M. Sc. ZOOLOGY SYLLABUS

Course Structure under

Choice Based Credit System (CBCS)

Semester Pattern Examination
(As per UGC model curriculum)
For academic session: 2023-24

FAKIR MOHAN UNIVERSITY
VYASA VIHAR, NUAPADHI, BALASORE, ODISHA-756089

Web site- www.fmuniversity.nic.in
Email Id- zoologyfmu@gmail.com

P. G. DEPT. OF ZOOLOGY FM UNIVERSITY

Department Overview:

The department of Zoology is a unique department in the University where multidisciplinary and interdisciplinary teaching and research in Zoology have established permanent roots. It is a diverse discipline that covers all branches of Zoological aspect in a dominant manner. This department started from the inception of the Institution in 2018. This serves as a valuable foundation to many students for understanding cellular and molecular level organization in living beings. The uniqueness of the department essentially lies in the fact that within its faculty there are experts and active researchers representing almost all areas of modern biology. This University situated on coastal belt of Odisha so this department focuses on diversity of chordates and non-chordates on the basis of morphology and cellular way in animal. Particularly, we focus on species diversity of marine and freshwater animal like fish and marine animals etc. We also aim at the rapid collection of marine animal for establish a zoological museum in this laboratory.

Mission Statement:

- To uphold the core values of the university and to build up a Zoological Science Community, for the betterment of humanity with their knowledge, ethics and entrepreneurship.
- Provide inexpensive educational services, inspire to all the section of society to get expertise /skills at P.G. and above level in biological sciences.
- To develop research aptitude and a scientific advancement.
- Inculcate high values through a liberal education and also to provide platform to have non-formal educational services.
- To bring about an awareness regarding nature and biodiversity and help to solve different problems to establish sound and peaceful environment and life for community and society.
- Provide a broad range of Transform society through the empowerment of youth.
- Reinvent ourselves in response to the changing demands of society with high moral values as a good citizen.

Introduction to Program:

This program is one of the most fundamental units of basic sciences studied at Postgraduate level. The program helps to develop scientific tempers and attitudes, which in turn can prove to be beneficial for the society since the scientific developments can make a nation or society to grow at a rapid pace. After studying this program, students will be more equipped to learn and know about different biological systems, their coordination and control as well as evolution, behavior and biological roles of the animals in the ecosystem. Moreover, they will be able to qualitatively and quantitatively analyses evolutionary parameters using various bioinformatics and computational tools used in modern sciences. This will provide them ample opportunities to explore different career avenues.

Program Objective:

Programme objectives

- To encourage a clear, comprehensive and advanced knowledge in the field of animal sciences.
- To provide basic principles of biological sciences with special reference to Zoology and its applied branches
- To enable the students to explore the intricacies of life forms at cellular, molecular and nano-level.
- To sustain students' motivation and enthusiasm and to help them not only to appreciate the beauty of different life forms but also to inspire them in the dissemination of the concept of biodiversity conservation.
- To make the students equipped with the changing scenario opening up new avenues for them in the field of plant sciences and make them entrepreneurs.
- To develop problem solving skills in students and encourage them to carry out innovative research projects thereby enkindling in them the spirit of knowledge creation

Program Outcomes

- Students will be able to understand Nature, environment natural resources and their conservation, Classification & ethology of different animals, Human genetics, cell biology and Evolution.
- Students can Apply the wide range of subject based skills to various fields that provide a base for future career in disciplines such as Health Sciences, Publishing, Teaching and Research.
- Able to distinguish between the Structure, Function, Behaviour and evolution of different animals.
- Students will Perform, Assess and implement practical techniques and procedure to solve biological problems and analyses and quantify data collected during any project.
- Students will understand the applications of Biological techniques to various fields of biology

Programme specific outcome

Animal science is a combination of basic and applied science. Conventional studies have been supplemented with knowledge on molecular techniques. The course has been designed to advantage students to study on various aspects of zoology along with its practical applications. After studying this subject course students can take up teaching at different levels, research work in various institutes and organisation, doctoral work, environment impact study, biodiversity assessment, entrepreneurship, scientific writing relevant to current topic.

Outcome 1	Zoology starts with the study of the non-chordate and chordates to show the evolutionary significance in the animal kingdom and each phyla depicts the complexity of life. In real scientific world, the student will enhance their skill by exploring the structure and functional peculiarities of different organisms. This course fulfills the basic knowledge in Non-Chordate and Chordate for those students who wish to pursue career in allied species diversity in fields and other technical and medical programs.
Outcome 2	Students will learn the methods of classifying organisms based on the classical morphological characters as well as the advanced use of DNA data. Students will accumulate the knowledge about the rules and regulations of naming an organism. After the completion of this unit they will have a fair idea about biological diversity especially related to animals and their conservation and management.
Outcome 3	Students come to know the information needed to construct a phylogenetic tree of animals to distinguish between morphological and molecular data in creating phylogenetic trees to understand biological evolution, natural selection.
Outcome 4	Upon successful completion of this subject, the students can apply their knowledge of biochemistry to correlate the structure and functional relationships of biomolecules in living organisms. The knowledge of applied biochemistry has vast and diverse applications these days when there is a necessity to diagnose and treat metabolic disorders and diseases.
Outcome 5	Students can apply their knowledge of cell biology in not only performing research at post graduate level, but also in the doctoral level. The advanced studies are being conducted in all the topics that have been included in the paper, for e.g. cellular communication; signal transduction, cell cycle etc. The students can apply their knowledge of genetics to selected examples of mutations as exemplified in many diseases and various chromosomal aberration related syndromes.
Outcome 6	This course will make the students adapt in the working of analytical instruments. They also become confident to use bioinformatics software and work with different databases for applications in upcoming fields of biology, which in turn make them competent for jobs in clinical and medical data analysis labs.
Outcome 7	The students will understand various physiological organ-systems and their importance to the integrative functions of the animal body, especially on humans.
Outcome 8	The chapters on genetics make them appreciate the flow of inherited characters from one generation to the other and study about the interaction of different genes in different organisms. The students will also gain knowledge related to quantitative, population and evolutionary genetics, in addition to microbial genetics. The course structure also fulfills the important criteria regarding the preparation of students for the competitive examinations, for

	e.g. National Eligibility Test (NET), conducted by Council of Scientific and Industrial Research (CSIR), as well as various other entranceexaminations for pursuing doctoral research.
Outcome 9	Apply key principles of developmental biology toward evaluating and analyzing primary literature in the field. Be able to explain key concepts, including mechanisms by which differential gene activity controls development, mechanisms that determine cell fate and mechanisms that ensure consistency and reliability of development.
Outcome 10	This course will make the students adapt in the structure and functions of these microbes which in turn will give them confidence to work using these organisms. The students will become competent for jobs in dairy, pharmaceutical, industrial and clinical research. Understand the concepts of immunity and the mechanism of cellular and humoral immune response. Understand the genetic basis for immunological diversity in acquired immunity. Able to understand and relate to therapeutic agents used in medicine.
Outcome 11	Understanding the sustainability and impact of biodiversity. Understanding of the ethical issues with emphasis on ecology and biology. Students will be able to perform correlation analysis during research. Students will be able to perform regression analysis during research. Differences between rearing of crossbreed and bivoltine silkworm Culturing of mulberry plant. Rearing houses, plan and maintenance. Students will have the level of expertise information in aquaculture production, design, aquaculture health, feed technology and feeding, fishing, fishing management, applied sciences, processing and evaluation.
Outcome 12	By the end of this course, students will be able to find gaps in the existing research of their interest and conduct the research accordingly to write a research proposal. Publish research and review articles in the journal with impact factor. Write a project report as well as research paper.
Outcome 13	Understanding the sustainability and impact of biodiversity. Students will be able to perform cell biology and its components. Understanding common diseases. Students will have the level of expertise information in aquaculture production, design, aquaculture health, feed technology and feeding, fishing, fishing management, applied sciences, processing and evaluation.
Outcome 14	To provide in depth knowledge about the central dogma of life. To understanding the structure and function of DNA, RNA and protein. To understand the flow of genetic information and its regulation in cells. The offered paper must have promising roles in scientific (experimental/analytical) subject from genes to genome targeted to the application in medicinal and health sectors.
Outcome 15	Students after attending the course will understand role of bio-molecule involved in control and expression of genetic information and gene regulation at the level of transcription and translation in a better way. The offered paper must have promising roles in advance bio-molecular science in of subject from genes-protein to clinical therapeutics supports in diverse biomedical sectors.

P. G. DEPT. OF ZOOLOGY FM UNIVERSITY

P. G. SEMESTER EXAMINATION REGULATIONS SECTION-A

REGULATION OF GENERAL ACADEMIC MATTERS

The Departments shall follow Semester System of teaching and Examination based on continuous evaluation internally as well as externally subject to moderation of question papers. The system of evaluations of the students shall be based on Course Credit System.

Academic Year

The Academic Year of the department shall ordinarily be from JUNE to MAY. It may however, be modified by the Staff Council from time to time.

Semester

The academic year shall have two semesters, each of which shall be of 6 months duration.

Minimum working days in a Semester

A Semester shall have a minimum of 90 working/instructional days excluding examination days/Sundays/Holidays etc. The minimum number of classes in a semester shall not fall short of the number of classes as mentioned below.

One Credit hour courses= 10 classes minimum

Two Credit hour courses= 20 classes minimum

Three Credit hour courses = 30 classes minimum

Four Credit hour courses= 40 classes minimum

Credit hours

One credit shall signify the quantum of teaching imparted corresponding to one hour of theory class and two hours of laboratory/project work and two hours of seminar per week during a semester in respect of a particular course. Each teaching hour of theory class will be of 45 minutes and practical classes/project work will be of 120 minutes duration and seminar will be of 120 minutes duration. The P. G. Syllabus may be so designed that the total of credit hours for all four semesters shall be 80 spread equally over all semesters as far as practicable, tutorials and proctorials shall be treated as non-credit components.

Course

A course is a Unit of instruction under any discipline carrying a specific number of credit hours describing its weightage. All units of each paper are compulsory having equal weightage. Those courses, which a student must take as compulsory requirement, are, called Core Courses. Those courses, which a student opts out of a list courses offered by the department, are called specialized or Supportive Course I and II, choice should be exercised amongst all students of different faculties of the University. For the session, 25% of the syllabus has been underlined which are to be self-studied by the Students

Choice Based Credit System (CBCS) is introduced at the P. G. Semester-III level uniformly in all the subjects to be taught in paper-304. The students of P. G. Arts stream can opt for the CBCS course of Science stream.

Grade

The grade awarded to a student in any particular course shall be based on his/her performance in all the tests conducted during a semester and shall be awarded at the end of the semester. The grade in each course is expressed in numerical value in 10.00 scale. The marks of a student shall be converted to10.00 scale and the points scored thereby shall be called the “Grade Point”

in the course. Respective "Grade Point Average" (GPA) and "Overall Grade Point Average" (OGPA) shall be awarded at the end of each semester and all semester respectively. A 3.0 Grade Point is required for passing in individual paper and 4.0 GPA to pass any semester examination. The G. P. shall be rounded to one decimal point and GPA to two decimal points.

Grade Point Average (G.P.A.)

Grade Point Average (G.P.A.) of a semester shall be calculated as

$$GPA = \frac{\text{Summation of \{(Credits in each course) × (Grade point in that course)\}}}{\text{Total No. of Credits in that Semester}}$$

Where the summation is taken over all courses in a given semester, G.P.A. shall be rounded up to 2 decimal points.

O.G.P.A. (Overall Grade Point Average)

It is the average of accumulated grade points of a student, worked out by dividing the cumulative total of grade points by the cumulative total of credit hours of all the courses covered and completed by a student during all the Semesters. For the first semester of the programme the GPA and OGPA shall be the same.

$$OGPA = \frac{\text{Summation of \{(Credits in each semester) × (Total Credits in that semester)\}}}{\text{Total No. of Credits in that Semester}}$$

Where the summation is taken over all semesters in a given programme. OGPA shall be rounded up to e decimal points. For merit lists, in case of equality, the OGPA shall be calculated beyond two decimal places if necessary.

Conversion of grades to marks and classification of results under course credit system

The OGPA can be converted to percentage of marks in the following manner:

Percentage of Marks = (OGPA) ×10

A student after successful completion of all the semesters, Degree shall be awarded in the following manner:

O.G.P.A. ≥ 6.0: FIRST CLASS

O.G.P.A. ≥ 5.0 - < 6.0: SECOND CLASS

O.G.P.A. 4.0 - < 5.0: THIRD CLASS

O.G.P.A.<4.0:FAIL

Academic Calendar

The Examination Section and the academic section shall finalize the schedule of semester registration and other academic activities at the start of academic session. The Academic Calendar shall be prepared by the Academic Committee of the University in consultation with examinationsection.

