



**Bharathidasan Government College for Women (Autonomous)
(Affiliated to Pondicherry University)**

**B.Sc. Zoology (Honors)
B.Sc. Zoology (Honors with Research)**

REGULATIONS, CURRICULUM & SYLLABUS

**(Under the National Education Policy – NEP 2020
Effective from the Academic Year 2023-2024 Onwards)**

October 2024

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, fieldwork, community engagement, and service per Semester.
- ii. **Academic Year:** Means the year starts on the 1st day of July and ends on the 30th day of June of the 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 sessions 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 with 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 1st 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, and 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, skills such as communication, teamwork, and leadership shall be embodied in the Teaching-learning process to facilitate career options in the given field of specialization.

4. AGE LIMIT

The rules as applicable to other undergraduate 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:
Students should complete a **UG certificate in Zoology** from any University.
2. Lateral Entry for III Year B.Sc. /B.Sc. (Hons.) Zoology:
Students should complete a **UG Diploma course in Zoology** from any University.
3. Lateral Entry for IV Year B.Sc. (Hons.) Zoology:
Students should complete a **B.Sc., Zoology** from any University.

7. PEDAGOGICAL APPROACHES

a) Lecture Courses	Regular classroom lectures by qualified/experienced Expert Teachers • These Lectures may also include classroom discussion, demonstrations, case analysis • Use of Models, Audio-Visual contents, Documentaries, and PPTs may supplement.
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 work place 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.

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 the 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 a 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 break down the Programme of study at the 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 the first year will be awarded **UG Certificate in Zoology** provided they have earned a minimum of 42 credits in addition, they have to complete work 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 the second year will be awarded a **UG Diploma in Zoology** provided they have earned a minimum of 84 credits and in addition, they have to complete work 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 the third year will be awarded a **UG degree (B.Sc. in Zoology)**, provided they have earned a minimum of 124 credits.
4. Students who exit after completion of the 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 a 3/4 year period. Table I specifies the number of credits and the number of courses that a 3-year UG student and a four-year UG (Hons) Degree student are 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	8 Credits (4 courses of 2 credits each)	8 Credits (4 courses of 2credits 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 courses 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	120 Credits	160 Credits

Every Undergraduate (UG) programme offered by a College shall conform 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 of guidance of teaching at Tutorials/Practicals. UG programmes may be offered in a single major discipline, for example, B.Sc. (Zoology).

ii) **Minor Disciplinary Course (MID): (24/32 Credits)**

Minor disciplinary courses refer to those subjects that are Allied / Specialization / 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.Sc. (Zoology) student shall study allied subjects like Botany and Chemistry as these subjects have interlinkages with the Major Disciplinary subjects.

iii) **Multi-Disciplinary Courses (MLD): (9 Credits)**

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

- i) Natural Sciences
- ii) Physical Sciences
- iii) Humanities / Social Sciences

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

iv) **Ability Enhancement (AEC) courses: (8 Credits)**

All Undergraduate (UG) students are mandated to complete at least 8 Credits worth of Courses that focus on Communication and Linguistic skills, critical reading, and writing skills. These courses are expected to enhance the ability to articulate and presentation of their thoughts in the workplace. The College has designed these ability enhancement courses tuned to the requirements of a given major discipline.

i) English /Language

Ability Enhancement Course (AEC)	
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

v) Skill Enhancement Course (SEC): (9 Credits)

These courses focus on imparting practical skills with hands-on training. In order to enhance the employability of students, The College has designed such courses for the students for better employment/entrepreneurship/career development, etc., Example: Aquaculture, Vermitechnology and Apiculture.

vi) Value Added Common courses (VAC): (8 Credits)

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

- i) Understanding India
- ii) Environmental Studies
- iii) Digital Technologies
- iv) 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 on the University Website for reference of the colleges / students.

vii) Summer Internship (2 to 4 Credits)

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

viii) Community Engagement and Service (CES) (2 Credits)

All UG students are also mandated to participate in a 15-day community engagement activity during their winter vacation between the 3rd and 4th Semesters. This Community engagement activity is expected to expose the students to the social problems of the neighborhood village. Students may prepare a report on the activities carried out for an 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 the 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
Total - 25Marks	

Marks for Attendance are as follows:

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

Internal Test Scheme:

The Principal of the College schedules the Mid-Semester Exam for all courses during the 8/9th week of the start of classes. All faculty members are expected to conduct this Mid-Semester exam and for a 1.30 hr. duration and evaluate, upload the marks to the Controller of Examinations of the University / College. 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 25 marks. The breakup is as follows:

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

End-Semester University Exam:

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

A detailed Exam Time Table shall be circulated to all departments at least 15 days before the start of exams mostly during the 15/16th 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 (Answer any 10 out of 12 given), Sec. B (Answer any five out of 8 given), and Sec. C (Answer any 3 out of five given) Questions from all units of the syllabus	75 marks
b) Practical/Internship Project Work subjects (Based on Practical Exams/Presentation/Viva)	25 marks

Consolidation of Marks and passing Minimum:

Controller of Examinations of the College / University consolidates the Internal Assessment marks uploaded by the Colleges and marks secured by students in the 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 a pass during the first 3 years of study and students who secured less than 50 will be awarded 'P' (Pass Grade)

Arrear Exam:

A student who fails to secure 40% marks in aggregate is declared as Failed and she is eligible to take up a supplementary examination by registering to the said course in the following Semester. All other candidates who failed due to a shortage of attendance and 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 Country wide uniform letter grades for all UG courses. The following Table shows the seven letter grades and corresponding meanings and the grade points for the calculation of CGPA.

TABLE-2

Equivalent Letter Grade	Meaning	Grade Points for Calculation of CGPA
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 purposes = 50 marks
 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 gives the range of marks and letter grades. According to the 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.

Table II		
Range of Marks in%	Letter Grade Points for	Letter Grade Points for
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.

Table III		
Range of Marks in%	Letter Grade Points for	Letter Grade Points for
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
Below 40	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 are the number of credits that each subject carries.

Cumulative Grade Point Average (CGPA) CGPA shall be calculated as the weighted average of credits that the 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,

i.e., **SGPA** (S_i) = $\sum(C_i \times G_i) / \sum C_i$

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

(i) *Example for Computation of SGPA where the 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 the candidate has failed in two courses.

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

The CGPA shall also be calculated similarly 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 points 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 the case of audit courses offered, the students may be given a (P) or (F) grade without any credits. This may be indicated in the mark sheet. Audit courses will not be considered in the calculation of CGPA.

