

Information Brochure of Zoology 2025



DEPARTMENT OF ZOOLOGY

Undergraduate & Post Graduate

BIDHANNAGAR COLLEGE

Government of West Bengal

EB-2, Sector-1, Salt Lake, Kolkata-700064



Department of Zoology

Brief History

The Zoology Department of Bidhannagar College was established in 1997. From that year itself, the Honours Course in Zoology was introduced. The journey of the department started with only ten students (first batch) under the tutelage of three teaching faculties. From such a humble beginning, the department took a rapid stride not only in infrastructure but also in the number of students and teaching faculties as well. This has been possible with the shifting of the department to the new building of the college (present campus) in the year 2001 as the available space has increased significantly.

The Postgraduate Department of Zoology for the M.Sc. Degree Course was initiated from the academic session 2004-2005 with course-specific autonomy under the affiliation to the University of Calcutta, to which the Bidhannagar College was then affiliated. However, from the academic session 2008-2009 onwards, our college has been affiliated with the then newly founded West Bengal State University at Barasat, North 24 Parganas, West Bengal.

Over the financial years, the Postgraduate Department of Zoology has received Development Grants both from the Government of West Bengal and the University Grants Commission, New Delhi for the Xth and XIth Plan periods. As a result, efforts have been made to upgrade the laboratories with modern equipment and teaching aids. The departmental seminar library has also become enriched with invaluable and rare books. With further financial support, smart classrooms and faster broadband networking facilities are a reality now.

The exemplary performance both by the undergraduate and postgraduate students has created an enviable niche for this department in the academic arena. The alumni of this department have continued to glorify different positions in various academic and research institutions in India and abroad. This has paved the way for newly admitted students to find out their suitable future positions.



Admission related Information

Eligibility Criteria

A candidate who has passed the three year B.Sc. examination with Honours (Major) in Zoology will be eligible for admission to this course on the basis of merit. Online admission process will be notified in the college website: <https://www.bidhannagarcollege.org/>

Total number of seats -29

Selection Process

List of selected and waitlisted candidates are available in the website of the Bidhannagar College. No other communication regarding admission is entertained. The selected candidates are asked to report to the department on a specified date and time, failing which may lead to no further consideration for admission. If the seat remains vacant, the waitlisted candidates (as per the rank) are intimated through the college website to report to the department.

The duration of the course

The duration of the course is two academic years and the examination for the M.Sc. degree in Zoology will be held through four semesters.

Course layout

The course is comprises a total credit of 92 (ninety two) distributed over the four semesters. The courses shall be grouped as Departmental core courses, Electives, Skill Enhancement Course (SEC) & Ability Enhancement Comprehensive Course (AECC) and will carry credits according to the number and hours of theoretical and practical classes. Students are compulsorily offered three different elective papers during their semesters III and IV and they are to choose any one from the following three elective papers: Genome Structure & Genomics, Parasitology & Immunobiology and Environmental Biology & Ecotoxicology in Semester III and Advanced Genetic Analysis, Immunoparasitology and Environmental Management, Tools and Techniques in Semester IV.

Detail syllabus is provided at end of the brochure.



Fee Structure for M.Sc. Zoology

	Heads of Account	Amount (RS.)
Semester 1	1 Tuition fee	960
	2 Admission fee	100
	3 College examination	10
	4 Library Caution Deposit	25
	5 Laboratory Caution Deposit	30
	6 Student Activity fee	500
	7 Identity Card	50
	8 Library Card	50
	9 Session Charge	50
	10 Students Health Home Fee	10
	11 Magazine fee	125
	12 Library Fees@ 10/- per month	120
	13 Student Aid Fund	25
	14 Student management system	250
	15 Semester fee	2000
	16 Sem 1 Exam fee	1500
	Total	5805
Semester 2	1 Tuition fee	960
	2 Semester fee	2000
	3 Sem 2 Exam fee	1500
		Total
Semester 3	1 Tuition fee	960
	2 Admission fee	100
	3 College examination	10
	4 Session Charge	50
	5 Magazine fee	125
	6 Library Fees@ 10/- per month	120
	7 Student management system	250
	8 Semester Fee	2000
	9 Sem 3 Exam Fee	1500
	Total	5115
Semester 4	1 Tuition fee	960
	2 Semester fee	2000
	3 Sem 4 Exam fee	1500
	4 Certificate Production fee	50
	Total	4510
Total fees for 2 years		19890



About the Department

Departmental infrastructure

A) Classrooms and Laboratories

The Department of Zoology is placed in the 2nd floor of the Old Building of the College. It includes six Theory classrooms (four of which are smart classrooms), one dissection room, one Biochemistry laboratory, one advance microscopy room, three different rooms for elective special papers, one histology room, one PG examination room, one specimen Museum cum Departmental Seminar Library and reading room, one store room and one room each allotted for Departmental Faculty members and Head of the Department.

B) Departmental Seminar Library

The Department has a rich, well-stocked and well-arranged Seminar Library equipped with all the necessary text and reference books needed to cover the entire course. Seminar Library offers both reading and lending facilities. All the books are systematically arranged and catalogued.

C) Specimen Museum

The Department is equipped with highly organized Specimen Museum. It contains diverse collection of both microscopic and macroscopic Invertebrate and Vertebrate specimens with proper labeling for identifying and studies them. It also contains great collection of skulls and appendicular skeletons of different vertebrates for the study of osteology.

D) Equipment

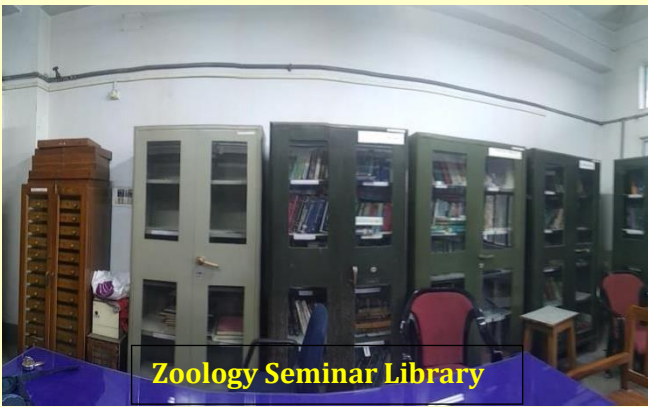
The laboratories are already well-equipped with sophisticated digital microscopes like ZEISS Axioscope, PCR, spectrophotometers, colorimeters, pH meters, cold centrifuge, microtomes, paraffin baths, glass distilled water plant, gel apparatus, immunological kits, enzyme study kits, water analysis kits, cameras, binoculars, a huge stock of chemicals and glassware, etc. for the use for departmental students.





PG Students using different instruments during their practical class





Zoology Seminar Library



Zoology Specimen Museum



Specimens in Museum



Collected Specimens



Collected Specimens



Faculty Members of Department of Zoology



Dr. Sutapa Sanyal

M.Sc. Ph.D.
Head of the Department
Associate Professor

Dr. Sutapa Sanyal joined WBES in the year 2007. She has 18 years of UG and PG teaching experience. She did her Ph.D. on **bacteriological contamination** of waste fed fish from University of Calcutta, India, West Bengal, in 2013. During her doctoral research she worked with various Coliforms, *Salmonella*, *Shigella*, *Vibrio* as well as multiple antibiotic-resistant bacteria. Further, she carried her research with **transferable drug-resistant coliforms** along with their transfer frequencies and mechanisms of transfer as a part of her **UGC sponsored minor research project**. She worked on the usage of formalin for self-life extension of fish. Presently she is interested in **biopreservation** of fish against pathogenic and spoilage flora. In this context she got a **major project from WBDSTBT**. She extracted successfully Bacteriocin like inhibitory substances from fish intestine. Isolated BLIS showed broad antibacterial spectrum. She has **20 successful publications** on her work. Two students are doing **Ph.D.** under her supervision.

Specialization:

- **Teaching areas:** Fishery and Aquaculture
- **Research interest:** Fish Microbiology

Email: sutapa2007.sanyal@gmail.com



Dr. Somnath Mandal has joined West Bengal Education Service under Higher Education Department, Govt. of West Bengal in 2008. Dr. Mandal has total 14 years of PG teaching experience. He has served in Jhargram Raj College before this college. He has 8 years research experience with 7 publications in National and International peer reviewed reputed Journals and Books. He has carried out a UGC funded MRP and at present carrying out a project funded by WBDST. He is member of PGBOS of Zoology and Governing Body, Bidhannagar College.

Dr. Somnath Mandal

M.Sc. Ph.D.
Assistant Professor

Specialization:

- **Teaching areas:** Parasitology, Enzymology, Biodiversity
- **Research interest:** Ecology, Parasitology, Biodiversity

Email: somu25_2@rediffmail.com



Mrs. Urmi Mitra has joined West Bengal Education Service under Higher Education Department Govt. of West Bengal in 2008. Mrs. Mitra has total 14 years of PG teaching experience. She has served in Krishnagar Govt. College before this college. She has several years of research experience with a publication in National peer reviewed reputed Journal and has 2 Book chapters. She is member of PGBOS of Zoology, Bidhannagar College and Life Member of The Zoological Society, Kolkata.