The broad format for academic calendar for P. G. with regard to admission, registration and commencement of classes shall be as follows:

Admission and Registration and
Commencement of Classes for 1st Semester-JULY
1st Semester Examination-DECEMBER
Commencement of Classes 2nd Semester-JANUARY-MAY
2nd Semester Examination-JUNE
Commencement of 3rd Semester Classes-JULY-NOVEMBER
3rd Semester Examination-DECEMBER
Commencement of 4th Semester Classes-JANUARY-APRIL
4th Semester Examination-APRIL & MAY
Final Results to be published in the month of-JUNE

Requirement for attendance

A candidate shall be required to attend 75% lectures, tutorials and practical classes separately during the semester (For late admitted students‟ attendance to be calculated from the date of admission). Condonation may be granted by the staff council only to the extent of 15% in exceptional cases. (Illness, accident, mishap in the family, deputation by University/ Department). When a candidate has been deputed by the University to represent the University/state for any activity, the lectures delivered during his/her absence for the purpose shall not be counted towards the calculation of attendance provided the student submits a certificate to that effect from the appropriate authority.

P. G. DEPT. OF ZOOLOGY FM UNIVERSITY

REGULATIONS ON EXAMINATION MATTERS SECTION-B

Mid Term Examination

In each Semester there shall be one Mid Term Assessment examination of 60 minutes duration (10HA+10Q+20WT). The Mid Term examination shall be conducted by department. The answer scripts shall be evaluated by internal examiners and the marks foils shall be retained in COE.

Semester Examination

After the end of each semester there shall be an examination of each theory paper of 3 hours duration and of each practical paper of 6 hours duration, which shall be called Term End / "Semester Examination". The maximum marks for each theory paper shall be 100 out of which 60 marks for term end and 40 marks (10HA+10Q+20WT) for Mid Term. The maximum marks for each practical/ semester/ project/ dissertation/ review examination shall be 100 for Science. Practical papers will be examined by one internal examiner and one external examiner. If necessary, the practical/ project/ dissertation/ review examination may be extended to the next day.

Results of Examinations

The results shall be declared ordinarily within four weeks of completion of the examinations. All such cases/complaints if any shall be disposed of by the Examination Section in a prefixed day and necessary corrections if any shall be reflected in the mark/grade sheet. The candidates shall have to appear in all the Units of a semester examination to be eligible to be a declared pass "provided he/she secures minimum pass marks/grade".

Passing percentage & duration

Passing Marks in Individual Paper: 50% (End Term and Internal Marks taken together) in each Theory/ Practical/ Project paper

Passing Marks in Aggregate: 55% **Division:** Yes Division; 1^{st}, 2^{nd} or 3^{rd}

Duration: four semesters (2year)

Back/ Improvement: There is provision for back/ improvement in the M.Sc.

Procedure for Repeat/Improvement

A student who wants to sit for the semester examination of first and/or second semester in the subsequent academic session (for repeat or improvement) he/she shall have to apply to the COE in plain paper before fifteen days of the commencement of the said examination. If allowed by the COE, he/she shall deposit the required fees for each paper with centre charge and produce the proof to the teacher in-charge examination with permission letter from the COE. In a semester to appear improvement examination the candidates must have passed the semester examination. A candidate can appear repeat examination of papers in which he/she has failed or not appeared. The Master Degree student seeking to appear/improvement examination in any course(s) shall get 2 chances for 1st and 2nd semester within 4 semesters.

Award of Degree Certificate, Grade/Mark sheet

A Degree certificate under the official seal of the university and signed by the Vice-Chancellor to each of the successful students of particular degree. The Controller of Examinations shall issue the mark/grade sheet of each semester to the candidates in the sheet of each semester to the candidates in the department.

Guideline for filling up of Forms for PG Classes (IMP/ Repeat)

A student shall repeat all the theory and practical papers in which he/she failed in the semester examination within a period of four semesters from the date of first registration. Such students shall have to apply to the Head of the Department during the filling up of form for the ensuing semester examination. If allowed, he/she shall deposit the fees as prescribed by the University.

Disciplines in the Examination

Late Comers: A student arriving in the examination hall/room fifteen minutes after the commencement of the examination shall not be ordinarily allowed to sit for the examination. No examinee shall be allowed to go out of the examination hall within one hour of commencement of examination. The invigilators shall keep a record of temporary absence of students from the examination hall/room during the examination.

Adoption of unfair means in the Examination:

Possession of unauthorized materials and using it, copying from scripts of other students or from any other source, showing his/her answer script to others during the examination, creating disturbance or acting in a manner so as to cause inconvenience to other students in the examination hall or near about shall be treated as adoption of unfair means or malpractice.

P. G. DEPT. OF ZOOLOGY FM UNIVERSITY

COURSE STRUCTURE

I[st] SEMESTER

Sl. No.	Paper code	Title	Paper Type	Credit Hours	Marks [Internal + End Term]
1	**ZOO-101**	**Non-Chordate and Chordate**	Theory	4	100 [40+60]
2	**ZOO-102**	**Biosystematics, Biodiversity and its conservation and climate change**	Theory	4	100 [40+60]
3	**ZOO-103**	**Evolution and Biogeography**	Theory	4	100 [40+60]
4	**ZOO-104**	**Biochemistry and Bioenergetics**	Theory	4	100 [40+60]
5	**ZOO-105**	**Practical**	Practical	8	100
Total				**24**	**500**

II[nd] SEMESTER

Sl. No.	Paper code	Title	Paper Type	Credit Hours	Marks [Internal + End Term]
1	**ZOO-201**	**Cell Biology and Genetics**	Theory	4	100 [40+60]
2	**ZOO-202**	**Instrumentation, Biophysics and Bioinformatics**	Theory	4	100 [40+60]
3	**ZOO-203**	**Comparative Physiology, Endocrinology and Ethology**	Theory	4	100 [40+60]
4	**ZOO-204**	**Comparative Embryology**	Theory	4	100 [40+60]
6	**ZOO-205**	**Practical**	Practical	8	100
Total				**24**	**500**
7	**VAC-ZOO-1**	**Fish and Fisheries (Non Credit Course)**	Theory	**3**	100

III[rd] SEMESTER

Sl. No.	Paper code	Title	Paper Type	Credit Hours	Marks [Internal + End Term]
1	**ZOO-301**	**Microbiology and Immunology**	Theory	4	100 [40+60]
2	**ZOO-302**	**Ecology, Biostatics and Applied Biology**	Theory	4	100 [40+60]
3	**ZOO-303**	**Vector Biology, Molecular Diagnosis and Clinical Parasitology, Ethology and Research Methodology**	Theory	4	100 [40+60]
4	**ZOO-304**	**Fundamental Zoology (CBCS)**	Theory	4	100 [40+60]
5	**ZOO-305**	**Practical**	Practical	8	100
6		**FAKIR MOHAN STUDIES (Non Credit Course)**			
Total				**24**	**500**

IVth SEMESTER

Sl. No.	Paper code	Title	Paper Type	Credit Hours	Marks [Internal + End Term]
1	**ZOO-401**	**Cell and Molecular Biology, Biotechnology (Special Paper)**	Theory	4	100 [40+60]
3	**ZOO-402**	**Cell and Molecular Biology, Biotechnology (Special Paper)**	Theory	4	100 [40+60]
4	**ZOO-403**	**Practical**	Practical	8	100
5	**ZOO-404**	**PROJECT**	Dissertation	4	100
6	**ZOO-405**	**PROJECT PRESENTATION**	Presentation	4	100
Total				**24**	**500**
7	**Value Added Course on Employability Skill Enhancement**		**Module**	**2**	

P. G. DEPT. OF ZOOLOGY FM UNIVERSITY

MARKING PATTERN

I[st] SEMESTER

Paper Sl. No.	Internal Evaluation				End Term Examination				Total
	Home Assignment	Presentation	Quiz	Written	Written*	Presentation	Report	Viva-Voce	
1	10	NA	10	20	60	NA	NA	NA	**100**
2	10	NA	10	20	60	NA	NA	NA	**100**
3	10	NA	10	20	60	NA	NA	NA	**100**
4	10	NA	10	20	60	NA	NA	NA	**100**
5	NA	10	NA	NA	70	NA	10	10	**100**

**** Includes experiments in case of practical papers***

II[nd] SEMESTER

Paper Sl. No.	Internal Evaluation				End Term Examination				Total
	Home Assignment	Presentation	Quiz	Written	Written*	Presentation	Report	Viva-Voce	
1	10	NA	10	20	60	NA	NA	NA	**100**
2	10	NA	10	20	60	NA	NA	NA	**100**
3	10	NA	10	20	60	NA	NA	NA	**100**
4	10	NA	10	20	60	NA	NA	NA	**100**
5	NA	10	NA	NA	70	NA	10	10	**100**

**** Includes experiments in case of practical papers***

III[rd] SEMESTER

Paper Sl. No.	Internal Evaluation				End Term Examination				Total
	Home Assignment	Presentation	Quiz	Written	Written*	Presentation	Report	Viva-Voce	
1	10	NA	10	20	60	NA	NA	NA	**100**
2	10	NA	10	20	60	NA	NA	NA	**100**
3	10	NA	10	20	60	NA	NA	NA	**100**
4	10	NA	10	20	60	NA	NA	NA	**100**
5	NA	10	NA	NA	70	NA	10	10	**100**

**** Includes experiments in case of practical papers***

IV[th] SEMESTER

Paper Sl. No.	Internal Evaluation				End Term Examination				Total
	Home Assignment	Presentation	Quiz	Written	Written*	Presentation	Report	Viva-Voce	
1	10	NA	10	20	60	NA	NA	NA	**100**
2	10	NA	10	20	60	NA	NA	NA	**100**
3	NA	NA	NA	NA	70	10	10	10	**100**
4	NA	NA	NA	NA	NA	NA	80	20	**100**
5	NA	NA	NA	NA	NA	80	NA	20	**100**

**** Includes experiments in case of practical papers***

SCHEME OF INTERNAL EVALUATION (THEORY):

Each theory paper consists of five units and irrespective of the credit hours assigned, will be of 100 marks, out of which, 40 will be internal marks (continuous evaluation) and 60 will be end term examination marks. There will be three components of internal evaluation – Quiz, Mid Term Written Test and Home Assignment as perthe details below.

Component	Unit(s)	Marks	Remarks
Quiz – I	I	10	Best of the two quizzes will be considered
Quiz – II	III	10	
Mid Term (Written)	I & II	20	There will be no internal evaluation for the last unit (V)
Home Assignment	IV	10	
Total	**I – IV**	**40**	**Q – 10 + HA – 10 + W – 20**

BOARD OF EXAMINERS:

Sl. No.	Section	Examiner(s)
01	Home Assignment and Quiz	Internal Course Teacher/ Instructor from the University P. G. Department
02	Seminar Presentation	Seminar Presentation from the University P. G. Department
03	Written (Mid Term)	Internal Course Teacher/ Instructor from the University P. G. Department
04	Viva-Voce	A board of examiners consisting of faculty members of the University P. G. Department, who are members of the BOS in the subject. The proposed Supervisor, if from outside the University Campus, may be coopted as a member examiner.
05	Written (End Term)	Examiner as appointed by the Board of Studies

Semester I

PAPERZOO-101 Non-Chordate and Chordate

Total Teaching Hours for Semester: 60 **No of Lecture Hours/Week: 4**

Max Marks: 100 (40+60 Marks) **Credits: 4**

Course Objectives/Course Description

Zoology starts with the study of the non-chordate and chordates to show the evolutionary significance in the animal kingdom and each phyla depicts the complexity of life. In real scientific world, the student will enhance their skill by exploring the structure and functional peculiarities of different organisms. This course fulfills the basic knowledge in Non-Chordate and Chordate for those students who wish to pursue career in allied species diversity in fields and other technical and medical programs.

Course Outcome

This course will make the students adapt in the structure and functions of these Non-Chordate and Chordate which in turn will give them confidence to work using these organisms. The students will become competent for jobs in forestry, biodiversity, medical, industrial and clinical research.

UNIT-I **Teaching Hours: 12**

Protozoa (Protist animals): Nutrition, Reproduction, Parasitic forms with special reference to human host.

Porifera: Canal system, Reproduction, Spicules of sponges.

Coelenterata: Polymorphism, Corals and Coral reef formation, Ctenophora and its affinities.

Platyhelminthes and Aschelminthes: Parasitism and Parasitic adaptations in helminthes.