DECLARATION OF RESULTS:

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

FIRST SEMESTER (100 level)							
S.No	Course Code	Nature of Course	Title of the Course	Credits	Hours/Week		
					L	T	P
1	ZMJDC-1	Major Disciplinary Course (compulsory)	Biology of Invertebrates - I	4	4	1	
2	ZMIDC-1	Minor Disciplinary Course (choose any one)	Fundamentals of Zoology (or) Wildlife Conservation (or) Zoonotic Diseases of Humans and Animals	4	4	1	
3	ZMLDC-1	Multi-Disciplinary Course (compulsory)	Humanities/Social Sciences –Public Administration	3	4		
4	AEC-1	Ability Enhancement	English I	2	4		
5	ZSEC-1	Skill Enhancement Course	<u>Vermitechnology</u> - Practical (or) Sericulture (or) Ecotourism	3			4
6	VAC-1	Value Added Courses	Understanding India	2	4		
7	VAC-2		Environmental Studies	2	4		
Total				20	30 Hours		

SECOND SEMESTER (100 level)							
S.No	Course Code	Nature of Course	Title of the Course	Credits	Hours/Week		
					L	T	P
1	ZMJDC- 2	Major Disciplinary Course (compulsory)	Biology of Invertebrates – II	4	4	1	

2	ZMIDC-2	Minor Disciplinary Course (choose any one)	<u>Public Health and Hygiene</u> (or) Basic Immunology (or) Value-Added Products of Animals	4	4	1	
3	ZMLDC-2	Multi- Disciplinary Course (compulsory)	Humanities - Pechikalai	3	4		
4	AEC-2	Ability Enhancement	Indian Language - I	2	4		
5	SEC-2	Skill Enhancement Course	<u>Apiculture – Practical</u> (or) Dairy Production Technology (or) Ornamental Fish Culture	3			4
6	VAC-3	Value Added Courses	Digital Technologies	2	4		
7	VAC-4		Health & Wellness/Yoga Education	2	4		
Total				20	30 Hours		

THIRD SEMESTER (200 level)

S.No	Course Code	Nature of Course	Title of the Course	Credits	Hours/Week		
					L	T	P
1	ZMJDC-3	Major Disciplinary Course (compulsory)	Biology of chordates	4	4	1	
2	ZMJDC-4		Ecology & Ecosystems	4	4	1	
3	ZMIDC-3	Minor Disciplinary Course (choose any one)	Economic Zoology - Practical (or) Agricultural Entomology (or) Food, Nutrition and Health	4	1		5
4	ZMLDC-3	Multi- Disciplinary Course (compulsory)	Physical Sciences - Introduction to Computer Science	3	4		
5	AEC 3	Ability Enhancement	English II	2	4		
6	ZSEC-3	Skill Enhancement Course	Aquaculture – Practical (or) Medical Laboratory Technology (or) Public health management	2			6

Total	20	30 Hours
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FOURTH SEMESTER (200 level)							
S.No	Course Code	Nature of Course	Title of the Course	Credits	Hours/Week		
					L	T	P
1	ZMJDC-5	Major Disciplinary Courses (compulsory)	Cell Biology	4	4	1	
2	ZMJDC-6		Genetics	4	4	1	
3	ZMJDC-7		Zoology Main Practical – I	4	1		4
4	ZMIDC-4	Minor Disciplinary Course (choose any one)	<u>Microbiology</u> (or) Environmental Biotechnology (or) Genetic Engineering	4	1		4
5	AEC 4	Ability Enhancement	Indian Language II	2	4		
6	Project	Winter Project/Internship	Community Engagement and Service	2			6
Total				20	30 Hours		

FIFTH SEMESTER (300 level)							
S.No	Course Code	Nature of Course	Title of the Course	Credits	Hours/Week		
					L	T	P
1	ZMJDC-8	Major Disciplinary Course (compulsory)	Animal Physiology	4	4	1	
2	ZMJDC-9		Developmental Biology	4	4	1	
3	ZMJDC-10		Zoology Main Practical - II	4			8
4	ZMIDC-5	Minor Disciplinary Course (choose any one)	<u>Forensic Entomology</u> (or) Toxicology (or) Tools and Techniques	4	4	2	
5	ZMJDC-11	Major Disciplinary Course	Summer Internship	4			6
Total				20	30 Hours		

SIXTH SEMESTER (300 level)							
S.No	Course Code	Nature of Course	Title of the Course	Credits	Hours/Week		
					L	T	P
1	ZMJDC-12	Major Disciplinary Course (compulsory)	Endocrinology	4	4	1	
2	ZMJDC-13		Animal Biotechnology	4	4	1	
3	ZMJDC-14		Evolution and Ethology	4	4	1	
4	ZMJDC-15		Zoology Main Practical - III	4			8
5	ZMIDC-6	Minor Disciplinary Course (choose any one)	<u>Vectors and Diseases Practical</u>	4	2	1	4
			(or)				
			Reproductive Biology				
			(or)				
			Medical Microbiology				
Total				20	30 Hours		

SEVENTH SEMESTER (400 level)							
S.No	Course Code	Nature of Course	Title of the Course	Credits	Hours/Week		
					L	T	P
1	ZMJDC-16	Major Disciplinary Course (compulsory)	Biostatistics and Bioinformatics	4	4	2	
2	ZMJDC-17		Fishery Biology	4	4	2	
3	ZMJDC-18		Zoology Main Practical IV	4			8
4	ZMIDC-7	Minor Disciplinary Course (choose any one)	<u>Life Style Diseases and Management</u>	4	4	1	
			(or)				
			Environmental Pollution and Human Health				
			(or)				
			Nano biology				
5	ZMIDC-8	Minor Disciplinary Course (choose any one)	<u>Animals and Human Welfare</u>	4	4	1	
			(or)				
			Neurobiology				
			(or)				
			IPR, Biosafety and Bioethics				
Total				20	30 Hours		

EIGHTH SEMESTER B.Sc. Zoology (400 level)							
S.No	Course Code	Nature of Course	Title of the Course	Credits	Hours/Week		
					L	T	P
1	ZMJDC-19	Major Disciplinary Course (compulsory)	Bio-Instrumentation and Techniques	4	4	2	
2	ZMJDC-20		Research Methodology	4	4	2	
3	ZMJDC-21		Biochemistry & Molecular Biology	4	4	1	
4	ZMJDC-22		Immunology	4	4	1	
5	ZMJDC-23		Zoology Main Practical V	4			8
Total				20	30 Hours		

(OR)

EIGHTH SEMESTER – B.Sc. Zoology (Honors with Research Project)							
S.No	Component	Course Code	Title of the Course	Credits	Hours/Week		
					L	T	P
1	ZMJDC-19	Major Disciplinary Course (compulsory)	Bio-Instrumentation and Techniques (Theory)	4	4	2	
2	ZMJDC-20		Research Methodology	4	4	2	
3	ZMJDC- 24	Research Project	Research Project	4	2	2	8
4	ZMJDC-25		Project Report	4	4	2	
5	ZMJDC-26		Project Viva-voce	4	-	-	-
Total				20	30 Hours		

SEMESTER – I
ZMJD-1: BIOLOGY OF INVERTEBRATES-I

Hours of Instruction / Week: 4 + 1 Hrs.
Total: 45 Hrs.

Total: 100 Marks
External 75 marks; Internal 25 marks

Course objective

1. To understand biodiversity, habitat, adaptation organization, and taxonomic status of invertebrates.
2. Explaining the basic aspects of classification and 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.

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 and classify up to classes with suitable example. Type study: Paramecium, Protozoan parasites of man.

Unit-II

Phylum Porifera: General characteristic features of Porifera and classify up to classes with suitable examples. Type study: Sycon.

Unit-III

[08 hrs]

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

Phylum Ctenophora: General characteristic features of Ctenophora and classify up to classes with suitable examples.

Unit-IV

[08 hrs]

Phylum Platyhelminthes: General characteristic features of Platyhelminthes and classify up to classes with suitable examples. Type study: Tapeworm.

