.M. and Hausman, R.E., (2009). *The Cell: A Molecular Approach*. (7th ed.). ASM Press & Sunderland (Washington DC), Sinauer Associates, MA.
7. Karp, G., (2010). *Cell and Molecular Biology: Concepts and Experiments* (8th ed.). John Wiley & Sons.
8. Loewy, A.G. and P. Sickevitz, 1969, *Cell Structure and Function*, Amerind Publishing Co., New Delhi-110 020, 516pp.
9. Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Robert Keith and Watson James. (2008). *Molecular Biology of the Cell*, 5th Edition, Garland publishing Inc., New York and London.

### **MJD-5: CELL BIOLOGY PRACTICAL**

1. Principle of Light microscope, Phase contrast microscope and Electron microscope.
2. Measurement of cell dimensions by using stage and ocular micrometer.
3. Study of ultrastructure of cell organelles – Plasma membrane, Nucleus, Nuclear Pore Complex, Mitochondrion, Golgi bodies, Endoplasmic Reticulum, Lysosomes.
4. Study of different stages of mitosis by temporary preparation/permanent slides of onion root tips.
5. Study of different stages of meiosis by temporary preparation/permanent slides.
6. Chironomous larva – squash preparation of giant chromosome.
7. Squash preparation of squamous epithelial cells from buccal smear.
8. Total count of RBC and WBC using Haemocytometer.
9. Blood Smear Preparation – Differential count of W.B.C.
10. Preparation of temporary stained mount to show the presence of Barr body in human female blood cells/ cheek cells.

## **MJD-6: ECOLOGY AND ECOSYSTEMS**

### **Unit 1: Ecology of individuals**

**(10 Hrs)**

Basic concepts and definitions: ecology, landscape, habitat, ecozones, biosphere, ecosystems, ecosystem stability, resistance and resilience; autecology; synecology; major terrestrial biomes; ecological amplitude; Liebig's Law of the Minimum; Shelford's Law of Tolerance; phenotypic plasticity; ecotypes; ecoclines; acclimation; ecological niche;

### **Unit 2: Ecology of populations**

**(10 Hrs)**

Concept of population and meta-population; r- and K-selection; characteristics of population: density, dispersion, natality, mortality, life tables, survivorship curves, age structure; population growth: geometric, exponential, logistic, density-dependent; limits to population growth;

### **Unit 3: Ecology of communities**

**(7 Hrs)**

Community structure and organization: keystone species, ecotone and edge effect; species interactions: positive and negative ecological succession and climax community.

### **Unit 4: Ecosystem ecology**

**(10 Hrs)**

Types of ecosystem: forest, grassland, lentic, lotic, estuarine, marine, desert, wetlands; ecosystem structure and function; abiotic and biotic components of ecosystem; food chain, food web; ecological efficiencies; ecological pyramids: pyramids of number, biomass, and energy.

### **Unit 5: Biogeochemical cycles and nutrient cycling**

**(8 Hrs)**

Carbon cycle; nitrogen cycle; phosphorus cycle; sulphur cycle; hydrological cycle; nutrient cycle models; ecosystem input of nutrients; biotic accumulation; ecosystem losses; nutrient supply and uptake;

### **Suggested Readings**

- Groom. B. & Jenkins. M. 2000. Global Biodiversity: Earth's Living Resources in the 21st Century. World Conservation Press, Cambridge, UK.
- Gurevitch, J., Scheiner, S. M., & Fox, G. A. 2002. The Ecology of Plants. Sinauer associates incorporated.
- Loreau, M. & Inchausti, P. 2002. Biodiversity and Ecosystem functioning: Synthesis and Perspectives. Oxford University Press, Oxford, UK.
- Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders.
- Pandit, M.K., White, S.M. & Pocock, M.J.O. 2014. The contrasting effects of genome size, chromosome number and ploidy level on plant invasiveness: a global analysis. *New Phytologist* 203: 697-703.
- Pimentel, D. (Ed.). 2011. Biological invasions: Economic and environmental costs of alien plant, animal, and microbe species. CRC Press.
- Singh, J.S., Singh, S.P. & Gupta, S.R. 2006. Ecology, Environment and Resource Conservation. Anamaya Publications. 8. Wilson, E. O. 1985. The Biological Diversity Crisis. *BioScience* 35: 700-706

## **MJD-6: ECOLOGY AND ECOSYSTEMS PRACTICALS**

1. To study the allelopathic influence of one plant species.
2. To prepare a checklist of invasive species.
3. To estimate the productivity of a pond ecosystem using light and dark Bottle method.
4. To study the plankton communities in a fresh water ecosystem.
5. To study the distribution of road side species and investigate the changes in species richness.
6. Field report: Visit to a forest/ river/ wetland ecosystem.

## **MJD-7: GENETICS**

### **Unit 1: Mendelian Genetics and its Extension and Modification**

**[8 Hrs]**

Introduction to genetics, Basis of Mendelian Principles Inheritance and Mendelian Laws, Incomplete dominance and co-dominance, Interaction of Genes – Multiple alleles, Lethal alleles, Epistasis, Pleiotropy.

### **Unit 2: Linkage, Crossing Over, and Genetic and Chromosomal Mapping**

**[12 Hrs]**

Linkage and crossing over – Drosophila – Morgan's Experiments - Cytological basis of crossing over, Molecular mechanisms of crossing over including models of recombination. Gene mapping with Recombination frequency. Coupling and repulsion.

### **Unit 3: Mutations and Chromosomal aberrations**

**[10 Hrs]**

Types of gene mutations (Classification), Types of chromosomal aberrations, Euploidy, Aneuploidy, and Polyploidy – Turners Syndrome, Klinefelters Syndrome, Down syndrome and Cat- Cry Syndrome. Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations: CLB method, attached X method.

### **Unit 4: Sex Determination and Sex-linked characters**

**[9 Hrs]**

Sex determination and sex linkage in Drosophila and Man. Sex-linked, sex-influenced and sex-limited characters. Sex-Influenced and Sex-Limited Characteristics, Cytoplasmic Inheritance, Genetic, Maternal Effect, Genomic Imprinting.

### **Unit 5: Human Genetics**

**[6 Hrs]**

Human genome project, Genetic disorders, Medical genetics-Chromosomal anomalies in malignancy; oncogenes and tumour suppressor genes, pharmacogenomics

### **Suggested Readings**

- 1) Benjamin A. Pierce. Genetics a Conceptual Approach, 7<sup>th</sup> Edition-2020, WH Freeman Publication.
- 2) Gardner, E.J., Simmons, M.J., Snustad, D.P. Principles of Genetics. VIII Edition. Wiley Indi
- 3) Klug, W.S., Cummings, M.R., Spencer, C.A. Concepts of Genetics. X Edition. Benjamin Cumming
- 4) Snustad, D.P., Simmons, M.J. Principles of Genetics. V Edition. John Wiley and Sons In
- 5) Verma P.S. and Agarwal V.K. – Concepts of Genetics
- 6) Rastogi V.B. A text book of Genetics, Kadarnath, Ramnath, Meerat.
- 7) Sambamurthy. AVSS - Genetics – Narosa Pub. House, New Delhi
- 8) P.K. Gupta. Genetics. Rastogi Publications.

- 9) David Sadava, David Hillis, H Heller. Life: The Science of Biology 12<sup>th</sup> Edition 2020, Macmillan Learning Publisher.

### **MJD-7: GENETICS PRACTICALS**

1. To study the Mendelian laws and gene interactions.
2. Observation of wild and Mutant forms of *Drosophila* (white eyed, bar eyed, vestigial wing, etc.).
3. Linkage maps based on data from *Drosophila* crosses.
4. Study on Normal Karyotype - male and female.
5. Pedigree analysis of some human inherited traits.
6. Chromosomal Disorder: Down syndrome, Turner and Klinefelter syndrome, etc.
7. Inheritance of Sex-linked diseases in man (haemophilia, red-green colour blindness, and Duchenne muscular dystrophy).

## MID-4 : GENETIC ENGINEERING

### Course Objectives:

1. To impart knowledge about major events in the development of rDNA technology and to acquire skills on techniques of construction of recombinant DNA - Cloning vectors and isolation of gene of interest.
2. To familiarize with the concepts of different operons and regulation of gene expressions in prokaryotes and eukaryotes.
3. To acquaint them with the different gene transfer methods and mappings.
4. To explain the applications of genetic engineering in biotechnology.

**Course Outcomes:** The student will be able to

1. Familiar with the tools and techniques for isolation and purification of genes, vector construction.
2. Understand the mechanisms of regulation of gene expression in different operons.
3. Know the techniques for transfer and expression of cloned gene and
4. Apply the knowledge of genetic engineering in biological research.

### Course Contents:

**Unit I** Cloning and amplification of DNA: Introduction, choice of the organism, use of restriction endonucleases for the production of DNA fragments. Vehicles for cloning - plasmids, phage vectors and cosmids. RNA isolation, preparation and use of cDNAs. Screening and determination of nucleotide sequences. Application of recombinant DNA technology. Oncogenes and their mode of action.

**Unit II** Isolation, sequencing and synthesis of genes: Isolation of genes, sequencing of genes, synthesis of genes, Cloning of specific eukaryotic genes and their expression in bacteria. Operon model: Isolation and chemical nature of repressor. Catabolite repression and role of cAMP and cAMP receptor protein (CRP) in the expression of glucose – sensitive operons. Lac operon, His operon, Trp operon of E. coli. Stringent and relaxed control. Regulation of gene expression in prokaryotes and eukaryotes: Transcriptional control, enzyme induction and repression. Constitutive synthesis of enzymes. Genes involved in regulation, regulatory gene, promoter gene, operator gene and structural genes. Genome imprint.

**Unit III** Gene transfer methods and transgenic organisms: Gene transfer methods for animals and plants, Agro bacterium mediated gene transfer, electroporation and particle gun. Transgenic animals, and transgenic plants. Restriction maps and molecular genetic maps: Restriction mapping, restriction fragment length polymorphisms (RFLP) Linkage and recombination between molecular and phenotypic markers, Random amplified polymorphic DNA (RAPDs) using PCR, Chromosome walking. Organic genome engineering and cell molecular memory/ Biosensors

**Unit IV** Applications of genetic engineering in biotechnology: Genome imprint, Dynamic genome engineering and cell molecular memory. Plant, animal cell and Tissue culture methods.

Biosensors: Genetically Modified Organism - Market potential, Diet, Leash, Potato, Rice BT.

### Recommended Books

1. Genes and Probes, A Practical Approach Series (1995) by Hames and SJ Higgins; Oxford Univ. Press.
2. Gel Electrophoresis of Nucleic Acids, A practical Approach (1990) by D Rickwood and BD Hames. 3. Oxford Univ. Press.

## **MID-4 : MICROBIOLOGY**

Objectives: To emphasize the importance of integrating new knowledge on Microorganisms.

### **UNIT-I Scope of Microbiology**

Diversity of Microbes, Broad classification of bacteria, fungi, yeast and virus. Structure and functions of bacteria and virus , Bacterial Culture – Media & types.

### **UNIT-II Microbes of the Environment**

Air, Water and Soil and its role in ecosystem, Role of Microbes in Ecosystem Bioremediation of industrial wastes, sewage treatment plants,

### **UNIT-III Agricultural Microbiology**

Microorganisms as Biofertilizers, production and application of. Microbial biopesticides; Mechanism of N<sub>2</sub> fixation.

### **UNIT –IV Food Microbiology:**

Microbes of milk and food, Pasteurization and food spoilage. Fermentation techniques and Production of alcohol. Uses of microbes in food Industry - Bread, Vinegar,

### **UNIT- V Microbial Control**

Concept of Sterilization pasteurization, tantalization; fumigation, ultrasonication, and filtration.

### **Suggested Readings:**

1. Burden, K.L. and R.P. Williams (6th Ed.) 1968. Microbiology. The Macmillan Co., London
2. Roberts, T.A. and F.A. Skinner (Eds.) 1983. Food Microbiology: Advances and Prospects, Academic Press, Inc. London,
3. Pelczer, M.J., Reid, R.D. And Chan, E.C.S. (1996), Microbiology, V Ed., Tata McGraw Hill Publishing Company Ltd., New Delhi.
4. Ananthanarayanan, T And Jayaram Paniker, C.K. (2000), Text Book of Microbiology, VI Ed., Orient Longman Ltd., Madras.
5. C.B.Powar, H.F.Daginawala, (1965) General Microbiology Himalayan Publishing House

## MICROBIOLOGY PRACTICAL

1. Identification of microorganisms from the habitats [simple staining, differential staining,]
2. Morphological Observation of bacterial cell.
3. Methods of inoculation of microbes – Spore plate, Streak and Swab.
4. Motility study of Lactobacillus – Hanging drop method

### **Spotters:-** (Any Ten)

1. Mycoplasmas,
2. Rickettsiae,
3. Chlamydiae,
4. Staphylococcus aureus,
5. Streptococcus pneumoniae,
6. Salmonella,
7. HIV,
8. Hepatitis virus
9. Rabies virus.
10. Fermentor,
11. Bioreactors,
12. Biofilters

## MID-4: ENVIRONMENTAL BIOTECHNOLOGY

### Course Objectives:

- Make them understand the concept, organization, and energy flow in an ecosystem
- Impart knowledge of the process of biodegradation and bioremediation
- Equip with the knowledge on biological control and scope of biofertilizers in agriculture
- Educate about different types of waste and their eco-friendly management

### UNIT-I

[10 Hrs]

Structure of model ecosystem - terrestrial, aquatic ecosystems - Energy flow - Degradation of ecosystem. Consequences - Ecosystem management - Energy conservation – Alternative energy sources - Biofuels: Production of bioethanol, biobutanol from agriculture waste - Problems and perspectives - Biodiesels: mass cultivation of *Jatropha* and use of *Jatropha*, marine algae for the production of biodiesel.