Annelida: Adaptive radiation in polychaetes and Trochophore larva: structure and significance.

UNIT-II **Teaching Hours: 12**

Annelida: Metamerism and segmental organs, Origin of coelom, Excretion.

Arthropoda (excluding insects): Onychophora-Peripatus, Xiphosura - Limulus, Larval forms in Crustaceans, Life cycle of Sacculina and Parasitic castration.

Mollusca: Torsion and de-torsion in Gastropoda and Modifications of foot.

Echinodermata: Water vascular system, larval forms and their significance.

Minor Phyla: Structure and affinities of Rotifera, Brachiopoda, Phoronida.

UNIT-III **Teaching Hours: 12**

Protochordata: Origin of chordates, Biology and affinities of Balanoglossus, Structure and affinities of Herdmania, Structure and affinities of Amphioxus.

Cyclostomata: Structure and affinities of Petromyzon.

UNIT-IV **Teaching Hours: 12**

Pisces: Origin of fishes, Biology and affinities of Dipnoi, Biology and affinities of Latimeria, Development of swim bladder in fishes, Lateral line system in fishes.

Amphibia: Origin of tetrapoda, Parental care in Amphibia, Neoteny in Amphibia.

UNIT-V **Teaching Hours: 12**

Reptilia: Skull pattern, Biting mechanism and venom in snakes.

Aves: Origin of birds, perching mechanism in birds.

Mammalia: Structure, distribution and affinities of Prototheria and Metatheria. Dentition in mammal

Recommended Books

1. Barnes: The Invertebrates – A synthesis, 3rd edition, Blackwell, 2001
2. Hunter: Life of Invertebrates, Collier Macmillan Pub. 1979
3. Marshall: Parker & Haswell Text Book of Zoology, Vol. I, 7th edition, Macmillan, 1972
4. Moore: An Introduction to the Invertebrates, Cambridge University Press, 2001
5. Boolootian, R. A. and Stiles, K. A., College Zoology, 10th edition, Macmillan Publishing Co., Inc. New York, 1981.
6. Colbert, E. H., Morales, M. and Minkoff, E. C. Colbert's Evolution of the Vertebrates: A history of the backboned animals through time, 5th edition, John Wiley - Liss, Inc., New York, 2002.
7. Farner, D. S. and King, J. R., Avian Biology (in several volumes), Academic Press, New York, 1971.
8. Goodrich, E. S, Studies on Structure and Development of Vertebrates, Dover Publication, New York, 1958.
9. Hildebrand, M. Analysis of Vertebrate Structure, 4th edition, John Wiley & Sons, Inc., New York, 1995.
10. Jordan, E. L. and Verma, P. S., Chordate Zoology. S. Chand & Company Ltd, 1998. 7. Kotpal, R. L. The Birds, 4th edition, Rastogi Publications, Shivaji Road, Meerut, 1999.
11. Marshall, A. J., Biology and Comparative Physiology of Birds, Volume I & II, 1960. 9. McFarland, W. N., Pough, F. H., Cade, T. J. and Heiser, J. B., Vertebrate Life, Macmillan Publishing Co., Inc., New York, 1979.

PAPER ZOO-102 Biosystematics, Biodiversity and its conservation and climate change

Total Teaching Hours for Semester: 60 **No of Lecture Hours/Week: 4**
Max Marks: 100 (40+60 Marks) **Credits: 4**

Course Objectives/Course Description

Students will learn the methods of classifying organisms based on the classical morphological characters as well as the advanced use of DNA data. Students will accumulate the knowledge about the rules and regulations of naming an organism. After the completion of this unit they will have a fair idea about biological diversity especially related to animals and their conservation and management.

Course Outcome

Understanding the sustainability and impact of biodiversity. Understanding of the ethical issues with emphasis on ecology and biology.

UNIT I **Teaching Hours: 12**

Biosystematics: Definition and basic concepts of Biosystematics, Importance and applications of biosystematics in biology. Taxonomy: History of Taxonomy, Types of Taxonomy (Cyto, Biochemical & Behavioural), Classification, Artificial Vs Natural Classification, Species concept, Rules & Theories of ranking and nomenclature.

UNIT II **Teaching Hours: 12**

Taxonomic procedures - Taxonomic collections, Preservation, Curation, Process of identification. International Code of Zoological Nomenclature (ICZN)-Complete code. Biodiversity indices and their uses. Threat of species extinction. Wildlife Health and Population Management; Capture and Handling of Wild Animals. Radio telemetry.

UNIT III **Teaching Hours: 12**

Basic principles of resource management, definition and classification of resources, problems of resource depletion, preservation, conservation and restoration, patterns of resource depletion, resource economics and resource overuse. Indian case studies on conservation/management strategy (Project tiger, Biosphere reserve)

Current biodiversity loss - concept of endemism, rare, endangered and threatened species (RET), key stone species, IUCN account of biodiversity, red data book and hot spots, reasons to stop extinction, methods to save species. International conservation bodies; IUCN, UNDP, FAO, WWF

UNIT IV **Teaching Hours: 12**

Principles of conservation - ex-situ and in-situ conservation techniques. Biodiversity conservation: Species diversity, community diversity, ecosystem diversity and landscape preservation. Biodiversity index (Simpson's Index, Shannon-Wiener index), Similarity index (Sørensen index). Role of biotechnology in conservation of species. Ecotourism - positive and negative impacts. Genomics and Biodiversity Molecular Tools for diversity Studies and its significance.

UNIT V **Teaching Hours: 12**

Global warming, greenhouse gases, acid rain, ozone depletion. Holistic relationship between air water and land pollution. Factors responsible for climate change, El-Nino and La Nina phenomenon and its consequences. Effect of climate change on reproductive biology and biogeography. Environmental laws, environmental monitoring and bio indicators, environmental safety provisions in Indian constitution, major environmental laws in free India, ISO-14000.

Recommended Books

1. Edward O. Wilson, 1996, Biodiversity, 521pp. National Academy Press.
2. Alison J. Stattersfield, Michael J. Crosby, Adrian J. Long, and David C. Wege. 1998. Endemic Bird Areas of the World: Priorities for Biodiversity Conservation. 846pp.
3. Bibby, J., Collar, N.J., Crosby, M.J., Heath, M.F., Imboden, Ch., Johnson, T.H., Long, A.J., Stattersfield, A.J., and Thirgood, S.J. 1992. Putting biodiversity on the map: priority areas for global conservation.
4. Fundamentals of Ecology by Eugene P. ODUM (1972), W.B. Saunders Company, London.
5. Environmental Biology by Michael Reiss and Jenny Chapman, 2000. Cambridge Press, UK.
6. An Introduction to Ecology and Population by Emmel THOMAS, C. (1973), Notron, NY.
7. Fundamentals of Ecology by DASH, M.C., 1993. Tata McGraw-Hill Publishing Company.
8. Global Environmental Science: Lecture Notes for Physical Geography. 2021. by Jeffrey A. Lee.
9. Climate Change: Biological and Human Aspects (Kindle Edition). 2012. By Jonathan Cowie.

PAPER ZOO-103 Evolution and Biogeography

Total Teaching Hours for Semester: 60 **No of Lecture Hours/Week: 4**

Max Marks: 100 (40+60 Marks) **Credits: 4**

Course Objectives/Course Description

Students will learn the object of evolution study and biogeography matters. Students will accumulate the knowledge about the rules and regulations of naming an organism. After the completion of this unit they will have a fair idea about biogeography especially related to animals. After completion of this unit the students are going to have a fair idea about the patterns and processes governing the distribution of animals and how have they evolved. They are also going to learn analytical skills regarding phylogenetic. To gain understanding and appreciation of animal diversity, their phylogeny and the recent progress in the field and to understand the general concepts of evolution of animal development, morphology, genomes, natural selection, and speciation and other characters

Course Outcome

Students come to know the information needed to construct a phylogenetic tree of animals to distinguish between morphological and molecular data in creating phylogenetic trees to understand biological evolution, natural selection.

UNIT-I **Teaching Hours: 12**

Concepts and theories of organic evolution: Pre Darwinian concepts, Darwinism and its impact in the development of synthetic theory. Neo-darwinism: Birth of population genetics, Evidences of evolution, Components of population genetics, Mendelian population, gene pool, allele frequencies and genotype frequencies, Models depicting Hardy Weinberg law, Destabilizing forces of evolutionary equilibrium (Mutation, Migration, Selection, Meiotic drive and genetic drift).

UNIT II **Teaching Hours: 12**

Evolution of Social interaction and Cooperation; Sexual selection, Group selection, Hamilton's Rule, Red queen hypothesis, Kin selection, Parent – offspring conflict, mating systems, evolutionary pattern of invertebrate and vertebrate (birds, horses and human) ; DNA Barcoding; Cladogenesis and anagenesis

UNIT-III **Teaching Hours: 12**

Chromosomal, allozyme and DNA polymorphisms. Adaptive genetic polymorphism. Balanced polymorphism and heterosis. Genetic coadaptation and linkage disequilibrium. Isolating mechanisms. Concepts of species and models of speciation: allopatric, sympatric and stasipatric.

UNIT-IV **Teaching Hours: 12**

Population and structure, Population growth: Density dependent and independent, Survivorship, life history strategies (r and K selection), Competitions among species: Intraspecific and Interspecific, Lotka-Volterra interspecific competition model, Mimicry and Animal coloration, Island communities and colonization. Geological time scale and species evolution; Mass extinction, evolutionary tree.

UNIT V **Teaching Hours: 12**

Biogeography: Deepest Space and Time of Biogeography: Continental Drift and Climate Change; theory of island biogeography; The Species-Area Relationship and the Distribution of Rarity and Commonness. The Equilibrium Theory of Insular Biogeography.

Recommended Books

1. Organic Evolution: R.S. Lull
2. Dobzhansky Th.: Genetics and the Origin of Species. Columbia.
3. Freeman S. and Jon C. Herron (1998): Evolutionary Analysis. Prentice Hall
4. Futuyma D. J. (1998): Evolutionary Biology. Sinauer
5. Hartl D. L. and A. G. Clark (1989 & 1997): Principles of Population Genetics. Sinauer
6. Ridley M. (1993): Evolution. Blackwell.
7. Strickberger M. W. (2000): Evolution. White M. J. D. (1978): Modes of Speciation.Freeman
8. The Song of the Dodo, by David Quammen
9. The Future Eaters, by Tim Flannery
10. The Voyage of the Beagle, by Charles Darwin
11. Foundations of Biogeography: Classic Papers with Commentaries, edited by
12. Mark V. Lomolino, Dov F. Sax and James H. Brown

PAPER ZOO-104 Biochemistry and Bioenergetics

Total Teaching Hours for Semester: 60 **No of Lecture Hours/Week: 4**

Max Marks: 100 (40+60 Marks) **Credits: 4**

Course Objectives/Course Description

The paper is intended to develop understanding and provide scientific basis of the inanimate molecules that constitute living organisms. It also gives a thorough knowledge about the structure and function of biological macromolecules (proteins, carbohydrates, lipids, and nucleic acids), and the metabolic and bioenergetics pathways within the cell. Students learn to interpret and solve clinical problems.

Course Outcome

Upon successful completion of this subject, the students can apply their knowledge of biochemistry to correlate the structure and functional relationships of biomolecules in living organisms. The knowledge of applied biochemistry has vast and diverse applications these days when there is a necessity to diagnose and treat metabolic disorders and diseases.

UNIT I **Teaching Hours: 12**

Forces and interactions of biomolecules; chemical bonds – Covalent and Ionic bond (bond energy), Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction.), high energy molecules in living system (ATP, ADP, NAD, NADH, NADPH, FAD, FADH2), Laws of thermodynamics, Concept of free energy, enthalpy, entropy, Coupled reactions, group transfer, biological energy transducers, redox potential. Buffers and Solutions: Concept of pH, pKa, titration curve, acids, bases and buffers, Henderson-Hasselbalch Equation, biological buffer solutions. Principles of thermodynamics; Kinetics, dissociation and association constants; energy rich bonds and weak interactions; Bioenergetics.

UNIT II **Teaching Hours: 12**

Classification, structure and Properties of carbohydrates. Chirality and optical activity, stereoisomerism, cyclic structure of monosaccharide, (pyranoses and furanoses), structures of glucose. Absolute and relative configuration (D & L and R & S nomenclature). Disaccharides- structures of Maltose, Lactose, Sucrose, Trehalose, Raffinose. Polysaccharides. Structure and properties of homo and hetero polysaccharides. Storage polysaccharides. (Starch, Glycogen, cellulose, hemicellulose, and chitin) Derived sugars- Sugar acids (Aldonic, Aldaric and Saccharic acids), amino sugars. Derivatives of carbohydrates (Glycosaminoglycans, glycolipids, Proteoglycan and glycoproteins).