Unit-V

[09 hrs]

Phylum Aschelminth: General characteristic features of Aschelminth and classification up to classes with examples. Type study: Ascaris, Parasitic nematodes of Man-Mode of infection, treatment and preventive measures.

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. Ananthakrishnan, 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.

ZMID-1: FUNDAMENTALS OF ZOOLOGY
(For other Majors as Allied)

Hours of Instruction / Week: 4 + 1 Hrs.

Total: 100Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

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 and understand the complex interaction among various living organisms.

UNIT I: (08 Hrs)

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

UNIT II: (09 Hrs)

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

UNIT III: (12 Hrs)

Respiration in Arthropods. Metamorphosis in Insects. Economic importance of Mollusca. Larval forms in Echinodermata.

UNIT IV: (06 Hrs)

Life cycle and retrogressive metamorphosis in Ascidia.

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. Textbook 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, Meerut.

ZMID-1: WILDLIFE CONSERVATION

Hours of Instruction / Week: 4 + 1 Hrs.

Total: 100 Marks

Total: 45 Hrs.

UNIT-1: CONCEPT OF BIODIVERSITY, HUMAN-WILD LIFE INTERACTION

[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 the 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 (Quadrant, Line Transect, Belt Transect, Pitfall, 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 color, 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.

ZMID-1: WILDLIFE CONSERVATION PRACTICAL

Hours of Instruction / Week: 2 Hrs.

Total: 25 Marks

Total: 15 Hrs.

Fieldwork 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, and estimation of wildlife populations.
3. The participants will be given hands-on training to analyze the data collected in the field using software with field reports.
4. Basic techniques in Wildlife Photography

ZMID-1: ZOONOTIC DISEASES OF HUMANS AND ANIMALS

Hours of Instruction / Week: 4+1 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

Course Objectives:

Students should be able to:

- Recognize and comprehend the zoonotic potential of diseases presented after 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 justify each success).

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 Humans: Encephalitis Influenza, Lymphocytic, Choriomeningitis, Monkeypox.

Unit: II

[10 hrs]

Zoonotic Bacterial Diseases of Humans: 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 Humans: 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.

ZMID-1: ZOONOTIC DISEASES OF HUMANS AND ANIMALS PRACTICAL

1. Identification of vectors.
2. Identification of Bacterial diseases.
3. Identification of Viral diseases
4. Identification of Protozoan parasites
5. Institute Models: CDC
6. Visit any vector centers.

ZSEC-1: VERMITECHNOLOGY- PRACTICAL

Hours of Instruction / Week: 4 Hrs.

Total: 100 Marks

Total: 45 Hrs.

Internal 50 marks ; External 50 marks

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 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 earthworms. 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.

ZSEC-1: VERMITECHNOLOGY - PRACTICAL

Hours of Instruction / Week: 4 Hrs.

Total: 100 Marks

Total: 15 Hrs.

External 50 marks; Internal 50 marks

INVERTEBRATES

SPOTTERS:

A - Classify giving reasons up to order:

1. Amoeba
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. Amoeba – Binary fission
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. Earthworm- Body setae and Penial setae

VERMITECHNOLOGY

1. Major types of soil (red soil, black soil, alluvial soil).
2. Study of morphological characteristics of earthworm.
3. Identification of Common Earthworm species (*Eisenia fetida* and *Eudrilus eugeniae*).
4. Demonstration of the 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 method and Silpaulin method).
8. Preparation & Collection of Vermiwash.
9. Harvesting of Vermicomposting.
10. Economic importance of earthworms (bait, food and medicine, and agriculture).
11. Vermitechnology farm visit-Report.

ZSEC-1: SERICULTURE

Hours of Instruction / Week: 4 Hrs.

Total: 100Marks

Total: 45 Hrs.

External 50 marks; Internal 50 marks

Unit I.

(07 hrs)

Scope and history of sericulture, Systematic position of Silkworm, Species of silkworm, Biology and life history of mulberry silkworm *Bombyx mori*.

Unit II.

(08 hrs)

Sericulture Industry. Major steps and requirements of sericulture, Species of Mulberry, Types of Mulberry plantation.

Unit III.

(14hrs)

Rearing of silkworm - steps in rearing, grainage management of seed to rearers and commercial rearing-spinning of marketing of cocoons, post cocoon processing-stifling, reeling, and spinning. Silk and chemical nature

Unit I

(06 hrs)

Diseases of Silkworm - causative agents, symptoms, and countermeasures of maggot disease, fabrine, polyhedrosis, flacherie, green muscardine.

Unit V.

(10 hrs)

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 handbook of Sericulture and Silk Production. PrabhaShekar and Martin Hardingha.

ZSEC-1: ECOTOURISM

Hours of Instruction / Week: 3 Hrs.

Total: 100Marks

Total: 45 Hrs. External 50 marks; Internal 50 marks

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 in 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 hrs]

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 hrs]

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 hrs]**

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 hrs]**

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

ZMJD-2: BIOLOGY OF INVERTEBRATES – II

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 75 marks ; Internal 25 marks

Unit-I (08 hrs)

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

Unit-II: (09 hrs)

Phylum Onychophora: General characteristic features of Onychophora and classify up to classes with suitable example. Affinities of Onychophora.

Unit-III: (09 hrs)

Phylum Arthropoda: General characteristic features of Arthropods and classify up to classes with suitable examples. Mouth parts in insects and larval forms in arthropods. Type study: Prawn

Unit-IV: (09 hrs)

Phylum Mollusca: General characteristic features of Mollusca and classify up to classes. Torsion in Mollusca. Type study: Pila

Unit-V: (10 hrs)

Phylum Echinodermata: General characteristic features of Echinodermata and classify up to order. Water vascular system in starfish. Larval forms of echinoderms. Type study: Sea star
Hemichordata: General Characteristics and classification with examples.

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. Ananthakrishnan, 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.

ZMID-2: PUBLIC HEALTH AND HYGIENE

Hours of Instruction / Week: 3 Hrs.

Total: 100Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

UNIT – I Concepts of Public Health and Hygiene: [09hrs]

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

UNIT – II Environment and Health Hazards: [08 hrs]

Need for 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 Diseases: Venereal disease and AIDS.

UNIT – IV Non – communicable diseases and their preventive measures: [09 hrs]

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

UNIT – V Health Education in India: [09 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: Textbook 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: BASIC IMMUNOLOGY

Hours of Instruction / Week: 3 Hrs.

Total: 75 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

Objectives:

- To study the process which helps to maintain the organism's internal environment, when challenged with foreign substances.
- To understand the basics of Immunology

Unit: I (Hours 9)

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

Unit: II (Hours 9)

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

Unit: III (Hours 9)

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 (Hours 9)

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 (Hours 9)

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.

ZMID-2: BASIC IMMUNOLOGY PRACTICAL

Hours of Instruction / Week: 2 Hrs.

Total: 25 Marks

Total: 15 Hrs.

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. Payers patches
8. Bursa fabricus
9. T – cell
10. B- cell
11. MALT
12. GALT

ZMID-2: VALUE ADDED PRODUCTS OF ANIMALS

Hours of Instruction / Week: 3 Hrs.

Total: 75 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

Unit-I:

(Hours 9)

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 manufactured.