### UNIT-II

[12 Hrs]

Nature of recalcitrant compounds - Anthropogenic activities generating recalcitrant chemical waste - BHC, DDT, nitro phenols, polycyclic aromatic carbons. Biodegradation – microbial conversion of recalcitrant toxic compounds into TCA cycle intermediates eg: *Pseudomonas putida*. Bioremediation, Degradation pathways - naphthalene, BHC, and nitro phenols. Use of microbes for reconstruction of ecosystems - Genetics of biodegradation. Microbes as biosensors for detecting pollution. Superbug – cleaning of oil spills.

### UNIT-III

[8 Hrs]

Biological methods of pest management - Role of Juvenile hormones, pheromones and their analogs for pest management, Chromosomal manipulation and androgenesis of pest, sterile male technology, Biological control of weeds. Bacterial (BT), viral, fungal insecticides - Technology for mass production and formulation of biopesticides - Problems and prospects.

### UNIT-IV

[8 Hrs]

Biofertilizers - Important diazotrophic, microbes - mechanism of symbiotic and asymbiotic biological nitrogen fixation - Regulation of nitrogen-fixing genes (Nif genes). Manipulation of Nif genes for constitutive expression of nitrogenase - Ammonia transport and its significance. Mass production of biofertilizers - *Rhizobium*, *Azolla*.

### UNIT-V

[7 Hrs]

Waste management - Nature and classification of agriculture, domestic and industrial waste - Recycling methods. Solid waste treatment. Biological and non-biological methods of waste water treatment. Reclamation of treated waste water.

### Reference Books

- Environmental Biotechnology: Concepts and Application by Jordening H J and Winter J.
- Environmental Biotechnology: Theory and Application by Evans G M and Furlong J C.
- Environmental Biotechnology by Bhattacharya B C and Banerjee R.
- Environmental Biotechnology: Basic Concepts and Applications by Indu Shekhar Thakur.
- Environmental Biotechnology by V Kumaresan and N Arumugam.
- Environmental Biotechnology by Perry L McCarty and Bruce E Rittmann.
- Textbook of Environmental Biotechnology by P K Mohapatra.
- Environmental Biotechnology by T Srinivas.

## **SEMESTER - V**

### **MJD-8: ANIMAL PHYSIOLOGY**

**Objectives:** Explaining various aspects of physiological activities of animals with special reference to mammals

**Unit – I Nutrition** [7 Hrs]

Types of Nutrition. Food and feeding mechanisms, Digestive enzymes and their role in digestion.

**Unit – II: Respiration** [10 Hrs]

Respiratory organs, Respiratory pigments and functions. Transport of gases (CO<sub>2</sub> and O<sub>2</sub>) – Chloride shift, Haldane and Bohr's effect. Circulation: Composition, properties and functions of Blood, Mechanism of blood clotting, Structure of human heart- Cardiac cycle, Origin of heart beat, Pace maker, Regulation of heart beat, ECG, Blood Pressure, Arrhythmias.

**UNIT– III: Excretion** [8 Hrs]

Kidney, Nephron - structure and mechanism of urine formation in mammals, Osmo ionic regulation and thermoregulation.

**UNIT– IV: Muscle Physiology** [10 Hrs]

Types of muscles, Structure and chemical composition of skeletal muscle, Mechanism of muscle contraction. Nerve Physiology: Neuron–Structure, types of neurons. Nerve impulse, Synapse, Synaptic transmission of impulses, Neurotransmitters and reflex arc.

**UNIT-V: Receptors** [10 Hrs]

Photoreceptor–Structure of a mammalian eye, Retina–visual pigments, Physiology of vision. Phonoreceptor – Structure of mammalian ear , Mechanism of hearing, Physiology of equilibrium, Chemoreceptor's

**Suggested Readings**

- Sambasivaiah, Kamalakararao and Augustine chellappa1990.A Textbook of Animal physiology and ecology, S. Chand & co., Ltd., New Delhi– 110 055.
- Parameswaran, Anantakrishnan and Ananta Subramanyam, 1975. Outlines of Animal Physiology
- S. Viswanathan [printers & Publishers] Pvt. Ltd.
- William S. Hoar, 1976. General and comparative physiology, prentice Hall of India Pvt. Ltd., New Delhi. 110 001.
- Wood. D. W., 1983, Principles of Animal Physiology 3rd Ed.,
- Prosser, C. L. Brown, 1985, Comparative Animal Physiology, Satish Book Enterprise, Agra.

### **MJD-8: ANIMAL PHYSIOLOGY PRACTICAL**

1. Qualitative tests for identification of carbohydrates, proteins and fats
2. Study of activity of salivary amylase under optimum conditions
3. T.S. of duodenum, liver, lung, kidney, spinal cord, bone and cartilage
4. Differential count of human blood

## **MJD: 9: DEVELOPMENTAL BIOLOGY**

### **Course Objectives:**

While studying the **Developmental Biology** course, the student shall be able to:

- The main objective of Developmental Biology course is to provide four-dimensional thinking of students to truly understand the patterns and process of embryonic development, body plan, fate map, induction, competence, regulative and mosaic development, molecular and genetic approach for the study of developing embryo which is not necessarily shared with any other disciplines in the biological sciences.
- The relevance of Developmental Biology to the study of human disease will be exemplified throughout using different model organisms.
- Acquire knowledge on the fertilization and morphogenetic movements in the developing embryo.
- To understand the embryo organizer, inductions and differentiation.
- To study gametogenesis, fertilization, cleavage and gastrulation, stages in developing embryo.
- To acquaint students with basic knowledge of experimental embryology.

### **Course Outcomes:**

- Developmental Biology displays a rich array of material and conceptual practices that can be analyzed to better understand the scientific reasoning exhibited in experimental life sciences. Based on learning contents of embryology, students can have a systematic and organized learning about the knowledge and concepts of growth and development.
- Students would gain expertise in explaining how a variety of interacting processes generate an organism's heterogeneous shapes, size and structural features that arise on the trajectory from embryo to adult or more generally throughout a life cycle.
- Gains knowledge about gametogenesis, cleavage mechanisms, gastrulation and role of hormones in metamorphosis and regeneration.
- After learning the development of life from cell to multicellularity complex and coordinated systems in organisms the students can apply this knowledge for research, and education, to solve the problems related to development in animals through research.
- Developmental Biology enquires about the fundamental processes that underpin the fertilization of an egg cell and its step-by-step transformation into the fascinating complexity of a whole organism.
- Students will also understand that cells only express a proportion of their genome, and that differential gene expression underlies cell differentiation and any alteration in the entire process of development leads to devastating diseases.
- Students would have a systematic and organized learning about the knowledge and concepts of growth and development of organisms. Developmental Biology displays a rich array of material and conceptual practices that could be analysed to better understand the scientific reasoning exhibited in experimental life sciences.
- To understand the overall chronology of the development and the role of various morphogens (protein/mRNA) in specification and determination of various organs and body axis formation.

**UNIT-I:**

Potency, commitment, specification, Induction, Competence, Determination and differentiation of embryonic cells. Embryonic stem cells, origin and mechanism of Cell lineage, Fate maps. Imprinting; Mutants and transgenics in analysis of development. Genomic equivalence, cytoplasmic determinants and Nuclear transplantation experiments.

**UNIT-II:**

Origin and migration of germ cells; production of gametes and establishment of polarity. Fertilization; Cell surface molecules in sperm egg recognition in animals; Molecular events of post fertilization. Cleavage types, Blastula formation, Gastrulation and Molecular mechanism in germ layers formation. Environmental regulation of normal development.

**UNIT-III:**

Axis and pattern formation in Drosophila, Amphibia and Chick. Cell aggregation and differentiation in dictyostelium. Organogenesis- vulva formation in caenorhabditis elegans, eye lens induction. Development in tetrapod Limb (Amphibians) and Neural fold formation.

**UNIT-IV:**

Sex determination in animals (mechanism of primary and secondary sex determination) Hormonal regulation of sexual phenotypes. Regeneration - types of Regeneration; Axial patterning during Regeneration. Metamorphosis: hormonal regulation of metamorphosis in insects and amphibians.

**UNIT- V:**

Ageing and senescence- Reactive oxygen species and cell senescence; dietary restriction and anti aging action: genetic control of longevity; Age related diseases. Programmed cell death- Incidence of Apoptosis; Apoptosis during animal development; Apoptosis in metamorphosis and morphogenesis; Apoptosis during limb development: Biochemical and molecular mechanisms involved in Apoptosis.

**Suggested reading material:**

1. Austen, C.R. and Short, R.V. Reproduction in Animals
2. Ethan Bier The Coiled Spring Harlsor Laboratory Press, NewYork
3. F.T. Longo, Fertilization, Chapman & Hall
4. Molecular Developmental Biology – 2008, T. Subramonian, Narosa Publishing House
5. R.G. Edwards, Human Reproduction
6. S.F. Gillbert, Developmental Biology, Sinauer Associates Inc., Massachusetts
7. Schatten and Schatten. Molecular Biology of Fertilization.

**MJD: 9: DEVELOPMENTAL BIOLOGY PRACTICAL**

1. Frog: Egg, blastula and yolk plug stage.
2. Chick: Egg, 24 hrs, 36 hrs, 48 hrs, 72 hrs and 96 hrs developmental stages.
3. Placental types in Mammals.

## MJD-10: BICHEMISTRY AND MOLECULAR BIOLOGY

### Biochemistry and Molecular Biology Objectives:

While studying the **Molecular Biology** Course, the student shall be able to:

- This course provides concept in molecular understanding of structural and functional
- properties of cell and various processes associated which have potential applications in
- Molecular, Biochemical and Biomedical research.
- To provide Knowledge about the complex organization in the Eukaryotics Cell and the
- molecular mechanisms of the cellular processes that exist in all the cell types.
- To gain knowledge on DNA models, structure and functions of mitochondrial DNA,
- DNA repair mechanisms, Transcription, translation, Replication, Gene regulation
- mechanisms with emphasis on Eukaryotics.

### Molecular Biology Course Outcomes:

After Completion of the **Molecular Biology** course the student will be able to:

- The study of molecular biology provides the necessary information about the Chemistry of life to allow the students to understand the basis of life.
- The study of Molecular Biology stands as a tribute to human curiosity for seeking to discover, and to human creative intelligence for devising the complex instruments and elaborate techniques by which these discoveries can be made.
- Comparative analysis of Prokaryotic and Eukaryotic cells.
- Gain insight into the most significant Molecular and cell- based methods used today to expand our understanding of Biology.
- Students world gain expertise in understanding the complex molecular mechanisms occurring in cell and the applications of molecular technologies for betterment of life.
- Understand and our apply the Principles and techniques of Molecular Biology which prepares students for further education employment in teaching, basic research or the health Professions.
- Students will acquire knowledge about replication, transcription, translation, post transcriptional and post translational modifications, gene regulation, DNA repair mechanisms and various molecular tools and techniques like PCR, southern and western blotting, recombinant DNA technology etc. they will also know the various tools and techniques related to bacterial microbiology.

**UNIT I:** Scope of Biochemistry – Dissociation constant of water, Hydrogen ion concentration, Buffers and electrolytes. Acidity, alkalinity and pH determination. Carbohydrate: classification and structure of carbohydrate with examples. Protein: classification and structure with examples. Lipid: classification and structure with examples.

**UNIT-II:** Enzymes: classification, mechanism of enzyme action, factors affecting enzyme action, Isoenzymes. Vitamins: Structure and function of fat and water soluble vitamins. Intermediary metabolism-Glycolysis -TCA Cycle- Electron transport chain, Deamination, of amino acids, B- Oxidation of fatty acids. HMP shunt pathway

### **UNIT III:**

Watson and Crick Model: Types of DNA; Properties of DNA(C-value paradox, Cot value)  
Nuclear and mitochondrial genome, mitochondrial and maternal Inheritance Structure of gene  
(Cistron, Muton, Recon, Cis-trans test)

DNA damage and repair: Biological indication of repair, photo reactivation, Excision repair,  
Recombination repair, SOS repair, and Mismatch repair.

Replication in Prokaryotes: Geometry of DNA replication, semi conservative replication.

Enzymology of DNA replication: DNA polymerase I, II and III; Replication of Eukaryotic  
Chromosomes; Eukaryotic DNA polymerases; Multiple fork; Replication of Chromatin.