Carbohydrate metabolism: Glycogenolysis, Glycogenesis, Glycolysis- Energetics and Regulation, Fermentation reactions (Lactic acid and alcoholic fermentation), Gluconeogenesis, Reciprocal regulation of Glycolysis and Gluconeogenesis, Citric acid cycle- Energetics and regulation, Glyoxylate cycle. Pentose phosphate pathway.

UNIT III **Teaching Hours: 12**

Electron transport chain, Electron transfer reactions in mitochondria, Electron carriers, Ubiquinone, Cytochromes, Iron sulfur centers, Methods to determine sequence of electron carriers, Fractionation of Multi enzyme complexes I, II, III, IV of Mitochondria and their inhibitors, Oxidative phosphorylation, ATP synthesis, Chemiosmotic model, Proton gradient, Structure of ATP synthetase, Mechanism of ATP synthesis, Brown fat, Regulation of Oxidative phosphorylation.

UNIT IV **Teaching Hours: 12**

Proteins- peptide bond, psi and phi angle, Ramachandran's plot, Structural organizations of proteins (primary, secondary, tertiary and quaternary, Domains, Motifs & Folds), conformational analysis. Structure and functional classification of proteins. Structure- function relationship. Thermodynamics of protein folding, chaperones and chaperonins, Stability of Protein Structures; Denaturation and renaturation of proteins.

Metabolism of Lipids: Biosynthesis of saturated and unsaturated fatty acids and cholesterol. Beta oxidation of Fatty acids: activation, transport to mitochondria, metabolic pathway. Oxidation of saturated and unsaturated fatty acids. Alpha and omega oxidation, metabolic disorders (Triglyceridemia, NaymanSacchs Disease). Nucleic acids: Biosynthesis and regulation of purine and pyrimidine nucleotides, Catabolism of purines and pyrimidines.

UNIT V **Teaching Hours: 12**

Nomenclature and classification; Mechanism of enzyme action- Enzyme substrate binding, Binding energy, entropy change; Active site structure and determination-Irreversible inhibitors, affinity labeling & suicide inhibitors; Michaelis-Menton, Lineweaver–Burk, Edde-Hofstee and Hanes-Woolf equations; Multi-substrate reactions- Random sequential, Ordered, Theorel-Chance mechanism, Ping-pong (double reciprocal) mechanism;

Enzyme Inhibition-Competitive; Non-competitive; Un-competitive and mixed, Determination of nature of inhibition and Ki by LB & Dixon plots; Regulation: allosterism, covalent modifications; Coenzymes and cofactors; Enzyme assay: principles and techniques-Fixed time, continuous and coupled assays (Spectrophotometric, Isotopic, Spectrofluorometric & Titrimetric.); Enzyme purification, Objective and strategy, Choice of source, Methods of homogenization, Methods of separation, Basis of solubility(pH treatment; Salting in & salting out; Changing dielectric constant; Heat treatment), Basis of size and mass.

Recommended books

1. Berg et al.: Biochemistry (5th Ed.), Freeman, 2001
2. Nelson et al: Lehninger Principles of Biochemistry (3rd Ed.), Pearson, 2004
3. Mathews et al.: Biochemistry (3rd Ed.), Benjamin/Cummings Publuishing, 1990
4. Segal Biochemical calculations (2nd.), John Wiley & Sons, 1976
5. Watson et al: Molecular Biology of the Gene (2nd Ed.), Benjamin/Cummings,1976

PAPERZOO-105 PRACTICAL

Total Teaching Hours for Semester: 120 **No of Lecture Hours/Week: 8**

Max Marks: 100 **Credits: 8**

Course Objectives/Course Description

To provide in-depth practical knowledge in the anatomical details about the various animals. To understand the principle behind various techniques in Molecular Biology, and Animal Evolution and biochemistry

Course Outcome

This course will make the students adept with the biochemistry of various life processes which in turn will give them confidence to work using these organisms. Integrate knowledge of anatomical form with understanding of physiological function and developmental processes. Gain first-hand experience with anatomical structure. The students will become competent for jobs in dairy, pharmaceutical, industrial and clinical research.

Collection, Identification and study of Invertebrate and Vertebrate (pictures and specimens)

1. Invertebrate: Porifera, Coelenterate, Helminthes, Annelida, Arthropoda
2. Invertebrate: Arthropoda, Mollusca and Echinodermata
3. Vertebrata: Pisces and Amphibia
4. Vertebrata: Reptiles, Aves and Mammalia
5. Recognition of fauna from museum study and taxonomic key preparation

Mounting

Setae of earthworm, Ovary of earthworm, Larvae of crustaceans, Echinoderms, Statocyst of Prawn, Osphradium of Pila, Radula of Pila, Pecten of bird, Feathers of birds. Scales of fishes.

Biosystematics, Biodiversity and its conservation and climate change

1. Estimation of Biodiversity following transact and quadrate method.
2. Calculation of Biodiversity indices.

Evolution and Biogeography

1. Biodiversity assessment, Measuring species diversity of different habitat;
2. Diversity Parameters for comparative study of habitats

Biochemistry and Bioenergetics

1. Laboratory safety guidelines
2. Preparation of buffers applying HH equation
3. Validation of Beer-Lambert's Law (colorimetery and spectrophotometer)
4. Qualitative and Quantitative analysis of carbohydrates
5. Isolation and quantification of protein (Folin Lowry/BCA, Bradford).
6. Determination of isoelectric pH of proteins / amino acids
7. Estimation of Ascorbic acid in citrus using 2, 6 dichlorophenol Indophenol.
8. Estimation of glycogen content of liver.
9. Determination of isoelectric point of glycine.
10. Determination of unknown sugar.

Seminar presentation

Semester II

PAPER ZOO-201 Cell Biology and Genetics
Total Teaching Hours for Semester: 60 **No of Lecture Hours/Week: 4**
Max Marks: 100 (40+60 Marks) **Credits: 4**

Course Objectives/Course Description

This paper has been designed in a standard manner to impart knowledge of the cell and its various attributes among the post graduate students. The topics included in this paper give not only the basic idea about the subject but also provides in-depth knowledge. Students get an idea about the cellular structures, as well as how these structures are helpful for the cell to communicate with its environment and transduction of various signals, whether intracellular or extra-cellular. Furthermore, students also learn the mechanism of mitotic and meiotic cell division as well as how the cell cycle is regulated.

The chapters on genetics make them appreciate the flow of inherited characters from one generation to the other and study about the interaction of different genes in different organisms. The students will also gain knowledge related to quantitative, population and evolutionary genetics, in addition to microbial genetics. The course structure also fulfills the important criteria regarding the preparation of students for the competitive examinations, for e.g. National Eligibility Test (NET), conducted by Council of Scientific and Industrial Research (CSIR), as well as various other entrance examinations for pursuing doctoral research.

Course Outcome

Students can apply their knowledge of cell biology in not only performing research at post graduate level, but also in the doctoral level. The advanced studies are being conducted in all the topics that have been included in the paper, for e.g. cellular communication; signal transduction, cell cycle etc. The students can apply their knowledge of genetics to selected examples of mutations as exemplified in many diseases and various chromosomal aberration related syndromes.

UNIT I **Teaching Hours: 12**

Prokaryotes- Viruses: Structure and Replication, Bacteriophage (Lambda phage, Phi x 174), Animal DNA virus (SV 40),Retroviruses (HIV), Bacteria: Structure and reproduction of E. coli, Culture media and determination of growth rate, Plasmid and their functions; Eukaryotes- Cell Membrane, Lipid bi-layer, Membrane proteins & Fluid mosaic model, Transport, Diffusion, Osmosis and measurement of osmotic pressure, Active transport: Mechanism and related calculations, Targetting and sorting of proteins, Processing through endomembrane system, Targetting of cytosolic proteins; Mitochondria-Structure: Assemblies of respiratory chain & Fo-F1 ATPase, Oxidative phosphorylation, ATP and other high energy phosphate compounds; Cytoskeleton: Organization of Microtubules, Microfilaments and Intermediary filaments; Nucleolus: Structure and biogenesis of ribosomes; Cell Signalling- Cell-cell interaction, Chemical mediators, Cell surface and intracellular receptors; Cell death, Apoptosis.

UNIT II **Teaching Hours: 12**

Eukaryotic chromatin structure and chromosome Organization-Classes of DNA, Chromosomal proteins: histones and their modifications, non-histon proteins, scaffold/matrix proteins, Levels of chromatin condensation at interphase and metaphase stages; Nuclear matrix and organization of interphase nucleus; Centromere, kinetochore and telomere; Metaphase chromosome bandings.

UNIT III **Teaching Hours: 12**

Giant chromosomes: models for studies on chromosome organization and gene expression. Cell division- Mitosis: Role of maturation promoting factor, Chromosomal movement, Exit from mitosis; Cytokinesis; Meiosis: Overview Chromosome pairing and recombination, Genetic regulation of meiosis. Human cytogenetics: Karyotype and nomenclature of metaphase chromosome bands, Chromosome anomalies and disease, Common syndromes caused by aneuploidy, mosaicism, deletion and duplication, Chromosomal anomalies in malignancy (chronic myeloid leukemia, Burkitt's lymphoma, retinoblastoma and Wilms' tumour), Fragile site and X-linked mental retardation.

UNIT IV **Teaching Hours: 12**

Mendel's laws and their chromosomal basis; Extensions of Mendelism; Dominance relationships; Epistasis; Pleiotropy; Expressivity and penetrance; Methods of gene mapping: 3-point test cross in Drosophila, Gene mapping in human by linkage analysis in pedigrees, Tetrad analysis in Neurospora, Gene mapping in bacteria by conjugation, transformation and Transduction. Gene Mutation and DNA repair: Types of gene mutations, Methods for detection of induced mutations; P-element insertional mutagenesis in Drosophila; DNA damage and repair.

UNIT V **Teaching Hours: 12**

Nature of the gene and its functions- Evolution of the concept of gene, Fine structure of gene (rII locus) Regulation of gene activity in lac and trp operons of E. coli.General introduction to gene regulation in eukaryotes at transcriptional and post-transcriptional levels, organization of a typical eukaryotic gene, transcription factors, enhancers and silencers; Non-coding genes; Organization and function of mitochondrial DNA

Recommended Books

1. Lodish, Molecular Biology of the Cell.
2. Karp, G. (7th Edition), Cell and Molecular Biology: Concepts and Experiments.
3. Alberts ET Al., Essentials of Cell Biology
4. Brooker: Genetics : Analysis and Principles (Addison-Wesley, 1999)
5. Gardner et al: Principles of Genetics (John Wiley, 1991)
6. Griffith et al: Modern Genetic Analysis (Freeman, 2002)
7. Hartl & Jones: Essential Genetics: A Genomic Perspective (Jones & Bartlet, 2002)
8. Lewin, Genes VIII (Wiley, 2004)
9. Russell: Genetics (Benjamin Cummings, 2002)
10. Snustad & Simmons: Principles of Genetics (John Wiley, 2003).

PAPER ZOO-202 Instrumentation, Biophysics and Bioinformatics
Total Teaching Hours for Semester: 60 **No of Lecture Hours/Week: 4**
Max Marks: 100 (40+60 Marks) **Credits: 4**

Course Objectives/Course Description

Analytical tools are becoming very important tools in different fields of Biology. The paper deals with the principle, instrumentation and uses of such tools. This course fulfils the basic knowledge in analytical techniques for those students who wish to pursue career in allied health fields and other technical programs.

Course Outcome

This course will make the students adapt in the working of analytical instruments. They also become confident to use bioinformatics software and work with different databases for applications in upcoming fields of biology, which in turn make them competent for jobs in clinical and medical data analysis labs.

UNIT-I **Teaching Hours: 12**

Microscopy: Principle of operation and Instrumentation of light, Fluorescent and Electron microscopy, Microtomy. Chromosome analysis, Karyotyping and Karyomorphometrical analysis, Taxidermy. Centrifugation: Principle of centrifugation, the Svedberg equation, types of centrifuges and rotors. Density gradient centrifugation. Ultra-filtration -Principle, instrumentation and application. Dialysis-principle and uses. Precipitation- methods and applications. Flow Cytometry; Principle and uses

Chromatography- principle, types (Column, Ion exchange, Gel permeation, Affinity), Gas chromatography, HPLC, HPTLC

Electrophoresis - buffers, agarose gel electrophoresis, native and SDS -PAGE, Isoelectric focusing, Zymogram, 2 D gel electrophoresis, DGGE, PFGE, Protein staining, trouble shooting, Protein purification methods, salt fractionation, salting in and salting out, methods of crystallizing proteins

UNIT-II **Teaching Hours: 12**

Spectroscopy: Absorption and emission spectra. Electromagnetic radiation. Fluorescence and phosphorescence, Beer- Lambert's law, principle, operation and applications of Colorimeter, Spectrophotometer, Concept of Stoke's shift- hypochromicity, hyperchromicity, fluorimeter, flame photometer, Atomic absorption spectrophotometer. IR, Mass spectroscopy and NMR, ICP-MS, GC-MS, LC-MS, X ray crystallography.