Unit –II:

(Hours 9)

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:

(Hours 9)

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:

(Hours 9)

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:

(Hours 9)

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

Suggested Readings:

1. Krell,1996. Value-added products from beekeeping 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.

ZMID-2: VALUE ADDED PRODUCTS OF ANIMALS PRACTICAL

2. Different Types of Honeybees
3. Beehive architecture
4. Economically important freshwater and marine water fishes.
5. Identification of Breeds of Goat.
6. Identification of Poultry Breeds.
7. Breeds of Cattle
8. Value added Products related to syllabus-Samples
9. Visit to poultry, aquaculture, cow shala farm.

ZSEC-2: APICULTURE

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

Internal 50 marks; External 50 marks

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 bee species for apiculture –*Apis cerana indica*, *Apis mellifera*; 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, Beeswax, 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, the 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.

ZSEC-2: APICULTURE PRACTICAL

Hours of Instruction / Week: 2 Hrs.

Total: 100 Marks

Total: 15 Hrs.

Internal 50 marks; External 50 marks

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 an apiary/honey processing unit/institute and submission of a report.

BIOLOGY OF INVERTEBRATES - II PRACTICAL

I. DISSECTION

1. Prawn- Nervous system

II. MOUNTING

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

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. *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

12. **E. Visit to sea shore.**

ZSEC-2: DAIRY PRODUCTION TECHNOLOGY

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 50 marks; Internal 50 marks

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, yogurt, gluten, etc.

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

Milk products: Cheese, yogurt, gluten, etc. Milking Management. Gathering cows 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-V: 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, Ruminant 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.

ZSEC: DAIRY PRODUCTION TECHNOLOGY PRACTICAL

1. Visit to dairy plant: ghee refinery, butter manufacturing unit, powder plant, cheese factory, ice-cream unit, casein 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, yogurt, chakka, shrikhand, cheese, ice cream, kulfi, dried and condensed milk products: milk powder- skim milk, whole milk, Whitner, condensed milk and dairy by-product (skim milk, casein, caseinate, whey concentrate, powder, lactose, ghee residues).
3. Sensory evaluation of milk and milk products.

ZSEC-2: ORNAMENTAL FISH CULTURE

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

Objectives:

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

UNIT – I

(Hours 9)

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 India. Taxonomy of important freshwater and marine ornamental fish of indigenous and exotic species.

UNIT – II

(Hours 9)

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

UNIT – III

(Hours 9)

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

UNIT –IV

(Hours 9)

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

UNIT –V

(Hours 9)

Aquarium design, Construction, and preparation: size, shape, substrate, ornamental aquatic plants. Construction and functions of Biofilters; 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 Inter science, 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 Pub. Co, Inc. New York –USA.

ZSEC-2: ORNAMENTAL FISH CULTURE PRACTICAL

Hours of Instruction / Week: 2 Hrs.

Total: 25 Marks

Total: 15 Hrs.

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
ZMJD-3: BIOLOGY OF CHORDATES

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

Course Outcome: Create an appreciation of the 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 and classification up to classes. Protochordata- Salient features of Cephalochordata, Affinities of Cephalochordata. Salient features of Urochordata. Structure and life history of Ascidia. Retrogressive metamorphosis – Process and Significance.

Unit - II **[7 hrs]**

Cyclostomata, General characters. 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 and classify up to orders with examples. Rana hexadactyla: External features, Digestive system, Respiratory system, Structure and function of Heart and Brain and Parental care.

Reptilia: General characters of Reptilia, Classification of Reptilia, and classification up to order 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. Columbia 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 and classify up to classes with examples. Rabbit: External features, Digestive system, Respiratory system, Structure and function of Heart and Brain. Comparison of Prototherians, Metatherians, and Eutherians. Dentition in mammals. Aquatic Mammals adaptations.

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. Saras Publication. 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. Ekambaranatha Ayyar, 1973. A manual of zoology. Part II. (S. Viswanathan Pvt.Ltd., Madras).
5. P.S. Dhami & J.K. Dhami, 1981. Chordate zoology. (R. Chand & Co.). 550 pages.
6. Gurdarshan Singh & H. Bhaskar, 2002. Advanced Chordate Zoology. Campus Books, 6 Vols. 1573 pp., tables, figs.
7. A.K. Sinha, S. Adhikari & B.B. Ganguly, 1978. Biology of animals. Vol. II. Chordates. (New Central Book Agency, Calcutta). 560 pages.
8. R.L.Kotpal, 2000. Modern textbook of zoology, Vertebrates. (Rastogi Publ., Meerut). 632 pages.
9. E.L. Jordan & P.S. Verma, 1998. Chordate zoology. (S. Chand & Co.). 1092 pages.
10. G.S. Sandhu, 2005. Objective Chordate Zoology. Campus Books, vii, 169 pp.
11. Sandhu, G.S. & H. Bhaskar, H. 2004. Textbook of Chordate Zoology. Campus Books, 2 vols., xx, 964 p., figs.
12. Veena, 2008. Lower Chordata. (Sonali Publ.), 374 p., tables, 117 figs.

ZMJDC-4: ECOLOGY AND ECOSYSTEMS

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

Unit 1: Ecology of Individuals

(Hours 10)

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

(Hours 10)

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

(Hours 7)

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

Unit 4: Ecosystem Ecology

(Hours 10)

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

(Hours 8)

Carbon cycle; nitrogen cycle; hydrological cycle; 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.

MID-3: ECONOMIC ZOOLOGY – PRACTICAL (for botany students)

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 50 marks; Internal 50 marks

UNIT – I Aquaculture (Hours 9)

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

UNIT – II Pisciculture (Hours 9)

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 (Hours 9)

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

UNIT – IV Apiculture (Hours 9)

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 the apiculture industry (Honey, Bees Wax, Propolis, Royal jelly, Pollen, etc.) and their uses.

UNIT – V Agricultural Crop Pest and Management (Hours 9)

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 Royce Ltd. London.
5. S.S. Khanna and H.R. Singh. A Textbook of Fish Biology & Fisheries Published by Narendra Publishing House. 3rd edition. (ISBN13: 9789384337124).
6. Dokuhon, Z.S. (1998). Illustrated Textbook on Sericulture. Oxford & IBH Publishing Co., Pvt. Ltd. Calcutta.

MID-3: ECONOMIC ZOOLOGY – PRACTICAL (for botany students)

I.FUNDAMENTALS OF ZOOLOGY

SPOTTERS: Amoeba, Entamoeba, Paramecium, Sycon, Obelia, Aurelia, Fasciola, Taenia, Ascaris, Leech, Mussel, Star fish, Amphioxus, Ichthyophis, Cobra, Pigeon & Rabbit.

II.PUBLIC HEALTH AND HYGIENE

Identification of Parasites

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

III.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 an artificial hive (Langstroth/Newton), its various parts, and beekeeping equipment.
7. Project report on the life cycle of any one crop pest or a product obtained from the apiculture industry.

ZMID-3: AGRICULTURAL ENTOMOLOGY

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

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 outbreak

[7 hours]

Definition of pest, categories of pests, parameters of insect population level, 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, cutworm, 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, behavioral 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 Douthett, 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.

ZMID-3: AGRICULTURAL ENTOMOLOGY PRACTICAL

Hours of Instruction / Week: 2 Hrs.

Total: 25 Marks

Total: 15 Hrs.

