

**A PROGRAMME FOR UNDERGRADUATE
COURSE IN ZOOLOGY, RGU**

**Learning Outcomes based Curriculum Framework
(LOCF)
for B.Sc. HONOURS (ZOOLOGY)**



Effective from 2021-22 Session

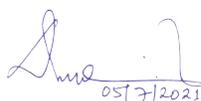
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05/7/2021

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Preamble

Institutional infrastructures of colleges and universities within the country are incomparable and uneven, and they function with an additional variation of adopting different road maps for teaching and learning process. Thus, we have different syllabi, teaching methods hands-on-training, and different learning outcomes. Introducing uniformity, whenever and wherever tried, has obviously not worked with the desired outcome. Added to this, failure to keep pace with the advancing knowledge base, half-hearted engagement and integration with other disciplines, and poor-transfer of skill sets to the students to negotiate efficiently with the changing needs, have made it essential to graduate from incremental inputs to syllabi revisions alone, to the use of disruptive approaches to reshape the subject- specific course structures, with measurable learning outcomes. The approach, if adopted, is bound to generate opinions of teachers and students alike to resist the change. However, the intention is to understand the subject of Zoology in the evolving biological paradigm in modern times; where, living beings need to be understood at the level of atomic interactions; and comparative systems of organisms need to be studied through the prism of integrated chemical, physical, mathematical and molecular entities to appreciate the inner working of different organisms at morphological, cellular, molecular, interactive and evolutionary levels. The syllabi could be shaped with a customised approach depending on the institutional infrastructure and geographical location, yet it should cater, in principle, to the expected learning outcomes more or less uniformly. For example, in diverse geographical domains with diverse skill sets, examples illustrated in detail for teaching and hands on exposure and field work could differ by involving the study of available species across the ladder of evolution, yet the comparative biology taught should provide a uniform level of understanding of the subject. After all, the purpose is to understand inner working of living- beings by comparing various systems within invertebrates and vertebrates i.e., from a single cell protozoan to multicellular humans, and develop a comprehensive understanding and appreciation of the differences through ICT tools and well-designed hands-on practical exposures. Added to this, if the same principle is followed to understand different phyla through the ladder of evolution and compare cardinal features for classification involving both morphological and molecular tools, along with associated laboratory work, the final product would be better trained without rote learning. Diversity in the life forms need to be understood by a Zoologist for its socio-economic capital, in case a student is interested in entrepreneurship, through applied aspects of Zoology; and by a career-researcher as a ladder towards multiscale hierarchical systems, where chemical and physical



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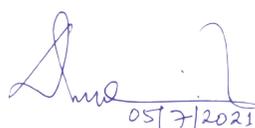
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principles would apply from molecules to self-assembled and organized organisms. The vibrancy to synthesize out of the knowledge gained and come out with disruptive outcomes, would define the learning outcomes of the future UG and PG students.

Apart from the above mentioned attributes expected of a UG/PG student related to the subject area of Zoology to be studied in an integrated and cross-disciplinary manner with a comprehensive understanding of all living systems, their relationship with the ecosystem, and unravelling of their application value; the scale, character and rigour of which may vary from one institution to the other, it would, however, be mandatory to bring in uniformity in the learning outcomes with respect to the 'broad-range skill sets' related-to-the-discipline of the study and the 'Social skills'. Within the broad-range skill sets related to the discipline, what would be required is to impart and assess the quality of critical thinking, analytical and scientific reasoning, reflective thinking, information and digital literacy, and problem-solving capacity. These are part of the defined characteristic attributes to be demonstrated by a UG/PG in any discipline, as defined by the Core Committee on LOCF of UGC. On similar lines, what is expected of the social skills is to imbibe values for cooperative teamwork, moral and ethical awareness and reasoning, multicultural competence, leadership readiness and qualities and self- directed and lifelong learning attitude. Again, this has been a general guideline defined by the UGC Core Committee. It is obvious all of us together need to meet the challenge to bring in these attributes within each subject area of study, in the present case the subject of Zoology.

Specific Details:

Background: Students should be equipped to identify the major groups of organisms, discuss the basis of their biodiversity and draw parallels with their phylogenetic relationship, using well thought cardinal features of classification on the basis of morphology and molecular information wherever available. This principle of comparative biology should be followed in understanding comparative anatomy, physiology and other functions for all in the hierarchy of animal evolution, instead of dealing with each phylum/order/species and each system as a stand-alone. This shall allow the student to gain comprehensive knowledge about different animal species in one go, appreciating the differences and similarities, thereby achieving proficiency in handling them experimentally or for research purposes. This would also reduce the burden of teaching on mentors, though initially a little hard work to shape the contents of the curriculum is required. Teachers would need to be trained for the same as well for a uniform approach to deliver and communicate.



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A comprehensive knowledge of structure-function relationship at the level of gene, genome, cell, tissue, organ, and systems, through development would further add to the knowledge base and the learning outcome in terms of editing of genes and genomes for industrial application and research purposes. Short dissertations could be designed around these problems to give them hands-on-training and equip them with skill sets of use in future, in the areas of applied aspects of Zoology.

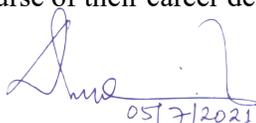
1. Introduction

Zoology deals with the study of animal kingdom specially the structural diversity, biology, embryology, evolution, habits and distribution of animals, both living and extinct. As it covers a fascinating range of topics, the modern zoologists need to have insight into many disciplines. The learning outcomes-based curriculum framework for a B.Sc. degree in Zoology is designed to cater to the needs of students in view of the evolving nature of animal science as a subject. The framework is expected to assist in the maintenance of the standard of Zoology degrees/programmes across the country by reviewing and revising a broad framework of agreed expected graduate attributes, qualification descriptors, programme learning outcomes and course-level learning outcomes. The framework, however, does not seek to bring about uniformity in syllabi for a programme of study in Zoology, or in teaching-learning process and learning assessment procedures. Instead, the framework is intended to allow for flexibility and innovation in programme design and syllabi development, teaching-learning process, assessment of student learning levels.

2. Learning Outcomes based approach to Curriculum Planning

The courses should be delivered in terms of concepts, mechanisms, biological designs & functions and evolutionary significance cutting across organisms at B.Sc. level. These courses should be studied by students of all branches of biology. Both chalk and board, and PowerPoint presentations can be used for teaching the course.

The students are expected to learn the courses with excitements of biology along with the universal molecular mechanisms of biological designs and their functions. They should be able to appreciate shifting their orientation of learning from a descriptive explanation of biology to a unique style of learning through graphic designs and quantitative parameters to realize how contributions from research and innovation have made the subjects modern, interdisciplinary and applied and laid the foundations of Zoology, Animal Sciences, Life Sciences, Molecular Biology and Biotechnology. These courses and their practical exercises will help the students to apply their knowledge in future course of their career development in higher education and



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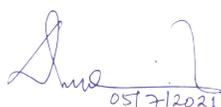
research. In addition, they may get interested to look for engagements in industry and commercial activities employing Life Sciences, Molecular Biology and Biotechnology. They may also be interested in entrepreneurship and start some small business based on their interest and experience.

2.1 Nature and extent of the B.Sc. degree Programme in Zoology

B.Sc. Zoology course will help to understand the behaviour, structure and evolution of animals. Zoologists use a wide range of approaches to do this, from genetics to molecular and cellular biology, as well as physiological processes and anatomy, whole animals, populations, and their ecology. The scope of Zoology as a subject is very broad. The intention is to understand the subject of Zoology in the evolving biological paradigm in modern times; where, living beings need to be understood at the level of atomic interactions; and comparative systems of organisms need to be studied through the prism of integrated chemical, physical, mathematical and molecular entities to appreciate the inner working of different organisms at morphological, cellular, molecular, interactive and evolutionary levels. The key areas of study within the disciplinary/subject area of Zoology comprise animal diversity, principles of ecology, comparative anatomy and developmental biology of vertebrates, physiology and biochemistry, genetics and evolutionary biology, animal biotechnology, applied zoology, behaviour, immunology, reproductive biology, and insect, vectors and diseases. B.Sc. degree programme in Zoology also deals with skill enhancement courses such as apiculture, aquarium fish keeping, medical diagnostics, sericulture etc. The depth and breadth of study of individual topics dealt with would vary with the nature of specific Zoology programmes. As a part of the efforts to enhance the interest and employability of graduates of Zoology programmes, the curricula for these programmes are expected to include learning experiences that offer opportunities for higher studies and research at reputed laboratories.

2.2 Aims of Bachelor's degree programme in Zoology Honours

Zoology is the study of all animal life; from primitive microscopic malaria-causing protozoa to large, advanced mammals, across all environmental spheres from red deer in mountain forests to dolphins in deep oceans, and from underground burrowing voles to golden eagles in the skies. Some of these animals are useful to us and we nurture them as pets or livestock; some are serious pests or disease-causing; and some are simply splendid and awe-inspiring. No matter what our relationship with the animals is, we need to understand their behaviour, population dynamics, physiology and the way they interact with other species and their environments. It provides students with the knowledge and skill base that would enable them



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to undertake further studies in Zoology and related areas or in multidisciplinary areas that involve advanced or modern biology and help develop a range of generic skills that are relevant to wage employment, self-employment and entrepreneurship.

