M. Sc. ZOOLOGY SYLLABUS

Course Structure under

Choice Based Credit System
(CBCS)

SemesterPatternExamination
(As per UGC model curriculum)
For academic session: 2021-22

FAKIR MOHAN UNIVERSITY
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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:

1. 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.

2. Provide inexpensive educational services, inspire to all the section of society to get expertise /skills at P.G. and above level in biological sciences.

3. To develop research aptitude and a scientific advancement.

4. Inculcate high values through a liberal education and also to provide platform to have non-formal educational services.

5. 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.

6. Provide a broad range of Transform society through the empowerment of youth.

7. 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:

1. To encourage a clear, comprehensive and advanced knowledge in the field of animal sciences.

2. To provide basic principles of biological sciences with special reference to Zoology and its applied branches.

3. To enable the students to explore the intricacies of life forms at cellular, molecular and nano-level.

4. 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.

5. 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.

6. 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

1. Students will be able to understand Nature, environment natural resources and their conservation, Classification & ethology of different animals, Human genetics, cell biology and Evolution.

2. 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.

3. Able to distinguish between the Structure, Function, Behaviour and evolution of different animals.

4. Students will Perform, Assess and implement practical techniques and procedure to solve biological problems and analyses and quantify data collected during any project.

5. Students will understand the applications of Biological techniques tovarious 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. 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

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

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.

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

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.

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; 1st, 2nd or 3rd

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.

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 and Wildlife Management**	Theory	4	100 [40+60]
3	**ZOO-103**	**Evolution and Biogeography**	Theory	4	100 [40+60]
4	**ZOO-104**	**Biochemistry**	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 and Endocrinology and**	Theory	4	100 [40+60]
4	**ZOO-204**	**Comparative Embryology**	Theory	4	100 [40+60]
5	**ZOO-205**	**Practical**	Practical	8	100
Total				**24**	**500**

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**	**(A)Cell and Molecular Biology, Biotechnology or (B) Biosystematics and taxonomy**	Theory	4	100 [40+60]
3	**ZOO-402**	**(A)Cell and Molecular Biology, Biotechnology or (B) Biosystematics and taxonomy**	Theory	4	100 [40+60]
4	**ZOO-403**	**Practical**	Practical	8	100
5	**ZOO-405**	**PROJECT**	Dissertation	4	100
6	**ZOO-404**	**PROJECT PRESENTATION**	Presentation	4	100
Total				**24**	**500**

SEMESTER SYSTEM OF 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 40+60 Marks

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

Protozoa (Protist animals): Nucleus and reproduction, Colonial protozoans and theories on the origin of metazoans. Porifera: Canal system.

Cnidaria: Nematocysts and Polymorphism in Siphonophora. Annelida: Adaptive radiation in polychaetes and Trochophore larva: structure and significance.

UNIT-II

Mollusca: Nervous system and Modifications of foot. Arthropoda (excluding insects): Affinities of trilobites, Crustacean larvae and their significance. Echinodermata: larval forms and their significance

UNIT-III

Salient features and affinities of: Placozoa, Mesozoa, Ctenophora, Rotifera,Phoronida, Echiura and Sipuncula. Characteristic features and affinities of the following: Protochordata(Hemichordata, Urochordata, Cephalochordata), Cyclostomes and Dipnoi.

UNIT-IV

Origin of the following: Amphibia, Reptiles, Birds and Mammals. Adaptive radiation in Chordates: Aquatic, Terrestrial, Aerial, Arboreal, Fossorial. Parental care in Amphibians.

UNIT-V

Skull in Reptiles. Venom and anti-venom in Ophidians. Flightless birds. Modification of beaks, feet and palate in birds. Dentition. Stomach in ruminant.