I. Spotters

1. Spodoptera
2. Rhinoceros beetle
3. Eriophyid mite
4. Batocera
5. Pyrilla
6. Earias vittella
7. Helicoverpa
8. Mealybug
9. Ladybird beetle
10. Zambesi flies

II. Different methods of insect sampling

1. Sweep net
2. Sticky traps
3. Light traps
4. Pitfall 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.

ZMID-3: FOOD, NUTRITION AND HEALTH

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

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 with 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 nourishes 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 [10hrs]

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: Lifestyle disease and social health problems [8 hrs]

Lifestyle-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- colds, 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

ZSEC-3: AQUACULTURE - PRACTICAL

Skill Enhancement Course – 3

Hours of Instruction / Week: 3 Hrs.

Internal 50 marks External 50 marks

Total: 100 marks

1. LEARNING OBJECTIVES:

1. To comprehensively understand the principles and practices of cultivating aquatic organisms.
2. To understand the environmental impacts of aquaculture and learn sustainable practices to minimize negative effects.
3. To integrate knowledge from biology, chemistry, environmental science, and economics to address aquaculture challenges.

2. LEARNING OUTCOME AND SCOPE:

1. To develop practical skills in aquaculture techniques, including breeding, feeding, disease management, and water quality control.
2. To research and develop new species for aquaculture, including both fish and invertebrates.
3. To apply genetic and breeding techniques to improve the growth rates, disease resistance, and overall quality of cultured species.

UNIT – I:

(09 hrs)

Introduction - Scope of aquaculture. Classification and biology of cultivable finfishes – 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:

(09 hrs)

Marine fisheries of India - Major fisheries of India (Sardine, Mackerel, tuna), and their characteristics; Indian major and exotic carp 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:

(09hrs) 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 Carp, pearl oyster.

UNIT – IV:

(09 hrs)

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:

(09 hrs)

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, byproducts, and value-added products of fish.

References:

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, Oxford and IBH Publishing Co Pvt.Ltd., Mumbai.
5. B.N. Yadav, - Fish and Fisheries, Daya Publishing House, Delhi.

Planet Resources:

https://nfdb.gov.in/PDF/06_Ras%20Booklet%20Eng.pdf

<https://brill.com/view/book/edcoll/9789004380271/BP000069.xml>

<http://eprints.cmfri.org.in/10666/1/7.%20Geetha%20Sasikumar.pdf>

<https://royalsocietypublishing.org/doi/10.1098/rsos.182061>

https://www.afcd.gov.hk/english/fisheries/fish_aqu/fish_aqu_techsup/files/common/Series1_FishFeedManagement.pdf

ZSEC-3: Skill Enhancement Course – AQUACULTURE - Practical

Hours of Instruction / Week: 2 Hrs.

Total: 100Marks

Total: 15 Hrs.

Internal 50 marks; External 50 marks

A. PROCHORDATES

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

B. PISCES:

Cartilaginous Fishes

1. Narcine
2. Trygon
3. Shark

Bony Fishes

1. Zebrafish
2. Hippocampus
3. Ostracion
4. Tetradon
5. Diodon
6. Echeneis

Ornamental fishes:

1. Locally available any five aquarium fishes

Accessory respiratory organs

1. Sacco branchus
2. Clarias
3. Anabas.

C. Amphibia:

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

D. Reptilia:

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

5. Varanus

E. Snakes:

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

F. Aves:

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

G. 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

AQUACULTURE

1. Observation of common edible fin and shell fishes.
2. Identification of aquatic weeds.
3. Observation of ichthyoplankton.
4. Observation of fish parasites.
5. Mounting of scales in fishes.
6. Morphometric and meristic characteristics in fishes.
7. Culture of different fin fishes.
8. Observation of craft and gears.
9. Finding the reproductive index of fish.
10. Fish or prawn farm visit.

ECOLOGY AND ECOSYSTEMS PRACTICAL

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 the light and dark Bottle method.
4. To study the plankton communities in a freshwater ecosystem.
5. To study the distribution of roadside species and investigate the changes in species richness.
6. Field report: Visit to a forest/ river/ wetland ecosystem.

ZSEC-3: MEDICAL LABORATORY TECHNOLOGY

Hours of Instruction / Week: 3 Hrs.

Total: 75 Marks

Total: 45 Hrs.

Unit-I: [Hours 9]

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: [Hours 8]

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

Unit-IV: [Hours 10]

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: [Hours 8]

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 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-5th Jaypee brothers medical publishers.
5. G.K.Pal and Pravati Pal .Textbook of practical physiology- Universities Press.

ZSEC-3: MEDICAL LABORATORY TECHNOLOGY PRACTICAL

Hours of Instruction / Week: 2 Hrs.

Total: 25 Marks

Total: 15 Hrs.

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 a clinical laboratory and report submission
9. Blood Grouping
10. Identification of Parasites.

ZSEC-3: PUBLIC HEALTH MANAGEMENT

Hours of Instruction / Week: 3 Hrs.

Total: 100Marks

Total: 45 Hrs.

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 classroom interactions, discussions, tutorials, quizzes, seminars and assignments to be used to deliver the course.

UNIT – I (10hrs)

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 (15th 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

ZMJD-5: CELL BIOLOGY

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

Unit 1: Overview of Cells and Cell Membrane

[Hours 9]

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

Unit 2: Cellular Components

[Hours 13]

Mitochondria – Ultrastructure, Composition and Functions; Semi-autonomous nature, Endosymbiotic 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

[Hours 7]

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

Unit 4: Cell Division

[Hours 6]

Cell cycles – Mitosis and Meiosis; Stages and Features. Cell cycle regulation various checkpoints and the role of cyclins and Cell proteins.

Unit 5: Cell Signalling and Cancer

[Hours 10]

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.

ZMJD-6: GENETICS

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

Unit 1: Mendelian Genetics and its Extension and Modification

[Hours 8]

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

[Hours 12]

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

[Hours 10]

Types of gene mutations (Classification), Types of chromosomal aberrations, Euploidy, Aneuploidy, and Polyploidy – Turners Syndrome, Klinefelter's 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

[Hours 9]

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

[Hours 6]

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

Suggested Readings

- 1) Benjamin A. Pierce. Genetics a Conceptual Approach, 7th 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 textbook 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 12th Edition 2020, Macmillan Learning Publisher.

ZMJD-7: ZOOLOGY MAIN PRACTICAL - I

Hours of Instruction / Week: 2 Hrs.

Total:100 Marks

Total: 15 Hrs.

External 50 marks; Internal 50 marks

I.CELL BIOLOGY

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 the ultrastructure of cell organelles – Plasma membrane, Nucleus, Nuclear Pore Complex, Mitochondrion, Golgi bodies, Endoplasmic Reticulum, and 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 a 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.
11. Visit to any Instrumentation laboratory.

II GENETICS - PRACTICAL

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's syndrome, etc.
7. Inheritance of Sex-linked diseases in men (hemophilia, red-green color blindness, and Duchene muscular dystrophy).
8. Visit any medical center for observation of anomalies.

ZMID-4: MICROBIOLOGY

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

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

UNIT-I

(Hours 9)

Scope of Microbiology

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

UNIT-II

(Hours 9)

Microbes of the Environment

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

UNIT-III

(Hours 9)

Agricultural Microbiology

Microorganisms as Biofertilizers, production and application of. Microbial biopesticides;
Mechanism of N₂ fixation.