Dr. Urmi Mitra

M.Sc., Ph.D
Assistant Professor

Specialization:

Teaching areas: Parasitology, Immunology, Biochemistry, Molecular Biology, Animal Behaviour, Osteology

Research interest: Ecotoxicology, Parasitology and Immunology

Email: urmimitra@gmail.com



Dr Dip Mukherjee joined WBES IN 2014. Dr Mukherjee oversees cutting-edge fish toxicology research using combined physiological and biochemical approaches. He has about 15 years of research experience in the field of aquatic toxicology and fisheries sciences and has 27 research articles and 7 book chapters in various Internationally and Nationally reputed publishing houses to his credit (CV attached). He has attended many International and National seminars and symposia. Further, he is guiding one Ph.D. student for her research on toxicity of some emerging contaminants along with their amelioration using plant extracts/probiotics. He has expertise regarding various physiological and biochemical techniques used to assess toxicity of contaminants to fish and other aquatic organisms.

Dr Dip Mukherjee
M.Sc., Ph.D
Assistant Professor

Specialization:

- **Teaching areas:** Parasitology, Toxicology and Ecology
- **Research interest:** Ecotoxicology

Email: : dip.m@rediffmail.com



Dr. Suman Bej has joined West Bengal Education Service under Higher Education Department, Govt. of West Bengal in 2015 in this College. Dr. Bej has total 8 years of PG teaching experience. He has several years of research experience with 11 publications in National and International peer reviewed reputed Journals and Books. He is the member of PGBOS of Zoology, Bidhannagar College and Indian Science Congress Association (ISCA). He also serving the additional charge of Academic Coordinator of Netaji Subhas Open University Study Centre of PG course at this College.

Citations: 47; -h-index- 5; i10-index-1

Web of Science Researcher ID: [AFJ-5916-2022](https://orcid.org/0009-0001-5916-2022)

Scopus author ID: [57226409890](https://orcid.org/0009-0001-5916-2022)

Google Scholar Link:

<https://scholar.google.com/citations?user=aWzuB9cAAAAJ&hl=en>

Research Gate Link:

<https://www.researchgate.net/profile/Suman-Bej>

Dr. Suman Bej

M.Sc. Ph.D.

Assistant Professor

Specialization:

- **Teaching areas:** Cell Biology, Developmental Biology, Endocrinology, Reproductive Biology, Ecotoxicology, Environmental Biology and General Zoology
- **Research interest:** Ecotoxicology, Environmental Biology, Pesticide Toxicity and, Biodiversity

Email: sumanbej.sb@gmail.com



Dr. Biswatosh Ghosh has joined West Bengal Education Service under Higher Education Department, Govt. of West Bengal in 2015 in this College. Dr. Ghosh has total 7 years of PG teaching experience. He has several years of research experience with 7 publications in National and International peer reviewed reputed Journals and Books. He is the member of PGBOS of Zoology, Bidhannagar College and Life members of Zoological Society, Kolkata, Electron Microscope Society of India, Indian Science Congress Association (ISCA), and Ethological Society of India (ESI).

Dr. Biswatosh Ghosh

M.Sc. Ph.D. D.I.T.A.

Assistant Professor

Specialization:

- **Teaching areas:** Taxonomy, Biodiversity, Conservation, Animal Behaviour, Genetics, Evolution
- **Research interest:** Animal Behaviour, Semiochemistry, DNA Barcoding, Toxicology

Email: biswabios.atgc@gmail.com





Dr. Ananya Ali has joined the West Bengal Education Service, under Higher Education Department, Govt. of West Bengal, in 2025 in this college. Dr. Ali has six years of teaching experiences in different degree colleges. He has seven publications in different international journals and books. He is life member of Indian Biophysical Society from 2018.

His area of interest is Computational biology, Immunology, Biochemistry.

Dr. Ananya Ali

M.Sc., PhD.

Assistant Professor

Specialization:

- ❖ Teaching areas: Parasitology, Immunology, Biochemistry, Biostatistics, Population Biology, Evolution.
- ❖ Research interest: Computational biology, Immunology, Biochemistry, Bioinformatics.

e-mail: aliananya17@gmail.com

Departmental Activities

The department of Zoology carries out various indoor and outdoor activities throughout the year where the PG students actively participate.

1) Excursions: *The Department organizes field study tours or excursions as per the syllabus to study the wild animals in their natural habitat or to visit research institutes.*

2) Departmental Seminars/Invited Lectures: *The Department organizes variety of departmental and college level Seminars and invited lectures where both the teachers and students are actively participate. The invited Speakers range from distinguished professors to esteem and resourceful emerging young researchers. It is believed that these lectures are an efficient way of introducing students to variety of field of studies and field of research or diverse career opportunities. Department had also organized several webinars during the pandemic years in benefit of students.*

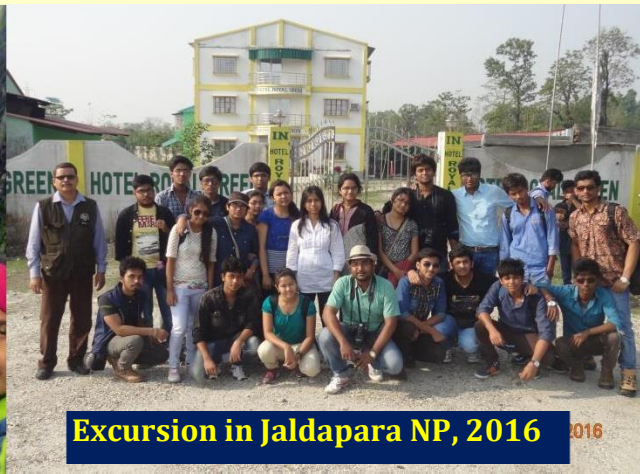
3) Wall Magazine: *The students of this department prepare wall magazine where they portray different scientific facts, new discoveries, and current research etc.*

4) Participation in outdoor activities: *The students are actively participating in various outdoor events of both academic and non-academic (extra-curricular) and secure different awards. Students of both UG and PG secure 1st position in ZOO Festival (2017) organized by Zoological Garden, Alipore, they also secure top 3 positions in Students' Elocution Program organized by Zoological Garden.*

5) Participation in indoor activities: *Students are actively participates in different programs of the College like Tree plantation and conservation, Teachers' day, fresher's welcome, games and sports, NSS programs, Cultural programs etc. and also secure many awards in competitive activities every year.*

6) Parent Teacher Meeting: *Parent-teacher meeting is conducting in regular manner at department to for their betterment and to make healthy teaching-learning environment at the department and to address the assessment procedure, class attendance and overall performances/lacunae of the individual students.*







Departmental Cultural Programs organized by Students



Celebrating Teachers' Day 2019



Organized National Level Seminar, 2019



Tree Plantation, their Conservation and Celebrated Earth's Day, Quiz, Cultural programs -2019





Champion in Tug of war 2022: Department of Zoology



Annual Sports meet 2022



Departmental Seminar on Outdoor Ecology



Presentation of Zoology Wall Magazine 2022

Parent - Teachers' Meeting 2022



Career Opportunity

As our Postgraduate Course is autonomous, we have designed our course curriculum in such a way that it will fit for several frontline National and State level Exams, other Government job examinations and research-oriented fields the students are seeking for after they pass out. Each year a number of postgraduate students appear in the National Eligibility Test (NET) for the Junior Research Fellowship (JRF) and Lectureship (LS) and State Eligibility Test (SET), GATE and few of them also able to cracks the hard shell. Students who clear the NET examination can continue higher studies for the Ph.D. Degree and also for the position of teaching faculties in the Colleges, Universities, and Institutions across India. Our lab courses are so designed that students can also present themselves before the research and development wing of different pharmaceutical companies, and pathological laboratories. Beside these opportunities, students are going for the preparation of different Government as well as Private Jobs.