Recommended Books

1. Barnes: Invertebrate Zoology (Holt-Saunders International, 4th edition, 1980)
2. Barnes: The Invertebrates – A synthesis, 3rd edition, Blackwell, 2001
3. Hunter: Life of Invertebrates, Collier Macmillan Pub. 1979
4. Marshall: Parker &Haswell Text Book of Zoology, Vol. I, 7th edition, Macmillan, 1972
5. Moore: An Introduction to the Invertebrates, Cambridge University Press, 2001
6. Boolootian, R. A. and Stiles, K. A., College Zoology, 10th edition, Macmillan Publishing Co., Inc. New York, 1981.
7. 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.
8. Farner, D. S. and King, J. R., Avian Biology (in several volumes), Academic Press, New York, 1971.
9. Goodrich, E. S, Studies on Structure and Development of Vertebrates, Dover Publication, New York, 1958.
10. Hildebrand, M. Analysis of Vertebrate Structure, 4th edition, John Wiley & Sons, Inc., New York, 1995.
11. 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.
12. 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.
13. Moore, J. A., Biology of Amphibia, Academic Press, 1964.
14. Parker, T. S. and Haswell, W. A., TextBook of Zoology, Vol. II, ELBS, 1978.
15. Romer, A. S. and Parsons, T. S., The vertebrate body, 6th edition, CBS Publishing Japan Ltd, 1986.
16. Sinha, A. K., Adhikari, S. and Ganguli, B. B.: Biology of Animals, Vol. II, New Central Book Agency, Calcutta, 1988.
17. Young, J. Z. The life of vertebrates, 3rd edition, ELBS with Oxford University Press, 1981.

PAPER ZOO-102 Biosystematics, Biodiversity and Wildlife Management

40+60 Marks

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

Definition and basic concepts of Biosystematics and Taxonomy, Importance and applications of biosystematics in biology, Materials basis of biosystematics: different attributes. Trends in biosystematics - Chemotaxonomy, Cyto-taxonomy and Molecular taxonomy. Principles & methods of Animal Taxonomy: Concepts of species and hierarchical taxa, biological nomenclature, classical &quantitative methods of taxonomy of animals. and Diversity Ecology and Evolutionary Biology Conservation.

UNIT II

Procedure keys in taxonomy, Taxonomic procedures - Taxonomic collections, Preservation,Curation, Process of identification. InternationalCode of Zoological Nomenclature (ICZN)-Complete code. Biodiversity indices and their uses.

UNIT III

Wildlife habitat, species and populations. Threat of species extinction. Wildlife Health and Population Management; Wildlife Health; Population Management- Capture and Handling of Wild Animals. Radio telemetry.

UNIT IV

Concept of conservation with special reference to forest and wildlife management a) Conservation verses preservation b) Conservation Genetics-Genetic management of threatened species and c) Management and Conservation Practice d) Values of biodiversity and conservation ethics e) Significance of ecological restoration in conservation Concept of stakeholders. International conservation bodies; IUCN, UNDP, FAO, WWF

UNIT V

Organisms of conservation concern: Rare, endangered species. Conservation strategies.Genomics and Biodiversity Molecular Tools for diversity Studies-Significance of Molecular Tools in Diversity and Conservation Studies,Barcoding.

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.

PAPER ZOO-103Evolution and Biogeography **40+60 Marks**

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

An overview of evolutionary thoughts, developments and the concept of synthetic theory.Population genetics: Gene frequencies in Mendelian population, Hardy-Weinberg law-its formalization and application and Conditions for the maintenance of genetic equilibrium.

UNIT II

Elemental forces of evolution, Mutation, Selection (types of selection, selection coefficient, selection in natural population), Migration and Genetic drift: Changes in gene frequency in small population.

UNIT-III

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

Phylogenetic relationship. Chromosome phylogeny in Drosophila (based on inversion polymorphism). Molecular phylogenies. Neutral theory, Molecular clock. The polytypic species, subspecies and infraspecies categories. The role of hybridization in evolution: Definition and immediate effect of hybridization

UNIT V

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.Species distribution. Biogeographical zones of India.

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

PAPERZOO-104 Biochemistry 40+60Marks

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

Structure of atoms, molecules and chemical bonds. Thermodynamics: Elementary knowledge, oxidation-reduction, Principles of biophysical chemistry: pH, buffer, Handerson-Hasselbach equation, colligative properties. Stabilizing interactions (Van der Waals, hydrophobicinteraction).Carbohydrates: Chemistry, Pathways, their integration and regulation[Glycolysis and gluconeogenesis, Kreb's cycle, oxidative phosphorylation, Hexose monophosphate pathway, glycogen metabolism], peptidoglycan.