UNIT –IV

(Hours 9)

Food Microbiology:

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

UNIT- V

(Hours 9)

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 Edn., Orient Longman Ltd., Madras.
5. C.B.Powar, H.F.Daginawala, (1965) General Microbiology Himalayan Publishing House.

ZMID-4: GENETIC ENGINEERING

Hours of Instruction / Week: 3 Hrs.

Total: 75 Marks

Total: 45 Hrs.

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

Unit I:

(Hours 9)

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:

(Hours 9)

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.

UNIT III:

(Hours 9)

Regulation of gene expression in prokaryotes and eukaryotes: Transcriptional control, enzyme induction and repression. Constitutive synthesis of enzymes. Genes involved in regulation, regulatory genes, promoter genes, operator genes, and structural genes. Genome imprint.

Unit IV:

(Hours 9)

Gene transfer methods and transgenic organisms: Gene transfer methods for animals and plants, Agrobacterium-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 V:

(Hours 9)

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

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ZMID-4: ENVIRONMENTAL BIOTECHNOLOGY

Hours of Instruction / Week: 3 Hrs.

Total: 75 Marks

Total: 45 Hrs.

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 of biological control and the scope of bio fertilizers 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 Jatropa and use of Jatropa, 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: Pseudomonasputida. 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 wastewater treatment. Reclamation of treated wastewater.

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 InduShekhar 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

ZMJD-8: ANIMAL PHYSIOLOGY

Hours of Instruction / Week: 3 Hrs.
Total: 45 Hrs.

Total: 100 Marks
External 75 marks; Internal 25 marks

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

Unit – I Nutrition

[Hours 7]

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

Unit – II: Respiration

[Hours 10]

Respiratory organs, Respiratory pigments, and functions. Transport of gases (CO₂ and O₂) – 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 heartbeat, Pacemaker, Regulation of heartbeat, ECG, Blood Pressure, Arrhythmias.

UNIT– III: Excretion

[Hours 8]

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

UNIT– IV: Muscle Physiology

[Hours 10]

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 the reflex arc.

UNIT-V: Receptors

[Hours 10]

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

Suggested Readings

- Sambasivaiah, Kamalakara Rao and Augustine Chellappa 1990. 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.
- Williams. 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.

ZMJD: 9: DEVELOPMENTAL BIOLOGY

Hours of Instruction / Week: 3 Hrs.

Total: 75 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

Course Objectives:

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

- The main objective of the Developmental Biology course is to provide four-dimensional thinking for 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 of 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 embryos.
- 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 the learning contents of embryology, students can have 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.
- To understand the overall chronology of the development and the role of various morphogens (protein/mRNA) in the specification and determination of various organs and body axis formation.

UNIT-I:

(Hours 9)

Potency, commitment, specification, Induction, Competence, Determination, and differentiation of embryonic cells. Embryonic stem cells, origin, and mechanism of Cell lineage, Fate maps.

UNIT-II:

(Hours 9)

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.

UNIT-III:

(Hours 9)

Axis and pattern formation in *Drosophila*, and Chick. Organogenesis- vulva formation in *Caenorhabditis elegans*, eye lens induction. Development in tetrapod Limb (Amphibians) and Neural fold formation.

UNIT-IV:**(Hours 9)**

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

UNIT- V:**(Hours 9)**

Aging and senescence- Reactive oxygen species and cell senescence; dietary restriction and anti-aging action: genetic control of longevity; Age-related diseases. Programmed cell death- Apoptosis; 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.

ZMJD-10: ZOOLOGY MAIN PRACTICAL - II

Hours of Instruction / Week: 2 Hrs.

Total: 100 Marks

Total: 45 Hrs.

Eternal 50 marks; Internal 50 marks

I. ANIMAL PHYSIOLOGY

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

II. DEVELOPMENTAL BIOLOGY

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.
4. Mounting of chick embryo – 24, hours, 36 hrs, and 48 hrs.
5. Visit to poultry farm to observe chick developmental stages.

ZMID-5: TOXICOLOGY

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

Course objectives:

- 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, and hepatotoxicology.
- To apprise the students about the toxicants along with their application and their effects on the biosphere as well as human health.

Unit- I:

(Hours 9)

Introduction and scope of toxicology and classification of xenobiotics. Principles of toxicology- Dose-response relationship- Toxicity tests {acute (LD50, LC50, ED50) 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:

(Hours 9)

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:

(Hours 9)

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:

(Hours 9)

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:

(Hours 9)

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'Brien.
6. Pesticides and Human Welfare - D.L. Gunn and J.G.R. Stevens.
Oxford University Press- 1978.
7. The Encyclopedia of Americana - Vol.15.

ZMID-5: FORENSIC ENTOMOLOGY

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

Course Objectives:

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: (Hours 9)

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

UNIT-II: (Hours 9)

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: (Hours 9)

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: (Hours 9)

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

UNIT –V: (Hours 9)

Organizational structure of Forensic Science Laboratories at central & State level (FSL, FSL, GEQD, FPB, NICFS, CDTS, NCRB, NPA). Mobile Forensic Science Laboratory. Ethics in Forensic Science. Duties of Forensic Scientist, Qualification of Forensic Scientist.

Reference Book:

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

ZMID-5: TOOLS AND TECHNIQUES

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

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 micro technique.

Course Outcomes:

- Students would be trained in various tools and techniques used to gain insight into biological processes.
- Students would be experts in 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.

UNIT-I:

(Hours 9)

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., ultracentrifugation.

UNIT-II:

(Hours 9)

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:

(Hours 9)

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:**(Hours 9)**

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:**(Hours 9)**

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.

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 Phychopharmacology- 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, Arthur.

SEMESTER – VI

ZMJD-12: ENDOCRINOLOGY

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

Objectives:

- Explain the role of hormones in the physiological activities of animals with special reference to humans.

UNIT – I:

(Hours 9)

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:

(Hours 9)

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:

(Hours 9)

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 the adrenal gland.

UNIT – IV:

(Hours 9)

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

UNIT – V:

(Hours 9)

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, contraception. 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

ZMJD-13: ANIMAL BIOTECHNOLOGY

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

UNIT I: (Hours 9)

General Introduction and Achievements of Biotechnology. Genetic Engineering and rDNA technology (Restriction endonucleases, DNA ligases, Topoisomerases, Methylases, Nucleases, Polymerases, Reverse transcriptase, and their Properties and functions). Cloning vectors (plasmids, Bacteriophages, Cosmids, yeast 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: (Hours 9)

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: (Hours 9)

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: (Hours 9)

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

UNIT V: (Hours 9)

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

ZMJD-14: EVOLUTION AND ETHOLOGY

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

Objectives:

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

UNIT –I:

(Hours 9)

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

UNIT –II:

(Hours 9)

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

UNIT –III:

(Hours 9)

Origin of Species, Phylogenetic 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:

(Hours 9)

History and scope of ethology: Motivation - learning- types of learning (imprinting, habituation, conditioned reflex, unconditioned reflex, latent learning); 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:

(Hours 9)

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, 1. 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.

ZMJD-15: ZOOLOGY MAIN PRACTICAL - III

Hours of Instruction / Week: 2 Hrs.

Total: 100 Marks

Total: 15 Hrs.