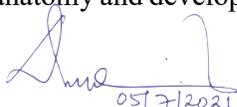
The modern era requires a classical zoologist with a modern approach to master many subjects of Zoology. There is a need for the students to compete with the globe, therefore, the main focus of this curriculum is to enable the student to be professionally competent and successful in a career. Having Zoology as backbone of the curriculum, this course, with the department centric electives will enhance the skills required to perform research in laboratory and experimental research. The students can choose to focus on a “whole animal” or a “bits of animals” approach. The “whole animal” pathway makes the students proficient in the identification and study of animals while the latter approach provides the skills required to pursue laboratory and experimental work such as disease research, DNA technologies, wildlife forensics etc. The curriculum can be modified to such extent that a student at B.Sc. level can be a specialist in immunology, ornithology, animal behaviour or entomology. For such specializations, the curriculum needs to focus on special skills to maximise the students’ employment probability; for example few skills needed by industry may include the species-specific monitoring for key species, handling of dangerous/ poisonous/ wild animals and the use of Geographic Information Systems (GIS) for data collection.

3. Graduate Attributes in Zoology Honours

Disciplinary knowledge and skills: Capable of demonstrating (i) comprehensive knowledge and understanding of major concepts, theoretical principles and experimental findings in Zoology and its different subfields (animal diversity, principles of ecology, comparative anatomy and developmental biology of vertebrates, physiology and biochemistry, genetics and evolutionary biology, animal biotechnology, applied Zoology, aquatic biology, immunology, reproductive biology, and insect, vectors and diseases), and other related fields of study, including broader interdisciplinary subfields such as chemistry, physics and mathematics; (ii) ability to use modern instrumentation for advanced genomic and proteomic technology.

Skilled communicator: Ability to impart complex technical knowledge relating to Zoology in a clear and concise manner in writing and oral skills.

Critical thinker and problem solver: Ability to have critical thinking and efficient problem-solving skills in the basic areas of Zoology (animal diversity, principles of ecology, comparative anatomy and developmental biology of vertebrates, physiology and biochemistry,



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genetics and evolutionary biology, animal biotechnology, applied Zoology, aquatic biology, immunology, reproductive biology, insect, vectors and diseases etc.).

Sense of inquiry: Capability for asking relevant/appropriate questions relating to issues and problems in the field of Zoology, and planning, executing and reporting the results of an experiment or investigation.

Team player/worker: Capable of working effectively in diverse teams in both classroom, laboratory and in industry and field-based situations.

Skilled project manager: Capable of identifying/mobilizing appropriate resources required for a project, and manage a project to completion, while observing responsible and ethical scientific conduct; and safety and chemical hygiene regulations and practices.

Digitally literate: Capable of using computers for Bioinformatics and computation and appropriate software for analysis of genomics and proteomics data, and employing modern bioinformatics search tools to locate, retrieve, and evaluate location and biological annotation genes of different species.

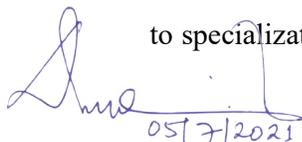
Ethical awareness/reasoning: Capable of conducting their work with honesty and precision thus avoiding unethical behavior such as fabrication, falsification or misrepresentation of data or committing plagiarism, and appreciating environmental and sustainability issues. Research ethics committee expects them to declare any type of conflict of interest that may affect the research. Any plan to withhold information from researchers should be properly explained with justification in the application for ethical approval.

Lifelong learners: Capable of self-paced and self-directed learning aimed at personal development and for improving knowledge/skill development and reskilling.

4. Qualification Descriptors for a Bachelor's Degree programme in Zoology Honours

The qualification descriptors for a Bachelor's degree programme in Zoology may include the following:

- Demonstrate (i) a fundamental/systematic or coherent understanding of the academic field of Zoology, its different learning areas and applications, and its linkages with related disciplinary areas/subjects; (ii) procedural knowledge that creates different types of professionals related to Zoology area of study, including research and development, teaching and government and public service; (iii) skills in areas related to specialization area relating the subfields and current developments in the academic



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field of Zoology.

- Use knowledge, understanding and skills required for identifying problems and issues related to Zoology. A keen interest in research and the study of living organisms.
- Communicate the results of studies undertaken accurately in a range of different contexts using the main concepts, constructs and techniques of the subject(s).
- Meet one's own learning needs, drawing on a range of current research and development work and professional materials.
- Apply one's subject knowledge and transferable skills to new/unfamiliar contexts to identify and analyse problems and issues and solve complex problems with well-defined solutions.
- Demonstrate subject-related and transferable skills that are relevant to Zoology- related job trades and employment opportunities
 - Good observation skills
 - Able to work precisely
 - A logical approach to problem-solving
 - Good oral and written communication abilities
 - Able to work independently or with team members

5. Learning Outcomes in Bachelor's Degree programme in Zoology Honours

5.1 Knowledge and Understanding

- Demonstrate (i) in-depth knowledge and understanding about the fundamental concepts, principles and processes underlying the academic field of Zoology and its different subfields (animal diversity, principles of ecology, comparative anatomy and developmental biology of vertebrates, physiology and biochemistry, genetics and evolutionary biology, animal biotechnology, applied Zoology, aquatic biology, immunology, reproductive biology, and insect, vectors and diseases, apiculture, aquarium fish keeping, medical diagnostics, and sericulture) (ii) procedural knowledge that creates different types of professionals in the field of Zoology and related fields such as, apiculture, aquarium fish keeping, medical diagnostics, and sericulture, etc.(iii) skills related to specialization areas within Zoology as well as within subfields of Zoology, including broader interdisciplinary subfields (Chemistry, Physics and Mathematics).
- Over the years, Zoologists were able to find many differences within the same breed

of an animal species. As a Zoology professional one can study extinct animals by specializing in Paleozoology, on the different types of birds in Ornithology; opt for studying Herpetology and Arachnology, the branches dealing with the study of snakes and spiders, respectively or

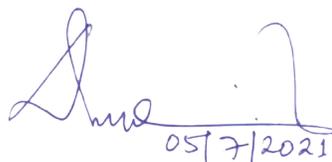
- Appreciate the complexity of life processes, their molecular, cellular and physiological processes, their genetics, evolution and behaviour and their interrelationships with the environment.
- Study concepts, principles and theories related with animal behaviour and welfare.
 - Understand and interpret data to reach a conclusion
 - Design and conduct experiments to test a hypothesis.
 - Understand scientific principles underlying animal health, management and welfare.
 - Accept the legal restrictions & ethical considerations placed for animal welfare.
 - Understand fundamental aspects of animal science relating to management of animals.
 - Assess problems and identify constraints in management of livestock.

5.2 Subject Specific Intellectual and Practical Skills

The students will be able to

- Understand how organisms are classified and identified
- Demonstrate knowledge of basic zoological principles
- Use appropriate information with a critical understanding
- Learn basic laboratory and analytical skills
- Use effective methods for modifying animal behaviour
- Participate in animal management programmes in an effective manner
- Work safely and effectively in the laboratories and in animal facilities
- Demonstrate competence in handling and statistical analysis of data gained from practical
- Learn communication and IT skills, including the collation and statistical analysis of data, citing & referencing work appropriately, communication using a range of formats

In course learning outcomes, the student will attain subject knowledge in terms of individual course as well as holistically.



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5.3 Distribution of different types of courses with their credits for B.Sc. Zoology (Honours)

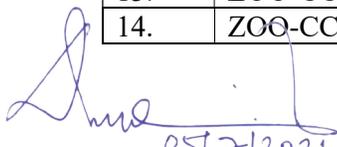
Semester	Core Courses	Elective Courses				Semester wise Credits
		DSE	GEC	AECC	SEC	
I	ZOO-CC-111		GEC 1	AECC 1	SEC 1	24
	ZOO-CC-112					
II	ZOO-CC-121		GEC 2	AECC 2	SEC 2	24
	ZOO-CC-122					
III	ZOO-CC-231		GEC 3		SEC 3	26
	ZOO-CC-232					
	ZOO-CC-233					
IV	ZOO-CC-241		GEC 4		SEC 4	26
	ZOO-CC-242					
	ZOO-CC-243					
V	ZOO-CC-351	DSE 1				24
	ZOO-CC-352	DSE 2				
VI	ZOO-CC-361	DSE 3				24
	ZOO-CC-362	DSE 4				
Total Minimum Credits	84	24	24	8	8	148

5.4 Learning Outcomes of different types of courses for B.Sc. Zoology Honours

Core Courses (CC) for Zoology Honours

There shall be fourteen (14) compulsory core courses in Zoology (Honours). Each course shall be associated with a practical component.

S. No.	Course Code	Course Name	Credit	Semester
1.	ZOO-CC-111	Systematics & Diversity of Protists and Non-Chordates	6	I st
2.	ZOO-CC-112	Cell Biology & Histology	6	
3.	ZOO-CC-121	Comparative Structure and Function of Chordates	6	II nd
4.	ZOO-CC-122	Developmental Biology and Evolution	6	
5.	ZOO-CC-231	Physiology of Chordates	6	III rd
6.	ZOO-CC-232	Genetics	6	
7.	ZOO-CC-233	Biochemistry	6	
8.	ZOO-CC-241	Behaviour and Chronobiology	6	IV th
9.	ZOO-CC-242	Ecology	6	
10.	ZOO-CC-243	Molecular Biology	6	
11.	ZOO-CC-351	Biotechniques	6	V th
12.	ZOO-CC-352	Microbiology, Parasitology & Immunology	6	
13.	ZOO-CC-361	Biostatistics & Bioinformatics	6	VI th
14.	ZOO-CC-362	Applied Zoology	6	


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Discipline Specific Elective Courses (DSE)

DSE course in Zoology Honours may be offered from the below prescribed list. Students have to choose two DSE course in Fifth and Sixth semester each from the prescribed list, being offered by the respective college affiliated to RGU. **However, the students of Zoology who opt for BOT-GE-003 (Biodiversity and Conservation) as their Generic Elective shall not opt for ZOO-DE-363 (Biodiversity and Conservation Biology) as contents of both the papers are similar.**

S. No.	Course Code	Course Name	Credit	Semester
1.	ZOO-DE-351	Genetic Engineering and Biotechnology	6	Semester V th : One may choose any two out of the five courses as DSE1 and DSE2
2.	ZOO-DE-352	Evolutionary Biology	6	
3.	ZOO-DE-353	Endocrinology	6	
4.	ZOO-DE-354	Mammalian Physiology	6	
5.	ZOO-DE-355	Human Reproductive Biology	6	
6.	ZOO-DE-361	Agrochemicals & Pest management	6	Semester VI th : One may choose any two out of the five courses as DSE3 and DSE4
7.	ZOO-DE-362	Wildlife Conservation and Management	6	
8.	ZOO-DE-363	Biodiversity and Conservation Biology	6	
9.	ZOO-DE-364	Aquatic Biology	6	
10.	ZOO-DE-365	Pisciculture and Aquatic Ecology	6	
11.	ZOO-DE-369	Project Work (Dissertation)	6	

Ability Enhancement Course (AEC)

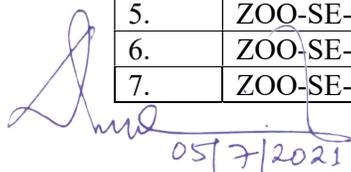
AEC are compulsory courses. In Semester-I, the students have to either choose English or Hindi as their AEC while in Semester-II, students have to opt for EVS course.