Discontinuous Replication: Fragments in Replication fork and detection of fragments; Events in  
the Replication fork; De novo initiation and covalent extension. Bidirectional replication,  
Termination of replication.

### **UNIT-IV:**

Synthesis of RNA:- RNA Polymerase, Promoter, Auxiliary Proteins, RNA chain initiation,  
elongation, termination and Splicing mechanism. Types of RNA, Processing of mRNA, rRNA  
and tRNA, Ribozyme. Genetic code, Identification of start and stop codon, Universality of  
genetic code Degeneracy, Wobblers Hypothesis. Codon usage, Genetic code of Mitochondria.  
Ribosome structure (Prokaryotic and Eukaryotic), Protein synthesis: Initiation, Elongation and  
Termination of polypeptide chain, Signal peptide hypothesis, Post translational modification,  
Polyproteins, Inhibitors of translation.

### **UNIT-V.**

Temporal response, Induction, Repression, Lac Operon, Galactose Operon Lambda Operon,  
Tryptophan Operon. Gene regulation in Eukaryotes- I: Gene families, Gene alteration (Gene loss,  
Gene amplification, gene rearrangement), Regulation of synthesis of primary transcripts (gene  
organization that affects regulation-Activator gene; Transcriptional control by hormones,  
Methylation). Gene regulation in Eukaryotes-II: Brief description of Chromatin remodeling,  
Enhanceosome, Reporter or Chimeric genes, Role of binding motifs in gene expression (Helix-  
Turn-Helix motif, Zinc finger and Leucine Zipper), miRNA.

### **Suggested reading material:**

1. Cell and Molecular Biology by EDR De Robertis and EMR De Robertis Jr, Indian Edition, B.I. Publicaitons, Pvt. Ltd.
2. Human Physiology by Stuart Era Fox, W.M.C. Brown Publishers, USA 1984 or Recent Edition.
3. Cell and Molecular Biology-E.D.P. De Robertis and E.M.F.
4. Concepts in Molecular Biology-S.C. Rastogi, VN. Sharma and Ananda Tandon (1993) Genes VII by Benjamin Lewin.
5. Harper's review of Biochemistry by D.W. Martin et al1990.
6. Molecular Biology by David Freifelder, 1993.
7. H.S. Srivastava, Elements of Biochemistry (2006) Rastogi Publications, Meerut.
8. Rastogi, S.C., 2007, Outlines of Biochemistry: A Quick Review.
9. Veerakumari.L, 2004, Bio Chemistry, MJP Publications.
10. Harpers Biochemistry – Robert K.Muuay., Daryl.K.Granner., Peter.A.Mayes., & Victor.W.Rodwell (2004) Prentice Hall International, ISBN-8385-3612-3.
11. Principles of Biochemistry y A.L Lehninger, D.L Nelson& M.M.Cox (1993) Worth publishers New york.

## **MJD-10: BICHEMISTRY AND MOLECULAR BIOLOGY PRACTICAL**

1. Qualitative tests for identification of carbohydrates, proteins and lipids.
2. Qualitative tests for identification of ammonia, urea and uric acid (Nitrogenous excretory products).
3. To prepare dilutions of Riboflavin and verify the principle of spectrophotometry.
4. To identify different amino acids in a mixture using paper chromatography.
5. Demonstration of DNA extraction from blood or tissue samples.
6. To estimate amount of DNA using spectrophotometer.

## MID-5: TOXICOLOGY

### Course objectives:

While studying the **Toxicology** course, the student shall be able to:

- Provides broad theoretical knowledge within toxicology and development of a general working knowledge of the principles and practice of clinical toxicology.
- Basic toxicology concepts including: mechanisms of toxicology, absorption, distribution and excretion of toxicants, xenobiotic metabolism, toxicokinetics, chemical carcinogenesis, hepatotoxicology.
- Based on student interest some of the following areas may be included: genetic toxicology, developmental toxicology, renal toxicology, toxic effects of pesticides, toxic effects of metals, toxic effects of radiation, venoms and animal poisons, air pollution, ecotoxicology, food toxicology, forensic toxicology, occupational toxicology, regulatory toxicology, other.
- This course includes the study of Pesticides that are agrochemicals and used for preventing, repelling, mitigating or destroying any pests. It includes insecticides, fungicides, rodenticides and herbicides etc. These insecticides are of chemical or biological origin that controls the insect.
- The course indicates the mechanism of Pest control that may result in the form of killing the insects or otherwise preventing it from its destructive behaviors. Insecticides are either natural or man-made synthesized and are applied to target pests in a myriad of formulations (EC, WP, SP, FP, G etc.) and delivery systems (sprays, baits, slow-release diffusion, dust, etc.). In recent years, the bacterial genes coding for insecticidal proteins have been incorporated into various crops that deal with the mortality of the pests feeding on them.
- The course highlights various categories of insecticides and their relative efficacy in relation to other control methods in a particular ecosystem. Use of bio-pesticides and other plant derived pesticides form an important part of IPM (Integrated Pest Management).
- The course indicates the biodiversity of insects in different ecosystems and the impact of global climatic changes on insects diversity and their behaviour. Insects are important for the survival of different biota on the earth. Effect of various anthropogenic activities and pollutants on insects is correlated with maintenance of different ecosystems.
- To apprise the students about the toxicants along with their application and their effects on biosphere as well as human health.

### Unit- I:

Introduction and scope of toxicology and classification of xenobiotics. Principles of toxicology- Dose response relationship- Toxicity tests {acute (LD<sub>50</sub>, LC<sub>50</sub>, ED<sub>50</sub>) and chronic toxicity tests on aquatic and terrestrial animals}, Variations in toxic response. Mechanism of toxic action of pesticides (Receptor concept, nature of receptors, Theory of toxicants- receptors interactions and mechanism of action of some pesticides) Toxicokinetics- i) Classic toxicokinetics ii) Physiologic toxicokinetics

### Unit- II:

Translocation of toxicants; Absorption of Toxicants, Distribution of Toxicants, Excretion of Toxicants Biotransformation of Xenobiotics; Biotransformation sites, Biotransformation enzymes, Biotransformation reaction and bioactivation Bioaccumulation of Xenobiotics; Bioconcentration, Bioaccumulation and Biomagnification; Biomagnification of lipophilic and recalcitrant substances Toxic effect of metals - Mercury, Lead, Cadmium and Arsenic

**Unit- III:**

Toxic Response of Blood: Toxicology of erythron, leukon, platelets and homeostasis Toxic Response of Liver; Mechanism and types of toxin – induced liver injury; critical factors in toxicant induced liver injury; detoxification mechanisms by liver. Toxic Response of Kidney; Susceptibility of the kidney to toxic injury; Biochemical mechanisms / mediators of renal cell injury.

**Unit-IV**

Toxic Response of Reproductive system; Endocrine disruption: endocrine disruptors (including screening and puberty) in humans and mammals. Testicular and ovarian dysfunction. Deterioration in fertility by toxicants.

**Unit- V:**

Xenobiotic effect on basic metabolism (Carbohydrates, Proteins, Lipids) Teratogens and Teratology (Relationships between maternal and developmental toxicity) Antidotal therapy; Types of antidotes and antidotal procedures. Risk assessment – Hazard identification; Risk characterization and Safety evaluation of Chemicals.

**SUGGESTED READING MATERIAL**

1. Casarett & Doull's- Toxicology- The basic science of poisons- C.D. Klassen, Mary, O.D & John Doull.
2. Concepts of Toxicology Dr. Omkar, Vishal Publishing C.2003.
3. Environmental toxicology of pesticides- F. Mastimura, G.M.Boush and T.Misato.
4. Introduction of Biochemical Toxicology- E.Hodgson & F.E.Gutherie.
5. Pesticides action and metabolism- O'Brrien.
6. Pesticides and Human Welfare- D.L. Gunn and J.G.R.Stevens. Oxford University Press- 1978.
7. The Encyclopedia of Americana- Vol.15.

## MID-5: FORENSIC ENTOMOLOGY

**Course Objectives:** After studying this paper the students will know-

- The overview of forensic entomology and its applications.
- The stages of death.
- The role insects play in the decomposition of carrion.
- The life cycle of insects.
- The forensic importance of insects.

**Course Outcome:** This course will enable the students to:

- Identify the relationship between insect type and the stages of death.
- Distinguish among major insect types associated with carrion.
- Estimate time of death.
- Types and identification of microbes of forensic significance.

### UNIT-I

(10 Hrs)

Forensic Entomology: Introduction and history of entomology, general entomology and arthropod biology and taxonomy of arthropod, forensically important insects.

### UNIT-II

(10 Hrs)

Insects of forensic importance; collection of entomological evidence during death investigations; the role of aquatic insects in forensic investigations; life cycles of insects.

### UNIT-III

(15 Hrs)

Stages of decomposition: insect succession on carrion and its relationship to determine time since death; factors influencing insect succession on carrion, its application to forensic entomology.

### UNIT –IV

(10 Hrs)

Forensic Entomotoxicology: Current concepts, trends, challenges and techniques. Implication of morphometric and growth rate

### Reference Book:

1. J.H.Byrd and J.K. Tomberlin, 3<sup>rd</sup> Edition Forensic Entomology (2009).
2. D.B.Rivers And G.A. Dahlem, 1<sup>st</sup> Edition, the Science of Forensic Entomology(2022).
3. J.Amendt, M.Lee Goff and C.P.Campobasso, Current Concept of Forensic Entomology (2010)

## MID-5: TOOLS AND TECHNIQUES

### Course Objectives:

While studying the **Tools & Techniques**, the student shall be able to:

- To study the different tools used in biology and research.
- To learn about the operational handling and maintenance of laboratory instruments and glassware.
- To study different types of microscopy used in biology.
- To learn about different molecular and cellular separation techniques and their application in biological research.
- To study principles and methods of microtechnique.

### UNIT-I.

Chromatography: Molecular sieve chromatography: Principle, Determination of void volume and molecular mass of native molecules.

Ion exchange chromatography: Ion exchange materials – Cation and anion exchange materials. Principle and separation of charged molecules. Principle and application of TLC and HPLC.

Centrifugation: Techniques-Density gradient., ultra centrifugation.

### UNIT-II

Electrophoresis: principle, Matrices used in electrophoresis – PAGE for separation of proteins, molecular mass determination. Separation of nucleic acids using agarose gel- electrophoresis. Pulse field electrophoresis and isoelectric focusing. Blotting techniques: western, southern and northern blotting techniques.

### UNIT-III.

Introduction to cell and tissue culture: Preparatory techniques – cleaning, sterilization, sterile handling tissue culture laboratory requirements, Design of tissue culture laboratory: Equipments and purpose.

Cell types (Primary and secondary) and cell lines, Cell proliferation measurements, Cell viability testing: Dye inclusion and dye exclusion tests.

Culture media: composition, preparation and sterilization, macro and micro nutrients, Importance of serum and limitation with serum media, cell harvesting methods.

The biology of stem cell: overview; different types of stem cells – embryonic stem cells, fetal tissue stem cells, adult stem cells, stem cell nuclear transfer; somatic cell nuclear transfer, Animal cloning.

### UNIT-IV.

Electromagnetic spectrum of light- Simple theories of absorption of light by molecules. Beer-Lambert law. Types of detectors: UV-Visible spectrophotometry, Infra red spectrophotometry, Fluorescent spectroscopy. Flame photometry, AAS, IC-OES, ICP-MP.

Electrophysiological methods: Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, CAT.

### UNIT-V:

Microscopic techniques: Principles of microscopy Scanning and transmission microscopes. Image processing methods in microscopy. Different fixation and staining techniques for Light microscope and Electron microscope. Microtomy and processing of tissues for Light microscope and Electron microscope. Cryopreservation and cryotechniques for microscopy Freeze-etch and freeze-fracture methods for EM.

**Course Outcomes:**

- Students would be trained in various tools and techniques used to gain insight into biological processes.
- Students would be expertise techniques used for imaging, isolation, purification and characterization of various biological substances.
- Students would gain basic knowledge of the underlying principles and practical strategy of the analytical and preparative techniques that are fundamental to study and understanding of life processes.
- Identify and describe the different equipment and tools used in a biology laboratory.
- Correctly operate different laboratory instruments.
- Correctly operate different types of microscopes.
- Prepare tissue for section cutting and correctly operate a microtome.
- Choose and perform correct staining technique for any given tissue sections.
- Describe cellular separation techniques.
- Properly handle and maintain glassware.
- Properly operate laboratory equipment.

**SUGGESTED READING MATERIAL:**

1. A Biologists Guide to Principles and Techniques of Practical Biochemistry, K. Wilson & K.W. Goulding, ELBS Edn.
2. Animal Cell Culture – A practical approach, Ed.John. R. W.Masters IRL Press.
3. General Zoological Microtechniques - P.M. Weesner.
4. Principles and techniques of Biochemistry and molecular biology by Kein Wilson and John Walker, VII volume, Cambridge press Edition.
5. Neuro anatomical Techniques, N.J. Stransfed and T.A. Miller Springer Verlag, New York Heidelberg, Berlin.
6. Principles of Neuro Phycho pharmacology- Robert S. Feldman, Jerrold S. Meyer and Lind F. Quenzer. Sinauer Associates, Inc. Publishers. Sunderland. Massachusetts.
7. Biophysical chemisty by Upadhyay – Upadhyay - Nath. Analytical Biochemistry (Biochemical techniques) by Dr P. Asokan. Chinnaa publications.
8. Introduction to Instrumental analysis, Robert Braun. McGraw Hill International Edition.
9. Vogel's Qantitative Chemical Analysis by Vogel, ArthurI.