Internal 50 marks ; External 50 marks

I. ENDOCRINOLOGY

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

II. ANIMAL 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. Visit to PCR laboratory.
11. Blotting techniques – Western and Southern blot, Electrophoresis

III. EVOLUTION AND ETHOLOGY

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 - Field visit.

ZMID-6: VECTOR AND DISEASES PRACTICAL

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

Internal 50 marks ; External 50 marks

Course outcome

- After completion of the course the student can:
- Learn in detail about insect, and vector diseases
- Identify in detail with examples of insect, and vector diseases
- Deliberate the details of insect, and vector diseases
- Learn in-depth Insect, vectors and diseases

UNIT I: (Hours 9)

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, and 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: (Hours 9)

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

UNIT III: (Hours 9)

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

UNIT IV: (Hours 9)

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: (Hours 9)

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

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

I. MICROBIOLOGY

1. Identification of microorganisms from the habitats [simple staining, differential staining,]
2. Morphological Observation of bacterial cells.
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

II. FORENSIC ENTOMOLOGY

1. Collecting insects, soil and leaf litter
2. Identification of forensically important insects
3. Identification of aquatic insects.

III. VECTORS AND DISEASES

1. Study of different kinds of mouth parts of insects.
2. Study of the 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.
5. Study of different diseases transmitted by the above insect vectors.
6. Field visit.

ZMID-6: REPRODUCTIVE BIOLOGY

Hours of Instruction / Week: 3 Hrs.
Total: 45 Hrs.

Total: 100 Marks
External 75 marks; Internal 25 marks

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 the basic principles of the reproductive process, this course will focus on sexual reproduction by emphasizing mammalian, especially human, reproduction.

COURSE OUTCOME

- Demonstrate knowledge of key principles of reproductive endocrinology including a) biosynthesis and chemistry of the different classes of hormones, and 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 the advantages and disadvantages of the methodology used. Define different types of stem cells; compare and applications

UNIT I: (Hours 9)

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

UNIT II: (Hours 9)

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

UNIT III: (Hours 9)

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

UNIT IV: (Hours 9)

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:**(Hours 9)**

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.

ZMID: 6-MEDICAL MICROBIOLOGY

Hours of Instruction / Week: 3 Hrs.

Total: 100Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

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.

Unit I: Sample collection, transport, and diagnosis

(Hours 13)

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.

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.

ZMID-6: MEDICAL MICROBIOLOGY PRACTICAL

Hours of Instruction / Week: 2 Hrs.

Total: 25 Marks

Total: 15 Hrs.

1. Identify bacteria, *E. coli*, *Salmonella*, *Pseudomonas*, *Staphylococcus*, and *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), and dermatomycoses (ringworms).
6. Study of various stages of Malaria parasite in RBCs using permanent mounts/Photomicrographs.
7. Visit to Microbiology laboratory.

SEMESTER – VII

ZMJD-16: BIOSTATISTICS AND BIOINFORMATICS

Hours of Instruction / Week: 3 Hrs.
Total: 45 Hrs.

Total: 100 Marks
External 75 marks; Internal 25 marks

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: (Hours 9)

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

UNIT II: (Hours 9)

Measures of central tendency - Mean, Mode and Median, Variance, Standard deviation, Standard error, and Coefficient of variance with suitable examples. Simple Correlation, Simple Regression, Chi-square test, student's-test.

UNIT III: (Hours 9)

Introduction - Scope of Bioinformatics and bioinformatics resources, Principles of protein structure -Tertiary and Quarternary structure, DNA and RNA Sequencing; Sequence alignment – pairwise and multiple sequence alignment, tools of bioinformatics
- BLAST and FASTA.

UNIT IV: (Hours 9)

Biological databases - Gene Bank - NCBI, EMBL, and DDBJ - Protein databases (primary, composit and secondary) SWISSPROT, PIR, and PROSITE. Structure databases - Proteomics, Genomics - Human Genome Project - metagenomics, concepts of metabolome and metabolomics.

UNIT V: (Hours 9)

Networking and Internet: Introduction to networks, types of networks, application of network, use of the internet, WWW, the 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, 1stEdition.
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.

ZMJD-17: FISHERY BIOLOGY

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

Objectives:

- To study and understand the biology of fishes and make the students know about the cultural techniques of fishes.

UNIT– I:

(Hours 9)

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:

(Hours 9)

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:

(Hours 9)

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:

(Hours 9)

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:

(Hours 9)

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 fish.

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, Oxford and IBH Publishing Co Pvt. Ltd., Mumbai.
5. B.N. Yadav, - Fish and Fisheries, Daya Publishing House, Delhi.

ZMJD-18: ZOOLOGY MAIN PRACTICAL – IV

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 50 marks; Internal 50 marks

I BIOSTATISTICS

1. Frequency distribution of mean, median, mode & standard deviation.
2. Construction of graphs – bar & histogram.
3. Correlation between height and weight.

II BIOINFORMATICS

1. Genome sequences – DNA and Protein.

III. SPOTTERS

1. Parts of computer
2. Copies of the genome
3. Sequence of DNA and Protein.

IV. FISHERY BIOLOGY

1. Determine the morphometric measurement of the fish
2. Analysis of the 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.
5. Visit to landing centres

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*

ZMID-7: LIFESTYLE DISEASES AND MANAGEMENT

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

Objective:

1. To give a general awareness of health and wellbeing.
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 lifestyles and associated diseases.
2. Develop your own thinking, opinions, and attitudes about the global lifestyle changes on health issues.

UNIT I:

(10 hours)

General awareness of Basic biochemistry (lipids, proteins, vitamins, and minerals), Lifestyle 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.

ZMID-7: ENVIRONMENTAL POLLUTION AND HUMAN HEALTH

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

Objective:

- This paper deals with different aspects of environmental contamination, which have adverse effects on human health.
- It will lay emphasis on understanding the 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.

ZMID-7: NANO BIOLOGY

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

UNIT I: (Hours 9)

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

UNIT II: (Hours 9)

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

UNIT III: (Hours 9)

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

UNIT IV: (Hours 9)

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: (Hours 9)

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 materials for Medical Diagnosis and Therapy, Wiley – VCH, 2006.
4. Veenitha Singh. Nanobiology. 2012.

ZMID-8: ANIMALS AND HUMAN WELFARE

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

Unit – I: (Hours 9)

Biodiversity and Human Welfare

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

Unit – II: (Hours 9)

Animal husbandry:

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

Unit – III: (Hours 9)

Culture: Vermiculture, Apiculture, Pisciculture and Poultry

Unit – IV: (Hours 9)

Communicable diseases:

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

Unit – V: (Hours 9)

Non – Communicable Diseases

Oral Cancer - cause/causative agents, symptoms, diagnostics, precaution /prevention, and remedy.
Stress-related disorders - Hypertension, Diabetes type II, anxiety, insomnia, migraine, depression (cause, symptoms, precaution, and remedy).

ZMID-8: NEUROBIOLOGY

Hours of Instruction / Week: 3 Hrs.