S. No.	Course Code	Course Name	Credit	Semester
1.	ENG-AE-111	Communicative English	4	I st
2.	HIN-AE-111	हिंदी शिक्षण (Hindi Shikshan)	4	
3.	EVS-AE-121	Environmental Studies (EVS)	4	II nd

Skill Enhancement Course (SEC)

SEC may either be opted by the Zoology Honours Students or any other Science discipline students. However, Zoology Honours students have to compulsorily opt for at least two courses from the below mentioned list while the other two courses may be opted from the same department or other related science departments.

S. No.	Course Code	Course Name	Credit	Semester
1.	ZOO-SE-001	Apiculture	2	I st and III rd Semester
2.	ZOO-SE-003	Sericulture	2	
3.	ZOO-SE-005	Freshwater Ornamental Fishery	2	
4.	ZOO-SE-007	Livestock Management and Animal Husbandry	2	
5.	ZOO-SE-002	Dairy Production and Technology	2	II nd and IV th Semester
6.	ZOO-SE-004	Medical Laboratory Diagnostics	2	
7.	ZOO-SE-006	Public Health and Hygiene	2	


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Generic Elective Courses (GEC)

GEC are specifically for Honours students from other disciplines. The students have to opt for GEC in Semester-I, Semester-II, Semester-III and Semester-IV. Zoology shall offer one GEC in Semester-I while in Semester-II, Semester-III and Semester-IV, students may opt any one of the course from the below mentioned list of GEC.

S. No.	Course Code	Course Name	Credit	Semester
1.	ZOO-GE-111	Animal Diversity	6	I st
2.	ZOO-GE-121	Human Physiology	6	II nd (Any one out of the three course)
3.	ZOO-GE-122	Food, Nutrition and Health	6	
4.	ZOO-GE-123	Basics of Systematics and Classification	6	
5.	ZOO-GE-231	Global Climate change	6	III rd (Any one out of the two course)
6.	ZOO-GE-232	Natural Resource Management	6	
7.	ZOO-GE-241	Environmental Biotechnology	6	IV th (Any one out of the two course)
8.	ZOO-GE-242	Systematics and Evolutionary Biology	6	

The core courses would fortify the students with in-depth subject knowledge concurrently; the discipline specific electives will add additional knowledge about applied aspects of the program as well as its applicability in both academia and industry. Generic electives will introduce integration among various interdisciplinary courses. The skill enhancement courses would further add additional skills related to the subject as well as other than the subject. In brief, the students who graduate with this type of curriculum would be able to disseminate subject knowledge along with necessary skills to suffice their capabilities for academia, entrepreneurship and Industry.

6. Course Structure for Bachelor's Programme in Zoology with details

6.1 Core Courses (CC)

These courses provide an in depth understanding of relevant theories, concepts, and principles of zoology besides having an insight into the philosophy of the subject. The students are likely to have a strong foundation in Zoology.

S.N.	Name of course	Theory	Practical	Credits
1.	Systematics & Diversity of Protists and Non-Chordates	4	2	6
2.	Cell Biology and Histology	4	2	6
3.	Comparative Structure and Function of Chordates	4	2	6
4.	Developmental Biology & Evolution	4	2	6
5.	Physiology of Chordates	4	2	6
6.	Genetics	4	2	6
7.	Biochemistry	4	2	6
8.	Behaviour and Chronobiology	4	2	6

9.	Ecology	4	2	6
10.	Molecular Biology	4	2	6
11.	Biotechniques	4	2	6
12.	Microbiology, Parasitology & Immunology	4	2	6
13.	Biostatistics & Bioinformatics	4	2	6
14.	Applied Zoology	4	2	6

6.2 Discipline Specific Elective Courses (DE)

With the course content largely subject specific, the first aim of these courses is to engage all students in enriching the enjoyable and intellectually stimulating learning experiences. Methods are designed to support independent learning. The courses are likely to help students acquire subject-specific, cognitive and transferable skills to solve complex problems.

S.N.	Name of course	Theory	Practical	Credits
1.	Genetic Engineering and Biotechnology	4	2	6
2.	Evolutionary Biology	4	2	6
3.	Endocrinology	4	2	6
4.	Mammalian Physiology	4	2	6
5.	Human Reproductive Biology	4	2	6
6.	Biodiversity and Conservation Biology	4	2	6
7.	Wildlife Conservation and Management	4	2	6
8.	Insect Pest and Pest management	4	2	6
9.	Aquatic Zoology	4	2	6
10.	Pisciculture and Aquatic Ecology	4	2	6
11.	Dissertation	-	-	6

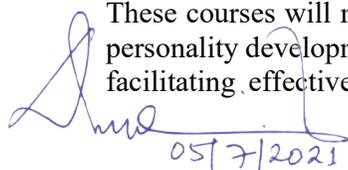
6.3 Generic Elective Courses (GE)

These courses enable the students to apply knowledge and understanding to address not only the core issues but also the issues of general importance where the knowledge of Zoology can be an added advantage. The courses will facilitate the students to develop all-round knowledge and skills on the integrated subjects in life sciences. The Generic Elective courses, thus, shall be opted by students from allied discipline willing to enhance their Zoological knowledge and skills.

S.N.	Name of course	Theory	Practical	Credits
1.	Animal Diversity	4	2	6
2.	Human Physiology	4	2	6
3.	Food, Nutrition and Health	4	2	6
4.	Global Climate change	4	2	6
5.	Natural Resource Management	4	2	6
6.	Environmental Biotechnology	4	2	6
7.	Systematics and Evolutionary Biology	4	2	6
8.	Basics of Systematics and Classification	4	2	6

1.4 Ability Enhancement Courses (AE)

These courses will mainly enhance the ability and personal skills of the students and help in personality development besides making them aware about the latest happenings or trends and facilitating effective communication with correct usage of technical language in order to


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present complex concepts and information. The students will learn to express in competitive and professional environments, orally and in writing in a clear and concise manner.

S.N.	Name of course	Theory	Practical	Credits
1.	Communicative English	4	-----	4
2.	हिंदी शिक्षण (Hindi Shikshan)	4	-----	4
3.	Environmental Studies (EVS)	4	-----	4

1.5 Skill Enhancement Courses

These courses will encourage and enhance the investigative and analytical skills of students resulting in their ability to formulate problems clearly, identify key issues and reach the solution with logical arguments. The classroom sessions are aimed to provide industry-standard skills and can be helpful in fetching jobs.

S.N.	Name of course	Theory	Practical	Credits
1.	Apiculture	1	1	2
2.	Sericulture	1	1	2
3.	Dairy Production and Technology	1	1	2
4.	Medical Laboratory Diagnostics	1	1	2
5.	Ornamental freshwater fish production	1	1	2
6.	Livestock management and Animal Husbandry	1	1	2
7.	Public Health and Hygiene	1	1	2

The experiments involving animals will be performed through permanent slides/photographs/video recording/ as per UGC guidelines.

7.0 Assessment and Evaluation

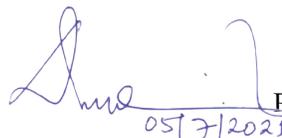
Assessment methods, Conduct of Examinations, Eligibility Conditions and Declaration of Results

Academic performance in various courses i.e. Core, Discipline Electives and Skill Enhancement Courses are to be considered as parameters for assessing the achievement of students. All students shall be subjected to the process of continuous evaluation and assessment. A number of appropriate assessment methods will be used to determine the extent to which students demonstrate desired learning outcomes.

Marks allocation for Internal Assessment and End Semester Examinations, Question Paper pattern, Duration of Examination for various courses, Attendance and other eligibility conditions for appearing in the examination, and Declaration of Results shall be done in accordance with the relevant provisions as stipulated in the above cited regulation and also the Ordinance(s) of the university.