# SEMESTER – VI

## MJD-12: ENDOCRINOLOGY

### Objectives :

Explaining the role of hormones on physiological activities of animals with special reference to humans.

### UNIT – I

Scope of Endocrinology, Endocrine glands, hormones and hormone action, Structure, hormone secretion and functions of hypothalamus and pituitary gland, Pineal gland: Melatonin and serotonin – circadian rhythm.

### UNIT – II

Structure of thyroid gland – Biosynthesis of thyroid hormones, Biological functions of Thyroid hormones, Regulation of Thyroid secretion, Hormones of parathyroid Glands and their biological action. Role of calcitonin in calcium and phosphate homeostasis in blood. Disorders of thyroid and parathyroid.

### UNIT – III

Adrenal Cortex – Glucocorticoids, Mineralocorticoids and their biological function. Renin Angiotensin System. Adrenal Medulla – Catecholamines – Synthesis and Biological action. Corticosteroids: Biosynthesis, secretion, actions, metabolism and excretion of cortisone Cortisol, corticosterone, deoxycorticosterone and aldosterone. Disorders of adrenal gland.

### UNIT – IV

Pancreatic (Islets of Langerhans) hormones – Insulin, Glucagon – Biosynthesis, Regulation, Biological action, Gastrointestinal Hormones: Gastrin, secretin, pancreaticozymin Cholecystokinin etc. Disorders of pancreas gland.

### UNIT – V

Male reproductive system: Structure of Testes, Biosynthesis of testosterone and inhibin, Regulation and functions. Female reproduction system: Structure of Ovary, Biosynthesis of estrogen, Feedback regulation and functions Female Reproductive Cycle – Estrous, Menstrual, contraceptions. Placental hormones – parturition – Lactation. Disorders associated with gonadal hormones.

### Suggested Readings

1. Mac E Hadley, 1992 Endocrinology, Third edition, prentice Hall, New Delhi Jersey
2. Wilson J.D and Foster D.W 1992, William's textbook of endocrinology, 8th edition, WB saunders company, Philadelphia.
3. Turner C.D and Bagnarr, J.T., 1994, General Endocrinology, 6th edition, WB saunder's company, Philadelphia [saunder's international students edition]
4. Prakash S Lohar Endocrinology, Hormones and Human Health.
5. Hormones" by A.W. Norman and G. Litwack, Academic Press 2nd Edition

## **MJD-12: ENDOCRINOLOGY PRACTICAL**

1. Observation of permanent slides – Pancrease, Testes,Ovary, Adrenal Pituitary
2. Test for Pregnancy
3. Fertility test

## **MJD-13: BIOTECHNOLOGY**

### **UNIT I**

General Introduction and Achievements of Biotechnology. Genetic Engineering and r-DNA technology (Restriction endonucleases, DNA ligases, Topoisomerases, Methylases, Nucleases, Polymerases, Reverse transcriptase and their Properties and functions). Cloning vectors (plasmids, Bacteriophages, Cosmids, Yeasts Shuttle vectors, Viruses, PBR-322 and its derivatives, S.V 40 and other vectors) used in Gene cloning. Cloning Strategies and Screening Analysis of recombinants (Single colony hybridization Technique), immunologic test, Southern blotting.

### **UNIT II**

Animal cell culture techniques: Types of cell culture - primary and established culture; organ culture; tissue culture; three dimensional culture and tissue engineering; feeder layers; disaggregation of tissue and primary cell culture; cell separation; cell synchronization; cryopreservation.

### **UNIT III**

Animal cell culture techniques: Culture media - Balanced salt solutions and simple growth medium, Physical, chemical and metabolic functions of different constituents of culture medium; Role of carbon dioxide, serum, growth factors, glutamine in cell culture; Serum and protein free defined media and their applications.

### **UNIT IV**

Transgenesis in animals: cell transformation; vector-less gene transfer – calcium mediated, electroporation, electrofusion, liposome mediated gene transfer, microinjection. Gene transfer through vectors - Adenoviruses, ALVs, Baculoviruses, SV40.

### **UNIT V**

Application of transgenic animals: Animals as models for human diseases, live-stock improvement, bovine growth hormone, silk worm as bioreactors. Techniques, significance and applications of sericulture, apiculture, aquaculture (fish, prawn and pearl), poultry, diary and rabbit farming.

Suggested readings:

1. Animal cell culture; A practical approach, 4th Edition, by Freshney. R.I. John Wiley publication.
2. Methods in cell biology; Volume 57, Animal cell culture methods, Ed. Jennie P. Mather, David Barnes, Academic press.
3. Mammalian cell biotechnology; A practical approach, Ed. M. Butler, Oxford University press.
4. Exploring genetic mechanism; Ed. Maxine Singer and Paul Berg.
5. Principles of genetic manipulation; Ed. Old and Primrose, 6th Edition. Blackwell science publication.
6. Biotechnological innovations in Animal productivity, BIOTOL Series, Butterworth - Heineman Ltd. Oxford, 1992
7. An introduction to embryology. WB Saunders company, Philadelphia, Balinsky. BI, 1970
8. P.K.Gupta – Elements of Biotechnology [2001] Rastogi publication, Meerut.
9. 5. Lohar.P.S – Biotechnology (2005) – MJP Publishers, Chennai – 5.

## **MJD-13: BIOTECHNOLOGY PRACTICAL**

1. Identification techniques – Morphological, Biochemical and molecular techniques
2. 16S RNA typing: Phylogenetic tree construction
3. Preservation of pure culture – Lyophilisation
4. Isolation of DNA from Bacteria
5. Isolation of plasmids
6. Restriction and ligation
7. Preparation of competent cell
8. Gene transfer in microbes – calcium mediated, electroporation, vector mediated
9. Identification of recombinants – antibiotic markers, Blue-white colony
10. PCR
11. Blotting techniques –Western and Southern blot, Electrophoresis

## **MJD-14: EVOLUTION AND ETHOLOGY**

Objectives :

To explain the scientific concepts of animal evolution through theories and evidences and understanding of Animal Behaviors.

### **UNIT –I**

Origin of Life on Earth, Evidences of Evolution – Morphological, Embryological, and palaeontological. Geological time scale – Fossils & Fossilization, Dating of Fossil Living, connecting and Extinct Fossils.

### **UNIT –II**

Theories of Evolution : Lamarckism, Neo-lamarckism, Darwinism, Neo-Darwinism, Devries concept of Mutation, Modern version of Mutation theory.

### **UNIT –III**

Origin of Species, Phylogentic and biological concept of species: Mechanisms of reproductive isolation; Models of speciation, Hardy –Weinberg law of genetic equilibrium. natural selection, mutation, genetic drift and migration.

### **UNIT IV**

History and scope of ethology: Motivation- models of motivation (Lorenz's psychohydraulic model and Deutsch's model); learning- types of learning (imprinting, habituation, conditioned reflex, unconditioned reflex, latent learning); neural mechanisms in behaviour role of hypothalamus and other brain centers, hormones and behavior; sociobiology- social groups – merits and demerits, properties of organized societies, social groups in mammals, social stress. Pheromones and chemical communications, human pheromones.

### **UNIT V**

Description and types of animal behaviour. Types of communications in insects. Pheromones and their role. Parental care in fishes. Courtship behaviour in fishes and birds. Biological Rhythm: Circadian rhythm. Migration in insects, fishes and birds.

Suggested Readings:

1. Dobzhansky, T., F.J.ayala, G.L.Stebbins and J.M.Valentine 1998. Evolution, Surjeet Publications, New Delhi.
2. Dobzhansky T 1984 Genetics and Origin of species. Columbia Univ. Press.
3. Alcock, I. Animal behaviour- an evolutionary approach. Sinauer Associates Inc., Massachussets
4. Chandrasekharan, M.K. Biological Rhythm. Vishwanathan Printers, Chennai.
5. Lull, R.S. 1976. Organic Evolution. Light & Life Publisher.

## **MJD-14: EVOLUTION AND ETHOLOGY PRACTICAL**

### **Evolution**

1. Study of Fossils
2. Homologous organs
3. Analogous organs
4. Industrial melanism
5. Adaptive radiation ( Darwin finches)
6. Living fossils
7. Connecting link
8. Hardy Weinberg law calculation

### **Ethology**

1. Tagging (paper/aluminium) of animals and recapture to study patterns of migration.
2. Study of different types of nests of animals.
3. Study of Parental Care

## MJD-15: PUBLIC HEALTH ENTOMOLOGY

### Objectives:

The course provides an opportunity for students to gain in-depth knowledge of Public Health Entomology and intense training on the modern approaches for epidemiology, prevention and control of vectors and vector-borne diseases.

### Course Outcome:

Upon completion of the course, students will have

1. A foundational understanding of public health entomology, encompassing vector biology, ecology, environment, epidemiology, and vector-borne disease control.
2. Investigating outbreaks and epidemics of vector-borne illnesses.
3. Using contemporary instruments for vector-borne disease detection and diagnosis.
4. The ability to make sound decisions when organizing and carrying out suitable preventative and control actions, such as monitoring and assessment, within the framework of integrated vector management

### Unit I:

[08 hrs]

Principles and practices of public health: Public Health- what it is; causation, prevention, social determinants of health, health systems, health policy and Public Health action. Disease control institutions: WHO, CDC, NCDC, NCVBDC, VCRC, NIRT, NIE, NIMR. Introduction to medically important Arthropods: Characteristics of different Classes of Arthropoda. Classification of Insecta. Characteristics of Orders: Diptera – Siphonaptera – Anoplura – Hemiptera – Dictyoptera

### Unit II:

[08 hrs]

Characteristics of Families Culicidae – Phlebotomidae – Muscidae – Tabanidae – Calliphoridae. Characteristics of mosquitoes – Anopheles – Culex – Aedes – Mansonia. Characteristics of sand flies: Phlebotomus – Sergentomyia. Characteristics of flies: Musca – Calliphora. Characteristics of fleas: Xenopsylla – Pulex – Ctenocephalides. Characteristics of Pediculus – Pthirus. Characteristics of families Ixodidae – Argasidae – Trombiculidae – Sarcoptidae, Characteristics of Ticks: Boophilus – Rhipicephalus – Haemaphysalis – Ornithodoros, Characteristics of mites: Leptotrombidium – Sarcoptes.

### Unit: III

[10 hrs]

**Biology of blood feeding arthropods of public health importance-** Life history of importance vector mosquitoes *Anopheles* (*An. stephensi*, *An. culicifacies*, *An. fluviatilis*), *Aedes* (*Ae. aegypti*, *Ae. albopictus*), *Culex* (*Cx. quinquefasciatus*, *Cx. tritaeniorhynchus*), *Mansonia* (*Ma. annulifera*, *Ma. uniformis*) – Sandflies (*Phlebotomus argentipes*) – black flies (*Simulium damnosum*)

**Biology of blood feeding and filth breeding arthropods of public health importance -** Life history of horse flies, tsetse flies, house flies, myiasis causing flies, fleas (species of *Xenopsylla* and *Ctenocephalides*), Triatomine bug, bed bug, head and body louse.

**Biology of blood feeding acarina of public health importance-** Life history of Ixodids (*Haemaphysalis*, *Ixodes*, *Dermacentor*, *Rhipicephalus*, *Amblyomma*), Argasid (*Argas*, *Ornithodoros*) and Mites (*Sarcoptes*, *Leptotrombidium*, *Dermatophagoides*).

### Unit IV:

[09 hrs]

**Pesticides in public health:** Pesticides origin - Use of pesticides – History of pesticides/Insecticides– Definition of various terms– Classification of pesticides: According to hazardous category, chemical type, physical state, main use etc. – Chemical Pesticides – Bio-larvicides – Insect growth regulators – Mode of action – Advantages of chemical control and its

utility in vector control – Pesticide formulations: Types of formulations – conventional and newer formulations (nano based).

## **Unit V**

**[10 hrs]**

**Control of mosquitoes and flies (Black flies, Sand flies, Biting midges, Tabanids, Stable flies):** Selection of suitable site-specific control measures – Personal protection measures – zooprophylaxis – Insecticide treated fabrics – Long lasting insecticide treated mosquito nets (LLINs) – Insecticide spraying (larviciding – indoor residual spraying – space spraying) – Alternatives – biological control – environmental management including source reduction.

**Control of Tsetse flies and Triatomine bugs:** Tsetse fly: Prevention and control – Traps and insecticide impregnated screens – Insecticide spraying (ground and aerial). Triatomine bugs: Introduction to control measures – Application of insecticides – insecticides and formulations – House modification/ improvement – improvement of Peri-domestic environment – insecticide treated bed nets – fumigant canisters.