Achievements by the Student of our Department

Sl. No.	Name	Year of passing	Position/ Achievement
1	Ankur Bhawal	2005	NET, Asst. Professor Vidyasagar College, Kolkata
2	Subhadipa Majumder	2005	NET, Ph.D.
3	Avinandan Mukherjee	2009	NET, Asst. Professor, Charuchandra College, Kolkata
4	Somaditya Dey	2010	NET, Asst. Professor West Bengal Education Service
5	Debarati Mukherjee	2010	Post-Doctoral Fellow
6	Amit K. Gayen	2012	NET, Asst. Professor
7	Sankarshan Roy	2012	Entomology Div., WB Govt.
8	Bidisha Chakraborty	2016	Researcher, UC Davis,
9	Debdatta Nath	2016	Researcher, N Dakota Univ
10	Pritam Chatterjee	2016	CSIR-UGC NET LS
11	Arpita Das	2017	CSIR-UGC NET JRF
12	Nilanjan H. Chatterjee	2017	CSIR-UGC NET JRF
13	Nilanjana Banerjee	2017	CSIR-UGC NET JRF
14	Sayan K. Mukhopadhyay	2017	CSIR-UGC NET LS
15	Nandini Pal	2017	WB SACT, RBC College
16	Partha Ganguly	2017	SRF, RKMVC
17	Purandar Sarkar	2018	CSIR-UGC NET JRF, Assistant Professor (WBES)
18	Moumita Roy	2018	CSIR-UGC NET JRF
19	Pulak Jana	2018	CSIR-UGC NET JRF
20	Meheli Kanji	2019	CSIR-UGC NET JRF, WB SACT
21	Lipika Medda	2019	WB SACT, East Calcutta Girls College
22	Sulagna Dutta	2019	WB SET
23	Arka Mukherjee	2019	WB SET, NET-JRF, Researcher in ZSI, Kolkata
24	Deepshikha Saw	2020	CSIR-UGC NET JRF, Researcher in NIB Genomics
25	Md Sujaur Molla	2020	CSIR-UGC NET JRF
26	Priya Majumder	2021	CSIR-UGC NET LS, GATE
27	Ritika Sarkar	2022	CSIR-UGC NET JRF, GATE
28	Victor Banerjee	2022	CSIR NET JRF, WB SET, GATE
29	Srinjoy Das	2022	GATE, JRF ZSI, Kolkata
30	Anima Barman	2024	CSIR NET LS



Analysis of the Department and Future Plans

Our Strength:

- ✓ *Academic Autonomy*
- ✓ *Excellent Teaching-learning standard.*
- ✓ *Friendly atmosphere for learning.*
- ✓ *Principal Sir is from Zoology background and actively engaged in teaching.*
- ✓ *All the Professors are actively engaged in research work.*
- ✓ *Professors are very responsible and efficient in administrative work.*
- ✓ *Several Smart classrooms and dedicated special paper laboratory.*
- ✓ *Well-equipped laboratory with all the necessary instrument facilities.*
- ✓ *Rich and well-arranged Seminar Library and Specimen Museum.*
- ✓ *Good number of our passed out student regularly cracks NET and SET Examinations.*

Our Weakness:

- *Inadequate faculty members and non-teaching staff at the department.*

Opportunities:

- ✓ *NET and SET oriented Syllabus*
- ✓ *Mandatory PG Dissertation work is carried out.*
- ✓ *Guidance is provided for CSIR-UGC NET and SET*
- ✓ *Conducting Excursion to relate theoretical knowledge with practical life.*
- ✓ *Students actively participate in all departmental and college activities for their all-round development.*
- ✓ *Monitoring the progress of individual student throughout the course.*
- ✓ *Guidance for Career related query.*
- ✓ *Wi-Fi internet facility is available in the department.*

Future Plans

- ✓ *To initiate Ph.D. program at this Department.*



P.G. Syllabus

Bidhannagar College, Affiliated to West Bengal State University Department of Zoology

Draft Syllabus for Two Year Post Graduate Course of Zoology Under Choice Based Credit System (CBCS)

(With effect from the session 2021-2024)

The new syllabus for the M. Sc. Course in Zoology of Bidhannagar College would commence from July, 2021 (2021 – 2022 session). The following are the rules and regulations for the Two-year M. Sc. Course in Zoology.

1. The college is affiliated to West Bengal State University (W.B.S.U), Barasat, District North 24 Parganas, which would award the M. Sc. Degree.
2. A candidate who has passed the three year B.Sc. Examination with Zoology Honours from the W.B.S.U would be eligible to apply for admission to this course following the guidelines of the UGC and Govt. of West Bengal. A limited number of seats would be offered to eligible students of other Universities as per existing rules of the Dept. of Higher Education, Govt. of West Bengal.
3. The Post-Graduate Department of Zoology, Bidhannagar College exercises academic autonomy for the post-graduate courses. Under the system of academic autonomy, Board of Studies for Post-Graduate (PGBOS) studies in Zoology exists to provide necessary guidance in matters of syllabus formulation, appointment of examiners, publication of results and any other problem pertaining to the Post-graduate course in Zoology.
4. The Post-graduate course in Zoology would be conducted in English language only.
5. The duration of the course would be two academic years and the examination for the M.Sc. degree in Zoology would be held through four semesters over a total 1200 marks. The duration of the semesters would be as follows:

Semester - Odd	Semester - Even
Semester – I (July – December)	Semester – II (January – June)
Semester – III (July – December)	Semester – IV (January – June)

6. A candidate pursuing the M.Sc. course in Zoology would be considered eligible for appearing in the examination provided he /she prosecutes regular course of studies in Zoology maintaining the minimum



percentage of attendance in both theory and practical classes, as notified by the college / university time to time.

7. Course structure

The course shall comprise total marks of 1150 and credit of 92 distributed over the four semesters. The course shall be grouped as (a) core and (b) elective subjects and will carry credits according to the number of theoretical / practical classes required, study hours and laboratory hours etc.

Core subjects will be compulsory for all. For elective subjects each student has to opt for only one elective from the list of the courses offered in each of the Semester III and Semester IV.

- Options-Student will have to opt for 1 course in Semester III and Semester IV (1 theory paper in ZTE 303 and ZTE 402 and their corresponding practical papers in ZPE 403 and 404).

SEMESTER III	SEMESTER IV
ZTE 303 A: Genome Structure & Genomics B: Parasitology & Immunobiology C: Environmental Biology & Ecotoxicology	ZTE 402 : A: Advanced Genetic Analysis and Human Genetics B: Immunoparasitology C: Environment Management, Tools and Techniques.

Format of the Two-Year M.Sc. Course in Zoology

Semester		Paper Code	Subject	Paper Full Marks	Semester Full Marks	Credit	Semester Credit
Semester I (Odd)	Theory	ZT 101	Life Forms, Evolution and Taxonomy	50		4	
		ZT 102	Genetics, Molecular Biology and Immunology	50		4	
		ZT 103	Cell Biology & Developmental Biology	50		4	
	Practical	ZP 104	Lab Course: I	50		4	
		ZP 105	Lab Course: II	50		4	
		AECC	Industrial and Applied Biology	50		2	
TOTAL					300		22
Semester II (Even)	Theory	ZT 201	Biochemistry & Biophysics	50		4	
		ZT 202	Parasitology & Microbiology	50		4	
		ZT 203	Ecology & Quantitative Biology	50		4	
	Practical	ZP 204	Lab Course: III	50		4	
		ZP 205	Lab Course: IV	50		4	
		SEC	Histopathological and Diagnostic Techniques	50		2	
TOTAL					300		22
	Theory	ZT 301	Physiology, Endocrinology	50		4	



Semester wise distribution of total marks and credit

Semester III (Odd)		ZT 302	Animal Behaviour & Conservation Biology	50		4	
	Theory	ZTE 303	A: Genome Structure & Genomics	50		4	
			B: Parasitology & Immunobiology				
			C: Environmental Biology & Ecotoxicology				
	Practical	ZP 304	Lab Course: V	50		4	
ZP 305		Lab Course: VI	50		4		
	GEC	Ecosystem and Environmental Hazards	50		4		
TOTAL					300		24
Semester IV (Even)	Theory	ZT 401	Modern Techniques and Bioinformatics	50		4	
		ZTE 402	A: Advanced Genetic Analysis and Human Genetics	50		4	
			B: Immunoparasitology				
	C: Environment Management, Tools and Techniques						
	Practical	ZPE 403	Lab Course VII: A/B/C	50		4	
ZPE 404		Lab Course VIII : A/B/C	50		4		
	ZP 405	A: Project Work/ Review	50		4		
		B: Grand viva	30		2.5		
		C: Attendance (Sem I to Sem IV)	20		1.5		
TOTAL					300		24
TOTAL COURSE					1200		92

Semester IV	200	100	300	12	12	24
Grand Total			1200			92

Marks/Credit	Marks			CREDIT		
	Theory	Practical	Total	Theory	Practical	Total
Semester I	200	100	300	14	8	22
Semester II	200	100	300	14	8	22
Semester III	200	100	300	16	8	24



Question Pattern and Marks distribution

- A. Core Subjects** : **Compulsory for all.**
- B. Elective Subjects** : **Student will choose any one of the three Elective subjects being offered.**
- C. Choice Based Credit Course** : **Student will choose any one of the CBCCs being offered.**
- D. Division of Theoretical Marks**
- 1. Theoretical of 50 marks** : **40 (Theoretical) + 10 (Internal Assessment)**
40 (Theoretical) = 10 MCQ of 1 mark each + 6 questions of 5 marks each.
10 (Internal Assessment) = 10 MCQ of 1 mark each.
- E. Division of Practical Marks**
- 1. Practical of 50 marks** : **30 (Internal Assessment) + 20 (Viva-voce)**
- 2. Project Work/ Review of 50 marks** : **30 (Work) + Presentation (10) + Interaction (10)**
- F. Grand Viva** : **30**
- G. Attendance** : **20 (Semester I to Semester IV)**

Attendance requirement

No student shall be considered to have pursued a regular course of study unless he/she is certified by the Head of the Department of Zoology to have attended 75% of the total number of lectures and practical course conducted in each semester, during his/her course of study. Provided that he/she fulfils other conditions, the Head, Department of Zoology, may permit a student to the next Semester who falls short of the required percentage of attendance by not more than 10% of the lectures and practical course conducted during the Semester.