UNIT II

Amino acid: Sources of amino acids: Dietary proteins and intermediates of carbohydrate metabolism; Protein structure: secondary,tertiary and quaternary structure, Ramachandran plot, protein isolation, Solubility and protein targeting. Molecules derived from amino acids: Porphyrin, bilirubin, creatine, glutathione, dopamine, noradrenaline, adrenaline, GABA, serotonin, histamine, melanin, thyroxine Structure, Synthesis and significance of polyaminesAmino Acid Catabolism-Transamination, Deamination: Transdeamination and oxidative deamination, Toxicity of ammonia, Ammonia detoxification, Urea cycle, Reactions and their regulation.

UNIT III

Lipids: chemistry, Cholesterol: Biosynthesis and degradation, Lipid transport and storage, Fatty acid metabolism, Biosynthesis of eicosanoids: Prostaglandins, leucotrienes and thromboxanes, Structure and function of eicosanoids. Nucleic acids: Biosynthesis and regulation of purine and pyrimidine nucleotides, Catabolism of purines and pyrimidines.

UNIT IV

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; Kinetics-Single substrate reactions: Steady state and equilibrium kinetics, Michaelis-Menten equation and plot, Linear kinetic plots: Lineweaver Burk, Edie Hofstee, Cornish Bowden, Calculations on enzyme kinetics;Multi-substrate reactions-Random sequential, Ordered, Theorel-Chance mechanism, Ping-pong (double reciprocal) mechanism;

UNIT V

Enzyme Inhibition-Competitive; Non-competitive; Un-competitive and mixed, Determination of nature of inhibition and Ki by LB & Dixon plots; Regulation: allosterism, covalent modifications; Multi enzyme complex and multifunctional enzymes; Enzyme distribution, diversity and evolution; 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-105PRACTICAL **100**Marks

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.

1)Taxonomic study of museum specimens on non-chordrates.

2)Histological slides on endocrine glands.

3)Total count of RBC and WBC in human blood.

4)Estimation of hemoglobin in human blood.

5)Blood group determination: Demonstration of antigen- antibody interaction by

Suitable method.

6)Localization of mitochondria in animal cell using vital stain.

7)Demonstration of Barr bodies in human buccal mucosa cell.

8)Temporary aceto-carmine squash preparation of chromosomes.

9)Permanent slides on different phases of cell division

10)Calculation of Biodiversity indices.

11)Preparation of human Karyotype.

12)Problems related to genetics.
13)Fixativesandstainingtechniqueforhistologicalsection(Microtomy).

Semester II

PAPER ZOO-201Cell Biology and Genetics **40+60 Marks**

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

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

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

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

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

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)
7. Snustad& Simmons: Principles of Genetics (John Wiley, 2003).

PAPER ZOO-202 Instrumentation, Biophysics and Bioinformatics 40+60 Marks

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

Microscopy: Principle of operation and Instrumentation of light, Fluorescent and Electron microscopy, Microtomy. Chromosome analysis, Karyotyping and Karyomorphometrical analysis, Taxidermy. Centrifugation: Principle of sedimentation, Methods in preparatory ultracentrifugation (Differential and density gradient Centrifugation), Chromatography: Principle and application of molecular exclusion chromatography, Ion exchange chromatography, Affinity chromatography, Gas-liquid chromatography and HPLC. Electrophoresis: Principle and application of electrophoretic separation, Types of solid support used (Cellulose acetate, Starch, Agar, Agarose and PAGE) and its importance, Isoelectrofocussing.

UNIT-II

Spectrophotometry: Principle and application of ultraviolet and visible spectrophotometry andSpectrofluorimetry, X-ray diffraction crystallography, Radioisotopic techniques: Nature of radioactivity, application of radioactivity in biology (carbon dating, liquid scintillation counting, Geiger- Muller counter, autoradiography).

UNIT-III

Concept of biomolecules: Chemical composition and bonding, three dimensional structure, Chemical reactivity, macromolecules and their monomeric submits, Weak interactions in aqueous system, ionization of water, weak acids, weak bases, buffers and buffering capacity, Principle of bioenergetics: Bioenergetics and thermodynamics, phosphoryl group transfers and ATP, Biological oxidation reduction reactions.