**Control of bedbugs, fleas, lice, ticks, mites and others:** Bedbugs: Detection – repellents – household measures – insecticide treated bed nets – smoke generators – smoke density – residual insecticide spraying; prevention and control of rodents (physical, trapping, application of baits) – control of rodent ectoparasites - control of fleas in human, rat, cat, dog control of lice (head, crab or pubic and body lice) – control of ticks: hard and soft ticks, - control of mites: trombiculid, scabies, dust and domestic mites – control of cyclops – fresh water snails – venomous arthropods.

## **References:**

1. Bonita R., Beaglehole, R. and Kjellstrom, T. (2006). Basic Epidemiology (Second edition). WHO, Geneva.
2. Gordis, L. (2018). Epidemiology (Sixth edition.). Philadelphia: Elsevier Saunders
3. John W Creswell (2007). Qualitative inquiry & research design, New Delhi: Sage publications
4. National ethical guidelines for biomedical and health research involving human participants. New Delhi: Indian Council of Medical Research; 2017.
5. Park K. Park's textbook of Preventive and Social Medicine. 27th ed. Jabalpur: M/s Banarsidas Bhanot Publishers; 2023.
6. Raju K. H, Sabesan S, Subramanian S, and Jambulingam P. Validating the Association of Japanese Encephalitis Vector Abundance with Paddy Growth, Using MODIS Data. Vector-Borne and Zoonotic Diseases. 2018; 18(10).
7. Rothman K, Greenland S, and Lash TL. Modern epidemiology, 4th Edition. Philadelphia, PA: Lippincott Williams & Wilkins.
8. Roy D.N. and Brown A.W.A. (1970). Entomology (Medical and Veterinary) including insecticides & insects & Rat control; The Bangalore Printing & Publishing Co. Ltd., Bangalore.
9. Sabesan S, Raju KH, Subramanian S, Srivastava PK, Jambulingam P. Lymphatic filariasis transmission risk map of India, based on a geo-environmental risk model. Vector-Borne and Zoonotic Diseases. 2013; 13(9): 657-65.
10. WHO (2016). Handbook: Vector surveillance and control at ports, airports and ground crossings. International Health Regulations. Available from: [WHO.int/ihr/publications/9789241549592/en/](http://WHO.int/ihr/publications/9789241549592/en/)

## MJD-15: PUBLIC HEALTH ENTOMOLOGY PRACTICAL

1. Demonstration of mouth parts and wings of medically important insects.
2. Identification of *Culex quinquefasciatus*, *Cx. tritaeniorhynchus*, *Anopheles stephensi*, *Aedes aegypti*, *Ae. albopictus*, *Mansonia annulifera*, *Ma. uniformis*.
3. Identification of *Phlebotomus papatasi*, *Ph. argentipes*, *Chrysomya bezziana*.
4. Identification of *Xenopsylla astia*, *Xe. brasiliensis*, *Xe. cheopis*, *Pthirus pubis*, *Pediculus capitis*.
5. Identification of *Boophilus*, *Rhipicephalus*, *Haemaphysalis*, *Ornithodoros*.
6. Demonstration of life cycle stages of mosquitoes.
7. Dissection and mounting of mouth parts: Sandfly, mosquito.
8. Environmental and entomological risk assessment of dengue transmission in an endemic area.
9. Visit to Department of Vector borne disease control centres.
10. Preparation of stains - JSB I and II, Leishman and Giemsa.
11. Preparation of blood smears (thick and thin) and staining with JSB. Leishman and Giemsa For detection of malarial parasites.
12. Identification of human malaria parasite species through examination of blood smears:  
(I) *Plasmodium vivax* (II) *P. falciparum* (III) *P. malariae* (IV) *P. ovale*
13. Staining and examination of blood smears for detection of microfilariae.
14. Dissection and examination of mosquitoes for filarial parasite (*Wuchereria bancrofti* and *Brugia malayi*)
15. Demonstration of various stages of filarial parasites and differentiation of species.

## MID-6: VECTORS AND DISEASES

### Course outcome

- After completion of the course the student is able to:
- Learn in detail of insect, vector diseases
- Identify in detail with examples insect, vector diseases
- Deliberate the detail of insect ,vector diseases
- Learn in depth Insect, vectors and diseases

### UNIT I

Introduction to Insects General Features of Insects, Morphological features, Head – Eyes, Types of antennae, Mouth parts w.r.t. feeding habits. Concept of Vectors : Brief introduction of Carrier and Vectors (mechanical and biological vector), Reservoirs, Host-vector relationship, Vectorial capacity, Adaptations as vectors, Host Specificity. Insects as Vectors: Classification of insects up to orders, detailed features of orders with insects as vectors – Diptera, Siphonaptera, Siphunculata, Hemiptera

### UNIT II

Dipteran as Disease Vectors: Dipterans as important insect vectors – Mosquitoes, Sand fly, Houseflies; Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis; Control of mosquitoes.

### UNIT III

Study of sand fly-borne diseases – Visceral Leishmaniasis, Cutaneous Leishmaniasis, Phlebotomus fever; Control of Sand fly Study of house fly as important mechanical vector, Myiasis, Control of house fly

**UNIT IV** Siphonaptera as Disease Vectors: Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases – Plague, Typhus fever; Control of fleas.

Siphunculata as Disease Vectors: Human louse (Head, Body and Pubic louse) as important insect vectors; Study of louse-borne diseases –Typhus fever, Relapsing fever, Trench fever, Vagabond's disease, Phthiriasis; Control of human louse

**UNIT V** Hemiptera as Disease Vectors: Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors, Control and prevention measures.

### PRACTICAL VECTORS AND DISEASES

1. Study of different kinds of mouth parts of insects.
2. Study of following insect vectors through permanent slides/ photographs: Aedes, Culex, Anopheles, Pediculus humanus capitis,
3. Pediculus humanus corporis, Phthirus pubis, Xenopsylla cheopis, Cimex lectularius'.
4. Phlebotomus argentipes, Musca domestica, through permanent slides/ Photographs.
6. Study of different diseases transmitted by above insect vectors.

### Reference:

1. Imms, A.D. (1977). A General Text Book of Entomology. Chapman & Hall, UK
2. Chapman, R.F. (1998). The Insects: Structure and Function. IV Edition, Cambridge University Press, UK
3. Pedigo L.P. (2002). Entomology and Pest Management. Prentice Hall Publication
4. Mathews, G. (2011). Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases. Wiley-Blackwell

## **MID-6: REPRODUCTIVE BIOLOGY**

### **COURSE OBJECTIVES**

- This course will take a comprehensive look at the exciting process of reproduction by examining the role of hormones, the process of puberty, and the production of offspring.
- While a variety of species will be used to explain basic principles of the reproductive process, this course will focus on sexual reproduction by emphasizing mammalian, especially human, reproduction.

### **COURSE OUTCOME**

Upon successful completion of this course, students should be able to:

- Demonstrate knowledge of the key steps in sexual determination and differentiation at chromosomal, gonadal, internal and external genitalia, and hypothalamic levels.
- Describe the key gross and microscopic components of the human reproductive system.
- Describe gametogenesis and structure of gametes and relate it to their function.
- Demonstrate knowledge of key principles of reproductive endocrinology including: a) biosynthesis and chemistry of the different classes of hormones, b) mechanisms of action of hormones.
- Demonstrate a detailed and comparative knowledge of the control of human reproduction. Demonstrate a detailed and comparative knowledge of the physiology of pregnancy, parturition and lactation in humans.
- Evaluate the principles, merits and limitations of various forms of reproductive technology in use.
- Describe the process of in vitro fertilization and evaluate advantages and disadvantages of the methodology used Define different types of stem cells; comparison and applications

### **COURSE CONTENT**

#### **UNIT I**

Sexual Differentiation and Development. Male Gross Anatomy and spermatogenesis; Testicular Descent; Testicular Thermoregulation; Erection; Ejaculation. Male Reproductive Endocrinology-Semen Physiology.

#### **UNIT II**

Overview of Female Reproductive Anatomy; Folliculogenesis. Oogenesis; Atresia, Endocrine Control of Ovarian Function.

#### **UNIT III**

Female: Ovulation; Corpus Luteum Formation. Prostaglandins and Role in Reproduction. Puberty and the Menstrual Cycle. Hypothalamus and pituitary; Neuroendocrine Control of Reproduction.

#### **UNIT IV**

Sperm and Ova Transport; Sperm Capacitation and Acrosome Reaction; Fertilization Early Embryonic Development and Maternal Recognition of Pregnancy Gestation; Prenatal Development and Placentation.

## **UNIT V**

Human Contraception and Human reproductive Technologies. In vitro fertilization techniques. Stem cells; types, comparison and applications (embryonic, adult, induced pluripotent stem cells).

### **Suggested readings**

1. Human reproductive biology 4th edition, 2013, Jones And Lopez, Academic Press: New York
2. Pathways to pregnancy and parturition. 2003. P.L. Senger. Current Conceptions, Inc.
3. Biology of Human Reproduction. 2002. Ramon Pinon, Jr. University Science Books.
4. Human Sexuality. 2003. Simon LeVay and Sharon M. Valente. Sinauer Associates, Inc.

## MID: 6-MEDICAL MICROBIOLOGY (THEORY)

### Unit I:

Hours: 13

#### Normal microflora of the human body and host pathogen interaction:

Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract. Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS.

#### Sample collection, transport and diagnosis

Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests, Complement fixation, PCR, DNA probes).

### Unit 3: Bacterial diseases

Hours: 10

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control: Respiratory Diseases: Streptococcus pyogenes, Haemophilus influenzae, Mycobacterium tuberculosis. Gastrointestinal Diseases: Escherichia coli, Salmonella typhi, Vibrio cholerae, Helicobacter pylori. Others: Staphylococcus aureus, Bacillus anthracis, Clostridium tetani, Treponema pallidum, Clostridium difficile.

### Unit 4: Viral and fungal diseases

Hours: 10

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control: Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis.

Brief description of each of the following types of mycoses and one representative disease to be studied with respect to transmission, symptoms and prevention: Cutaneous mycoses: Tinea pedis (Athlete's foot). Systemic mycoses: Histoplasmosis. Opportunistic mycoses: Candidiasis.

### Unit 5: Protozoan diseases and Antimicrobial agents

Hours: 12

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control: Malaria, Kala-azar.

Antimicrobial agents: General characteristics and mode of action: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism. Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin. Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine Antibiotic resistance, MDR, XDR, MRSA, NDM-1.

## **MID-6: MEDICAL MICROBIOLOGY (PRACTICAL)**

1. Identify bacteria, *E. coli*, *Salmonella*, *Pseudomonas*, *Staphylococcus*, *Bacillus* (any three) on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests.
2. Study of composition and use of important differential media for identification of bacteria: EMB Agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS.
3. Study of bacterial flora of skin by swab method. 4. Perform antibacterial sensitivity by Kirby-Bauer method.
5. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms).
6. Study of various stages of Malarial parasite in RBCs using permanent mounts/Photomicrographs.

### **SUGGESTED READING**

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.

## SEMESTER – VII

### MJD-16: IMMUNOLOGY

#### Course Objectives:

- To provide knowledge on essential features of antigens and antibodies and their types and different theories of Antibody formation.
- To acquire knowledge on types of immunity, phagocytosis, interferons and complement system.
- To explain the concept of hypersensitivity, auto immunity and transplantation.
- To provide knowledge on immune deficiencies and several immunological techniques.

#### Course Outcomes:

The student will be able to

1. Gain knowledge on different types of antigens, antibodies and how different types of antibodies are produced.
2. Outline, compare and contrast the key mechanism of innate and adaptive immunity.
3. Gain knowledge on undesirable immunological reactions and their complication in health management.
4. Apply knowledge in disease diagnosis through serological tests.

#### Course Contents:

##### Unit I

Introduction: Scope of Immunology, Historical background of Immunology, Biological aspects of Immunology, Self and non-self-recognition, specificity, memory of immune system. Antigens: Essential features of Ag, haptens, Carrier molecule, Immunological valence, Antigenic determinants. Adjuvants: Freund's complete and incomplete. Antibodies: Nature, Primary structure of immunoglobulins, Classification of Immunoglobulins: Types – IgG (G1, G2, G3 & G4), IgM, IgA, IgD and IgE (Origin, structural functions). Antibody diversity: Mini gene theory, Mutation theory, Germ line theory, Somatic recombination, V (D) J recombination, Combinatorial diversity, Junctional diversity.

##### Unit II

Cells of the Immune system, T and B cells maturation, activation, receptors and functions. Immunity: Types - Active and passive immunity. Cell mediated immunity, humoral immunity, immune response - primary and secondary response. Phagocytosis, mechanism of phagocytosis. Interferon: Types of Interferons. Complement system: Nature, components of complement. Pathways: Classical and alternative pathways. Complement fixation tests.

##### Unit III

Hypersensitivity (HS): Type I: Allergies and anaphylaxis – IgE, Mast cell degranulation, biologically active agents released in reactions, Clinical manifestations.