8.0 Suggested List of Supplementary Web Resources for Laboratory Exercises

1. Anatomy of Frog: Pro Dissector (CD)- www.prodissector.com
2. Physiology of Frog: Physio Ex 4.0 (CD)- www.physioex.com
3. Anatomy of Chordates: The Vertebrate Dissection Guide Series (CD)–Learning Development Centre, University of Portsmouth
4. Anatomy of earthworm: The dissection works (CD); Source –www.scienclass.com; www.neosci.com
5. Anatomy of shark: Shark dissection and anatomy (video)- www.neosci.com
6. Cockroach dissection- www.ento.vt.edu
7. Mammalian Physiology– www.biopac.com


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B.Sc. Zoology Core Courses (CC)

Semester	Core course	Course Title	Credit
I	ZOO-CC-111	Systematics and Diversity of Protists and Non-Chordates	Theory:04 Practical: 02 Total: 06

About the course

The course is a walk for the Bachelor's entrant through the amazing diversity of living forms from simple to complex one. It enlightens how each group of organisms arose and how did they establish themselves in the environment with their special characteristics. It also deals with the differences and similarities between organisms on the basis of their morphology and anatomy which led to their grouping into taxa and clades.

Learning outcomes

After successfully completing this course, the students will be able to:

- Develop understanding on the diversity of life with regard to protists and non-chordates.
- Group animals on the basis of their morphological characteristics/ structures.
- Develop critical understanding how animals changed from a primitive cell to a collection of simple cells to form a complex body plan.
- Examine the diversity and evolutionary history of a taxon through the construction of a basic phylogenetic/ cladistics tree.
- Understand how morphological change due to change in environment helps drive evolution over a long period of time.

Theory

UNIT I: Animal Systematics

15 Lectures

Systematics and taxonomy. Species concept, clades. Concept of type specimen, taxidermy and maintenance of museum specimen. Nomenclature and utility of scientific names. Classification: morphological and evolutionary (molecular). Relationship of taxa: phylogenetics and cladistics with special reference to paraphyly, monophyly, apomorphy, plesiomorphy and phenoplasticity

UNIT II: Diversity in Protists and acoelomate Metazoa

15 Lectures

Structure and diversity in Protists. Origin of Metazoans: Diploblastic and triploblastic organization; symmetries; body cavities; protostomes and deuterostomes. Special features and structural diversity in sponges. Cnidarians: Special features; transition of third germ layer; polymorphism and division of labour; coral reef forming Cnidarians. The Bilateria: Basic characteristics. The acoelomates: Basic organization and adaptive radiations in flatworms.

UNIT III: Diversity in pseudocoelomate and coelomate Non chordates

15 Lectures

The Ecdysozoa: characteristics of the representative taxa. Pseudo coelomates; Basic organization and adaptive radiations in roundworms. The coelomates: Basic organization and adaptive radiations in Arthropods- Ancestors/ fossil arthropods. Adaptive radiations in Crustaceans, Myriapods, Chelicerates, Insects, etc. Basic organization and diversity in Annelids. Basic organization and diversity in Molluscs. Disruption of bilateral symmetry and its significance. Basic organization of Echinoderms; their affinity to Chordates.

UNIT IV: Comparative Anatomy and Physiology of Invertebrates **15 Lectures**

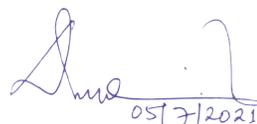
Canal system in Porifera. Locomotion of Protozoa, Annelida and Mollusca and their locomotory organs. Respiratory systems of Arthropod. Circulatory system in Arthropods. Torsion in gastropods. Nervous systems of Mollusca. Larvae in echinoderms and their affinities with chordates. Locomotion system in Echinodermata. Coelom and its modifications in invertebrates. Venoms and venomous insects. Excretory system in invertebrates.

Practical

1. Study of animals through slides and museum specimens in the laboratory with details on their classification, biogeography and diagnostic features (record book).
2. Study of animals in nature during a survey of a National Park or Forest area.
3. Collection of five species (preferably invertebrates, insects) belonging to a clade. A project work on their generic identification, description and illustration with a note on their locality. Also, the assessment of their relationship by constructing a cladogram using characters and character states.
4. Microscopic study of structure of certain protists
5. Study of locomotory organs of protozoa and Annelida
6. Respiratory organs in Arthropoda
7. Nervous system in Mollusca
8. Description of polymorphic cnidarians with division of labour

Recommended readings

- Barnes, R. S. K.; Calow, P.; Olive, P. J. W.; Golding, D. W.; Spicer, J. I. (2002) The Invertebrates: a Synthesis, Blackwell Publishing.
- Hickman, C.; Roberts, L.S.; Keen, S.L.; Larson, A. and Eisenhour, D. (2018) Animal Diversity, McGraw-Hill.
- Holland, P. (2011) The Animal Kingdom: A Very Short Introduction, Oxford University Press.
- Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. and Nelson.
- Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
- Bushbaum, R. (1964) Animals without Backbones. University of Chicago Press.



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राजीव गांधी विश्वविद्यालय
Jt. Registrar (Acad. & Conf.)
Rajiv Gandhi University
Rono Hills, Doimukh (A.P.)

Semester	Core course	Course Title	Credit
I	ZOO-CC-112	Cell Biology and Histology	Theory:04 Practical: 02 Total: 06

About the course

The course provides a detailed insight into basic concepts of cellular structure and function. It also gives an account of the complex regulatory mechanisms that control cell function.

Learning outcomes

After successfully completing this course, the students will be able to

- Understand the functioning of nucleus and extra nuclear organelles and understand the intricate cellular mechanisms involved.
- Acquire the detailed knowledge of different pathways related to cell signaling and apoptosis thus enabling them to understand the anomalies in cancer.
- Develop an understanding how cells work in healthy and diseased states and to give a 'health forecast' by analyzing the genetic database and cell information.

Theory

UNIT-I: The structure and organelles of prokaryotic and eukaryotic cells. 15 Lectures

Cell biology, its scope in modern perspective. Cell theory and its modern version and interpretation. General structure of prokaryotes, bacteria, archaea and eukaryotes. Extra nuclear cell organelles: Ultrastructure and functions of endoplasmic reticulum, ribosome, Golgi apparatus, lysosome, peroxisomes. Mitochondria: Origin, structure, composition, genome organization and function. Cytoskeleton: composition and functions; microtubules and microfilaments. Nucleus: size, shape, structure and functions of interphase nucleus. Types of chromosome; Giant chromosome – Polytene & lampbrush. Ultrastructure of nuclear membrane and pore complex. Nucleolus: general organization, chemical composition and functions, nuclear sap/ nuclear matrix, nucleo-cytoplasmic interactions.

UNIT-II: Cell membrane and transport mechanism

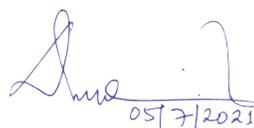
15 Lectures

Cell membrane organization: cell membrane: origin, structure, composition, models and function. Fluid mosaic model. Lipid Composition, inner and outer leaflets. Structure and functions of membrane proteins: Integral, peripheral and lipid-anchored membrane proteins. Junctional complexes, membrane receptor modifications: microvilli, desmosomes and plasmodesmata. Transport across membrane: diffusion and osmosis. Active and passive transport, endocytosis and exocytosis

UNIT-III: Cell cycle and cell signaling

14 Lectures

Cell cycle, cell division- mitosis and meiosis. Cell division check points and their regulation. Programmed cell death (Apoptosis). Cell regulation and Cell signaling: Signaling molecules and their receptors. Functions of cell surface receptors. Regulation of signaling pathways.



UNIT-IV: Structural and functional significance of animal tissues 15 Lectures

Introduction to tissues. Epithelial tissue: types, structure and characteristics. surface modifications. Connective tissue cells. Structure and function of loose, dense and adipose tissue. Cartilage and bone: classification, and fine structure. Blood: plasma, blood cells, lymph– their structural and functional. Muscular tissue: ultrastructure of smooth, skeletal and cardiac muscles. Structure and classification of neurons. Types of supporting (glial) cells and their function. Myelin sheath and its formation.

Practical

1. Study of prokaryotic and eukaryotic cell types with the help of chart, slide and video.
2. Disruption of cells, isolation and identification of subcellular components, isolation of nuclei (Demonstration).
3. Chromosome segregation in mitosis and meiosis.
4. Preparation of polytene chromosome from *Drosophila*/Chironomous larvae
5. Preparation of mitotic chromosome from Onion root tips
6. Preparation of chromosome squashes from grasshopper/cockroach testes for the observation of stages of meiosis.
7. Study of types of tissue through permanent slides: epithelial, connective, muscular, nervous etc.
8. Study of histology of tissues by preparing permanent stained slides through microtomy.

Recommended readings

1. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments (6th edition) John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006) Cell and Molecular Biology (8th edition) Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. (5th edition) ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M.; Kleinsmith, L.J.; Hardin. J. and Bertoni, G. P. (2009) The World of the Cell. (7th edition) Pearson Benjamin Cummings Publishing, San Francisco.



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Rajiv Gandhi University
Rono Hills, Doimukh (A.P.)

Semester	Core course	Course Title	Credit
II	ZOO-CC-121	Comparative Structure and Function of Chordates	Theory:04 Practical: 02 Total: 06

About the course

The course makes a detailed comparison of the anatomy of the different taxa of chordates. It also highlights how in the taxonomic hierarchy, there is an increase in the complexity of structure and function. The course thus gives an overview of the intricate life processes and adaptive radiations in chordates.

Learning outcomes

After successfully completing this course, the students will be able to

- Develop an understanding of the characters used to classify besides being able to differentiate the organisms belonging to different taxa.
- Acquire knowledge of the coordinated functioning of complex human body machine.
- Understand the relative position of individual organs and associated structures through dissection of the invertebrate representatives.
- Understand a comparative account of various organ systems in vertebrates
- Realize that very similar physiological mechanisms are used in very diverse organisms.
- Get a flavor of research by working on project besides improving their writingskills. It will further enable the students to think and interpret individually.
- Undertake research in any aspect of animal physiology in future.