UNIT- IV

Thermodynamics–Isolated, close and open system, first and second law of thermodynamics, enthalpy and entropy, Biological steady state and its maintenance, Gibb's free energy. Model Membrane and dynamics. Nanotechnology – Characteristics of nanoparticles and application.

UNIT-V

Basics of computers. Internet: Webpages, Internet protocols, Search engines, Subject Directories etc. Biological Database management systems, Nucleic acid sequences databases, Genome databases (e.g. Human Genome Project), Protein sequence and structure databases. Applications of bioinformatics: Data retrieval systems: data query and data mining (Pubmed, Entrez), Sequence retrieval system (SRS) and protein identification resource (PIR). Molecule structure: domains, folds and motif analysis.

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 and Endocrinology 40+60 Marks

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

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 ofheart 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

Nervous system - Neurons, action potential, gross neuroanatomy of the brainand 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, urineformation, Thermoregulation - Comfort zone, body temperature– physical, chemical, neural regulation, acclimatization. Stress and adaptation Digestive system - Digestion, absorption, energy balance, BMR.

UNIT-III

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 neurohypophysialhormones, Pituitary pathophysiology.

UNIT-IV

Hypothalamic control of adenohypophysial function, Neuroendocrine system and neurosecretion 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

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.

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 40+60Marks

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

Developmental Biology: Four principles of Karl Ernst von Baer; Gametogenesis Spermatogenesis and Oogenesis); Ultrastructure of sperm and ovum, Model organisms in developmental biology (*Caenorhabitiselegans*, Dorsophila, Amphibians, chick and mouse).

UNIT-II

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seedformation and germination.

UNIT-III

Descriptive embryology with particular reference to frog and chick Egg types; Cleavage Patterns; Fate maps; Morphogenetic movement and formation of germ layers; Gastrulation in amphibian and birds.

UNIT-IV

Organizer concept: Properties and physiology of organizer; Primary Organizer and Primary Induction, neurulation. Secondary Induction: Development and patterning of vertebrate limb, proximal- distal and dorso- ventral axis formation, Involvement of pattern forming genes.

UNIT-V

Experimental Embryology: Basic Concepts Standard techniques and methods of experimental embryology: Experiments on the analysis of early development and differentiation (Experiments of Spemann and Mangold) vital dyeing, extirpation, isolation, transplantation Role of nucleus, cytoplasm and yolk.

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-205PRACTICAL 100marks

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) Calculation of mean, median, mode and variance of givendata.
2) TestofsignificanceusingStudent ' st-test.
3) Studyofdifferentlarvalstagesoffrog/toad.
4) Histological slides related to frog/toad and chickembryology.
5) Estimation of lipids andcholesterol.
6) Window preparation of chick embryo at 48/72 hours ofincubation.
7) ValidationofBeer-Lambert ' slawbyUV-visiblespectroscopy.
8) Absorption maxima of bromophenol bluesolution.
9) Separationofaminoacidsbypaperchromatography.
10) Estimation of pH of different water/soil by pH meter.
13) Analysis of zooplankton from different watersamples.
14) Census techniques to countanimals.
15) Studyofeconomicallyimportantanimals(Silkworm/Honeybee/Fish/ Prawn).
16) SeminarPresentation.

Semester III

PAPER ZOO-301 MicrobiologyandImmunology 40+60 Marks

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

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

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

Infectionand microbial diseases:Host-parasiterelationship,TypesofdiseasesControl of microorganisms by physical, chemical and chemotherapeutic agents, Microbial genetics: Methods of genetic transfers; Transformation, Conjugation, Transduction,Mapping genesbyinterrupted mating, and Transposableelements.

UNIT-IV

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,alternativeandlectin pathway).