Type II: Antibody mediated HS reactions; Mechanism, pathogenicity and cases of type II reactions; Haemolytic-disease of new born (HDN).

Type III: Immune complex mediated HS reactions: Mechanism & pathogenicity of type III reactions. Soluble immune complexes and insoluble immune complex mediated reactions. Arthus reaction, Serum sickness.

Type IV: Delayed type (or) cell-mediated HS reactions; Mechanisms and pathogenicity, Tuberculin reaction.

Type V: Stimulatory HS reactions. Mechanism and pathogenicity, Grave's disease.

Blood groups: AB, Rh system, Lewis-Luthern systems, significance, practical application of immuno methodology in blood transfusions, Erythroblastosisfetalis.

#### **Unit IV**

Auto immunity: Introduction, Auto recognition, classes of auto immuno diseases. (Hashimoto disease, thyrotoxicosis, Systemic lupus erythematosus, autoimmune haemolyticaemia, Rheumatoid arthritis). Transplantation: Terminology, Auto graft, Isograft, Allograft, Xenograft, Immunological basis of transplantation reactions, Graft Vs Host reaction, Immuno suppression, General mechanisms of Immune suppression, Immune suppression, drugs (azothioprine, methotrexate, cyclophosphamide, cyclosporin-A, Steroids). Vaccines: types and their role.

#### **Unit IV**

Major Histocompatibility Complex: MHC in mice and HLA in man-fine structure and functions only. Immunological techniques: Precipitin curve, Immuno diffusion, one and two dimensional, single radial immuno diffusion, Ouchterlonyimmuno diffusion. Immuno-electrophoresis: Rocket immuno-electrophoresis; CIE, Graber and William technique. Agglutination: Direct and Indirect, Widal test, VDRL test. Radioimmunoassay: ELISA – Principle, Methodology and applications. Immuno-fluorescence: Direct, indirect and Sandwich, in situ localization by techniques such as FISH and GISH.

#### **Recommended Books:**

1. Essential immunology- Ivan M. Roitt.
2. Introduction to Immunology – John W.Kinball.
3. Immunology – D.M. Weir.
4. Immunology – Janis Kuby.

## MJD-17: BIOSTATISTICS AND BIOINFORMATICS

Objective:

To get a basic knowledge of statistical methods and the application of information technology to the management and analysis of biological data.

### UNIT I:

Biostatistics – Definition and Scope – Collection of Data – Census and sampling methods – Variable-Discrete and Continuous. Presentation of Data–Diagrammatic representation of Bar, pie, histogram, frequency polygon, frequency curve. Concept of statistical population and sample characteristics of frequency distribution.

### UNIT II:

Measures of central tendency - Mean, Mode and Median, Variance, Standard deviation, Standard error and Coefficient of variance. Simple Correlation, Simple Regression, Chi-square test, student's-t-test.

### UNIT III:

Introduction - Scope of Bioinformatics and bioinformatics resources, Principles of protein structure-Tertiary and Quaternary structure, DNA and RNA Sequencing; Sequence alignment – pair wise and multiple sequence alignment, local and global alignment, tools of bioinformatics - BLAST, FASTA and CLUSTALW.

### UNIT IV:

Biological databases- Gene Bank -NCBI, EMBL and DDBJ- Protein databases (primary, composite and secondary) SWISSPROT, PIR and PROSITE. Structure databases-PDB, CATH, SCOP, Proteomics, Genomics-Human Genome Project., metagenomics, concepts of metabolome and metabolomics. Specialised Genome database (SGD, TIGR and AceDB).

### UNIT V

Networking and internet: Introduction to networks, types of network, application of network, use of internet, WWW, concept of E-Mail. Computer and its application to biology; Basic Knowledge of Medical transcription and Bio-Informatics; Potentials of bioinformatics.

### Suggested Readings

1. Gurumani, N. 2004, Introduction to Bio-statistics, M.J.P. Publishers, Delhi.
2. Annadurai, B., 2007, A Text Book of Biostatistics, 1<sup>st</sup> Edition.
3. Saha, T.K. (1992) Biostatistics in theory and Practice, Emkay Publications., New Delhi– 15.3.
4. S.Sundara Rajan and R.Balaji, 2002, Introduction to Bioinformatics, Himalaya Publishing House, New Delhi.
5. Smith, Introduction to bioinformatics, Pearson Education Ltd., New Delhi.

## **MJD-18: FISHERY BIOLOGY**

Objectives:

To study and understand the biology of fishes and make the students to know about the culture techniques of fishes.

### **UNIT– I**

Introduction-Scope of aquaculture. Classification and biology of cultivable fin fishes – food and feeding, digestive enzymes and their role with food habits; Age and growth-Respiratory structure and functions; Reproduction and reproductive cycles of Catla.

### **UNIT– II**

Marine fisheries of India, Major fisheries of India (Sardine, Mackerel, tuna), and their characteristics; Indian major and exotic carps and their characteristics. Fishing technology-fishing craft and gear; Types of fish culture: Extensive, intensive, semi-intensive and pokkali culture-cage and pen culture. Monosex and monoculture-polyculture-advantages of polyculture-integrated fish culture.

### **UNIT– III**

Site selection – elementary survey –design and construction of fish and prawn ponds (stocking pond and rearing pond), Maintenance and management of culture ponds. Selection criteria for cultivable species –Culture of Crab, pearl oyster.

### **UNIT– IV**

Fish disease management: Common bacterial, viral, fungal, protozoan and crustacean diseases, their symptoms and treatment. Control of aquatic weeds, predatory and weed fish control. Feeds for cultivable species – natural, supplementary and artificial feeds.

### **UNIT– V**

Marketing the products: Harvesting and transport -marketing the fish to local markets and for export. Quality control and norms of MPEDA for export of fishes-HACCP concept; Fish preservation-canning and freezing method. Products, by products and value added products of fishes.

### **Suggested Readings**

1. Rath,R.K.(2000) Freshwater Aquaculture. Scientific Publishers, (India), PO. Box. 91, Jodhpur.
2. Jhingran, AVG (1991) Fish and Fisheries of India. Hindustan Publishing Co.
3. T.V.R. Pillay, 1990. Aquaculture principles and practices. Fishing News (Book) Ltd., London
4. R.Santhanam, N. Sukumaran and Natarajan,-A manual of freshwater aquaculture, Oxfordand IBH Publishing Co Pvt. Ltd., Mumbai.
5. B.N.Yadav,- Fish and fisheries, Daya Publishing House, Delhi.

## FISHERY BIOLOGY PRACTICAL

1. Determine the morphometric measurement of the fish
2. Analysis of gut content of the fish
3. Dissection of fish – Urinogenital organs of the fish.
4. Determination of the age of the fish by using scales.

### Spotters

1. Scoliodon
2. Torpedo
3. Trygon
4. *Labeorohita*
5. *Harpadon*
6. *Exocoetus*
7. *Wallagoattu*
8. *Anguilla*
9. *Pleuronectus*
10. *Sardinella*
11. *Rastrelliger*
12. *Carynx*

## **MID-7: ENVIRONMENTAL POLLUTION AND HUMAN HEALTH**

### **Program Outcomes:**

- This paper deals with different aspects of environmental contamination, which have adverse effects on human health.
- It will lay emphasis on understanding mechanisms of pollutants impacting human health by developing an understanding of different types of pollutants, their sources and mitigation measures.
- The students will also be introduced to the concept of permissible limits.

### **UNIT 1: (10 Hrs)**

Definition of pollution; pollutants; classification of pollutants; concept of biotransformation and bioaccumulation. Air pollution- Introduction- Ambient air quality: monitoring and standards (National Ambient Air Quality Standards of India); air quality index; Primary and Secondary Pollutants- Causes- Effect of Air Pollution on human health- Control measures.

### **UNIT 2: (8 Hrs)**

Water pollution- Introduction- Drinking water quality- Water Pollutants- Causes- Effects of water pollution on human Health- Control measures.

### **UNIT 3: (8 Hrs)**

Soil pollution- Introduction- Soil pollutant and its sources- Causes- Effects of Soil pollution on human Health- Control measures.

### **UNIT 4: (10 Hrs)**

Thermal pollution- Introduction- sources of thermal pollution- Causes- Effects on human Health- Control measures- Radioactive pollutants-Effects on human health- Control measures.

### **Unit 5: (9 Hrs)**

Solid waste- causes, impacts and management. Effect of Biomedical pollutants - Control Measures. Noise pollution- Sources- permissible ambient noise levels- Effects on human health- Control measures.

### **Text Books:**

1. Pepper, I.L., Gerba, C.P.& Brusseau, M.L. 2006. Environmental and Pollution Science. Elsevier Academic Press.
2. Purohit, S.S.& Ranjan, R. 2007. Ecology, Environment & Pollution. Agrobios Publications.

### **Reference Books:**

1. Gurjar, B.R., Molina, L.T. & Ojha C.S.P. 2010. Air Pollution: Health and Environmental Impacts. CRC Press, Taylor & Francis.
2. Hester, R.E. & Harrison, R.M. 1998. Air Pollution and Health. The Royal Society of Chemistry, UK.
3. Park, K. 2015. Park's Textbook of Preventive and Social Medicine (23rd edition). Banarsidas Bhanot Publishers.
4. Vesilind, P.J., Peirce, J.J. & Weiner R.F. 1990. Environmental Pollution and Control. Butterworth-Heinemann, USA.

### **MID-7: ENVIRONMENTAL POLLUTION AND HUMAN HEALTH PRACTICAL**

1. **Water Analysis:** Parameters analysis: Oxygen, Carbon dioxide and pH.

## **MID-7: LIFE STYLE DISEASES AND MANAGEMENT**

### **Scope:**

1. To give a general awareness of health and well being.
2. To have a basic awareness of modern lifestyle and the diseases associated with it.

### **Course Outcomes:**

1. Obtain knowledge and understanding of health, nutrition and other modern lifestyle and associated diseases.
2. Develop own thinking, opinions and attitudes over the global lifestyle changes on health issues.

### **UNIT I:**

**(10 hours)**

General awareness of Basic biochemistry (lipids, proteins, vitamins and minerals), Life style habits, healthy and unhealthy food & habits. Arteriosclerosis : Characteristics, causes – Diagnosis- Prevention and management

### **UNIT II:**

**(10 hours)**

Hypertension: Characteristics, Causes, Diagnosis, Prevention and Management, Stroke, Causes, Diagnosis and Management. Anxiety, Depression, Migraine, Insomnia- Causes, Diagnosis, Prevention and Management.

### **UNIT III:**

**(8 hours)**

Diabetes mellitus: Classification – type I, type II and gestational, Causes, Diagnosis, and Management. Obesity- classification according to BMI (brief description), symptoms, causes, diagnosis, treatment and management.

### **UNIT IV:**

**(8 hours)**

Cancer: Introduction, Types- Causes, Diagnosis, Prevention-Management.

### **UNIT V:**

**(9 hours)**

Nephritis- Types, Causes, Symptoms, Diagnosis, Treatment and management. Liver diseases- symptoms, causes, diagnosis, treatment and management.

### **References:**

1. Biochemistry – U. Satyanarayana, U. Chakrapani , third edition, ISBN 81-87134-80-1
2. Textbook of Medical Physiology, by Arthur C Guyton, John E Hall Prism Saunders 9th Edition ISBN: 81-7286-034-X.
3. Cell and Molecular Biology by Gerald Karp, John Wiley & Son, Inc. New York ISBN 9780470-16961-2, 5th Edition.

## **MID-7: LIFE STYLE DISEASES AND MANAGEMENT PRACTICAL**

1. Measurement of blood pressure.
2. Measurement of blood glucose level.
3. Measurement of height and weight of class students.

## **MID-7: NANOBIOLOGY**

### **UNIT I**

Overview of cell structures, bio-macromolecules, chemical building block of cells.

### **UNIT II**

Introduction and scope of Nano biotechnology - DNA nanotechnology, DNA nanotubes, and its applications.

### **UNIT III**

Nanotechnology, Nanoparticles-different types, structures and its applications in biology – Nanoparticles for biological assays, nanoparticles for targeted drug delivery system. Ligands used for intracellular delivery.

### **UNIT IV**

Nanoparticles toxicity to various organisms- in-vitro and in-vivo in different organs and their related systems. Engineered nanoparticles for biomedical applications, merits and demerits.

### **UNIT V**

Engineered nanoparticles in therapeutics – cell targeting – gene delivery – bio-imaging – drug encapsulation and release – immune response.

### **Suggested Readings**

1. B.K. Parthasarathy. Introduction to Nanotechnology. 2007
2. Challa Kumar (Ed) – Biological and Pharmaceutical Nanomaterials, Wiley – VCH Verlag, Weinheim, 2006.
3. Challa Kumar (Ed) – Nano materilas for Medical Diagnosis and Therapy, Wiley – VCH, 2006.
4. Veenitha Singh. Nanobiology. 2012.