Theory

Unit – 1 Introduction to chordates and Protochordata

15 Hours

General Characteristics and outline classification. Salient features and classifications of Protochordates: Hemichordates, Cephalochordates, Urochordates. Larval forms in protochordates, Retrogressive metamorphosis in urochordates. Affinities of Hemichordata. Origin of Chordates: Dipleurula concept and the Echinoderm theory of origin of chordates

Unit – 2 Agnatha, Pisces and Amphibia

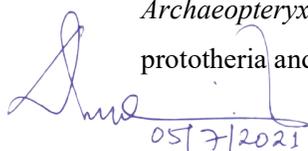
15 Hours

General characteristics and classification of cyclostomes up to class, Salient feature and classification of Pisces up to order. Origin of tetrapods. Salient features and classification of Amphibia up to order. Amphibian metamorphosis and Neoteny. Parental care in fishes and amphibians. Fish migration, Osmoregulation, Lateral line and balancing organs

Unit – 3 Reptilia, Aves and Mammals

15 Hours

Salient features and classification of Reptilia, Aves and Mammals up to order. Affinities of sphenodon, Poisonous and non-poisonous snakes, Poison apparatus and biting mechanism in snakes. *Archaeopteryx*-a connecting link. Flight adaptations in birds, Migration in birds. Affinities of prototheria and Marsupials. Dentition in mammals and adaptive radiation in mammals.



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Unit – 4 Comparative Anatomy

15 Hours

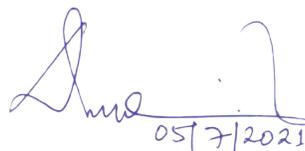
Comparative anatomy of Integuments, circulatory system (heart and aortic arches) and urinogenital system in vertebrates. Comparative anatomy of limb bones and girdles in vertebrates.

Practical

1. Identification, classification and study of morphological characteristics of Hemichordates and Protochordates, Fishes, amphibians, reptiles, birds and mammals.
2. Collection and preservation of specimens (permissible as per wildlife act) from Arunachal Pradesh and submission to the laboratory
3. Study of scales of fishes (cycloid, placoid, ganoid, ctenoid), mouth parts specially of hill stream and cold water -fishes from Arunachal Pradesh; Beak and Feathers of birds
4. Fish: study of weberian ossicles, gills, digestive system and reproductive system
5. Study of poison apparatus of snakes and morphological study of carapace of turtles
6. Comparison of two species of birds belonging to same genus (Interspecific difference).
7. Comparison and weighting of characters of two birds belonging to same family but dissimilar genera.
8. Skeleton of Mammals
9. Comparative study of brain with the help of models and charts.
10. Comparative study of urinogenital system with the help of models and charts.
11. Comparative study of heart with the help of models and charts.
12. Study of axial and appendicular skeleton of vertebrates.

Recommended readings

1. Young, J.Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.
2. Pough H. Vertebrate life, VIII Edition, Pearson International.
3. Darlington P.J. The Geographical Distribution of Animals, R.E.Krieger Pub Co.
4. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution, IV Edition. Jones and Bartlett Publishers Inc.
5. Weichert, C.K. (1970) Anatomy of Chordates (4th edition).
6. Jordan, E. L. and Verma, P. S. (2015) Chordate Zoology (14th edition).
7. Saxena, R. K. and Saxena, S. (2015) Comparative Anatomy of Vertebrates (2nd edition).
8. Ganguly, Sinha and Adhikari. Biology of Chordates.
9. Kotpal, R.L. Vertebrates. Rastogi Publications
10. Jordan P. Nigam. Chordates. S. Chand



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Semester	Core course	Course Title	Credit
II	ZOO-CC-122	Developmental Biology & Evolution	Theory:04 Practical: 02 Total: 06

About the course

The course explains the sequence of events starting with a single cell to the production of a very complex organism. The course not only describes how embryos develop (embryology), but also highlights how the processes of development are brought about by changing individual cells into specialized cells with specific functions (the cellular level), and how genes within the genome of the organism drive and guide these changes (the molecular level). It also deals with a comparative account of development in some select groups of animals.

Learning outcomes

After successfully completing the course, the students will be able to

- Develop critical understanding how a single-celled fertilized egg becomes an embryo and then a fully formed adult by going through three important processes of cell division, cell differentiation and morphogenesis.
- Understand how developmental processes and gene functions within a particular tissue or organism can provide insight into functions of other tissues and organisms.
- Realize that very similar mechanisms are used in very diverse organisms; and development is controlled through molecular changes resulting in variation in the expression and function of gene networks.
- Understand how the field of developmental biology has changed since the beginning of the 19th century with different phases of developmental research predominating at different times.
- Examine the evolutionary history of the taxa based on developmental affinities.
- Understand the relevance of developmental biology in medicine or its role in development of diseases.

Theory

UNIT I: Introduction to Embryonic Development

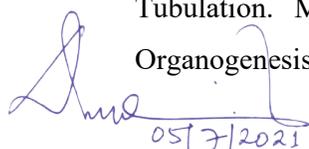
15 Lectures

Reproduction: a basis of species sustenance. Asexual and sexual reproduction and their relevance in corresponding environments. Germ cells, Gamete formation, types, external and internal fertilization; causes of Infertility. Structural and biochemical changes in gametes during and after fertilization, block to polyspermy. Fate maps, their relevance. *In vitro* fertilization; Amniocentesis; Artificial insemination (AI); Gamete intra-fallopian transfer (GIFT). Intra-cytoplasmic sperm injection (ICSI); Test tube baby.

UNIT II: Post-fertilization Development

15 Lectures

Developmental commitment. Mosaic and regulative development. Direct and indirect development. Cleavage: types and patterns. Body plan and symmetries. Gastrulation. Tubulation. Morphogenesis: Epiboly, emboly/ invagination, involution and ingression. Organogenesis: formation of gut, heart, kidney and muscles. Role of extra embryonic


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membranes in development. Placenta: types, structure and functions. Hormonal regulation of metamorphosis in insects and amphibian. Regeneration: epimorphosis, morpholaxis and compensatory regeneration. Development, ageing and apoptosis. Teratogenesis

UNIT III: Origin of Life and Organismal Evolution

15 Lectures

Origin of life on Earth: Arrival of simple form from primordial chemicals. Theories of origin of life. Multicellularity: from simple collections of poorly differentiated cells to complex body plans. Origin of Tetrapods (horse and man). Evidences of evolution: Hardy-Weinberg Equilibrium, Selection, Migration, speciation, isolation.

UNIT IV: Understanding evolution

15 Lectures

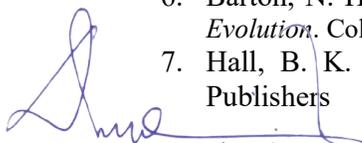
Nonrandom mating, Cost/ benefit of sex, Sexual conflict, Evolution in asexual systems Life-history adaptations, Trade-offs, Number and size of offspring; Parent-offspring conflict. Genetic drift, Neutral evolution; Theories of evolution-Lamarckism, Darwinism and Natural Selection. Linkage disequilibrium; Epistasis. Heritability; Breeding value. Sources of variation: mutation, recombination, epigenetic variation. Zoological time scale, continental drift and distribution of animals; Zoogeographical realms and faunal diversity.

Practical

1. Types of eggs based on quantity and distribution of yolk: sea urchin, insect, frog, Chick.
2. Comparative study of cleavage patterns in Frog and Amphioxus models.
3. How do cells move, change shape and size during morphogenetic movement of Blastulation, Gastrulation in Frog, Amphioxus, Chick?
4. Study of development of chick embryo through incubated chick eggs up to 96 h.
5. Extra embryonic membranes of chick through permanent slides.
6. Some videos to develop understanding on the process of development.
7. Study of adaptive radiations in feet of birds and mouth parts of insects.
8. Understanding embryological evidence of evolution (through charts and videos).
9. Study of types of fossils.
10. Analogy and homology (wings of birds and insects, forelimbs of bat and rabbit).
11. Serial homology in appendages of *Palaemon*.

Recommended readings

1. Gerhart, J. *et al.* (1997) Cells, Embryos and Evolution. Blackwell Science
2. Gilbert, S.F. (2010) Developmental Biology (9th edition). Sinauer
3. Wolpert, L. (2007) Principles of Developmental Biology (3rd edition). Oxford University Press
4. Campbell, N. and Reece, J. (2014) Biology (10th edition). Benjamin Cummings
5. Ridley, M. (2004). *Evolution*. III Edition. Blackwell Publishing.
6. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). *Evolution*. Cold Spring, Harbour Laboratory Press.
7. Hall, B. K. and Hallgrímsson, B. (2008). *Evolution*. IV Edition. Jones and Bartlett Publishers


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Semester	Core Course	Course Title	Credit
III	ZOO-CC-231	Physiology of Chordates	Theory:04 Practical: 02 Total: 06

About the course

The course offers insight into the physiology of chordates while giving an account of their anatomy. This course also explores vertebrate morphology with the aims of understanding major events in the history of vertebrate evolution and integrating the morphology of vertebrates with their ecology, behaviour and physiological adaptation in diverse habitats. Thermal relations encountered in endo- and ectothermic animals will be explained. Selective pressures that shape to different physiological phenotypes will also be addressed in the course.

Learning outcomes

After successfully completing this course, the students will be able to:

- Have a detailed discussion of major organ systems.
- Understand how cells, tissues, and organisms function at different levels. The course content also provides the basis of understanding their abnormal function in animal and human diseases and new methods for treating those diseases.
- Develop an understanding of the related disciplines, such as cell biology, neurophysiology, pharmacology, biochemistry etc.
- Get a flavor of research besides improving their writing skills and making them well versed with the current trends. It will further enable the students to think and interpret individually due to different aspects chosen.
- Undertake research in any aspect of animal physiology in future.