UNIT-V

Antigen-antibody interaction: Strength of antigen-antibody interactions, Cross reactivity, precipitation reactions, agglutination reactions; ELISA (indirect, sandwich,competitive)andELISPOTassay,Westernblotting);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 ofMicrobiology.
2. Crighton T.E., Proteins- Structure and Molecular Properties, W.H. Freeman and Company, NewYork.
3. Freifelder D., Essentials of MolecularBiology.
4. Freifelder D., Physical Biochemistry, W.H. Freeman andCompany.
5. Kuby, W.H., Immunology, Freeman,USA.
6. Madigan et al., Brock Book ofMicroorganisms.
7. Paul W, Fundamentals ofImmunology.
8. Prescott,Microbiology.
9. Roitt L.M., Essential Immunology, ELBSEdition.
10. Voet D. and Voet J.G., Biochemistry, John Wiley andSons.

PAPERZOO-302 Ecology, Biostatics and Applied Zoology 40+60Marks

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

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, Interspecific competition; Lotka- Volterra Model of interspecific competition. Modern concepts of Niche. Niche parameters. Niche overlap.

UNIT II

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

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

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

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

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-303 Vector Biology, Molecular Diagnosis and Clinical Parasitology, Ethology and Research Methodology 40+60Marks

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

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.

UNIT-II

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-III

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, Enterobiusvermicularis, Dracunculusmedinensis, Toxoplasma gondii* and *Trichomonasvaginalis*. 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-IV

Objective and significance of animal behavior. Major contribution of scientists: In classical ethology and modern behavioural biology. Methods of study of animal behavior, Development of behaviour: Innate and Learned; Comparative account on characteristics of instinct and learning; Types of fixed action patterns (FAPs); Neuro-genetic mechanism of instinct. Learning and Memory: Classification or forms of learning and memory, Neural mechanisms of learning and memory. Evolution of behaviour, Hormones and behaviour, Motivation and behavior, Pheromones, Territoriality, Mating and sexual behavior in vertebrate and invertebrate.

UNIT-V

Research: Definition, importance, meaning and characteristics. Steps in Research. Research problem: identification, selection and formulation. Data: definition, types, sources, data collection methods. Review of literature, Reference and Bibliography. Research report: types, contents, styles and steps in drafting. Editing the final draft, way of writing papers and Thesis writing. Significance of Impact factor, citation index, science citation index, HOG index and SCOPUS. Regulatory guidelines and Ethics in Research: Safety issues and Biosafety regulation related to recombinant DNA research. Ethical issues and regulations for using transgenic plants and genetically modified crops. Ethical issues related to the use of small and large animals for research. Ethical issues related to the use of human - subjects, embryos, tissues, and stem cells - for research.

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. Alcock: Animal Behaviour- An Evolutionary Approach. (7th ed.) Sinaur Associates, Inc. 2001.
13. Drickamer&Vessey: Animal Behaviour –Concepts, Processes and Methods (2nd ed.), Wadsworth,1986.
14. Gadagkar: Survival Strategies-Cooperation and Conflict in Animal Societies. UniversitiesPress,1998.
15. Goodenough et al: Perspectives on Animal Behaviour, Wiley, 1993.
16. Grier: Biology of Animal Behaviour, Mosby, 1984.
17. Hallidy and Slater: Animal Behaviour (vols. I-3) Blackwell Scientific Publ., 1983.
18. Krebs &Davis: Behavioural Ecology. (3rd ed.) Blackwell, 1993.
19. Lehner: Hand Book of Ethological Methods. (2nd ed.) Garland, 1996.
20. Manning &Dawkins: An introduction to Animal Behaviour (5th ed.), Cambridge Univ. Press, 1998.
21. Slater &Halliday: Behaviour and Evolution, (1st ed.) Cambridge Univ. Press, 1994

PAPER ZOO-304 Fundamental Zoology (CBCS Syllabus) 40+60 Marks

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

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

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

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: Wildlife Management

Wildlife habitat, species and populations. Threat of species extinction. Wildlife Health and Population Management. Organisms of conservation concern: Rare, endangered species. Conservation strategies.

Unit V: Economic Zoology

Sericulture, Apiculture, Pisciculture, Lac culture, Earthworm farming (Vermiculture), marine, dairy and biotech based products etc.