Gradation of students' performance

Marks 50 Credit 4	Marks 100 Credit 8	Grade Point Scale	Grades	Letter grade	CLASS
40-50	80-100	10	Outstanding	O	1ST
35-39	70-79	9	Excellent	A+	1ST
30-34	60-69	8	Very Good	A	1ST
28-29	55-59	7	Good	B+	1ST
25-27	50-54	6	Fair	B	2ND
23-24	45-49	5	Average	C	2ND
20-22	40-44	4	Poor	D	3RD
19 and less	39 and less	Below 4	Fail	F	



Grade Point Scale

It is a *Grade Point Scale* (GPS) ranging from 0 (zero) to 10 (ten) where the maximum attainable grade point is 10 and any grade point obtained below 4 represents fail. The values in the Grade Point scale would be representative of the range of percentage of marks obtained, Grade, Letter Grade and Class in a particular paper in a given Semester Examination as depicted in the Table above.

Credit Point

For a particular paper in a given semester, *Credit Point* is defined as the factor of Grade Scale point obtained (according to the percentage of marks obtained) and Maximum Credit Point allotted to the concerned paper.

Summation of Grade Point Average (SGPA)

For a particular semester, *Summation of Grade Point Average (SGPA)* is defined as the quotient of the summation of Credit Points Obtained (CPO) to summation of Maximum Credit Points (MCP) multiplied with Maximum Grade Point Scale.

i.e $SGPA = \Sigma (CPO/MCP) \times \text{Grade Point Scale (10)}$

Cumulative of Grade Point Average (CGPA)

For a particular semester, *Cumulative Grade Point Average (CGPA)* is defined as the average of the four SGPA obtained by a student in four semesters during the concerned academic session of the M.Sc. course of two years.

i.e. $CGPA = \Sigma (SGPA1 + SGPA2 + SGPA3 + SGPA 4) / 4$

N.B. 1 If a candidate obtains “*F*” *letter grade* in a particular paper, he/she would be deemed to have failed in that paper only. If the said candidate desires to continue the course he/she would be required to repeat that course in a supplementary examination in the next coming semester when offered. The candidate would have a maximum of two chances (excluding the first) to appear and qualify the examination in the said papers(s) in next two consecutive years. A candidate who still fails to pass the examination or remain absent in the examinations of the said papers(s) would be dropped from the rolls of the College.

N.B 2 A candidates might remain “*absent*” in not more than two papers in a semester. Such a candidate who has remained absent in one/two paper(s) may be allowed to continue in the following semesters, provided the candidate secures at least 40% marks in each of the rest of the papers in the last semester. However, the candidate would have to appear for the examination and qualify in the same paper(s) in the following year. Otherwise that candidate would have to repeat the entire semester in the next year. However, such a candidate would have a maximum of two chances (excluding the first) to qualify a semester in next two consecutive years. A candidate who still fails to qualify the semester or remain absent in the examinations of the said papers(s) would be dropped from the rolls of the College.

N.B 3 There would be no provision for supplementary examination in the same year for a given semester and a candidate who was absent in one/two paper(s) would have to wait for one academic year for clearing the same „absent“ paper(s) of the said semester.



SEMESTER I**Paper – ZT 101: Life Forms, Evolution and Taxonomy (Total Credit: 4)**

- 1. Trends in neural evolution in invertebrates:** Advancement of structure and function of ganglia in invertebrates.
- 2. Locomotion in invertebrates:** Foot modification in Mollusca and hydrostatic skeleton in Annelida.
- 3. Insect anatomy-** Basic structure, modification and function of body cover, head, mouthparts, thorax, wings and abdomen.
- 4. Insect physiology-** Basic structure, modification and function of digestive, circulatory, respiratory, excretory, and reproductive systems.
- 5. Basic vertebrate body design and characteristics:** Biological need, Size, shape, length, area and volume correlations, Allometric relation, Right size- advantages and disadvantages.
- 6. Lateral line sense organ and electroreception in fish:** Structural organization and functional characteristics of the lateral line system, vesicles of Savi and role of lateral line system in fish behavior.
- 7. Animal Taxonomy:** Classical and contemporary practices in animal taxonomy, Quantitative methods in animal taxonomy and Barcoding in taxonomy.
- 8. Molecular evolution:** Concepts of neutral evolution, molecular divergence and molecular clocks, Origin of new genes and proteins.
- 9. Population genetics:** Populations, gene pool, gene frequency, Hardy-Weinberg Law; concepts of natural selection and random genetic drift, adaptive radiation, convergent evolution, sexual selection and co-evolution.

Suggested Readings:

The Insects: Structure and Function by R. F. Chapman, Insect Physiology and Biochemistry by James L Nation, Sr., Evolutionary Biology by D. Futuyama, Principles of Systematic Zoology by Ernst Mayr, Principles and Techniques of Contemporary Taxonomy by Donald L. J. Quicke

Course Objectives:

“Nothing makes sense in biology except in the light of evolution”- Theodosius Dobzhansky. This oft-quoted and most agreed upon statement among scientists suggest that the theory of evolution is the scientific paradigm for biology and must be taught to every student of life sciences. This Evolution and Genetics part of the course is highly updated and tailor-made to make a PG student strong in the most fundamental aspect of biological sciences. The course is designed to prepare students with knowledge and skills of Taxonomy for exploring and assessing biodiversity and ecosystem health. There are emerging scopes of jobs as ecologists with good taxonomic knowledge in India and abroad.

Paper – ZT 102: Genetics, Molecular Biology & Immunology (Total Credit: 4)

- 1. Gene mapping methods:** Linkage maps, tetrad analysis, mapping with molecular markers and mapping by using somatic cell hybrids.
- 2. Human genetics:** Overview of human genome, structure & function, inheritance pattern, chromosomal abnormalities & genetic Disorders, Human Genome Project and evolution of human genes.
- 3. Microbial genetics:** Bacterial recombination, problems of bacterial gene mapping and viral replication.
- 4. DNA Replication:** Eukaryotic replication factors and machinery, extrachromosomal replicons.



5. **Transcription:** Transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport.
6. **Translation:** Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl-tRNA synthetase, and translational proofreading, translational inhibitors and post-translational modification of proteins.
7. **Control of gene expression at transcriptional and translational level:** Operon concept, role of chromatin in gene expression and gene silencing.
8. **Parasitic immunology:** Antigenic shift and drift, innate and adaptive response in parasitic infection.
9. **Autoimmunity:** Molecular mechanism, induced and spontaneous autoimmune diseases, organ specific autoimmune diseases, autoimmune diseases mediated by cellular damage, autoimmune diseases mediated by auto-antibodies, systemic autoimmune diseases and their treatment.
10. **Invertebrate immunology:** Toll like receptors, cellular and cytotoxic response of immune cell.

Suggested Readings:

Lehninger Principles of Biochemistry by David L. Nelson and Michael M. Cox, Molecular Cell Biology by Lodish et al., Molecular Biology of the Cell by Bruce Alberts et al., Kuby Immunology by Jenni Punt, Sharon Stranford, et al., iGenetics: A Molecular Approach by Peter J. Russell, Principles of Genetics by D. Peter Snustad and Michael J. Simmons, Molecular Biology by Robert Weaver.

Course Objectives:

The course aims to equip students with a basic knowledge of the structural and functional aspects of biological macromolecules, viz., DNA, RNA and proteins. After completion of the course, the students can apply this knowledge in their fields of research and higher education. The basic concepts on microbiology and antibiotics are needed for general information (useful for day-to-day life) and further advanced knowledge on the topic.