UNIT-III **Teaching Hours: 12**

Radioactive isotope, Radioactivity and units of radioactivity (Curie, Rutherford and Becquerel).GM and Scintillation counters. radioactive decay, Radiocarbon dating, autoradiography, use of radioisotope tracer techniques in disease diagnosis, PET scan for tumor detection, Radioimmunoassay, ELISA, Western Blot, Nanoparticles – synthesis and uses, application of nanotechnology in disease diagnosis and treatment, Microarrays.

UNIT- IV **Teaching Hours: 12**

Introduction and application of bioinformatics. Definition and types, Nucleotide sequence database - brief note on EMBL, NCBI and DDBJ. Protein structure database [PDB]. Sequence alignment: pair wise and multiple alignments [Definition, applications, BLAST and FASTA, Clustal W, PAM and BLOSUM matrices]. ORF. Structure prediction, and molecular visualization – use of Rasmol, PDB, ExPASY and KEGG. Online tools – SDSC Biology workbench.

UNIT-V **Teaching Hours: 12**

Genomics: Definition. Types [Structural, functional and comparative genomics]. Pharmacogenomics: Definition and its benefits in the health care sector. Genome projects- Human, Rice, Arabidopsis, Tomato, Hemophilus influenzae, Proteomics, Transcriptomics and Metabolomics – current status and potential applications in agriculture and medicine. Systems Biology- concept and applications. Molecular phylogeny and phylogenetic trees, tools for phylogeny analysis, Computer aided drug design. Docking Studies - Target Selection, Active site analysis, Ligand preparation and conformational analysis, Rigid and flexible docking, Structure based design of lead compounds and Library docking.

Recommended Books

1. Biophysics Tools and Techniques by Mark C. Leake · 2016
2. Foundations of Biophysics by A. L. Stanford · 2013
3. Introduction to Experimental Biophysics Biological Methods for Physical Scientists By Jay L. Nadeau · 2016.
4. Fundamentals of Bioinformatics by S. Harisha · 2010

Paper Zoo-203 Animal Physiology, Endocrinology and Ethology

Total Teaching Hours for Semester: 60 **No of Lecture Hours/Week: 4**
Max Marks: 100 (40+60 Marks) **Credits: 4**

Course Objectives/Course Description

To study and compare the functioning of organ systems across the animal world; To give an over view of the comparative functioning of different systems in animals and to learn more about human physiology**.** This paper will definitely supports the masters' students to learn about the basic to cutting edged themes of animal physiology and endocrine system. Several significant approaches also be focused for make more perpetual purposes of this present course.

Course Outcome

The students will understand various physiological organ-systems and their importance to the integrative functions of the animal body, especially on humans.

UNIT-I **Teaching Hours: 12**

Blood and circulation - Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, hemoglobin, immunity, homeostasis. Cardiovascular System: Comparative study of heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above. Respiratory system - Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.

UNIT-II **Teaching Hours: 12**

Nervous system - Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscletone and posture. Sense organs - Vision, hearing and tactile response. Excretory system - Comparative physiology of excretion, kidney, urine formation, Thermoregulation - Comfort zone, body temperature– physical, chemical, neural regulation, acclimatization. Stress and adaptation Digestive system - Digestion, absorption, energy balance, BMR.

UNIT-III **Teaching Hours: 12**

Chemical messengers, Hormones and their feedback systems. Mechanisms of hormone action (Fixed membrane - and mobile-receptor mechanisms), Receptor signal transductions, Techniques in endocrinology (Bioassay and Radioimmunoassay) Pineal, Thymus and Gastrointestinal Hormones Anatomy, Chemistry, Assay and Biological action of adenohypophysial and neurohypophysial hormones, Pituitary pathophysiology.

UNIT-IV **Teaching Hours: 12**

Hypothalamic control of adenohypophysial function, Neuroendocrine system and neuro secretion Clinical aspects of the hypothalamo-hypophysial system Thyroid gland: Anatomy, biosynthesis and function of thyroid hormones, Antithyroid agents and control of thyroid secretion, Parathyroid gland: Anatomy, Regulation of secretion and function of parathyroid hormone.

UNIT-V **Teaching Hours: 12**

Endocrine pancreas: Anatomy, regulation of secretion, Chemistry and functions of insulin and glucagon. Adrenal gland (cortex and medulla): Anatomy, biosynthesis, function of cortical and medullary hormones and regulation of their secretion, General idea about hormones influencing carbohydrate metabolism, hormones of some invertebrates. Ethological concept, Orientation in animals, Courtship and mating behavior, Physiological basis of behavior, Learning, Migration in fishes and birds.

Recommended Books

1. Comparative Physiology: Primitive Mammals by International Conference on Comparative Physiology (4:1978: Crans-sur-Sierre) · 1980
2. Comparative Physiology of the Vertebrate Digestive System by C. Edward Stevens, Ian D. Hume · 2004
3. Comparative Physiology of Vertebrate Respiration by G. M. Hughes, George Morgan

PAPER ZOO-204 Developmental Biology
Total Teaching Hours for Semester: 60 **No of Lecture Hours/Week: 4**
Max Marks: 100 (40+60 Marks) **Credits: 4**

Course Objectives/Course Description
To introduce the concepts and process in developmental biology; to help students understand and appreciate the genetic mechanisms and the unfolding of the same during development and to expose the learner to the new developments in embryology and its relevance to Man.

Course Outcome
Apply key principles of developmental biology toward evaluating and analyzing primary literature in the field. Be able to explain key concepts, including mechanisms by which differential gene activity controls development, mechanisms that determine cell fate and mechanisms that ensure consistency and reliability of development

UNIT-I **Teaching Hours: 12**
Developmental Biology: Four principles of Karl Ernst von Baer; Gametogenesis Spermatogenesis and Oogenesis); Ultrastructure of sperm and ovum, Model organisms in developmental biology (*Caenorhabitis elegans*, Dorsophila, Amphibians, chick and mouse).

UNIT-II **Teaching Hours: 12**
Identification of developmental genes: spontaneous and induced mutation, mutant screening, developmental mutations in Drosophila. Cleavage and gastrulation; axes and germ layers; morphogenesis– cell adhesion, cleavage and formation of blastula, gastrulation, neural tube formation, cell migration; Axis specification in Drosophila; origin of anterior- posterior and dorsal- ventral patterning- role of maternal genes, patterning of early embryo by zygotic genes; segmentation genes- the gap genes, the pair– rule genes, the segment polarity genes, the homeotic selector genes- bi thorax and antennapedia complex.

UNIT-III **Teaching Hours: 12**
Development of chick limb- development and patterning of vertebrate limb, proximal-distal and dorso- ventral axis formation, homeobox genes in patterning, signaling in patterning of the limb; insect imaginal disc– determination of wing and leg imaginal discs, organizing center in patterning of the wing, butterfly wing development, the homeotic selector genes for segmental identity; insect compound eye– morphogenetic furrow, ommatidia, signaling, eyeless gene; kidney development– development of ureteric bud and mesenchymal tubules.

UNIT-IV **Teaching Hours: 12**
Postembryonic development: Growth- cell proliferation, growth hormones; aging- genes involved in alteration in timing of senescence; regeneration– epimorphic regeneration of reptile (salamander) limb, requirement of nerves for the proliferation of blastema cells; embryonic stem cells and their applications; medical implications of developmental biology: genetic errors of human development- the nature of human syndromes– pleiotropy, genetic heterogeneity, phenotypic variability, mechanism of dominance; gene expression and human disease– inborn errors of nuclear RNA processing, inborn errors of translation; Teratogenesis: Malformations and disruptions, Gene – phene relationship, Autophene, Allophene and Pleiotrophy; Teratogenic agents (Retinoic acid, pathogens, alcohol, drugs and chemicals, heavy metals); Environmental oestrogens.

UNIT-V **Teaching Hours: 12**

Metamorphosis and Regeneration: Metamorphosis of Amphibians and Insects; Hormonal control of metamorphosis. Heterochrony- neoteny, progenesis (Brief accounts); regeneration - different types of regeneration; Histological processes during regeneration; Polarity and Metaplasia in regeneration; Lens regeneration in amphibia; Bone and neural regeneration (Medical -Advances in regeneration). segmentation genes. Homeotic selector genes.

Human Welfare and Developmental Biology: Infertility - causes, ART- OI, AI, donar conception, IVF, ICSI, GIFT, ZIFT, PGD, Surrogacy. Cloning experiments- (Amphibians, Mammals and Human). Stem cells and their applications, Prenatal and Neonatal care, Ultra Sound monitoring of the fetus, Birth control, Ethical issues

Recommended Books

1. Alberts et al.: Molecular biology of the cell. Garland, 2002.
2. Gilbert: Developmental biology. Sinauers, 2003.
3. Kalthoff: Analysis of biological development. McGraw-Hill, 1996.
4. Wolpert: Principles of development. Oxford, 2002.

PAPERZOO-205 PRACTICAL

Total Teaching Hours for Semester: 120 **No of Lecture Hours/Week: 8**

Max Marks: 100 **Credits: 8**

Course Objectives/Course Description

The paper imparts practical knowledge on the biology of cells and also on the basic experiments in biochemistry. It deals with detailed microscopic studies of basic cell multiplication processes like mitosis and meiosis. Microscopy techniques are given utmost importance. Furthermore, knowledge of Genetics will help them to solve various complicated genetic problems. To study and compare the functioning of organ systems across the animal world; to give an over view of the comparative functioning of different systems in animals and to learn more about human physiology.

Course Outcome

The students gain expertise in observing cells and processes like mitosis and meiosis under microscope, which in turn will help them work better in clinical laboratories. Furthermore, the students will learn the importance of cell fractionation. Students will also learn various aspects of Genetic experiments. Students become confident to use bioinformatics softwares and work with different databases for applications in upcoming fields of biology, which in turn make them competent for jobs in clinical and medical data analysis labs. The students will understand various physiological organ-systems and their importance to the integrative functions of the animal body, especially on humans.

1. Histological slides on endocrine glands.
2. Permanent slides on different phases of cell division
3. Total count of RBC and WBC in human blood.
4. Estimation of hemoglobin in human blood.
5. Localization of mitochondria in animal cell using vital stain.
6. Demonstration of Barr bodies in human buccal mucosa cell.
7. Temporary aceto-carmine squash preparation of chromosomes.
8. Preparation of human Karyotype.
9. Genetic Problems in Recombination and Linkage
10. Genetic problems in population genetics
11. Effect of salivary amylase activity on starch at different temperature
12. Effect of salivary amylase activity on starch at different pH
13. To examine the relative activity of enzymes in the fore, mid, and hindgut of a typical insect.
14. Oxygen consumption in fish (normal and stressed).
15. Identification of different developmental stages of frog (egg, blastula, gastrula, neurula, Tadpole stage of frog with external gill and internal gill).
16. Regeneration studies in fish (Zebra Fish) / Earth worm.
17. ENTREZ, NCBI
18. Description and working principles of instruments.

Seminar presentation

Semester III

PAPER ZOO-301 Microbiology and Immunology

Total Teaching Hours for Semester: 60 **No of Lecture Hours/Week: 4**
Max Marks: 100 (40+60 Marks) **Credits: 4**

Course Objectives/Course Description

Microbes play a very significant role in the lives of higher organisms. The paper surveys the features of microbes like bacteria, viruses, fungi, algae and protozoa in order to make the students understand their biology so as to manipulate them. This course fulfils the basic knowledge in microbiology for those students who wish to pursue career in allied health fields and other technical programs. This paper focuses on the fundamental science of immunology and explores the clinical and therapeutic aspects of immunology. Topics include immune genetics and molecular structure of immune globulins, T cell & B cell development, MHC antigens, modern vaccines, functions and dysfunctions of the components of the immune system; applications of immunological technologies in modern scientific research and development. These topics will help the students to absorb most of the fundamentals in immunology and this can benefit in understanding the advanced topics in this area.