Theory

Unit – 1 Digestion, Respiration and Circulatory Physiology

15 Lectures

Physiology of digestion and absorption of carbohydrate protein and fat in mammal. Physiology of Respiration in vertebrate, diffusion and transport of gases, respiratory quotients. Single and Double circulation. Structure of mammalian heart. Blood: composition and function; blood groups and mechanism of blood coagulation. Acid-base balance, thermoregulation.

Unit – 2 Nervous system and Myology

15 Lectures

Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Types of synapse, Synaptic transmission and, Neuromuscular junction;. Types and structure of muscles; physiology of muscle contraction

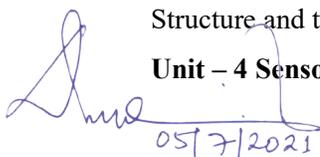
Unit – 3 Excretion and bones

15 Lectures

Ammonotelism, uricotelism and ureotelism. Physiology of excretion: structure of nephron and mechanism of urine formation. Role of ADH and aldosterone. Osmoregulation in vertebrates. Structure and types of bones and cartilages; Bone formation and resorption

Unit – 4 Sensory Organs and Function

15 Lectures


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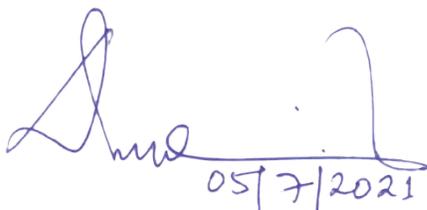
Lateral line system in fishes. Structure of Ear, Mechanism of hearing and balancing. Structure of Eye, physiology of vision, defects of vision and their correction. Olfactory System and Mechanism of olfaction.

Practical

1. Qualitative analysis of nutrients: Carbohydrate, Proteins, Lipids.
2. Estimation of haemoglobin.
3. Counting of different types of blood cells using haemocytometer.
4. Study of action of salivary amylase.
5. Rate of oxygen uptake in fish.
6. Effect of temperature on opercular movement of fish.
7. Physiology of Reflex action in animals with diagrams
8. Preparation of Temporary mounts: Squamous epithelium, Striated muscle fibres, Nerve cells
9. Studies on ammonotelism, uricotelism and ureotelism in animals

Recommended readings

1. Vander, A.; Sherman, J. and Luciano, D. (2003) Human Physiology (9th edition).
2. Randall, D. *et al.* (2002) Eckert Animal Physiology (5th edition) Freeman.
3. Hill, R.W. *et al.* (2008) Animal Physiology (3rd edition) Sinaur Associates.
4. Guyton, A.C. *et al.* (2008) Textbook of Medical Physiology (15th edition) W.B. SaundersCo.
5. Withers, P.C. *et al.* (1992) Comparative Animal Physiology (1st edition) Brooks Cole.
6. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
7. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons
8. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.



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Semester	Core course	Course Title	Credit
III	ZOO-CC-232	Genetics	Theory:04 Practical: 02 Total: 06

About the course

The course is designed to revise basic concepts of Genetics and then move on to advanced concepts. Some key aspects include the mechanism of inheritance, gene structure and function, sex chromosomal and autosomal anomalies, aspects of human genetics, etc. will be covered. A strong emphasis will be laid on the modern tools and techniques used in genetics.

Learning outcomes

After successfully completing this course, the students will be able to:

- Understand how DNA encodes genetic information and the function of mRNA and tRNA
- Apply the principles of Mendelian inheritance.
- Understand the cause and effect of alterations in chromosome number and structure.
- Relate the conventional and molecular methods for gene manipulation in other biological systems.
- Discuss and analyse the epigenetic modifications and imprinting and its role in diseases.
- Get new avenues of joining research in related areas such as genetic engineering of cells, cloning, genetic disorders, human fertility programme, genotoxicity, etc

Theory

UNIT I: Concept of Genes and Genomics

15 Lectures

Genetics: scope and importance. Elements of heredity and variation: Classical and Modern concept of Gene (Cistron, muton, recon), Alleles etc. Mendel's laws of inheritance, Chromosomal basis of inheritance and its applications. Exceptions to Mendelian Inheritance: Incomplete dominance, Codominance, Multiple allelism, Pleiotropy, Epistasis . Polygenic inheritance.

UNIT II: The recombination and interaction of Genes

15 Lectures

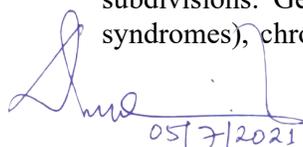
Linkage and crossing over, cytological basis of crossing over. Organelle inheritance (Mitochondrial) Extra-nuclear inheritance, Maternal Inheritance, Sex Chromosomes and sex-linkage: XX/XO, XX/XY, ZZ/ZW and haploidy/diploidy types, Gene dosage Compensation, Epigenetics. Structural and numerical alterations of chromosomes, meiotic consequences in structural heterozygotes. Autosomal dominant and autosomal recessive, X-linked dominant, and X-linked recessive. Haplodiploidy. Sex determination

UNIT III: Regulation of Gene expression, regulation and mapping 15 Lectures

Gene Expressions and regulation: One gene-one enzyme hypothesis /one polypeptide hypothesis. Concept of operon of bacteria and bacteriophages. Bacterial transposons. Transformation, transfection and transduction. Genetic complementation. Genetic mapping.

UNIT IV: Human Population Genetics and Genetic Counselling 15 Lectures

Human Genetics: Pedigree analysis; Karyotype, banding and nomenclature of chromosome subdivisions. Genetic disorders: chromosomal aneuploidy (Down, Turner and Klinefelter syndromes), chromosome translocation (Chronic Myeloid Leukemia) and deletion ("cry of


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cat” syndrome), gene mutation (sickle cell anemia). Genetic counselling, Gene isolation Manipulation and the techniques that revolutionized modern genetics.

Practical

1. Application of probability in the law of segregation with coin tossing
2. Frequency of the following genetic traits in human: widow’s peak, attached ear lobe, dimple in chin, hypertrichosis, colour blindness, PTC tasting
3. Study of mode of inheritance of the following traits by pedigree charts – attached ear lobe, widow’s peak
4. Familiarization with techniques of handling *Drosophila*, identifying males and females; observing wild type and mutant (white eye, wing less) flies, and setting up cultures
5. Demonstration of law of segregation (monohybrid and test cross) sex-linked inheritance in *Drosophila* making a cross between white eye dumpy winged or sepia eyed and wild type flies (criss-cross inheritance)
6. Demonstration of lethal alleles using Curly (Cy) mutant in *Drosophila*
7. Demonstration of multiple allelism by showing mutants of white eye series in *Drosophila*
8. Study of structural chromosome aberrations (dicentric, ring chromosomes and inversions in polytene chromosomes) from prepared slides/photographs

Recommended readings

1. Gardner, E.J. *et al.* (2006) Principles of Genetics (John Wiley).
2. Russell, P.J. (2010) Genetics (Benjamin Cummings).
3. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. (VIII edition) Wiley India.
4. Snustad, D.P. and Simmons, M.J. (2009). Principles of Genetics. (V edition) John Wiley and Sons Inc.
5. Klug, W.S., Cummings, M.R. and Spencer, C.A. (2015). Concepts of Genetics. (X edition) Benjamin Cummings.
6. Carroll S.B.; Doebley J.; Griffiths, A.J.F. and Wessler, S.R. (2018) An Introduction to Genetic Analysis. W. H. Freeman and Co. Ltd.



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सयुक्त कुलसचिव (शैक्षणिक एवं सम्मेलन)
राजीव गांधी विश्वविद्यालय
Jt. Registrar (Acad. & Conf.)
Rajiv Gandhi University
Rono Hills, Doimukh (A.P.)

Semester	Core course	Course Title	Credit
III	ZOO-CC-233	Biochemistry	Theory:04 Practical: 02 Total: 06

About the course

The course provides an introduction to the structure of biomolecules with emphasis on the techniques used for structure determination and analysis. The course covers basic aspects of sample preparation for analysis and aims to enlighten the students how structural information can be utilized for better understanding of biological processes.

Learning outcomes

After successfully completing this course, the students will be able to:

- Understand about the importance and scope of biochemistry.
- Understand the structure and biological significance of carbohydrates, amino acids, proteins, lipids and nucleic acids.
- Understand the structure and function of immunoglobulins.
- Understand the concept of enzyme, its mechanism of action and regulation.
- Understand the process of DNA replication, transcription and translation.
- Learn the preparation of models of peptides and nucleotides.
- Learn biochemical tests for amino acids, carbohydrates, proteins and nucleic acids.
- Learn measurement of enzyme activity and its kinetics.

Theory

UNIT I: Introduction to Biochemistry, Carbohydrates

15 Lectures

Introduction, scope and importance of Biochemistry. Water as biological solvent. Carbohydrates: Structure and biological importance. Classification - Reducing and non-reducing sugars, monosaccharides, Oligosaccharides (Disaccharides), polysaccharides (peptidoglycans and glycosaminoglycans). Catabolism of carbohydrates and ATP production, Glycolysis, Krebs cycle, Electron transport chain and ATP synthesis Phosphate pentose pathway, Gluconeogenesis, Glycogenolysis and Glycogenesis.

UNIT II: Lipids: Structure and Biological significance

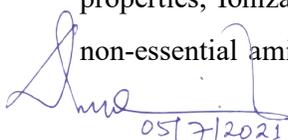
15 Lectures

Lipids: Structure and Biological significance. Fatty acids- Types and nomenclature (saturated and unsaturated). Classification- Triglycerides, Phospholipids, Sphingolipids, Cholesterol, β -oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms.