Paper – ZT 103: Cell Biology & Developmental Biology (Total Credit: 4)

1. **Cancer:** Oncogenes, proto-oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, therapeutic interventions of uncontrolled cell growth.
2. **Membrane Physiology:** Ion channels, active transport, membrane pumps; mechanism of sorting and regulation of intracellular transport; electrical properties of membranes.
3. **Cell communication:** Cell adhesion; extracellular matrix; signal transduction (electrical and chemical); Hematopoiesis.
4. **Basic concepts of development:** Potency, commitment, specification, determination and differentiation, morphogenetic gradients, genomic imprinting, cytoplasmic determinants and stem cells.
5. **Fertilization:** Structure of gametes, cell surface molecules in sperm-egg recognition in animals, molecular events of internal fertilization.
6. **Morphogenesis and organogenesis in animals:** Axes and pattern formation in *Drosophila*, organogenesis-vulva formation in *Caenorhabditiselegans* and development of vertebrate eye-lens and limb.
7. **Regeneration in animals:** Basic concept of morphallaxis and epimorphosis and type study of regeneration.
8. **Immunocontraception:** Basic concept, type, function, advantages and disadvantages.



9. Apoptosis and necrosis: Apoptosis vs. necrosis, intrinsic and extrinsic pathways of apoptosis, role of mitochondria in apoptosis.

10. Aging and Senescence: Cellular aging, replicative senescence, role of genetic and biochemical factors.

Suggested Readings:

Molecular Cell Biology by Lodish et al., Molecular Biology of the Cell by Bruce Alberts et al., Cell by G. M. Cooper, Developmental Biology by Scott F. Gilbert, Principles of Developmental Biology by Wilt and Hake, Principles of Development by Wolpert.

Course Objectives:

The cell is a powerful case study to help us explore the functional logic of living systems. All organisms are made up of cells. This course is designed to explore the fundamentals of cell biology. We hope learners will develop a deep intuition to understand the functional logic of a cell. To underscore the importance of cell biology in our lives, we will address questions of cellular disorders, and associated health implications in the human society. Developmental biology studies the mechanisms involved in growth and development of complex organisms. In many ways the basic understandings of developmental biology provide an invaluable foundation for other aspects of biology as well as medicine, especially as many health issues can be related back to early developmental defects during embryogenesis. This course aims to provide a broad, comprehensive look at embryology with special emphasis on vertebrate models, focusing on both classical experiments and modern molecular and genetic techniques.

Paper – ZP 104: Lab Course I (Total Credit: 4)

- 1. Mounting:** *Paramecium*, *Tubifex* and mouth parts of mosquito for identification of genera & sex.
- 2. Construction of phylogenetic tree from supplied data.**
- 3. Taxonomy:** Key preparation of insects
- 4. Cell adhesion and aggregation assay, cell viability assay (Trypan Blue method), fixation and staining of macrophage.**
- 5. Immunoblotting techniques.**

Course Objectives:

In Lab Course I students will be trained in practical and conceptual issues in taxonomy, biodiversity and evolutionary biology. It will provide methodological background and quantitative skills in morphological and molecular techniques of taxonomy and systematics. Hands-on training in immunology for better understanding and conducting future research in this area will be provided.

Paper – ZP 105: Lab Course II (Total Credit: 4)

- 1. DNA extraction and quantification (from goat liver / blood).**
- 2. Whole mount of chick embryo.**
- 3. Analysis of human karyotypes.**
- 4. Analysis and interpretation of genetic crosses with special reference to *Drosophila*.**
- 5. Analysis of human pedigree and construction of pedigree chart.**

Course Objectives:

Lab course II is intended to introduce students to standard biochemical techniques common in a molecular biology lab, such as DNA isolation etc. The course also will provide students with a hands-on understanding of how modern cell and molecular biology techniques can be used to discover and understand cellular function.



Ability Enhancement Compulsory Course (AECC-Industrial and Applied Biology) (Total Credit: 2)

- 1. Microbial fermentation and production of small and macro molecules:** Production of antibiotic, organic acid and restriction endonuclease.
- 2. Immunological techniques:** diagnostics, vaccines and hybridoma technology
- 3. Tissue and cell culture methods for animals:** overview
- 4. Transgenic animals:** microinjection and embryonic stem cell method, utility
- 5. Genomics and its application:** health and agriculture and gene therapy
- 6. Applied aquaculture:** Overview, objectives, types and their applications.
- 7. Bioremediation:** Overview, natural and managed bioremediation, types and examples
- 8. Biosensors:** types, mechanism & uses
- 9. Forensic entomology:** General entomology, insects of forensic importance, role of insects in forensic investigations, insect succession on carrion and its relationship to determine time since death, factor influencing insect succession, applications.

Suggested Reading:

Industrial Microbiology by G. Reed, Introduction to Applied and Industrial Microbiology by Aryadeep Roy Choudhury, A handbook of Practical and Clinical Immunology by Talwar and Gupta, Kuby Immunology by Punt, Stranford, et al., Biodegradation and Bioremediation by Martin Alexander, Forensic Entomology: An Introduction by Dorothy Gennard.

Course Objectives:

To integrate scientific and technological knowledge on the use of biological processes for industrial products at the cell and process level enable students to carry out research / investigation to solve practical problems associated with society and industrial applications independently.

SEMESTER II**Paper – ZT 201: Biochemistry & Biophysics (Total Credit: 4)**

- 1. Principles of biophysical chemistry and related calculations:** Chemical foundations, Bond, valency and interactions, Polarity of water molecule, laws of Thermodynamics, free energy, concept of solution, molarity, molality and related calculations and colligative properties.
- 2. Proteins:** Primary structure, Ramachandran plot, secondary structure, tertiary structure, and structure-function relationship of protein and folding of protein.
- 3. Enzymes:** Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis and isozymes.
- 4. Nucleic acids:** Structure and functions.
- 5. Metabolism of carbohydrates:** Carbohydrate catabolism: glycolysis, Krebs's cycle, electron transport chain, glycogenolysis; carbohydrate anabolism: gluconeogenesis, pentose phosphate pathway and glycogenesis.



6. **Metabolism of lipids and nucleotides:** Fatty acid biosynthesis, cholesterol biosynthesis, lipoprotein, oxidation; nucleic acid biosynthesis and catabolism and their interconversions.
7. **Microscopy:** Basic principles of light and electron microscopy, phase contrast microscopy, fluorescence microscopy, confocal microscopy, TEM, SEM, sample preparation for electron microscopy, new advancements in microscopy
8. **Centrifugation:** Svedberg coefficient and its determination, differential centrifugation
9. **Chromatography:** Principles and applications of gel-filtration, affinity, ion exchange, thin-layer, GC and HPLC
10. **Electrophoresis:** Principles and applications of paper, thin-layer, cellulose acetate, capillary, immuno- and 2D- gel electrophoresis, isotachopheresis, isoelectric focusing, PAGE and PFGE.
11. **Spectrometry:** UV/visible, fluorescence, CD, NMR and ESR spectroscopy molecular analysis using light scattering, mass spectrometry and surface plasma resonance.

Suggested Readings

Lehninger Principles of Biochemistry by Nelson and Cox, Voet, D., Fundamentals of Biochemistry: Life at the Molecular Level by Voet and Voet, Biochemistry by Berg, Tymoczko et al., Principles and techniques of Biochemistry and Molecular biology by Wilson and Walker.

Course Objectives

Identify different classes of biomolecules and structures, explain fundamental relationships between their structure and function and describe the principal organisation of prokaryotic and eukaryotic cells. Understanding Biochemistry enables students to understanding the central theme of life and its associated mechanisms. This stream is the bridge between the physical science and its application in biological processes. Students can intermingle with the different streams of science to create unison of understanding of any topic of biology.

Paper – ZT 202: Parasitology & Microbiology (Total Credit: 4)

1. **Understanding of the evolution of parasitic associations:** Evolution of parasitic protozoa and helminth.
2. **Emerging parasitic diseases:** Toxoplasmosis and Echinococcosis
3. **Parasite as bioindicator:** Effect indicator, accumulation indicator and sentinel organism.
4. **Parasitic habitats:** Parasitic habitat and environment, significant parasitic habitat and physicochemical characteristics of parasitic habitat.
5. **Structure and organization of bacteria and virus:** General characteristics, structural components and their functions and arrangement of the bacterial cell and virus.
6. **Microbial physiology:** Growth, yield and characteristics, strategies of cell division and stress response.
7. **Bacterial chemotaxis and quorum sensing:** In Gram positive and Gram negative bacteria.
8. **Antimicrobial therapy:** Antimicrobial drugs, mechanism of action and drug sensitivity test.

Suggested Readings:

Foundation of Parasitology by John Janovy and Larry Roberts, General Parasitology by Thomas Cheng, Microbiology by Tortora et al., Microbiology by Nester et al.

Course Objectives:



The course examines the general biology, life cycles, modes of transmission, and pathogenesis of major parasites on global human health. It will enable students to explore a number of important diseases, along with the diverse protozoans, worms, and arthropods responsible for them. The course will enable students to explore a number of important diseases, along with the diverse protozoans, worms, and arthropods responsible for them. Another portion of the course has been prepared to help understand the ability of our immune system to defend against invading pathogens or parasites in a logical fashion.