Course Outcome

This course will make the students adapt in the structure and functions of these microbes which in turn will give them confidence to work using these organisms. The students will become competent for jobs in dairy, pharmaceutical, industrial and clinical research. Understand the concepts of immunity and the mechanism of cellular and humoral immune response. Understand the genetic basis for immunological diversity in acquired immunity. Able to understand and relate to therapeutic agents used in medicine.

UNIT-I **Teaching Hours: 12**

Introduction: Concept of microbiology, Microbes and man, History of microbiology, Divisions of Microbiology, Microscopy, Microscopic units, Microbial culture, Pure culture, Subculture, Stains of microbes. Structural organisation: Prokarytic microorganisms, Structural details of prokaryotic cell. Difference between prokaryotic and eukaryotic cell, Eukaryotic microbes (Protozoa). Structure of bacteria, virus (Bacteriophage) and multiplication (Lytic cycle and Lysogenic cycle).

UNIT-II **Teaching Hours: 12**

Microbial Physiology: Growth in Bacteria: normal growth curve; methods of measuring growth. Yield and characteristics, strategies of cell division. Bacterial chemotaxis and quorum sensing. Microbes in soil ecology: fertility, petroleum formation, Microbial fermentation: manufacture of industrially important products.

UNIT-III **Teaching Hours: 12**

Infection and microbial diseases: Host-parasite relationship, Types of diseases Control of microorganisms by physical, chemical and chemotherapeutic agents, Microbial genetics: Methods of genetic transfers; Transformation, Conjugation, Transduction, Mapping genes by interrupted mating, and Transposable elements.

UNIT-IV **Teaching Hours: 12**

Cells and organs of the immune system: Hematopoiesis, Cells of the immune system, Organs of the immune system; Innate immunity: Anatomical barriers, connection between innate and adaptive immunity, Toll like receptors, Inflammation, phagocytosis; Antigen and antibody: Immunogenicity versus antigenicity, Epitope, basic structure of antibody, Antibody binding site, antibody classes and biological activity, antigenic determinant on immunoglobulin(Isotype,Allotype,Idiotype).Complementsystem(classical,alternativeandlectinpathway).

UNIT-V **Teaching Hours: 12**

Antigen-antibody interaction: Strength of antigen-antibody interactions, Cross reactivity, precipitation reactions, agglutination reactions; ELISA (indirect, sandwich, competitive) and ELISPOT assay, Western blotting);Major Histo-compatibility Complex (MHC) and antigen presentation; B-cell and T-cell receptor; B-cell maturation, activation and differentiation, T-cell maturation, activationanddifferentiation;T-cellmaturation,activationanddifferentiation;Cell mediated cytotoxic responses; Hypersensitivity reactions (Type I,II,III and IV), Cytokines, vaccine

Recommended Books

1. Black, A text book of Microbiology.
2. Crighton T.E., Proteins- Structure and Molecular Properties, W.H. Freeman and Company, NewYork.
3. Freifelder D., Essentials of Molecular Biology.
4. Freifelder D., Physical Biochemistry, W.H. Freeman and Company.
5. Kuby, W.H., Immunology, Freeman, USA.
6. Madigan et al., Brock Book of Microorganisms.
7. Paul W, Fundamentals of Immunology.
8. Prescott, Microbiology.
9. Roitt L.M., Essential Immunology, ELBS Edition.
10. Voet D. and Voet J.G., Biochemistry, John Wiley and Sons.

PAPER ZOO-302 Ecology, Biostatics and Applied Zoology

Total Teaching Hours for Semester: 60 **No of Lecture Hours/Week: 4**

Max Marks: 100 (40+60 Marks) **Credits: 4**

Course Objectives/Course Description

To learn interactions of biotic and abiotic components. To learn organizational structure of communities. To learn the human impact on the global environment. Students will also gain knowledge about the involvement of statistics in research. To introduce the concepts of origin and growth of sericulture. To understand the scientific approach to improve the mulberry and silkworm cultivation imparting knowledge in mulberry cultivation, silkworm rearing and silk reeling to create entrepreneurship in sericulture among the students community. The biology of aquatic organisms will be fully understood by the students and capable of distinguishing the biology of each group of organisms and the statistical approach of fishery science will be applied The basic principles of nutritional biology in finfish and shellfish will be gained by the students and the biochemical aspects of essential proximate composition will also be imparted. The efficacy and proper use of advanced technologies in applied aquaculture practices

Course Outcome

Understanding the sustainability and impact of biodiversity. Understanding of the ethical issues with emphasis on ecology and biology. Students will be able to perform correlation analysis during research. Students will be able to perform regression analysis during research. Differences between rearing of crossbreed and bivoltine silkworm Culturing of mulberry plant. Rearing houses, plan and maintenance. Students will have the level of expertise information in aquaculture production, design, aquaculture health, feed technology and feeding, fishing, fishing management, applied sciences, processing and evaluation.

UNIT I **Teaching Hours: 12**

Ecological principles and environmental biology -Introduction to environmental biology, Concept of ecosystem; Population and environmental health; Population dynamics- Intrinsic rate of natural increase, Population growth form, Population fluctuations and cyclic oscillation, Population density and structures, r- and k- selections and carrying capacity Biological communities and species interactions -Types of interactions between two species, Inter specific competition; Lotka-Volterra Model of inter specific competition. Modern concepts of Niche. Niche parameters. Niche overlap.

UNIT II **Teaching Hours: 12**

Bioaccumulation and bio magnification. Biogeochemical cycles: Nitrogen, Phosphorous and Sulphur cycles in terrestrial and aquatic ecosystems. Community organization and its dynamics. Energy flow models. Energy in ecological system- Law of thermodynamics as they relate to ecological energetic. Food webs. Ecological succession, its types and concept of climax. Ecology of various habitats. Remote sensing.

UNIT III **Teaching Hours: 12**

Mean, median, mode, standard deviation and Quartile deviation of grouped and ungrouped data; Concepts of Coefficient of Variation, Skewness and Kurtosis; Linear Regression and Simple Correlation; Elementary idea of Probability and Application of Theorems of Total and Compound Probability, relative frequency, probability distribution.

UNIT IV **Teaching Hours: 12**

Method of drawing of Random Sample from a Finite Population, Finding Standard Error of Sample of Mean and Confidence interval of Population Mean. Binomial, Poisson and Normal distribution; Chi-square Test of Independence and Goodness of Fit., Comparison of Means for

one Sample and Two Samples (Z and t-tests) ANOVA- One Way and Multiple Comparison, Testing Equality of k Variances, Randomized Blocks.

UNIT V **Teaching Hours: 12**

Economic Entomology- Sericulture, Apiculture, Lac culture, Aquaculture, Fish culture, Prawn culture, Pearl culture, Poultry, Dairy industry, Pest Management, Insects, Rodents.

Importance of coastal aquaculture; Aquafarms; Design and construction; Criteria for selecting cultivable species; Culture systems and management practices – extensive, semi-intensive and intensive culture practices,

Recommended Books

1. Venkitaraman: Economic Zoology (Sudarsana Publishers, 1983)
2. Srivastava: A Text Book of Applied Entomology, Vol. II & III (Kalyani Publishers,1988 & 1991)
3. Shukla & Upadhyaya: Economic Zoology (Rastogi Publishers, 1999-2000)
4. Odum: Fundamentals of Ecology (Saunders, 1971)
5. Primark: A Primer of Conservation Biology (2nd ed. Sinauer Associates)
6. Calabrese: Pollutants and High-Risk Groups (John Wiley,1978)
7. Raven, Berg, Johnson: Environment (Saunders College Publishing, 1993)
8. Bruning J.L. and B. L. Kintz (1977) Computational Handbook of Statistics, Scott,

PAPER ZOO-303Vector Biology, Molecular Diagnosis and Clinical Parasitology and Research Methodology

Total Teaching Hours for Semester: 60 **No of Lecture Hours/Week: 4**
Max Marks: 100 (40+60 Marks) **Credits: 4**

Course Objectives/Course Description

To overcome the major burden of vectors borne diseases and its molecular diagnosis and the clinical aspects also be a noteworthy contribution. Keeping this fact in mind this course paper also summarized all these things along with the research methodology (to create and nurture a research thought) with the present course. To understand the theoretical basis of conducting research. To design a research. Understanding the importance of the research paper. To impart knowledge regarding the ethics in research.

Course Outcome

By the end of this course, students will be able to find gaps in the existing research of their interest and conduct the research accordingly to write a research proposal. Publish research and review articles in the journal with impact factor. Write a project report as well as research paper.

UNIT-I **Teaching Hours: 12**

Principles of Epidemiology and epidemiological studies, Definition, aim and scope of epidemiology, target population, sampled population, Descriptive studies, Case reports, Case series – ecological and cross sectional studies. Analytical studies, observational (case-control, cohort), experimental (clinical/community trials), Surveillance concepts, tools and methods for vectors and disease, epidemic outbreak investigations. Vector Control: Aims, objectives, goals, Importance and advantages, recent trends, Alternatives to the use of insecticides (chemical, microbial), Types of vector control; Selective, integrated and comprehensive vector control. environmental management including source reduction.

UNIT-II **Teaching Hours: 12**

General concept of molecular diagnosis for parasitic infection. Advantages and disadvantages of molecular diagnosis, Fundamental techniques used in molecular diagnosis of endoparasites. clinical and laboratory diagnosis of *Hymenolepis nana*, *Clonorchissinensis*, *Enterobius vermicularis*, *Dracunculus medinensis*, *Toxoplasma gondii* and *Trichomonas vaginalis*. Clinical features of hookworm anaemia. Laboratory diagnosis of Amoebiasis, Xenodiagnosis of Parasites. Parasites as Therapeutic Organisms. Malarial parasite using ELISA, RIA. Counter Current Immuno electrophoresis (CCI), Complement Fixation Test (CFT). Epidemiology: Classification, landscape epidemiology, methods of epidemiological studies. Epidemiology of Malaria, Filaria, Kala-azar.

UNIT-III **Teaching Hours: 12**

Concepts of Research and Research Formulation: Need for research, stages of research; Basic concepts of research -Meaning, Objectives, Motivation and Approaches. Types of Research (Descriptive/Analytical, Applied/ Fundamental, Quantitative/Qualitative, Conceptual/ Empirical); Research formulation -Observation and Facts, Prediction and explanation, Induction, Deduction; Defining and formulating the research problem, Selecting the problem and necessity of defining the problem. Scientific Documentation: Laboratory record, CAS, Good Documentation Practises, Data Integrity. Workbook maintenance, Various funding agencies (National and International), Project proposal writing, Research report writing (Thesis and dissertations, Research articles, Oral communications); Presentation techniques - Assignment, Seminar, Debate, Workshop, Colloquium, Conference.

UNIT-IV **Teaching Hours: 12**

Research Communication: Basic concept and parameters of various Indexing agencies: Scopus and SC Imago (SNIP, SJR and Cite Score), Web of Science (Clarivate Analytics, Impact Factor) DOAJ, PubMed Central (PMC), Science Direct, UGC CARE, other indexing agencies (Index Copernicus, Google Scholar, EMBASE etc). Concept on Open access, types (Gold & Green).

Types of articles, basic concept on DOI, ISBN, ISSN, ORCID, Crossmark-Crossref, Concept on Volume and Issue. Literature review -Importance of literature reviewing in defining a problem, Critical literature review, Identifying gap areas from literature review. Original research article; technique of writing, different sections, finding journals (Elsevier® Journal Finder and Springer Journal Suggester). Basic concepts on Mini review, Short communication, Letter to the Editor. Commentaries, Book Chapter. Concept on publishing houses: International (e.g. Elsevier, Springer-Nature, Taylor-Francis, Willey Online, Sage etc.) and National (CSIR, Indian Academy of Science etc). Concept on Peer review process. Concept on Predatory Journal, Beall's List. Concept on Citations and References, Different referencing styles: APA, IEEE, MLA, and Chicago.

UNIT-V **Teaching Hours: 12**

Information Science and Research Software: Referencing software (EndNote, Mendeley, Zotero), Processing software (MS Word, MS Excel) Statistical software (Minitab, SPSS-ANOVA, t Test, Regression)

Ethics; Concept of Plagiarism (UGC guideline): Safety and precaution - ISO standards for safety, Lab protocols, Lab animal use, care and welfare, animal houses, hazards (symbols and NFPA Hazard Identification System) Extension: Lab to Field, Extension communication, Extension tools; Bioethics: Laws in India, Working with man and animals, Consent, Animal Ethical Committees and Constitution.