Total:100 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

Course Objectives:

1. To study the micro anatomical structure of a 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 the Nervous system
5. To understand the principles of different types of neurotransmitters

Course Outcomes:

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

UNIT-I:

(Hours 9)

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:

(Hours 9)

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:

(Hours 9)

Molecular mechanism of Excitation Carrier protein; Ion channels; Gating mechanisms. Synapses: Structure and Integration; Morphology and Ultrastructure of Synapse; Types of Synapses; Chemical transmission; Electrical transmission. Second messenger systems: Cyclic AMP and GMP; G-protein; IP₃; Calcium and Calmodulin.

UNIT-IV:**(Hours 9)**

Chemical composition of the nervous system 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:**(Hours 9)**

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.

SUGGESTED READING MATERIAL:

1. Basic Neurochemistry-G.J. Siegel, R.W. Albers, B.W. Agranoff, R. Katzman (1981) Little, Brown and company. Boston.
2. Introduction to Nervous system- T.H. Bullock, R. Cork, A. Granter (1977); W.H. Freeman & Co.
3. Mechanism of Drug Action on the Nervous System M.A.B. Brazil, R.W. Ryall. (1979), Cambridge University Press. Cambridge, London and New York.
4. Neuro anatomical Techniques, N.J. Strassman and T.A. Miller Springer Verlag, New York.
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, & R.H. Roth. (1982); Oxford University Press, NY and London. York Heidelberg, Berlin, 1980.

ZMID-8: IPR, BIOSAFETY AND BIOETHICS

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

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 biotechnology research and how to establish ownership of a novel finding.
- The students will be able to understand the legal aspects involved in biotechnology research

UNIT I:

(Hours 9)

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

UNIT II:

(Hours 9)

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 the use of genetic information – genetic engineering and bio warfare.

UNIT III:

(Hours 9)

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 bio piracy – ELSI of the human genome project.

UNIT IV:

(Hours 9)

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:

(Hours 9)

Introduction to intellectual property and intellectual property rights: Types, patents, copyrights, trademarks, design rights, geographical indications – the importance of IPR – patentable and non-patentable – 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, 2002 Glimpses of Biodiversity – B. Blotsoetti
3. Ethics in engineering, Martin. M.W. and Schinzing. 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

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

ZMJD-19: BIO-INSTRUMENTATION AND TECHNIQUES

Hours of Instruction / Week: 3 Hrs.

Total: 100Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

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 of various biochemical methods

Unit -I: Imaging and related techniques: (Hours 10)

Principles and applications of microscopy; Light microscopy; Fluorescence microscopy and Electron Microscopy - 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 and applications of ultraviolet and visible spectrophotometry (single and double beam, double wavelength spectrophotometers), Infrared spectrometers - Luminometry and densitometry – principles and their applications - Mass Spectroscopy - principles and application in Biology.

Unit- IV: Chromatography: (Hours 10)

Chromatographic techniques: Principle and applications – Column - thin layer – paper, affinity, and gas chromatography - Ion exchange and High-performance liquid chromatography techniques– Examples and 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 and its Classification.

ZMJD-20: RESEARCH METHODOLOGY

Hours of Instruction / Week: 3 Hrs.

Total: 100 marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

Unit I:

(Hours 9)

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

Unit II:

(Hours 9)

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:

(Hours 9)

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:

(Hours 9)

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:

(Hours 9)

Research Publications - Scientific writings, Research articles and their 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.

ZMJD-21: BIOCHEMISTRY AND MOLECULAR BIOLOGY

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

Biochemistry and Molecular Biology Objectives:

- To provide Knowledge about the complex organization in the Eukaryotic 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 Eukaryotes.

Molecular Biology Course Outcomes:

- 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.
- Gain insight into the most significant Molecular and cell-based methods used today to expand our understanding of Biology.
- 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:

(Hours 9)

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:

(Hours 9)

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:

(Hours 9)

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

UNIT-IV:**(Hours 9)**

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 the polypeptide chain, Signal peptide hypothesis, Post-translational modification, Polyproteins, Inhibitors of translation.

UNIT-V:**(Hours 9)**

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. Publications, 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 al., 1990.
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.Murray., Daryl.K.Granner., Peter.A.Mayes., & Victor.W.Rodwell (2004) Prentice Hall International, ISBN-8385-3612-3.
11. Principles of Biochemistry A.L Lehninger, D.L Nelson & M.M.Cox (1993) Worth publishers, New york.

ZMJD-22: IMMUNOLOGY

Hours of Instruction / Week: 3 Hrs.

Total: 100 Marks

Total: 45 Hrs.

External 75 marks; Internal 25 marks

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, interferon's, and complement systems.
- To explain the concept of hypersensitivity, autoimmunity, 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.

Unit I:

(Hours 9)

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, Classification of Immunoglobulins: Types –IgG (G1, G2, G3 & G4), IgM, IgA, IgD and IgE (Origin, structural functions). Antibody diversity: Mini gene theory, Mutation theory, Germline theory, Somatic recombination, V (D) J recombination.

Unit II:

(Hours 9)

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.

Unit III:

(Hours 9)

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 newborn (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, Erythroblastosisfetalis.

Unit IV: (Hours 9)

Autoimmunity: Introduction, Auto recognition, classes of autoimmune diseases. (Hashimoto disease, thyrotoxicosis, Systemic lupus erythematosus, autoimmune hemolytic anemia, Rheumatoid arthritis). Transplantation: Terminology, Auto graft, Isograft, Allograft, Xenograft, Immunological basis of transplantation reactions, Graft vs. host reaction, Immunosuppression, General mechanisms of Immune suppression, Immune suppression, drugs (azathioprine, methotrexate, cyclophosphamide, cyclosporin-A, Steroids). Vaccines: types and their role.

Unit IV: (Hours 9)

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 immunodiffusion, Ouchterlonyimmuno diffusion. Immuno-electrophoresis: Rocket immuno-electrophoresis. Agglutination: Direct and Indirect, Widal test, VDRL test. Radioimmunoassay: ELISA – Principle, Methodology, and Applications.

Recommended Books:

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

ZMJD-23: ZOOLOGY MAIN PRACTICAL V

Hours of Instruction / Week: 2 Hrs.

Total: 100 Marks

Total: 15 Hrs.

External marks 50; Internal marks 50

I.BIO-INSTRUMENTATION AND TECHNIQUES

1. Preparing various laboratory reagents.
2. Bio-instruments, Operating laboratory instruments, noting instrument readings, and 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 Spectrophotometer.
11. 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 and 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 the liver, breast tumors, cystic follicles of the 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 and Goulding. 1986. Principles and techniques of Practical Biochemistry. (3 ed) Edward Arnold, London.
4. Dawson, C. (2002). Practical research methods. 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 microtechnique and microscopy. Oxford University Press, New York, U.S.A.
7. Boyd, W. 1976: A textbook of Pathology. Structure and function in disease, 4th edition. Lea and Fibiger, 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.

II. RESEARCH METHODOLOGY

1. Data processing and analysis
2. Data analysis with statistical package SPSS, SAS, r , MATLAB, SQL

III. BIOCHEMISTRY 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 the amount of DNA using a spectrophotometer.
7. Visit to biochemistry laboratory.

III. IMMUNOLOGY PRACTICAL

1. Differential count of WBC
2. Total Count of WBC
3. Antigen and Antibody reactions – blood grouping

SPOTTERS

- 1 Histology of lymphoid organs
- 2 Immunodiffusion
- 3 Immunosuppressant drugs
- 4 Radio immune assay
- 5 VDRL Test, WIDAL Test