Paper – ZT 203: Ecology & Quantitative Biology (Total Credit: 4)

- 1. Concept of metapopulation:** Brief idea, island-biogeography model and factors regulating metapopulation.
- 2. Biodegradation:** Overview, requirements, factors, mechanism and environmental degradation of oil spill, plastic and pesticide.
- 3. Management of natural resources with reference to wildlife:** Conservation and community reserves, protected animals and plants, threats to conservation: Global and Indian perspectives
- 4. Measures of central tendency and dispersal:** Calculation of mean, median, mode, range, variance and standard deviation.
- 5. Linear Regression and Simple Correlation.**
- 6. Probability and Probability distributions:** Binomial, Poisson and Normal
- 7. Chi-square Test of Independence and Goodness of Fit Comparison of Means for one Sample and Two Samples (Z and t-tests).**
- 8. Analysis of variance:** One-way and two-way, multiple comparison tests.

Suggested Readings:

A Primer of Ecology by Gotelli; Ecology by Charles Krebs, Biostatistics by Zar

Course Objectives:

The Ecology section of the course is designed to help students in understanding the ecological dynamics in endangered ecosystems. Conservation biology part would make them capable to participate in conservation activities as professionals or volunteers. This course is designed to prepare the students to be ready for such professions. Quantitative biology section of the course has been designed to remove the alleged traditional fears of biology students in numerical methods of science. The topics included are expected to help the students in designing experiments or surveys, scientific data collection and management, finally in statistical interpretations from the data, the skills demanded in so many types of professions including research.

Paper – ZP 204: Lab Course III (Total Credit: 4)

- 1. Enzyme kinetics: Kinetic analysis of acid/alkaline phosphatase.**
- 2. Extraction and estimation of total protein from tissue/serum.**
- 3. TLC of amino acids / Lipids**
- 4. Histochemical reactions for carbohydrates, protein, lipid, DNA/RNA and alkaline phosphatases.**
- 5. Fixatives- Chemical composition, applications, Composition and procedure of H-E and Mallory's triple staining, techniques Identification of stained tissue sections.**

Course Objectives:

Lab Course III is intended to familiarize students with basic biochemical techniques to plan and carry out experiments. In addition, the course will also provide students with knowledge of histochemical techniques.



Paper – ZP 205: Lab Course IV (Total Credit: 4)

1. **Qualitative and Quantitative estimation of soil and aquatic microarthropods.**
2. **Field study for management practices in any PA or local community resource.**
3. **Water quality parameter analyses in the field.**
4. **Documentation and identification of local biodiversity:** Documentation and identification of local avi-
/entomo-/ichthyo-/herpeto-fauna
5. **Field study to quantify populations, community parameters in the field.**

Course Objectives:

Lab Course IV will provide an understanding of fundamentals of tropical ecology, including key habitat features, biodiversity, ecological processes and biotic interactions. The course will provide first-hand experience of ecological research in the tropics, through group exercises and field visits.

SEC: Histopathological and Diagnostic Techniques (Total Credit: 2)

1. **Histochemistry:** Principles and applications.
2. **Histochemical identification from processed tissue section.**
3. **Immunohistochemistry:** Principles and applications
4. **Study on Histopathology and preparation of Biopsy report of selected tissue samples.**
5. **Special staining techniques.**
6. **Complete blood count (CBC) test:** Requirement of this test, information received from the test.
7. **Blood test for Infections:**Widal, NS-1 antigen, antigenic dipstick test and CRP
8. **Estimation of Blood glucose, cholesterol and triglyceride:** Glucose estimation- Asatoor and King, ortho-Toluidine, GOD-POD, glucose tolerance test; cholesterol and triglyceride- enzymatic methods
9. **Liver function test (LFT):** Test for excretory functions (serum bilirubin, bile pigments, urobilinogen and bile salts), synthetic functions (A/G ratio, PT, Alpha- fetoprotein) and liver enzymes (ALT, AST, ALP, GGT)
10. **Urine test:** RE, test for sensitivity and ACR

Suggested Reading:

Junqueira's Basic Histology by Mescher and Junqueira, Diagnostic Pathology by Vasef and Auerbach, Textbook of Pathology by Harsh Mohan, Robbins and Cotran, Pathologic basis of disease by Vinay Kumar, Abul K. Abbas, Jon C. Aster.

Course Objectives and Scope of Employability:

The skill gained through this course in histopathology will introduce students to microscopic features of tissues and organs, giving them the opportunity to compare and contrast the normal with the abnormal in various disease states. Laboratory tests play an important role in clinical diagnosis, and the results often direct patient management. Tests should be requested appropriately in order to refine the differential diagnosis, and it is important to understand the theoretical basis of such tests and to be able to interpret their findings. Students will use logical and systematic thinking to solve problems with this diagnostic technique and procedure. This course will give students an edge to pursue career in various histopathological laboratories, diagnostic centers or paramedical institutions.



SEMESTER III**Paper – ZT 301: Physiology and Endocrinology (Total Credit: 4)**

- 1. Animal Homeostasis:** General concept, electrolyte balance and acid-base balance, Thermoregulation-comfort zone, body temperature– physical, chemical, neural regulation and acclimatization.
- 2. Stress physiology:** Basic concepts of stress and homeostasis, physiology of oxygen deficiency and toxicity.
- 3. Cardio-vascular physiology:** Conducting system, cardiac cycle, cardiac output, ECG and haemodynamics of blood flow.
- 4. Sensory systems:** Characteristics of sensory receptors, cutaneous sensations, taste and smell vestibular apparatus and equilibrium, hearing, the eyes and visions.
- 5. Mechanisms of Hormone Action:** Characteristic features, different types of classification, group I and II hormones, types, structure and biosynthesis of receptors, HRE and eicosanoids.
- 6. Hormone in metamorphosis and development:** Metamorphosis in insects and amphibians and the role of different hormones.
- 7. Hormones and diseases:** Mechanisms of hormonal alterations, consequences of insufficient and deficient hormonal action and major manifestations of hormonal dysfunctions.
- 8. Neuro-endocrine physiology:** Synaptic vesicles, docking, synaptic integration, acetylcholine, histamine and dopamine as neurotransmitter, neuroendocrine integration, neural control of muscle tone and posture.
- 9. Brainphysiology:** Neural basis of learning, memory, cognition, sleep and arousal.

Suggested Books:

Essentials of Human Anatomy and Physiology by Elaine N Marieb, Medical Physiology by Guyton and Hall, Animal Physiology by Schmidt Nielsen, Endocrinology by Williams, Molecular Endocrinology by Franklyn Bolander, Greenspan's Endocrinology, Endocrinology by Hadley, Neurobiology by Shepherd.

Course Objectives:

The basic "Physiology & Endocrinology" is a powerful study to help the students to explore the functional logic of living systems. All organisms are made up of cells & systems. This course is designed to explore the fundamentals of body structure & its function. We hope learners will develop a deep intuition to understand the functional logic of a basic anatomy & physiology. To underscore the importance of physiology in our lives, we will address anatomy of our body parts, physiological function and disorders endocrinological system associated with health implications in the human society.

Paper – ZT 302: Animal Behaviour and Conservation Biology (Total Credit: 4)

- 1. Social organization:** Levels of social organization, eusociality- advantages and disadvantages, evolution, kin selection, altruism and Hamilton's Rule-Relatedness.
- 2. Chronobiology:** Biological clock and its different attributes, circadian rhythm, role of pineal gland in regulating circadian rhythm, different other types of biological rhythms.
- 3. Foraging:** Optimality theory of foraging, prey and patch model, theory of economic defendibility.
- 4. Communication:** Channels of communication, types of signals, purpose of communication, vocalization in birds- calls and songs, different types of calls, development of song in birds, neuroendocrine basis of song development.



5. **Cooperation, territoriality and aggression:** Cooperation and reciprocity, territorial structure, optimal territory size, kin recognition and selection, mutualism, manipulation, aggression and deterrence.
6. **Concept of Biodiversity:** Introduction, values, megadiversity nations, hotspots, threats and conservation.
7. **Wild life conservation:** Protected Areas, threatened plants and animals, causes of threats, management of conservation.
8. **Man-Wildlife conflicts and development versus conservation.**
9. **International and national conservation authorities and legislations:** Concepts, nature of action, laws and legislative bodies, National and International authorities/organisations, local NGOs and trusts.
10. **Indian case studies on conservation / management strategy.**

Suggested Reading:

Animal Behaviour by Lee Dugatkin, Conservation Biology: A Primer for South Asia by Bawa, Primack and Oommen; Univ. Press. Kolkata

Course Objectives:

Studies of animal behaviors brought one of the only two Nobles for Zoology so far. Emerging fast from its psychological capsules, since then, study of animal behaviors in evolutionary approach has become one of the most attractive fields in biology. In a country of high biodiversity like India, students can flourish in research careers in this low-cost demanding field much more easily than any high cost equip dependent fields of biology. The course is hence designed and offered.