Recommended Books

1. Schimdt, G.D. and Roberts, L.S. Foundations of Parasitology
2. Hempel, P.S. Evolutionary Parasitology
3. Gunn, A. and Pitt, S.J. Parasitology: An Integrated Approach
4. Khalil, L.F. Jones, A. and Bray, R.A. Keys to the Cestode Parasites of Vertebrates
5. Rohde, K.Marine Parasitology
6. Duijn, V. 1973. Diseases of Fish
7. Dogiel, Perrushevski and Polyanski. 1958. Parasitology of fish.
8. Cheng 1964. The biology of animal parasites.
9. Smyth J.D. 1976 Introduction to Animal Parasitology.
10. Schell. 1970. How to know the trematodes.
11. Erasmus. 1972. The biology of trematodes.
12. Research Methodology- G.R. Basotia and K.K. Sharma.
13. Research Methodology- C.H. Chaudhary, RBSA Publication
14. Elements of Biostatistics in Health Science- W. Daniell.
15. Statistical Methods for Research: S. Singh et al (1988) Central Publishing Ludhiana.
16. Fundamentals of Biostatistics- Khan and Khanna, Ukaz Publication

PAPER ZOO-304 Fundamental Zoology (CBCS Syllabus)

Total Teaching Hours for Semester: 60 **No of Lecture Hours/Week: 4**
Max Marks: 100 (40+60 Marks) **Credits: 4**

Course Objectives/Course Description

For the interdisciplinary students (various subject wise) of this program the CBCS patterns might be a crucial part of present study program. The fundamental aspects of zoology also covered within the scope this course structure. That might be able to draw a good attention for others subject group learners.

Course Outcome

Understanding the sustainability and impact of biodiversity. Students will be able to perform cell biology and its components. Understanding common diseases. Students will have the level of expertise information in aquaculture production, design, aquaculture health, feed technology and feeding, fishing, fishing management, applied sciences, processing and evaluation.

Unit I: Animal Diversity **Teaching Hours: 12**

Animals and birds of national and state of Odisha importance (Lion, Tiger, Peacock, Sambar, Elephant Gangetic or freshwater Dolphin), Invertebrate in general, vertebrate in general. Animal taxonomic and classification system.

Unit I1: Evolution and Ecology **Teaching Hours: 12**

Evolutionary mechanism (Speciation; Variation; Isolation; Lamarckism and Darwinism), Ecosystem: Structural and functional components of ecosystem and energy flow models in ecosystem; Biotic and abiotic interactions. Environmental pollution and prevention (Air, water and Soil)

Unit IlI: Cell Biology Genetics & Histology **Teaching Hours: 12**

General Organization of Animal cell, Structure and functions of Plasma membrane, Mitochondrion, ER, Nucleus, Ribosomes, Golgi apparatus. Cell division (Mitosis and Meiosis). Mendelian Principles (Monohybrid and Dihybrid Cross), Mutation. Types, Structure and function of epithelial tissue, connective (bone, cartilage), muscle and nerve tissue.

Unit IV: Human Health & Diseases **Teaching Hours: 12**

Elementary idea on various systems and physiological processes of human being. Common diseases affecting human health, modern techniques in disease diagnosis & treatment.

Unit V: Economic Zoology **Teaching Hours: 12**

Beneficial insects (Honeybee, Silkmoth & Lac insects). Economic importance of Honey, Silk and Lac. Common edible fishes of Odisha, Fish products. Common breeds of domestic animals. Transgenic animals.

Recommended Books

1. Pandey Tata McGraw-Hill Education, 2003 - Animal diversity
2. Evolution and ecology of the organism by Michael Robertson Rose, Laurence D. Mueller · 2006
3. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology by P. S. Verma, V.K. Agarwal · 2018
4. BRS Cell Biology and Histology by Leslie P. Gartner · 2018
5. Applied and Economic Zoology by Dinesh Kumarnaznee Ashok Kumar Rathoure · 2015
6. Economic Zoology by G. S. Shukla, V. B. Upadhyay · 1994

PAPERZOO-305 PRACTICAL

Total Teaching Hours for Semester: 120 **No of Lecture Hours/Week: 8**

Max Marks: 100 **Credits: 8**

Course Objectives/Course Description

Microbes play a very significant role in the lives of higher organisms. The paper surveys the features of microbes like bacteria, viruses, fungi, algae and protozoa in order to make the students understand their biology so as to manipulate them. This course fulfills the basic knowledge in microbiology for those students who wish to pursue career in allied health fields and other technical programs. To provide in-depth practical knowledge in immune system as well as their functions and the anatomical details about the various animals.

Course Outcome

This course will make the students adept in the structure and functions of these microbes of various life processes which in turn will give them confidence to work using these organisms. The students will become competent for jobs in dairy, pharmaceutical, industrial and clinical research. Demonstrate a comprehensive and practical understanding of basic immunological principles involved in research and clinical/applied science. Explain the mechanisms and differences between primary and secondary responses and their relevance to immunizations.

1. Permanent slide
2. Blood group determination: Demonstration of antigen- antibody interaction by suitable method.
3. Calculation of mean, median, mode and variance of given data.
4. Test of significance using Student's t-test.
5. Estimation of pH of different water/soil by pH meter.
6. Analysis of zooplankton from different water samples.
7. Study of economically important animals (Silkworm/Honeybee/Fish/ Prawn).
8. Determination of dissolved O2 content of water.
9. Determination of dissolved CO2 content of water.
10. Determination of chlorine content of water.
11. Study of animal associations.
12. Collection of primary and secondary immune organs of Goat, sheep

Seminar presentation

Semester IV

SPECIAL PAPER ZOO-401 (A) Cell and Molecular Biology

Total Teaching Hours for Semester: 60 **No of Lecture Hours/Week: 4**

Max Marks: 100 (40+60 Marks) **Credits: 4**

Course Objectives/Course Description

In specialized subject of cell and molecular biology the gene-protein interactions profiling, regulations and multiple features of molecular techniques also highlighted. This module aims to provide students with an in-depth understanding of the basic concepts of molecular biology. The structural and functional aspects of basic biomolecules such as DNA, RNA and protein and mechanisms of DNA replication, transcription, translation and gene regulation will be dealt with. The course facilitates the students to have a strong understanding of the molecular basis of life and the underlying gen principles

Course Outcome

To provide in depth knowledge about the central dogma of life. To understanding the structure and function of DNA, RNA and protein. To understand the flow of genetic information and its regulation in cells. The offered paper must have promising roles in scientific (experimental/analytical) subject from genes to genome targeted to the application in medicinal and health sectors.

UNIT-I **Teaching Hours: 12**

Genes and genome in prokaryotes and eukaryotes, Regulation of gene expression in Prokaryotes: Operon concept, lac-operon; trp-operon, transcription attenuation, Lytic and Lysogemic cascades

UNIT-II **Teaching Hours: 12**

Regulation of gene expression in eukaryotes: Types of eukaryotic promoters, DNA-binding domains and protein-protein binding domains of regulatory proteins, Signal integration and combinational control, Transcriptional repressors, Signal transduction and control of transcription and control of transcriptional regulators, Gene silencing, siRNA.

UNIT-III **Teaching Hours: 12**

DNA replication, Enzymes and accessory proteins involved in DNA replication; DNA damage and repair; DNA amplification: Polymerase Chain Reaction, Genetic Engineering: Restriction enzymes, Different methods of construction of recombinant DNA, Cell transformation and Cloning, Transgenic animal, Expression of recombination protein using bacterial/animal vectors, Gene Knock out strategies.

UNIT-IV **Teaching Hours: 12**

Molecular techniques in genetic engineering: Isolation of DNA and RNA from animal tissues and blood, Probes, Restriction Fragment Length Polymorphism, Blotting techniques (Southern, Northern and Western), Genome sequencing (Shortgun and paired end strategies and comparative genome analysis, Study of gene expression: Transgenic and Knockout animals, Gene silencing.

UNIT-V **Teaching Hours: 12**

Application of biotechnology in Medicine and Health: Diagnosis of diseases, Production of Pharmaceuticals (hormones), Recombinant vaccines and Gene therapy. Forensic science, Human genome project, Enzyme and whole cell mobilization and its industrial application.

Recommended books

1. Alberts B., Bray D., Lewis J., Raff M., Roberts K. and Watson J.D., Molecular Biology of the Cell, Garland Publishing Inc., New York.
2. Darnell J., Lodish H. and Baltimore D., Molecular Cell Biology, Scientific American Book Inc.USA.
3. Dupraw W.J., Advances in Cell and Molecular Biology.
4. Glick, Molecular Biotechnology.
5. Lehninger, Principles of Biochemistry.
6. Meyers R.A. (E.D.), Molecular Biology and Biotechnology: A comprehensive Desk Reference, VCH Publishers,Inc.,New York.
7. Robertis De, Cell Biology.
8. Sambrook J., Fritsch E.F. and Maniatis T., Molecular Cloning: A Laboratory Mannual, Cold Spring Harbor Laboratory Press, NewYork.
9. Stryer, Biochemistry.
10. T.S. Brown, Genom1.
11. Voet D. and Voet J.G., Biochemistry, John Wiley andSons.
12. Watson J.D., Hopkins N.H., Roberts J.W., Steitz J.A. and Weiner A.M. Molecular Biology of Genes, The Benjamin/Cummings Publishing Company Inc., Tokyo.

P. G. DEPT. OF ZOOLOGY FM UNIVERSITY

SPECIAL PAPER ZOO-402 (A) Cell and Molecular Biology

Total Teaching Hours for Semester: 60 **No of Lecture Hours/Week: 4**

Max Marks: 100 (40+60 Marks) **Credits: 4**

Course Objectives/Course Description

In dedicated subject of cell and molecular biology the gene-protein interactions profiling, regulations and multiple features of molecular techniques also highlighted. The objective of this paper is to provide comprehensive idea about the structure and function of nucleic acid and regulations of gene expression.

Course Outcome

Students after attending the course will understand role of bio-molecule involved in control and expression of genetic information and gene regulation at the level of transcription and translation in a better way. The offered paper must have promising roles in advance bio-molecular science in of subject from genes-protein to clinical therapeutics supports in diverse biomedical sectors.

UNIT-I **Teaching Hours: 12**

Introduction - from genomics to metagenomics, global impact of metagenomics; Approaches to metagenomics analysis, 16S rRNA microarray (phylochip), sequence base analysis, functional based analysis, gene expression system, single cell analysis; data management and bioinformatics challenges of metagenomics, the importance of metadata, databases for metagenomics data, software, analysis of metagenomics sequence data.

UNIT-II **Teaching Hours: 12**

G-protein, Receptor tyrosine kinase, Intracellular receptors, Signal transduction through second messengers, cAMP dependent pathway, IP 3 /DAG pathway, MAPK pathway Mechanism of Steroid hormone action. RNA synthesis and processing: Transcription factors and machinery, Formation of initiation complex, RNA types and function.

UNIT-III **Teaching Hours: 12**

Antisense and ribozymes: Application of antisense and ribozyme technology in biotechnology; Heat shock proteins and their biological significance, Protein synthesis and processing: Ribosome, Formation of initiation complex, Elongation, Termination; Genetic code; Amino acylation of tRNA; Post-translational modification of proteins, Protein array, Gene chip, Protein Sequencing and peptide characterization (MALDI-TOF).

Unit IV **Teaching Hours: 12**

Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, Epigenetic modification, Angiogenesis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.

Unit V **Teaching Hours: 12**

Epigenetic landscapes of human genome; use of ENCODE and mod ENCODE to understand regulatory epigenetic landscape dynamics during development and disease; DNA modification and gene expression, analysis of DNA elements in human genome, DNA binding sites of proteins and their signature in the genome; examples of current CHIP-seq analyses in humans; transcriptional initiation through a genomic perspective, enhancer-promoter interactions, chromatin contact mapping in 3D as visualized in hi-seq/5C or FISH (3D architecture) taking examples of human studies. Studying the human transcriptome and proteome Coding vs non-coding sequences in human.

Recommended Books

1. Alberts B., Bray D., Lewis J., Raff M., Roberts K. and Watson J.D., Molecular Biology of the Cell, Garland Publishing Inc., New York.
2. Berg, Tymoczko and Stryer, Biochemistry, W.H. Freeman, NY.
3. Darnell J., Lodish H. and Baltimore D., Molecular Cell Biology, Scientific American Book Inc.USA.
4. Dupraw W.J., Advances in Cell and Molecular Biology.
5. Glick and Pasternak, Molecular Biotechnology.
6. Meyers R.A. (E.D.), Molecular Biology and Biotechnology: A comprehensive Desk Reference, VCH Publishers, Inc. New York.
7. Nelson and Cox, Lehninger Principles of Biochemistry, W. H. Freeman, NY.
8. Robertis De, Cell Biology.
9. Sambrook J., Fritsch E.F. and Maniatis T., Molecular Cloning: A Laboratory Mannual, Cold Spring Harbor Laboratory Press, New York.
10. Voet D. and Voet J.G., Biochemistry, John Wiley and Sons.
11. Watson J.D., Hopkins N.H., Roberts J.W., Steitz J.A. and Weiner A.M., Molecular Biology of Genes, The Benjamin/ Cummings Publishing Company Inc. Tokyo.