Recommended Books

1. Pandey Tata McGraw-Hill Education, 2003 - Animal diversity
2. Cleveland P. Hickman, Larry S Roberts, Susan L. Keen, Allan Larson, David Eisenhour McGraw-Hill Higher Education, 01-Oct-2008- Animal diversity
3. Evolution and ecology of the organism by Michael Robertson Rose, Laurence D. Mueller · 2006
4. Evolutionary Ecology by Eric R. Pianka · 2011
5. Evolutionary Ecology Concepts and Case Studies by Derek A. Roff, Riverside Daphne J. Fairbairn Professor of Biology both at The University of California, Daphne J. Fairbairn · 2001
6. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology by P. S. Verma,

V.K. Agarwal · 2018

7. BRS Cell Biology and Histology by Leslie P. Gartner · 2018
8. Applied and Economic Zoology by Dinesh Kumarnaznee Ashok Kumar Rathoure · 2015
9. Economic Zoology by G. S. Shukla, V. B. Upadhyay · 1994

PAPERZOO-305PRACTICAL **100***marks*

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) Comparative osteological studies of vertebrates (Amphibia, Reptilia, Aves and Mammalia).

2) Study of histological slides ofchordates.

3) Museum specimen ofchordates

4) Spectrophotometric estimationprotein.

5) Spectrophotometric estimationDNA.

6) Spectrophotometric estimationRNA.

7) Demonstrate the presence of sugar and ketone bodies inurine.

8) Effects of temp on enzyme activity (anyenzyme).

9) EffectsofpHonenzymeactivity(anyenzyme).

10) Effects of substrate concentration on enzyme activity (anyenzyme).

11) Estimation of alkaline phosphatase enzymeactivity.

12) Field tourreport.

Semester IV

PAPER ZOO-401 (A) Cell andMolecularBiology 40+60 Marks

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

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

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

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

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

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., NewYork.
2. Darnell J., Lodish H. and Baltimore D., Molecular Cell Biology, Scientific American Book Inc.USA.
3. Dupraw W.J., Advances in Cell and MolecularBiology.
4. Glick, MolecularBiotechnology.
5. Lehninger, Principles ofBiochemistry.
6. MeyersR.A.(E.D.), MolecularBiologyandBiotechnology:AcomprehensiveDesk Reference,VCHPublishers,Inc.,NewYork.
7. Robertis De, CellBiology.
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 BiologyofGenes,TheBenjamin/CummingsPublishingCompanyInc.,Tokyo.

PAPER ZOO-402 (A) Cell and Molecular Biology 40+60 Marks

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

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

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

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; Aminoacylation of tRNA; Post-translational modification of proteins, Protein array, Gene chip, Protein Sequencing and peptidecharacterization (MALDI-TOF).

Unit IV

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

Epigenetic landscapes of human genome; use of ENCODE and modENCODE 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., NewYork.
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 MolecularBiology.
5. Glick and Pasternak, Molecular Biotechnology.
6. MeyersR.A.(E.D.), MolecularBiologyandBiotechnology:AcomprehensiveDeskReference,VCHPublishers,Inc.NewYork.
7. Nelson and Cox, Lehninger Principles of Biochemistry, W. H. Freeman,NY.
8. Robertis De, CellBiology.
9. Sambrook J., Fritsch E.F. and Maniatis T., Molecular Cloning: A Laboratory Mannual, Cold Spring Harbor Laboratory Press, NewYork.
10. T.S. Brown, Genome.
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 BiologyofGenes,TheBenjamin/CummingsPublishingCompanyInc.Tokyo.

PAPER ZOO-401 (B) BIOSYSTEMATICSANDTAXONOMY 40+60 Marks

Course Objectives/Course Description

This chapter will support students about the specified understanding of multiple henomenons 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

Taxonomic evidence and evolutionary interpretation: Definition and evidence, Kindsofevidence,Similarity,HomologyandHomoplasy.

UNIT-II

Taxonomytoclassification:Principles,objectivesandarbitrariness,Monophylyand polyphyly, Grades and clades, Vertical and horizontal relationships, Divergence and diversity splitting and lumping, Relative antiquity, Ranks of characters.

UNIT-III

Taxonomic collection: Species registry, Collection methods, Preservation of collectedmaterial(curatingpreparation,relaxing,mounting,storage,cataloguing, maintaining quality ofcollection).