## **MID-8: ANIMALS AND HUMAN WELFARE**

### **Unit – I: Biodiversity and Human Welfare**

Threats to Biodiversity - Habitat loss and Man-Wildlife conflict. National parks, Sanctuaries and Biosphere reserves

### **Unit – II:**

#### **Animal husbandry:**

Breeds of cattle- milk breeds- draft breeds- Dairy and Dairy products

### **Unit – III: Culture:**

Vermiculture, Apiculture, Pisciculture and Poultry

### **Unit – IV**

#### **Communicable and non-communicable diseases**

Tuberculosis and Typhoid; Hepatitis (A and B), AIDS, Gonorrhoea and Syphilis Diseases of respiratory system- Asthma, Bronchitis.

Oral Cancer - cause/causative agents, symptoms, diagnostics, precaution /prevention and remedy.

### **Unit – V**

#### **Non – Communicable Diseases**

Stress related disorders

Hypertension, Diabetes type II, anxiety, insomnia, migraine, depression (cause, symptoms, precaution and remedy).

## **MID – 8 ANIMAL AND HUMAN WELFARE PRACTICAL**

1. Study of animals in Nature/National park
2. Study of various breeds of cattle.
3. Visit to a Fish culture pond.
4. Study of Apiculture.
5. Identification of parasites related to syllabus

## MID-8: NEUROBIOLOGY

### Course Objectives :

While studying the **Neurobiology** course, the student shall be able to:

1. To study the microanatomical structure of neuron
2. To describe the different types of Neurons and their organization
3. To understand the Molecular mechanism of transmission
4. To study the chemical composition of Nervous system
5. To understand the principles of different types of neurotransmitters

### UNIT-I

Anatomical techniques: Golgi Silver stain; Cobalt chloride Back-filling; HRP method; Procion yellow staining. Neurons and associated structures; Micro anatomy of neurons; Types of neurons and Glial cells. Organization of the Central Nervous System (Spinal cord; Brain stem; Cerebral cortex). Organization of the Peripheral nervous System (Sympathetic and Parasympathetic nervous system).

### UNIT-II.

Electrophysiological techniques (Voltage-clamp and Patch-clamp); Bioelectrical properties of Neurons-Neuronal excitability; The resting potential membrane potential; Nernst equation; Sodium and Potassium pump; Generation of the action potential; Propagation of nerve Impulse.

### UNIT III

Molecular mechanism of Excitation Carrier protein; Ion channels; Gating mechanisms. Synapses: Structure and Integration; Morphology and Ultra structure of synapse; Types of Synapses; Chemical transmission; Electrical transmission. Second messenger systems: Cyclic AMP and GMP; G-protein; IP<sub>3</sub>; Calcium and Calmodulin.

### UNIT-IV.

Chemical composition of the nervous system-Cerebro Spinal Fluid-CNS Barriers-Nerve Growth Factor. Synthesis-storage-release and inactivation mechanisms and functions of the neurotransmitters. Viz. Acetylcholine & Catecholamines (Norepinephrine, Epinephrine, Dopamine and Serotonin). Amino acid Neurotransmitters- Excitatory amino acids (Glutamate and Aspartate); Inhibitory Amino acids (GABA and Glycine). Peptide Neurotransmitters: Oxytocin, Vasopressin, Substance-P and Cholecystokinin.

### UNIT-V.

Major drug classes-brief history-absorption-binding-tolerance-excretion physiological and Behavioral Effects of the following drugs; Opium; Stimulants (Amphetamine, Cocaine, Nicotine and Caffeine) Hypnotic and Anxiolytic drugs. (Barbiturates & Benzodiazepines); Mind altering drugs (Marijuana, LSD) Drug abuse and treatment programs Etiology,

Pathology, Symptoms, Diagnosis and treatment strategies for the Neurological Disorders Viz. Schizophrenia, Depression; Epilepsy, Alzheimer's and Parkinson's disease.

**Course Outcomes:**

- Learnt about structure, function and organization of Neurons in the Central nervous system
- Understanding Electrophysiological techniques and Molecular mechanisms associated with action potentials
- Students learnt and gain knowledge on structure and function of different types of Synapses
- Gained information on different types of Neurotransmitters i.e. Amino acids and Peptides

**SUGGESTED READING MATERIAL:**

1. Basic Neurochemistry-G.J. Siegal, RW. Albers, B.W. Agranoff, R Katzman (1981) Little, Brown and company. Boston.
2. Introduction to Nervous system- T.H. Bullock, R Cork, A. Granner (1977); W.H Freeman & Co.
3. Mechanism of Drug Action on the Nervous System M.A.B. Brazil, RW. Ryall. (1979), Cambridge University Press. Cambridge, London and New York.
4. Neuro anatomical Techniques, N.J. Strassfeld and T.A. Miller Springer Verlag, New
5. Neurobiology. Shepherd, G.M. Oxford University press, London.
6. Principles of Neural Science -E.R Kandel and J.H. Schwartz. (1981); Elsevier North Holland. NY. Oxford.
7. Principles of Neuro Psychopharmacology- Robert S. Feldman, Jerrold S. Meyer and Lind F. Quenzer. Sinauer Associates, Inc. Publishers. Sunderland. Massachusetts.
8. The Bio Chemical basis of Neuropharmacology-J.R Cooper, F.E. Bloom, &RH. Roth. (1982); Oxford University Press, NY and London. York Heidelberg, Berlin, 1980.

## MID-8: IPR, BIOSAFETY AND BIOETHICS

### Objective

- This paper provides information on ethical issues involved in biotechnology experiments. This also addresses on Biosafety aspects in Biotechnology and intellectual property rights.
- To enable the students to know about the legal issues affecting the biotechnology research and how to establish ownership of a novel finding.
- The students will be able to understand the legal aspects involved in the biotechnology research

### CONTENTS

#### UNIT I:

**Introduction to ethics and bioethics:** Personal ethics: profession and professionalism – Moral Reasoning – Ethical theories – person as an experimenter – Moral leadership (integrity and ingenuity) - framework for ethical decision making;

#### UNIT II

**Biotechnology and ethics:** Biotechnology in agriculture and environment: benefits and risks – benefits and risks of genetic engineering – ethical aspects of genetic testing – ethical aspects relating to use of genetic information – genetic engineering and biowarfare.

#### UNIT III

**Ethical implications of cloning:** Reproductive cloning , therapeutic cloning ; Ethical, legal and socio-economic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research- GM crops and GMO's – biotechnology and biopiracy – ELSI of human genome project.

#### UNIT IV

**Introduction to biosafety:** Biosafety issues in biotechnology – risk assessment and risk management – safety protocols: risk groups – biosafety levels – biosafety guidelines and regulations (National and International) – operation of biosafety guidelines and regulations – types of biosafety containment

#### UNIT V Introduction to intellectual property and intellectual property rights rights:

Types, patents, copy rights, trade marks, design rights, geographical indications – importance of IPR – patentable and non patentables – patenting life – legal protection of biotechnological inventions – world intellectual property rights organization (WIPO)

### REFERENCES:

1. Principles of cloning, Jose Cibelli, Robert P. lanza, Keith H. S . Campbell, Michael
2. D.West, Academic Press,2002Glimpses of Biodiversity – B.Bltosetti
3. Ethics in engineering, Martin. M.W. and Schinzinger.R. III Edition, Tata McGraw-
4. Hill, New Delhi. 2003.
5. <http://books.cambridge.org/0521384737.htm>
6. <http://online.sfsu.edu/%7Erone/GEessays/gedanger.htm>
7. [http://www.actahort.org/members/showpdf?booknrarnr=447\\_125](http://www.actahort.org/members/showpdf?booknrarnr=447_125)
8. <http://www.cordis.lu/elsa/src/about.htm>
9. <http://www.csmt.ewu.edu/csmt/chem/jcorkill/bioch480/bioLN98.html>
10. <http://www.accessexcellence.org/AE/AEPC/BE02/ethics/ethintro.html>

## **SEMESTER - VIII**

### **MJD-19: BIO-INSTRUMENTATION AND TECHNIQUES (Theory)**

**Objectives:** To enable the students to 1. Understand the Principles of microscopy 2. Understand the structure and functioning of various biological instruments 3. Get enlighten their knowledge in various biochemical methods

#### **Unit -I: Imaging and related techniques:**

**Hours: 10**

Principles of microscopy; Light microscopy; Fluorescence microscopy and Applications of fluorescence microscopy; Electron Microscopy- Applications of electron microscopy; Flow cytometry, Chromosome banding, FISH, chromosome painting; Transmission (TEM), and Scanning (SEM) electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.

#### **Unit- II: pH and Centrifugation:**

**Hours 05**

pH meter: Principles and instrumentation, Centrifugation: Principles, types of centrifuges, types of rotors, differential and density gradient centrifugation, application. Sonication, Freeze drying.

#### **Unit- III: Spectrophotometry:**

**Hours: 10**

Principle involved in Spectrophotometer; Spectrophotometric techniques, Instrumentation: ultraviolet and visible spectrophotometry (single and double beam, double wavelength spectrophotometers), Infrared spectrometers - Luminometry and densitometry – principles and their applications - Mass Spectroscopy-principles of analysis, application in Biology.

#### **Unit- IV: Chromatography:**

**Hours: 10**

Chromatographic techniques: Principle and applications – Column - thin layer –paper, affinity and gas chromatography - Gel filtration - Ion exchange and High performance liquid chromatography techniques– Examples of application for each chromatographic system - Basic principles of electrophoresis.

#### **Unit-V: Histology and histopathology:**

**Hours: 10**

Histology: Histochemistry and Histopathology: Objectives and applications, Tissue fixation: Objectives, methods, chemical fixatives-types and chemistry of fixation; Physical methods: freezing and microwave fixation; choice of fixatives, fixation artifacts. Dyes: Natural and Synthetic, Classification.

## **MJD-19: BIO-INSTRUMENTATION AND TECHNIQUES (Practical)**

1. Preparing various laboratory reagents
2. Bio-instruments, Operating laboratory instruments, noting instrument readings, calculating results accurately.
3. Microscopy – Light microscopy: principles, parts & function
4. Micrometry- principle and measurement of microscopic objects: Low power and high power.
5. Camera Lucida drawing with magnification and scale.
6. Principle and working of phase contrast microscope
7. Principle & operation of Centrifuge
8. Preparation of standard acid and alkali and their standardization. b) Preparation of various solutions (normal, molar, and percent) and ppm/ppb by serial dilutions
9. Principle & operation of Colorimeter
10. Principle & operation of Spectrophoto
11. Chromosome banding, FISH, chromosome painting, Principle and technique of TLC (demonstration), TLC separation of Amino acids from purified samples and biological materials (demonstration), PCR - The Polymerase Chain Reaction (protocol) –demonstration, Study visit to an institute /laboratory
12. Microtomy and staining: Hematoxylin-eosin - Demonstration
13. Histology: Observations of permanent slides of mammalian organs – stomach, intestine, spleen, liver, kidney, lungs, testis, epididymis, vas deferens, ventral prostate, seminal vesicle, ovary, uterus and Fallopian tube.
14. Histometry: Histometrical measurements of a few organs.
15. Histopathology: Study of histopathological changes (permanent slides) – gastric ulcers, cirrhosis of liver, breast tumors, cystic follicles of ovary, pancreas in diabetics, cryptorchid testis and leukemia.

### **Suggested Readings:**

1. Bajpai, P.K. 2006. Biological Instrumentation and methodology. S. Chand & Co. Ltd.
2. K. Wilson and J. Walker Eds. 2005. Biochemistry and Molecular Biology. Cambridge University Press.
3. K. Wilson andKHGoulding. 1986. Principles and techniques of Practical Biochemistry. (3 edn) Edward Arnold, London.
4. Dawson, C. (2002). Practical research methods.UBS Publishers, New Delhi.
5. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.
6. Ruzin, S.E. (1999). Plant micro technique and microscopy. Oxford University Press, New York, U.S.A.

7. Boyd, W. 1976: A text book of Pathology. Structure and function in disease, 4th edition. Lea and Febiger, Philadelphia.
8. Pearse, A.G.E. (1980): Histochemistry, theoretical and Applied, J & A, Churchill Ltd., London.
9. Rogers, A.W. (1983): Cells and Tissues, An introduction to Histology and Cell Biology, Academic Press, NY.

## **MJD-20: RESEARCH METHODOLOGY**

### **Unit I**

Nature of Research – Concept and characteristics of Research, Types of Research - Observational, Correlational, Experimental. Importance of Research in Biology.

### **Unit II**

Formulation of Research – Selection of the research problem, Defining and Formulating the research problem - Review of Literature - Identifying the lacuna - Formation of working hypothesis.

### **Unit III**

Research Methods and Strategies – Scientific methods of Research - Research design, Research Process, Objectives of the Research, Functions of the Research, Features of Good Research, Development of Models, Qualities of Good Research Worker, Factors Which Hinder Research, Problems faced by Researchers in India. Ethics of Research.

### **Unit IV**

Data Collection and analysis – Importance of data, Sources of data, Qualitative data and quantitative data, Methods of Data collection, Observation, Types of observation. Methods of Sampling - Data Processing and Analysis strategies - Data Analysis with Statistical Packages - Hypothesis-testing - Generalization and Interpretation.