P. G. DEPT. OF ZOOLOGY FM UNIVERSITY

PAPER ZOO-401 (B) BIOSYSTEMATICSANDTAXONOMY

Total Teaching Hours for Semester: 60 **No of Lecture Hours/Week: 4**
Max Marks: 100 (40+60 Marks) **Credits: 4**

Course Objectives/Course Description

This chapter will support students about the specified understanding of multiple phenomenons in biosystematics and taxonomy. Such things have effective parts of the course structure and special paper also. To gain understanding and appreciation of animal diversity, their phylogeny and the recent progress in the field and to understand the general concepts of evolution of animal development, morphology, genomes, natural selection, and speciation and other characters.

Course Outcome

Students come to know the information needed to construct phylogenetic tree of animals to distinguish between morphological and molecular data in creating phylogenetic trees. To understand biological evolution, natural selection

UNIT-I **Teaching Hours: 12**

Taxonomic evidence and evolutionary interpretation: Definition and evidence, Kinds of evidence, Similarity, Homology and Homoplasy.

UNIT-II **Teaching Hours: 12**

Taxonomy to classification: Principles, objectives and arbitrariness, Monophyly and polyphyly, Grades and clades, Vertical and horizontal relationships, Divergence and diversity splitting and lumping, Relative antiquity, Ranks of characters.

UNIT-III **Teaching Hours: 12**

Taxonomic collection: Species registry, Collection methods, Preservation of collected material (curating preparation, relaxing, mounting, storage, cataloguing, maintaining quality of collection).

UNIT-IV **Teaching Hours: 12**

Identification methods: Literature, Keys, Pictures, Direct comparison, Combination of different methods in identification, Taxonomic publication, Preparation of taxonomic papers (description of keys, classification, synonymies, bibliography, nomenclature, illustrations).

UNIT-V **Teaching Hours: 12**

Reference works in taxonomy: Zoological record, Abstracts (biological, dissertation, entomology, helminthology, and protozoology), Taxonomy on web.

Recommended Books

1. GotoH.E.,AnimalTaxonomy, HodderAmoldH&S.
2. GreggJ.R. The Language of Taxonomy-An Application of Symbloic Logic to the Study of Classificatory System, Columbia University Press, NewYork.
3. Kapoor V.C., Principles and Practices of Animal Taxonomy, Science Publishers, NewDelhi.
4. Mayr E. and Ashlock P.D., Principles of Systematic Zoology, Mac Graw-Hill, Inc, NewDelhi.
5. Minelli A., Biological Systematics- The State of Art, Chapman and Hall,London.
6. Narendran T.C., An Introduction to Taxonomy, Zoological Survey of India,Kolkata.
7. Scott-Ram N.R., Transformed Cladistics, Taxonomy and Evolution, Cambridge

PAPER ZOO-402 (B) BIOSYSTEMATICSANDTAXONOMY

Total Teaching Hours for Semester: 60 **No of Lecture Hours/Week: 4**

Max Marks: 100 (40+60 Marks) **Credits: 4**

Course Objectives/Course Description

This chapter will support students about the specified understanding of multiple phenomenons in biosystematics and taxonomy. Such things have effective parts of the course structure and special paper also. To gain understanding and appreciation of animal diversity, their phylogeny and the recent progress in the field and to understand the general concepts of evolution of animal development, morphology, genomes, natural selection, and speciation and other characters.

Course Outcome

Students come to know the information needed to construct phylogenetic tree of animals to distinguish between morphological and molecular data in creating phylogenetic trees. To understand biological evolution, natural selection

UNIT-I **Teaching Hours: 12**

Molecular taxonomy: Population structure, Identification of species boundaries, Estimation of phylogenies.

UNIT-II **Teaching Hours: 12**

Collection and storage of tissues: Regulations, Removing and preserving tissues in the field (packing, documentation, preservation), Procedures (anesthesia, blood and haemolymph collection, venom collection), Transportation and storage of tissues.

UNIT-III **Teaching Hours: 12**

Barcoding: An initiative to inventorize species; Human Resources; Institutions- National and International organizations associated with taxonomic studies; Rules of Zoological Nomenclature.

UNIT-IV **Teaching Hours: 12**

Species concept and lower categories: The genetic species, Evolutionary species, Other kinds of species (taxonomic species, morpho species, palaeo species, bio species, agamo species), Subspecies, Other intraspecific groups, Super species.

UNIT-V **Teaching Hours: 12**

Higher categories: Base for recognition of higher taxa, Definition and characteristics of higher categories, Analysis of phylogenetic pattern, Examples of mammalian phylogeny, Evolutionary basis of taxa.

Recommended Books

1. Goto H.E., Animal Taxonomy, hodder Amold H &S.
2. GreggJ.R., The Language of Taxonomy-An Application of Symbolic Logic to the Study of Classificatory System, Columbia university Press, New York.
3. Hillis Eds. David M. and Mortitz Craig, Molecular Systematics, Sinauer Associates, Inc. Publishers, Sunderland, USA.
4. Mayr E. and Ashlock P.D., Principles of Systematic Zoology, Mac graw-hill, Inc, New Delhi.
5. Minelli A., Biological Systematics. The State of Art, Chapman and Hall, London
6. Narendran T.C., An introduction to Taxonomy, Zoological Survey of India,Kolkata.
7. Principles and Practices of Animal Taxonomy, by V.C.Kapoor, Science Publishers, New Delhi.
8. Scott-Ram N.R., Transformed Cladistics, Taxonomy and Evolution, Cambridge University Press, Cambridge.

PAPER ZOO-403 PRACTICAL

Total Teaching Hours for Semester: 120 **No of Lecture Hours/Week: 8**
Max Marks: 100 **Credits: 8**

Course Objectives/Course Description

To understood the principle behind various technique in Molecular Biology.

Course Outcome

Learn various techniques in molecular biology like DNA and RNA estimation. The students will become competent for jobs in dairy, pharmaceutical, industrial and clinical research.

1. Permanent Slide
2. Genomic DNA isolation from animal liver
3. Genomic DNA isolation from bacteria
4. Genomic DNA isolation from cauliflower
5. DNA estimation by DPA method
6. RNA estimation by Orcinol method
7. Estimation and purity checking of DNA and RNA by spectrophotometry
8. Isolation of DNA from yeast by microwave method and boiling assisted method
9. RNA isolation from Baker's yeast
10. Screening of auxotrophic mutants
11. Bacteriophage assay
12. Physical Mutagenesis

Seminar presentation

PAPER ZOO-404 PROJECT WORK

Total Teaching Hours for Semester: 0 **No of Lecture Hours/Week: 0**
Max Marks: 100 **Credits: 4**

Course Objectives/Course Description

The main objective of this course is the awareness and understanding of students in different research.

Course Objectives/Course Description

Students will be able to

1. Design an experiment that is innovative and productive.
2. Write a good research proposal, which will help them in their future career. Gain patience and perseverance to conduct quality research.
3. Apply good manufacturing practices during industrial work design experiments from pilot to large scales
4. synthesize products of industrial importance

Unit-1 **Teaching Hours: 0**

Not Applicable

Not Applicable

Text Books and Reference Books:

As per project

Essential Reading / Recommended Reading

As per project

Evaluation Pattern

Components- Thesis Submission and Viva

PAPER ZOO-405 PROJECT PRESENTATION

Total Teaching Hours for Semester: 0 **No of Lecture Hours/Week: 0**

Max Marks: 100 **Credits: 4**

Course Objectives/Course Description

The main objective of this course is present the project work

Course Outcome

Students will be able to

Assess the rational, empirical, and methodological strengths and weakness of different studies. Conduct a systematic search of the relevant presentation, in a defined area of psychological interest. Learning how to judiciously select studies and report their findings based on relevance.

Unit-1 **Teaching Hours:0**

Not Applicable

Not Applicable

Text Books and Reference Books:

As per presentation

Essential Reading / Recommended Reading

As per presentation

Evaluation Pattern

Components- presentation and open discussion

****

VALUE ADDED COURSE ON:
INDUSTRIAL FISH AND FISHERIES

SEC Course Title: FISH AND FISHERIES **CREDITS: 3**

1. Course /Paper Title: **Fishing Technology**
2. Maximum Marks: 100
   i) External (Univ. Exam.): 80
   ii) Internal Assessment: 20
4. Minimum Pass Marks
   i) External: 30
   ii) Internal: 07
5. Duration of Univ. Exam. : 3Hrs

Note: 1: There shall be one written theory paper of 50 marks. 20% marks shall be reserved for internal assessment (10 marks). 80% of the marks (40 marks) shall be reserved for external examination to be conducted by the University. Theory paper will be set for 40 marks.

Internal Assessment Test (20 marks)

The internal assessment under Choice Based Credit System shall be of 1 hour duration and shall comprise of two parts.

Part A: Total weightage of Part A will be10 marks and shall comprise of 8 short questions selecting at least from 2 to 3 units (50% of syllabus covered). A candidate will have to attend any 5 questions each carrying 1 mark.

Part-B: Total weightage of Part-B will be 10 marks and shall comprise of 2 long answer questions from first 2 to 3 units. A Candidate will have to attempt only 1 question of 5 marks.

Note 2: For paper setters: External End Semester University Examination

External examinations in theory shall consist of the 3 sections.

Section A: Section-A shall be of 16 marks and will comprise of 8 short answer type questions, one from each of the units and carrying 2 marks each. Answers should be precise having 40 to 60 words only and without any detailed explanation (**All Compulsory**).

Section B: Section-B shall be of 24 marks and will comprise of 4 medium answer type questions, one from each of the units and carrying 6 marks each. Answers should be comprehensive having 150 to 200 words only and with detailed explanation (**All Compulsory**).

Section C: Total weightage of Section-C shall be 40 marks and will comprise of 5 long answer type questions, one from each of the units. A candidate will have to attempt only 2 questions from all the questions and will carry 8 marks each. Answers should be of 500 to 600 words with detailed analysis/explanation/critical evaluation to the question.

Core Course Title: Aquaculture **CREDITS: 3**

Unit–I Basics of Aquaculture (10 hours)

1.1 Definition and History of aquaculture
1.2 Status and importance of aquaculture
1.3 Aquaculture practices
1.3.1 Extensive, Semi-intensive and Intensive aquaculture
1.3.2 Cage and Pen culture
1.3.3 Composite culture
1.3.4 Integrated fish farming
1.4 Criteria of selection of Cultivable Fish Species

Unit–II Preparation of Culture Ponds (10 hours)

2.1 Criteria of selection of suitable site for fish farms
2.2 Different types of ponds (Nursery, Rearing and Stocking ponds)
2.3 Preparation of Ponds
2.3.1 Control of aquatic insects
2.3.2 Control of aquatic weeds
2.3.3 Fertilization of ponds
2.4 Procurement and stocking of Seeds

Unit-III Fish Feed and Breeding Technology (10 hours)

3.1 Artificial feeding and its importance in aquaculture
3.2 Manufacture and formulation of fish feed
3.3 Feeding techniques (manual and mechanical)
3.4 Induced breeding
3.5 Design and working of Circular Hatchery
3.6 Bundh breeding (Dry and Wet bundh)

Unit–IV Fish Biotechnology and Health Management (10 hours)

4.1 Cryopreservation of gametes
4.2 Transgenic fish
4.3 Fish diseases and diagnosis
4.3.1 Bacterial diseases – Furunculosis, Columnaris
4.3.2 Fungal diseases – Saprolagnesis, Branchimycosis
4.3.3 Protozoan diseases – Ichthyophthiriasis, Costasis
4.4 Fish immunization and vaccination

Books Recommended

1. Jhingran, V.G. (1985) Fish and Fisheries of India
2. Rath, R.K. (2000) Freshwater Aquaculture
3. Gupta, S.K and Gupta, P.C (2008) General and applied ichthyology (Fish and Fisheries)
4. Ayyappan, S (2010) Handbook of Fisheries and Aquaculture
5. Pillay, T.V.R (1993) Aquaculture Principles and Practicies
6. Srivastava, C.B.L (2006) Atextbook of fishery science and Indian fisheries
7. Paulraj, R (1997) Aquaculture feed