UNIT-IV

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

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

Recommended Books

1. GotoH.E.,AnimalTaxonomy,HodderAmoldH&S.
2. GreggJ.R.,TheLanguageofTaxonomy-AnApplicationofSymbloicLogictothe 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 University Press,Cambridge.
8. Simpson G.G., Principles of Animal Taxonomy, Columbia University Press, New York.
9. Willams D.M. and Ebach M.C., Foundations of Systematics and Biogeography, SpringerScience+BusinessMedia,LLC,NewYork.
10. Willams D.M. and Foley P.L., Milestones in Systematics, CRC Press LLC, Boca Raton, Florida,USA.

PAPER ZOO-402 (B) BIOSYSTEMATICSANDTAXONOMY 40+60Marks

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

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

UNIT-II

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 oftissues.

UNIT-III

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

UNIT-IV

Speciesconceptandlowercategories:Thegeneticspecies,Evolutionaryspecies, Other kinds of species (taxonomic species, morphospecies, palaeospecies, biospecies,agamospecies), Subspecies, Other intraspecificgroups,Superspecies.

UNIT-V

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

Recommended Books

1. Goto H.E., Animal Taxonomy, hodderArnold H &S.
2. GreggJ.R.,TheLanguageofTaxonomy-AnApplicationofSymbloicLogictothe Study of Classificatory System, Columbia university Press, NewYork.
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, 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. PrinciplesandPracticesofAnimalTaxonomy,byV.C.Kapoor,SciencePublishers, NewDelhi.
8. Scott-Ram N.R., Transformed Cladistics, Taxonomy and Evolution, Cambridge University Press,Cambridge.
9. Simpson G.G., Principles of Animal Taxonomy, Columbia University Press, New York.
10. Willams D.M. and Ebach M.C., Foundations of Systematics and Biogeography, SpringerScience+BusinessMedia,LLC.NewYork.
11. Willams D.M. and Foley P.L., Milestones in Systematics, CRC Press LLC, Boca

PAPER ZOO-403(A)PRACTICAL 100Marks

CELL AND MOLECULARBIOLOGY

Course Objectives/Course Description

To understand the principle behind various techniques 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) Study on the life history ofDrosophila.
2) Preparation of salivary gland chromosome ofDrosophila.
3) Calorimetric estimation of DNA andRNA.
4) Preparation of permanent histologicalslides.
5) Isolation ofplasmid.
6) SeparationofDNAthroughagarosegelelectrophoresis.
7) Demonstration of DNA ladder/smear formation duringapoptosis.
8) Extraction and purification of protein by columnchromatography.
9) Separation of protein on SDS-PAGE and determination of molecularweight.
10) Isolation of protein fragments fromgel.
11) Studyontheeffectoftemperatureonplasmaproteins.
12) Estimation of inorganic composition of biologicalmaterials.
13) Seminar topic and Field tourreport.

PAPER ZOO-403(B) PRACTICAL 100Marks

PAPER ZOO-404PROJECT WORK 100Marks

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CERTIFICATE/ DIPLOMA COURSE ON: INDUSTRIAL FISH AND FISHERIES

SEC Course Title: INDUSTRIAL FISH AND FISHERIES **CREDITS: 4**

1. Course /Paper Title: **Fishing Technology**
2. Maximum Marks: 50
   i) External (Univ. Exam.): 40
   ii) Internal Assessment: 10
4. Minimum Pass Marks
   i) External: 15
   ii) Internal: 05
5. Duration of Univ. Exam. : 2½ Hrs

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/Colleges. Theory paper will be set for 40 marks.

Internal Assessment Test (10 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 be 5 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 marks.

Part-B: Total weightage of Part-B will be 5 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 8 marks and will comprise of 4 short answer type questions, one from each of the units and carrying 1.5 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 12 marks and will comprise of 4 medium answer type questions, one from each of the units and carrying 3 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 20 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 4 marks each. Answers should be of 500 to 600 words with detailed analysis/explanation/critical evaluation to the question.

Core Course Title: Aquaculture **CREDITS: 4**

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