### **Unit V**

Research Publications - Scientific writings, Research articles and its preparations, Journals, impact factor of journals, plagiarism, referencing and citation.

### **Suggested Readings**

1. Gupta, Santhosh; "Research Methods", Deep and Deep publications. New Delhi.
2. Kolthari, C.R., "Research Methodology, Methods and Techniques", Wish w a Prakashan, New Delhi.
3. Hair JR Joseph F; Bvsh Robert P; Ortinav, David, "Marketing Research", Tata Mc GrawHill publishing Co., New Delhi.
4. Trochin, William M.K., "Research Methods", Biztantra, New Delhi.
5. Saravanavel, P "Research Methodology, Kitalmahal, Allahabad.
6. Paneerselvam. R, "Research Methodology", Prentice Hall of India New Delhi.

## **MJD-21: COMPARATIVE PHYSIOLOGY**

### **Objectives**

- This course provides knowledge of animal body system to reveal physiological homologies, patterns of physiological adaptation to various environments.
- To introduce various principles that underlies higher level integrative bodily functions.
- To provide a comprehensive knowledge of functional physiological pathways common to all animals.
- To understand how organisms evolved their functional characteristics and how they stay alive in the face of constantly changing internal and external environments.

### **Learning outcome**

- Understanding of the basic concepts and processes of physiological regulation, from cellular to organ to organismal.
- Evaluation of physiological possibilities that animals have developed through natural selection.

### **Unit- 1**

**(5 hours)**

Principles of Animal physiology, Historical development of comparative evolutionary physiology, Homeostasis and Feedback control, thermal physiology. Body organization, body regions and body cavities.

### **Unit-2**

**(6 hours)**

Nutrition (Feeding and digestion) in Non-chordates, Rumen fermentation. Movements of GI tract, control and reflexes. Concept of Gut brain Axis. Metabolic scope (Scaling relationship) between BMR and Body mass. Metabolic rates as a function of body mass in mammals and arthropods.

### **Unit-3**

**(12 hours)**

Composition of Coelomic fluid and hemolymph of Non- chordates, Formation lymph. Physiological difference between Pulmonary and Systemic circulation of higher vertebrates. Lung volumes and their physiological interpretations and changes in lung volumes during pregnancy. Ventilation. Conducting system of heart, Comparison of action potentials of Pacemaker.

### **Unit-4**

**(10 hours)**

Muscle physiology: Muscle contraction, Neuro-muscular Junction, Physiology of electric organ. Neurophysiology: neuron and glia; neurotransmitters and their physiological functions; learning and memory; posture; Photoreception, Thermo reception, Chemoreception; Pheromones and other similar chemicals as means of communication among the animals.

## Unit-5

(12 hours)

Excretion and Osmoregulation in Non-chordates in fresh water, marine water and terrestrial environment. Contributions of Crustacean Antennal Glands and Molluscan Mantle to Acid-Base Regulation. Urine formation in Metanephros kidney. Various types of reproductive modes across Non-chordates, Uterine Physiology, Delayed implantation/Embryonic Diapause and its regulation, Estrous cycles and types of anestrus.

### References

1. Barnes RSK, Calow P, Olive PJW, Golding DW and Spicer JI (2001), The Invertebrates: A Synthesis, Third edition, Blackwell Science.
2. Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company
3. Kenney WL, Wilmore J and Costill D, Physiology of Sport and Exercise, Amazon, UK
4. 4.Moyces C and Schulte P (2013), Principles of Animal Physiology, Second Edition, Pearson International Edition, USA.
5. Prosser CL (1991), Comparative Animal Physiology, Part A, Environmental and Metabolic Animal Physiology, Fourth Edition, John Wiley & Sons Publication, Oxford.
6. Randall D, Burggren W and French KE (2001), Animal Physiology, Fifth edition, WH Freeman and Co, New York.
7. Schmidt-Nielsen K (2001), Animal Physiology: Adaptation and Environment, Fifth Edition, Cambridge University Press.
8. Withers PC (1992), Comparative Animal Physiology, First Edition, Fort Worth, Saunders College Publication.

## COMPARATIVE PHYSIOLOGY PRACTICAL

### Any Six of the Following Practicals:

1. Preparation of hemin and hemochromogen crystals ( CRE DI TS2 )
2. Study of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland
3. Study of permanent slides of spinal cord, duodenum, liver, lung, kidney, bone, cartilage
3. Qualitative tests to identify functional groups of carbohydrates in given solutions (Glucose, Fructose, Sucrose, Lactose)
4. 2. Estimation of total protein in your blood sample by Lowry's method.
5. Study of activity of salivary amylase under optimum conditions

### References

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co. □
2. Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company
3. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009). Harper's Illustrated Biochemistry. XXVIII Edition. Lange Medical Books/Mc Graw3Hill.
4. Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). Principles of Biochemistry. IV Edition. W.H. Freeman and Co.
5. Tortora, G.J. and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XII Edition, John Wiley & Sons, Inc.
6. 6.Widmaier, E.P., Raff, H. and Strang, K.T. (2008) Vander's Human Physiology, XI Edition., McGraw Hill

## MJD-22: ADVANCED BIOTECHNOLOGY

### Objectives

- To gain knowledge in the concepts of Plant and animal biotechnology would be developed.
- To understand various techniques involved in plant biotechnology.
- Ability to recall the transmissions, pathogenicity, symptoms of microorganisms.
- To understand various molecular techniques in disease diagnosis.
- Learning outcome
- Understanding of the concepts of plant and animal biotechnology
- To differentiate various vaccine producing methodologies
- To describe various molecular techniques in disease diagnosis

### UNIT I

(4 hours)

Historical aspects Biotechnology - Principles of sterile techniques and cell propagation - media and types of cell culture.

### UNIT II

(15 hours)

Plant tissue culture - Media composition (MS media) - Micropropagation techniques - somoclonal variation - somatic embryogenesis - haploid and triploid - Protoplast isolation and culture - hybrid and cybrid production, Synthetic seed production. Secondary metabolite production. Manipulation of reproductive process in animal: Artificial insemination – freezing of semen – Embryo technology – in vitro maturation and fertilization – transgenic animals- Scaling up of animal cell cultures

### UNIT III

(8 hours)

Medical Biotechnology – Zoonotic diseases: Bacterial, Viral, Fungal and Protozoan disease - diagnosis using modern techniques – DNA/RNA probes- application of Probes for diagnosis of existing and emerging disease in animal and human disease.

### UNIT IV

(6 hours)

Vaccines – Production of recombinant vaccines – bacterial, viral or parasitic infections – DNA Vaccines. Synthetic peptide, anti-idiotypic, deletion, mutant and vaccinia vectored vaccine – Prophylaxis.

### UNIT V

(10 hours)

Genetic engineering of Microorganisms and molecules – Protein production by genetically engineered mammalian cell lines, Stem cells and their applications-; Cell culture as a source of valuable products.

### References

1. Ignacimuthu. 1996. Basic Biotechnology. Tata McGraw-Hill.
2. Jenkins, N. (ed). 1999 Animal cell Biotechnology: Methods and protocols. Humana press, New Jersey. Pp 1-302.
3. Kojima, Lee, H. and Kun, Y. 2001. Photosynthetic microorganisms in Environmental Biotechnology. Springer – Verlag.
4. Kreuzer, H. and Massey, A. 2001. Recombinant DNA and Biotechnology: A guide for teachers, 2nd edition. ASM Press Washington.
5. Murray, E.T. 1991. Gene transfer and expression protocols – Methods in Molecular biology Vol.7. Humana Press.

6. Puhler, A.V.C.H. 1993. Genetic engineering of Animals. VCH Publishers, Weinbeim, FRG.
7. Sudhir, M. 2000. Applied Biotechnology and plant Genetics. Dominant publishers and distributors.
8. Traven. 2001. Biotechnology. Tata McGraw – Hill.
9. Walker,J.M. and Gingold, E.B. 1999.Molecular biology and Biotechnology, 3rd edition.Panima Publishing Corporation.
10. Watson, J.D., Gilman, M., Witkowski, J. and Zoller, M. 1992.Recombinant DNA (2nded) Scientific American Books, NY.

## MJD-23: REPRODUCTIVE PHYSIOLOGY

### Course learning objective:

- ✓ This course is meant for making the students learn about the various aspects of reproduction.
- ✓ It includes a detailed study of the male and female reproductive systems as well as factors that are important in maintaining reproductive health.
- ✓ The students are also made aware of new technologies in assisted reproduction as well as contraceptive methods.
- ✓ They are taught about social and public health issues related to family planning.

### Course learning outcome:

Upon completion of the course, students should be able to:

- ✓ Get in-depth understanding of morphology, anatomy and histology of male and female reproductive organs.
- ✓ Know different processes in reproduction starting from germ cell formation to fertilization and consequent pregnancy, parturition and lactation.
- ✓ Compare estrous and menstrual cycles and their hormonal regulation.
- ✓ Comprehend the interplay of various hormones in the functioning and regulation of the male and female reproductive systems.
- ✓ Know about the diagnosis and management of infertility, including latest methods, technologies and infrastructure in assisted reproduction.
- ✓ Understand the modern methods in contraception and their use in family planning strategies.
- ✓ Translate their understanding into development of products like non-hormonal contraceptives; contribute to drug discovery programmes as well as neonatal and maternal health programmes and work with family planning teams to understand the needs and preferences of individuals belonging to lower socioeconomic groups.

### Unit 1: Reproductive Endocrinology

**7hrs**

Hypothalamo–hypophyseal–gonadal axis. Regulation of gonadotropins and gonadal steroids secretion in male and female; Steroidogenesis. Puberty – Mechanism of action of hormones related to reproduction.

### Unit 2: Male Reproductive System

**9 hrs**

Anatomy of human male reproductive system. Structure and function of Testis, epididymis, vas deferens, prostate gland, seminal vesicle, bulbourethral gland. Spermatogenesis and its regulation; Sperm transport and maturation in male genital tract. Biosynthesis of testosterone, its feedback regulation and functions.

**Unit 3: Female Reproductive System****13 hrs**

Anatomy of female reproductive system. Structure and function of Ovary, fallopian tubes/oviducts, uterus, cervix, vagina and vulva. Folliculogenesis; Oocyte maturation and ovulation; Corpus luteum formation and regression. Biosynthesis of estrogen, its feedback regulation and functions. Female Reproductive Cycles – estrous and menstrual; stages, hormonal regulation and changes in the female tract during these cycles.

**Unit 4: Gestation and Lactation****9hrs**

Fertilization and Implantation. Maternal recognition of pregnancy; Feto-placental unit; Placental hormones. Stages of human gestation; Gestational adaptations; Hormonal regulation of gestation. Sexual differentiation in human embryo. Parturition and its hormonal regulation. Lactation – hormonal and feedback regulation

**Unit 5: Reproductive Health and Family Planning****7 hrs**

Contraceptive methods – natural, physical, chemical and surgical. Infertility in male and female: causes, diagnosis and management. Assisted Reproductive Technologies: sperm banks, frozen embryos, IVF, ET, EFT, IUT, ZIFT, GIFT, ICSI, PROST.

**REPRODUCTIVE PHYSIOLOGY PRACTICAL**

Any Six of the Following Practicals:

1. Examination of histological sections from photomicrographs/permanent slides of rat/human: testis, epididymis, prostate, seminal vesicle, Cowper's gland, t.s. of penis; sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina.
2. Principles of surgery in endocrinology – Ovariectomy, hysterectomy, castration and vasectomy in rats/humans.
3. How to set up and maintain an animal house, breeding techniques, care of normal and experimental animals.
4. Examination of vaginal smear of rats (from live animals).
5. Human vaginal exfoliate cytology through micrographs.
6. Sperm count and sperm motility in rat.
7. Study the effect of cryptorchidism on sperm count and motility in rats.
8. Study of modern contraceptive devices.
9. Study of different types of fertility tests in human – male and female.
10. Pregnancy test in human.
11. Visit of an IVF clinic to observe gamete collection, fertilization and embryo selection procedure.

**Suggested Readings:**

- Jones, R.E. and Lopez, K.H. (2014) *Human Reproductive Biology*. IV Edition, Elsevier.
- Johnson, M.H. and Everitt, B.J. (2018) *Essential Reproduction*. VIII Edition, London, Blackwell Science.
- Austin, C.R. and Short R.V. (Eds) (2012) *Reproduction in Mammals*. Cambridge University Press.
- De-Groot, L.J. and Jameson, J.L. (eds) (2001). *Endocrinology*. W.B. Saunders and Company.
- Franklyn F. Bolander (2012). *Molecular Endocrinology*. III Edition, USA, Academic Press.
- Knobil, E. and Neil, JD (eds.) (2014). *The Physiology of Reproduction*. IV Edition, Elsevier.
- Hatcher, R.A. et al. (1997). *The Essentials of Contraceptive Technology*. Population Information Programme. John Hopkins School of Public Health.
- Robert Martin (2013). *How We Do It: The Evolution and Future of Human Reproduction*. Basic Books.
- Peter T. Ellison (2001). *On Fertile Ground: A Natural History of Human Reproduction*. Harvard University Press.