Paper – ZT 303: A: Genome Structure & Genomics (Total Credit: 4)

1. **Genome structure:** Classes of DNA, chromosomal proteins- histones and their modifications, non-histone proteins, scaffold/matrix proteins, levels of chromatin condensation at interphase and metaphase stages, metaphase chromosome bandings; giant chromosomes- models for studies on chromosome organization and gene expression.
2. **Recombination and Repair:** DNA repair failure and human diseases, DNA repair mechanisms, Holliday's model and RecBCD complex.
3. **Mutagenesis:** Site directed mutagenesis, gap-duplex method, PCR in detection of mutagenesis.
4. **Mendelian Genetics:** Laws of Probability and Mendel's experiments, Mendel's reappraisals.
5. **Quantitative genetics:** Polygenic inheritance, heritability and its measurements, QTL mapping.
6. **Gene Expression Techniques:** Expression of recombinant proteins using bacterial, animal and plant vectors.
7. **Genome Editing:** Gene therapy, knockout technique, base editing, meganuclease, TALEN, ZFN, CRISPR cas9
8. **Genomics:** Overview, whole genome sequencing, subfields of genomics, correlated genetic, cytological and physical maps of chromosomes and RFLP.

Suggested Readings:

Molecular Cell Biology Lodish et al., Molecular Biology of the Cell by Alberts et al., iGenetics: A molecular approach by P.J. Russell

Course Objectives:

The course aims to equip students with a basic knowledge of the structural and functional aspects of biological macromolecules, viz., DNA, RNA and proteins. After completion of the course, the students can apply this knowledge in their fields of research and higher education.

Paper – ZT 303: B: Parasitology & Immunobiology (Total Credit: 4)

- 1. Understanding of the modifications (physiological, morphological, and behavioral) needed to assume a parasitic lifestyle.**
- 2. Classification of major parasitic taxa:** Classification of subkingdom Protozoa, classification of phylum Platyhelminthes and phylum Aschelminthes (upto class).
- 3. Study of life cycle pattern and biology of important parasites:** Life cycle pattern of protozoan parasite and life cycle pattern of helminthic parasite.
- 4. Parasitic metabolism:** Carbohydrate metabolism in protozoa and amino acid metabolism in helminthes.
- 5. Zoonosis:** Definition and types of zoonosis, examples of common zoonotic diseases, significance of zoonosis
- 6. Myiasis:** Obligatory and facultative myiasis, types of myiasis, family of flies involved in myiasis and maggot therapy
- 7. Parasites as Bio-indicator:** Effect indicator, accumulation indicator and sentinel organism.
- 8. Epidemiology:** Classification, epidemiology of malaria, kalaazar and filariasis.

Suggested Readings:

Foundation of Parasitology by John Janovy & Larry Roberts, Parasitology by KD Chatterjee

Course Objectives:

The course examines the general biology, life cycles, modes of transmission, and pathogenesis of major parasites on global human health. It will enable students to explore a number of important diseases, along with the diverse protozoans, worms, and arthropods responsible for them. The course will enable students to explore a number of important diseases, along with the diverse protozoans, worms, and arthropods responsible for them.

Paper – ZT 303: C: Environmental Biology & Ecotoxicology (Total Credit: 4)

- 1. Ecosystem Ecology and Biogeography:** Ecosystem structure, ecosystem function, energy flow and mineral cycling (C, N, P), primary production and decomposition, structure and function of some Indian ecosystems, terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine). Biogeography- Major terrestrial biomes; theory of island biogeography, biogeographical zones of India.
- 2. Restoration Ecology:** Overview of ecosystem degradation, rehabilitation, reclamation, mitigation, replacement, reference ecosystem and restoration; Strategies of restoration; Case studies on forest and aquatic ecosystems.
- 3. Semiochemistry:** Plant-animal interaction in the natural environment.
- 4. Major anthropogenic Global environmental problems:** Acid rain, global warming and climate change, smog, ozone depletion, eutrophication, natural calamities and light pollution.
- 5. Toxin and toxicity:** Introduction, classification of toxicants, toxicokinetics, toxicodynamics and biotransformation, toxicity tests, application of toxicology.
- 6. Venoms:** Components of Snake venom, Bee venom and spider venom – their pathogenicity and mechanisms. Medicinal uses of venom.
- 7. Xenobiotics:** Overview, types and effects of endocrine disruptors, biomedical wastes and radioactive materials.



8. **Determination of xenobiotic accumulation:** Overview, bioaccumulation, bioconcentration, biomagnification and their determination, factors affecting biomagnification, case studies
9. **Concept of safe level concentration:** Basic concept of MATC, threshold limit, NOAEL, LOAEL, safety, risk and ADI
10. **Pesticides and Heavy metals:** Overview, types, route of contamination, mode of action, effect on organisms.

Suggested Readings:

A Primer of Ecology by Gotelli; Ecology by Charles Krebs, Environmental Biology and Toxicology by P. D. Sharma, Environmental Biology (Principles Of Ecology) by Verma and Agarwal

Course Objectives:

This section of the course is designed to help students in understanding the ecological and effect of xenobiotics on the ecosystem.

Paper – ZP 304: Lab Course V (Total Credit: 4)

1. **Determination of activity of amylase from ectothermic and endothermic organisms**
2. **T.C., D.C., Arneith count and Blood groups.**
3. **Processing and double staining of different stages of estrous cycle of rats.**
4. **Identification of endocrine gland sections**
5. **Estimation of acetylcholinesterase in animal model.**

Course Objectives:

Lab course V will provide a thorough understanding of the concept of homeostasis in humans by studying vital physiological parameters.

Paper – ZP 305: Lab Course VI (Total Credit: 4)

1. **Study of nitrogenous waste products of animals from different habitats.**
2. **Study of facial expression and other behaviors in humans/animals.**
3. **Study of aggressive behavior in Ant/Fish.**
4. **Study of feeding and nesting behavior in birds/butterflies.**
5. **Field study of wild animals through dung, pug and hoof marks.**

Course Objectives:

The animal behavior practical course will provide valuable skills to equip students for work in a wide range of fields relating to animal behavior which is vital for wider habitat conservation and handling zoo animals.

GEC: Ecosystem and Environmental Hazards (Total Credit: 4)

1. **Biodiversity:** Different levels and aspects.
2. **Biodiversity usages.**
3. **Threats to biodiversity and Consequences of Biodiversity loss.**
4. **Biodiversity regulations:** Global treaties, Indian acts and laws, biodiversity authority and State boards.
5. **Concept of Ecosystem.**
6. **Major Indian Ecosystem.**
7. **Study of Resources in water, forests and Soil.**



8. Ecosystem services-concepts and examples.
9. Environmental movements in India relating to forests and other ecosystem
10. Conservation policies and laws in India.
11. Environmental Stressors: Chemicals, radiations, noise and chemical change.
12. Response to Environmental Stress: Health and cellular impact of environmental stress, endocrine response to stress, stress and adaptation, altered cellular signaling.

Suggested Readings:

Understanding Environmental Health: How We Live in the World: by Nancy Irwin Maxwell, Environmental Hazards by Keith Smith, Monitoring for Health Hazards at Work by John Cherrie, Sean Semple, et al., Conservation Biology: A Primer for South Asia by Bawa, Primack and Oommen.

Course objectives:

There is very little scope to argue against the claim that the entire life on earth is now highly endangered due to extreme loss of biodiversity and degradation of natural ecosystems. Thus, this course is offered to make all graduate students aware and sensitized well regarding this survival issue, irrespective of their academic specializations. The course content would make a student enriched with basic knowledge regarding the roles of biodiversity and ecosystem services in sustaining humans and other lives on earth and information on how both are threatened by irresponsible human activities. Upon completion of the course the students will understand the major concepts of environmental science, Identify how toxic chemicals used for many purposes are affecting ecosystem and human health and apply the scientific method and quantitative techniques to describe, monitor and understand environmental systems.

SEMESTER IV

Paper – ZT 401: Modern Techniques and Bioinformatics (Total Credit: 4)

1. **DNA microarray.**
2. **Proteomics:** Goals of proteome, genomics to proteomics, key questions that proteomics can answer, techniques and applications.
3. **Flow cytometry and FACS:** Principles and applications.
4. **Blotting techniques:** Principle, procedure and applications of Northern, Southern and Western blotting.
5. **Cloning and recombinant DNA technology:** Isolation of DNA, restriction endonuclease, vector, DNA transfer, screening of recombinant, genomic and cDNA library.
6. **Introduction to computers and bioinformatics:** Overview of computers and different storage systems, introduction to internet, basics of bioinformatics, basic idea on database system, brief description of different bioinformatics software and web tools.
7. **Biological databases:** Structure, types and utility.
8. **Sequence alignment.**
9. **Phylogenetic analysis.**
10. **Structure predictions for Nucleic acids and proteins:** Basic concept.