UNIT III: Protein structure and metabolism

15 Lectures

Proteins: Composition and Biological significance. Amino acids -Structure, classification and properties, Ionization, titration curve, pK and pI. Physiological importance of essential and non-essential amino acids. Catabolism of amino acids: Transamination, Deamination, Urea


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cycle. Enzymes: Nomenclature and classification, general properties, specificity, cofactors, isozymes. Mechanism of enzyme action (ES complex and lowering of activation energy, chemical catalysis). Kinetics (determination of K_m and V_{max} using Michaelis-Menten and Lineweaver-Burk plots). Regulation of enzyme activity, inhibition, allosteric regulation, role of covalent modifications; Concept of ribozymes and abzymes.

UNIT IV: Nucleic acids and mechanisms of replication, transcription and translation **15 Lectures**

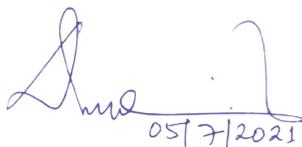
Structure -Bases, nucleosides and nucleotides. DNA structure: Conformation (A, B and Z), DNA double helix (Watson and Crick model). DNA and RNA as genetic material. Organization of nucleosomes and higher order structure. DNA replication: Machinery and Basic mechanism (Prokaryotes). Transcriptional unit and basic mechanism of transcription (Prokaryotes). Genetic code and basic mechanism of translation (Prokaryotes). Introduction to recombinant DNA techniques and their applications.

Practical

1. Preparation of models of amino acids and dipeptides.
2. Ninhydrin test for α -amino acids.
3. Benedict's test for reducing sugars.
4. Iodine test for starch.
5. Preparation of models of nitrogenous bases, nucleosides and nucleotides.
6. Qualitative test for DNA & RNA.
7. Determination of the activity of enzyme (amylase).
 - 7.1. Effect of [S] and determination of K_m and V_{max} .
 - 7.2. Effect of temperature.
 - 7.3. Effect of time.

Recommended readings

1. Nelson, D.L. & Cox, M.M. (2017) Lehninger Principles of Biochemistry (7th edition) Worth.
2. Berg, J.M.; Tymoczko, J.L. and Stryer, L. (2015) Biochemistry (7th edition) Freeman.
3. Zubay, G. (2017) Biochemistry (4th edition) McGraw-Hill.
4. Conn, E.E.; Stumpf, P.K.; Bruening, G. and Doi, R.H. (2006) Principles of Biochemistry (5th edition) Wiley.



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Rono Hills, Doimukh (A.P.)

Semester	Core course	Course Title	Credit
IV	ZOO-CC-241	Behaviour and Chronobiology	Theory:04 Practical: 02 Total: 06

About the course

The course aims to explain the natural behaviour patterns, how the behaviour varies among individuals and species (wild, domestic, and captive), how current and past environments and ecology influence not only behaviour, but also the underlying gene- environment interactions that shape it.

Learning outcomes

After successfully completing this course, the students will be able to:

- Learn a wide range of theoretical and practical techniques used to study animal behaviour.
- Develop skills, concepts and experience to understand all aspects of animal behaviour.
- Objectively understand and evaluate information about animal behaviour and ecology encountered in our daily lives.
- Understand and be able to objectively evaluate the role of behaviour in the protection and conservation of animals in the wild.
- Consider and evaluate behaviour of all animals, including humans, in the complex ecological world, including the urban environment

Theory

UNIT I: Behaviour and the response invoking stimuli

15 Lectures

Animal behaviour. Scope and importance of study. Proximate and ultimate causes of behavior. Types of stimuli invoking response: internal and external cues. Patterns of behaviour: Kinds of behaviour: foraging behaviour, Territorial behaviour. Mate selection and courtship behaviour. Parental care, defensive behaviour. Stereotyped Behaviours (Orientation, Reflexes); Innate/ Instinct behaviour. vs. Learnt Behaviour. Sensory filtering

UNIT II: Communication and regulation of behaviour

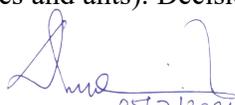
15 Lectures

Social organization (e.g., Honey bee, Termites etc.). Communication in living in groups. Evolution of sociality. Genetic basis of behaviour. Regulation of behaviour: Neural control: kineses, taxes, simple reflexes. Sensory processing: echolocation (bats). Hormonal control. Biological clocks: Advantages of biological rhythms. Circadian and circannual rhythms. Photoperiodism, tidal, solar and lunar rhythms, entrainments. Migratory behaviour in birds and fishes.

UNIT III: Innate behaviour; Evolution of reproductive behaviour

15 Lectures

Innate behaviour: communication (primates, bees and ants). Decision making. territorial


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behaviour, schooling behaviour. Mimicry and colouration. Evolution of reproductive behavior, mating systems and parental care. Asymmetry in sex, sexual dimorphism. Role of hormones in drive; role of pheromones in alarm spreading; social hierarchies in primates. Crypsis, predator detection, predator tactics.

Unit IV: Learning behaviour; conditioning; socio-biology

15 Lectures

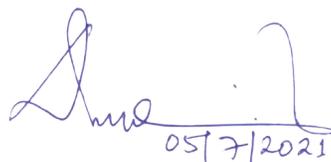
Learning (Learnt behaviour): habituation, imprinting, conditioned reflex, trial and error learning, latent learning, insight learning. Types of learning -Habituation, Imprinting and types of imprinting -filial and sexual, Classical conditioning, Instrumental learning and insight learning. Social behaviour: Social and cultural transmission of Behaviour; aggregation, group selection, kin selection, altruism. Elements of Socio-biology: Selfishness, cooperation, altruism, kinship and inclusive fitness.

Practical

1. Orientation of an animal to light.
2. Constructing an ethogram.
3. Chemical communication in ants.
4. Selective predation of coloured prey items.
5. Predatory behaviour of a carnivorous animal.
6. Nests and nesting habits of the birds and social insects
7. To study the behavioural responses of wood lice to dry and humid conditions.
8. To study geotaxis behaviour in earthworm.
9. To study the phototaxis behaviour in insect larvae.
10. Study of circadian functions in humans (daily eating, sleep and temperature patterns).
11. Visit to Forest/ Wildlife Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a short report.

Recommended readings

1. McFarland, D. (1999) Animal Behaviour (3rd edition) Pitman Publishing Limited, London, UK.
2. Manning, A. and Dawkins, M. S. (2015) An Introduction to Animal Behaviour (6th edition) Cambridge, University Press, UK
3. Alcock, J. (2005) Animal Behaviour (8th edition) Sinauer Associate Inc., USA.
4. Sherman, P. W. and Alcock, J. (2015) Exploring Animal Behaviour (6th edition) Sinauer Associate Inc., Massachusetts, USA.
5. Dunlap, J. C.; Loros, J.J. and DeCoursey, P. J. (2009) Chronobiology Biological Timekeeping (1st edition) Sinauer Associates, Inc. Publishers, Sunderland, MA, USA.
6. Kumar, V. (2002). Biological Rhythms: Narosa Publishing House, Delhi/ Springer - Verlag, Germany.



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Rono Hills, Doimukh (A.P.)

Semester	Core course	Course Title	Credit
IV	ZOO-CC-242	Ecology	Theory:04 Practical: 02 Total: 06

About the course

This course will take students on a journey through the physical workings of the Earth, the interactions between species and their environments. The course highlights on some of the important aspects *viz.* growth and survival of populations and communities in different habitats, energy flow in the ecosystems, interactions between the communities, exclusion of niches and consequences of changing environment on the biodiversity.

Learning outcomes

After successfully completing this course, the students will be able to:

- Know the evolutionary and functional basis of animal ecology.
- Understand what makes the scientific study of animal ecology a crucial and exciting endeavour.
- Engage in field-based research activities to understand well the theoretical aspects taught besides learning techniques for gathering data in the field.
- Analyse a biological problem, derive testable hypotheses and then design experiments and put the tests into practice.
- Solve the environmental problems involving interaction of humans and natural systems at local or global level.

Theory

UNIT I: An overview of Ecology, Ecosystems and Biomes

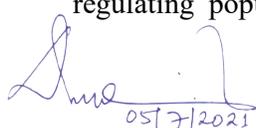
15 Lectures

Introduction and scope of Ecology. Multidisciplinary relevance in current perspective. Structure and function of ecosystem; Abiotic factors affecting survival and sustenance of organisms e.g., water, temperature, light, pH and salinity. Role of limiting factors in survival of biotic components. Major ecosystems of the world: Ecological features, limiting factors, zonation and classification of organisms of fresh water and marine ecosystems. Introduction to Biome: Ecological features of Tundra, Desert, Savannah and Tropical Rain forest, Biomes. Energy flow in ecosystem, food chain and food web. Productivity. Mineralization and recycling of nutrients: C, N, P & S.

UNIT II: Population ecology; Human population growth

15 Lectures

Ecology of populations: Unitary and Modular populations. Unique and group attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curves. Unique and group attributes of population: mortality, age ratio, sex ratio, dispersal. Factors regulating population dispersal and growth: Exponential and logistic growth. Population


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regulation: density-dependent and independent factors; r and K strategies.

UNIT III: Biotic community, characteristics and attributes

15 Lectures

Community characteristics: stratification; Dominance, diversity, species richness, abundance, Evenness, Similarity. Diversity and food-web indices. Ecotone and edge effect; Types of interaction: Positive interactions: commensalism, proto-cooperation, and mutualism. Negative interactions: parasitism and allelopathy; predation and predator-prey dynamics; herbivory. Interspecific competition and coexistence, Inter and intra-specific; abundance. Gause's Principle with laboratory and field examples. Ecological succession: Definition, Process, types, theories of succession.

UNIT IV: Environmental degradation; Environmental movement etc.