Suggested Readings:

Lehninger Principles of Biochemistry by Nelson and Cox, Principles of Biochemistry by Voet and Voet, Biochemistry by Berg, Tymoczko and Stryer.

Course objectives:

The aim of the course is to bridge between the physical science and its application in biological processes. Students can intermingle with the different streams of science to create unison of understanding of any topic of biology.

Paper – ZT 402 A: Advanced Genetic Analysis and Human Genetics (Total Credit: 4)

1. **Immunogenetics:** Generation of antigenic diversity, MHC haplotype and cytokine genes.
2. **Developmental genetics:** Antero-Posterior and Dorso-ventral axis formation. Maternal & Zygotic gene-function and regulation, Homeotic selector genes.
3. **Conservation genetics:** Overview, population, sampling & probability, demography, variations, heritability and estimating quantitative genetic diversity.
4. **Patterns of inheritance in man:** Autosomal and recessive pattern of inheritance.
5. **Common Genetic diseases:** Types of genetic diseases, Cystic fibrosis, Duchene muscular dystrophy, Fragile X Syndrome, chromosomal abnormalities, mitochondrial genetic inheritance.
6. **Detection and mapping of human disease genes:** Overview
7. **Genetic Counseling and prenatal diagnosis:** Overview, testing methods for genetic abnormalities.
8. **Treatment of genetic diseases:** Overview and possibilities.

Suggested Readings:

Genetics: A Conceptual Approach by Benjamin A. Pierce, Concepts of Genetics by Klug, Cummings, Genetics: Analysis and Principles by Robert Brooker.

Course Objectives:

After completion of the course on advance genetic analysis, the students can apply this knowledge in their fields of research and higher education.

Paper – ZT 402 B: Immunoparasitology (Total Credit: 4)

1. **Cells and molecules of immune system:** Overview of innate defense, first line defenses, the cells of the immune system, phagocytosis, inflammations, chemokines, CSFs, IFNs, ILs, TNFs and fever.
2. **Immunity at mucosal surfaces, generation of lymphocyte antigen receptors, immunoglobulin gene rearrangement, generation of antibody diversity, synthesis, assembly, secretion of immunoglobulins.**
3. **Antigen-antibody interaction:** Characteristics of antigen-antibody interaction, affinity and avidity, cross-reactivity, types of antigen-antibody reaction- precipitation, agglutination, opsonization, complement fixation, diagnostic procedures- different types of immunodiffusion techniques, IFA, RIA and ELISA.
4. **Molecular basis of antigenic variation and diversity in parasites:** Influenza, Tuberculosis, Malaria, Trypanosomiasis, Filariasis.
5. **Probe technology for parasitic diagnosis.**
6. **Immunization:** Principles of immunization and vaccination, Types of vaccines, Scheme of immunization, Cold chain system, new developments in vaccination strategies.
7. **The pattern of monocyte subpopulations in health and diseases.**



8. Natural Killer cells: Development, maturation, and clinical utilization.

Suggested Readings:

Immunology by Kuby, Roitt's Essential Immunology by Peter J Delves, Cellular and Molecular Immunology by Abbas, Lichtman & Pillai, Elements of Immunology by Khan etc.

Course Objectives:

The course aims to equip students with a basic knowledge of the structural and functional aspects of biological macromolecules, viz., DNA, RNA and proteins. After completion of the course, the students can apply this knowledge in their fields of research and higher education. Basic concepts on microbiology and antibiotics for general information (useful for day-to-day life) and further advanced knowledge on the topic.

Paper – ZT 402 C: Environment Management, Tools and Techniques (Total Credit: 4)

- 1. Environmental Management:** Environment Management System and Environment Management Plan
- 2. Environmental Quality Monitoring:** Air, Water and Noise Monitoring
- 3. Renewable Energy Resources:** Types of renewable energy, Advantages and disadvantages, Hydrogen as fuel of future.
- 4. Biology of Stem cells and environmental implication:** Zoo bank and cryopreservation
- 5. Analytical toxicology:** Analytical toxicology- Immunohistochemistry, FACS, fluorescence microscopy
- 6. Nutritional toxicology:** Overview
- 7. Genotoxicology:** Concept and assessment of biochemical, immunological and genotoxicological parameters
- 8. Remote Sensing and GIS:** Basics of Remote Sensing & GIS, GPS, Application of RS & GIS in environmental management
- 9. Environmental economics:** Cost-benefit analysis, polluters pay principle, environmental accounting

Suggested Readings:

Environment Management by Pandey.

Course Objectives:

The elective course of Environment Management is designed for those PG students who aspire to become a professional in the emerging field of Environment Management, as a manager or environment analyst.

Paper – ZPE 403 A: Lab Course VII (Total Credit: 4)

- 1. Chromosome preparations:** *Drosophila* / *Chironomus* polytene chromosomes.
- 2. Extraction of DNA from animal tissue (liver) /blood.**
- 3. Isolation of plasmid DNA : Miniprep**
- 4. Agarose gel electrophoresis for plasmid, genomic DNA.**
- 5. Separation of protein from animal tissue on native and /denaturation gel (PAGE) and western blotting.**

Course Objectives:

The course aims to provide students with the necessary training to enable them to understand the principles that underpin genetic research, and to translate that understanding into good research practice.

Paper – ZPE 403 B: Lab Course VII (Total Credit: 4)

- 1. Fixation, staining and identification of parasites of annelids and insects.**



2. **Parasites of fishes and birds: ectoparasites and blood parasites.**
3. **Recovery of larval stages of helminths and their staining.**
4. **Study of faecal smear and intestinal parasites of fowl and cattle.**
5. **Identification of parasites (prepared slides):** *Trypanosoma*, *Leishmania*, *Nyctotherus*, *Balantidium*, *Monocystis*, *Stomatophora*, *Entamoebahistolytica*, *Giardia*, *Opalina*, *Gregarina*, *Eimeria*, *Haemoproteus*, *Plasmodium vivax*, *Plasmodium falciparum*, *Myxobolus*, *Fasciola*, *Paramphistomum*, *Echinococcus*, *Taeniasolium*, *Raillietina*, *Ascaris*, *Wuchereria*, *Argulus*, *Phthirus*, *Cimex*, *Xenopsylla*, *Ctenocephalid*, Mosquito adult and larva (*Anopheles*, *Culex*, *Aedes*), Tick, Mite.

Course Objectives:

The course aims to provide students with the necessary training to enable them to understand the staining procedure and identification and localization of parasites.

Paper – ZPE 403 C: Lab Course VII (Total Credit: 4)

1. **Bioassay Test: Toxicity Evaluation of Heavy Metals/Pesticides using aquatic organisms.**
2. **Determination of Hepatosomatic and Gonadosomatic Index.**
3. **Identification of Crustaceans, insects, snails, fish from fresh water / lake / pond.**
4. **Physico-chemical analysis of Water:** Determination of pH, temperature, dissolved oxygen, free CO₂, alkalinity, hardness BOD, turbidity, Nitrites and Phosphates, salinity using conductivity meter.

Course Objectives:

The course aims to provide students with the necessary training on analysis of water, soil quality parameters.

Paper – ZPE 404 A: Lab Course VIII (Total Credit: 4)

1. **Human karyotyping:** Study of chromosomal aberrations with respect to number, translocation, deletion etc. from the pictures provided.
2. **Pedigree analysis.**
3. **Identification and staining of Barr body.**
4. **Case studies: Genetic counseling.**
5. **Institute visit.**

Course Objectives:

The course will provide students with the knowledge and training needed to approach and formulate scientific questions relevant to the advance genetic study.. The course will also survey the frontiers of genetic research and aims to make the students acquainted with to the applied advanced methods, technologies.

Paper – ZPE 404 B: Lab Course VIII (Total Credit: 4)

1. **Collection of antiserum and preparation of cell suspension from lymphoid organs, staining and identification of cell types.**
2. **Common tests of antigen-antibody reaction:** Analysis of blood group, immunodiffusion, demonstration of ELISA.
3. **Gram staining of bacteria.**



4. **Identification of lymphoid tissue:** Spleen, thymus, lymph node, Bursa of Fabricious, *In situ* localization of immune gland.
5. **Institute visit.**

Course Objectives:

The course will provide students with the knowledge and training of immunobiological techniques.

Paper – ZPE 404 C: Lab Course VIII (Total Credit: 4)

1. **Estimation of blood glucose and total serum protein concentrations of fish on exposure to a toxicant.**
2. **Testing of viability of cells exposed to toxins.**
3. **Isolation and identification of soil micro-arthropods.**
4. **Determination of pH and organic carbon from soil.**
5. **Field work/ study tour:** Visit to National Institute/Centre of Aquaculture/Fish Farm/ National Parks/Sanctuary and Preparation of Nature's Diary.

Course Objectives:

The course will provide students with the knowledge and training on parameters related to xenobiotic induced stress in animal model.

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