15 Lectures

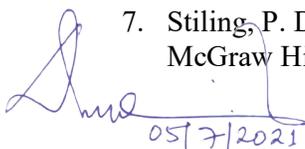
Environmental ethics; Pollution: Air, water and noise pollution and their control; Natural resources: Mineral, water and forest, their significance and conservation; Types of biodiversity, Hotspots, benefit and threat of conservation strategies; Biodiversity: status, monitoring and documentation; major drivers of biodiversity change; Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value. Application of ecology in management and Conservation programmes. Environmental education and public awareness

Practical

1. To measure microclimatic variables *viz.*, temperature, humidity and light conditions in a microhabitat.
2. Making an ecosystem in a wide-mouthed bottle.
3. Constructing a food web by observing and collecting organisms from a given area.
4. Preparing and clearly present an essay based on the evaluation of 4-7 publications
5. Studying the impact of herbivore on plant species (planted in pots under specific conditions)
6. Investigation of volatile inhibitory substances produced through decomposition of plant debris and root exudates.
7. Estimation of the ratio of the producers and consumers.
8. Studying insect diversity in a habitat.

Recommended readings

1. Colinaux, P. A. (1993) Ecology (2nd edition) Wiley, John and Sons, Inc.
2. Krebs, C. J. (2001) Ecology (6th edition) Benjamin Cummings.
3. Odum, E.P., (2008) Fundamentals of Ecology. Indian Edition. Brooks/Cole.
4. Ricklefs, R.E. (2000) Ecology (5th edition) Chiron Press.
5. Southwood, T.R.E. and Henderson, P.A. (2000) Ecological Methods (3rd edition) Blackwell Sci.
6. Kendeigh, F C. (1984) Ecology with Special Reference to Animal and Man. Prentice Hall Inc.
7. Stiling, P. D. (2015) Ecology Companion Site: Global Insights and Investigations. McGraw Hill Education.


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Semester	Core course	Course Title	Credit
IV	ZOO-CC-243	Molecular Biology	Theory:04 Practical: 02 Total: 06

About the course

The course provides an insight into the life processes at the subcellular and molecular levels. Other important aspects include DNA and molecular genetics including gene cloning, sequencing and gene mapping in addition to the powerful techniques that revolutionized the pharmaceutical, health and agricultural industries.

Learning outcomes

After successfully completing this course, the students will be able to:

- Develop an understanding of concepts, mechanisms and relevance of molecular biology in the current scenario.
- Get well versed in recombinant DNA technology which holds application in biomedical & genomic science, agriculture, environment management, etc. Therefore, a fundamental understanding of Molecular Biology will help in career building in all these fields.
- Apply their knowledge in problem solving and future course of their career development in higher education and research.
- Get new avenues of joining research in related areas such as therapeutic strategies or related opportunities in industry.

Theory

Unit -1: Central dogma; detailed information on nucleic acids

15 Lectures

Introduction to Molecular Biology, Central Dogma of Molecular Biology. Origin and evolution of life/ Prokaryotic and Eukaryotic Genes and Genomes. Structure and Function of DNA, DNA forms: Plasmid DNA, Genomic DNA and Repetitive DNA. Conformation, Structure and Topology of DNA. Structure and Function of RNA, Ribosomal RNA (rRNA), Transfer RNA (tRNA), Messenger RNA (mRNA), Noncoding RNA.

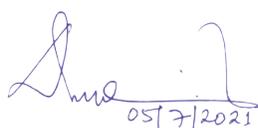
Unit –II: Chromosomes; DNA replication, recombination, repair etc. 15 Lectures

Chromosomes, Chromatin, Histones, Histone-modifications. DNA Replication, plasmid DNA replication, telomeric DNA replication, DNA polymerases and other regulatory proteins during DNA replication. Mutation, types of gene mutation, mutagenic agents, molecular basis of mutation, DNA recombination. DNA repair; direct DNA repair, base excision repair, nucleotide excision repair, mismatch repair,

Unit –III: RNA transcription, processing, editing, splicing etc.

15 Lectures

Transcription, RNA polymerase I, II, III, transcription factors. Regulation of gene expression in prokaryotes and eukaryotes. Operon Concept and Lac Operon, RNA processing: RNA splicing and alternative splicing, RNA editing, 5'-capping and 3'-polyadenylation of mRNA, rRNA and tRNA modifications and processing.



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Unit –IV: Ribosomes: Role in cell sustenance.

15 Lectures

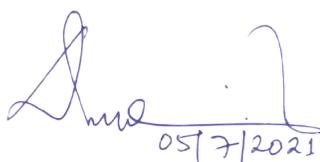
Ribosomes, Genetic Code, and Wobble hypothesis. Translation, protein synthesis in *E. coli* and eukaryotic cells. Aminoacylation of tRNA, initiation, elongation, peptide bond formation, translocation, termination. Post-translational modifications and processing of proteins

Practical

1. Preparation of ball and stick model for B-DNA molecule (A=T and G=C base pairs).
2. Isolation of genomic DNA by ethanol precipitation method.
3. Agarose gel electrophoresis of the plasmid DNA and the genomic DNA.
4. Demonstration of Electrophoretic apparatus
5. Study and interpretation of electron micrographs/photograph showing DNA replication, transcription and split genes.
6. Estimation of the growth kinetics of *E. coli* by turbidity method

Recommended readings

1. Watson, J.D. *et al.* (2013) Molecular Biology of the Gene (7th edition) CSHL Press Pearson.
2. Green, M. R and Sambrook, J. (2012) Molecular Cloning: a Laboratory Protocol (4th edition) CSHL Press.
3. Walter, P. (2007) Molecular Biology of the Cell (5th edition) Garland Science.



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Rajiv Gandhi University
Rono Hills, Doimukh (A.P.)

Semester	Core course	Course Title	Credit
V	ZOO-CC-351	Biotechniques	Theory:04 Practical: 02 Total: 06

About the course

This is the only laboratory course taught independently of lecture courses. It has full hands on approach to expose the students to modern techniques and methodologies. The diverse techniques from microscopy to spectroscopy, calorimetry, chromatography ELISA, tissue culture to cloning etc. are included to make the student well versed with these protocols and methods.

Learning outcomes

After successfully completing this course, the students will be able to:

- Understand the purpose of the technique, its proper use and possible modifications/improvement.
- Learn the theoretical basis of technique, its principle of working and its correct application.
- Learn the construction repair and adjustment of any equipment required for a technique.
- Learn the accuracy of technique.
- Learn the maintenance laboratory equipments/tools, safety hazards and precautions.
- Understand the technique of cell and tissue culture. Learn the preparation of solution of given percentage and molarity.
- Understand the process of preparation of buffer. Learn the techniques of separation of amino acids, proteins and nucleic acids.

Theory

UNIT I : Microscopy and Microtomy

15 Lectures

Microscopy: Introduction to Microscopy. Definitions-Resolving Power, Limit of Resolution and Magnification, Numerical Aperture. Types of microscopes Light - (bright field, dark-field, phase Contrast, Fluorescence and Confocal Microscopy), and Electron (SEM and TEM) Microscope. Measurements, Drawings and photomicrography. Microtomy: Tissue preparation, fixation, block preparation, sectioning, staining, dehydration and mounting.

UNIT II : Tools and techniques in Biochemistry and Physiology

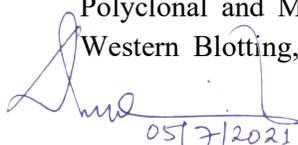
15 Lectures

Biochemistry and Physiology: Physiological Salines, Buffers and the use of pH meter. Subcellular Fractionation by Differential Centrifugation. Basic Principle and Application of Colorimetry and Spectrophotometry, Beer-Lambert's Law. Principle and applications of Electrophoresis: Separation of Biomolecules by SDS-PAGE. Agarose gel electrophoresis. Principle and Applications of Paper chromatography, Thin layer chromatography.

UNIT III : Tools and Techniques in Endocrinology and immunology

15 Lectures

Immunology and Endocrinology: Introduction to Antigens, Antibodies, Adjuvants. Raising Polyclonal and Monoclonal Antibodies. Antigen-Antibody Interactions- Immunodiffusion, Western Blotting, ELISA, RIA. Principle & Working of ELISA, Reader. Application of


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Immunological techniques in disease diagnosis. Polymerase Chain Reaction and Fluorescence *in-situ* hybridization.

UNIT IV: Cell culture, maintenance of Laboratory animals

15 Lectures

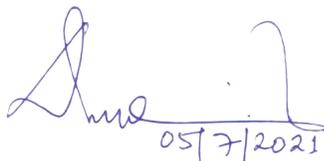
Cell Culture and Laboratory Animals: Cell culture and its basic requirements. Culture media- Nutrient and Non-nutrient, commonly used media for human cell lines. Sterilization of culture wares and Media, laminar flow. Types of animal cell culture, cell viability testing, cryopreservation. Maintenance and Handling of laboratory rats and rabbits. Bioethics.

Practical

1. Preparation of buffer and determination of pH.
2. Identification of amino acids in the mixture using paper chromatography.
3. Verification of laws of spectrophotometry.
4. Separation of proteins using SDS-PAGE.
5. Tissue fixation, paraffin block preparation, sectioning.
6. Preparation of permanent slides of microscopic organisms/ small insects.
7. Demonstration of bright field, phase contrast, fluorescence, confocal and electron microscopes.

Recommended readings

1. Boyer, R. (2000) Modern Experimental Biochemistry (3rd edition) Benjamin-Cummings.
2. Pearse, A.G.E. (1980-1993) Histochemistry - Theoretical and applied, Volume I-III, Churchill-Livingstones.
3. Plummer, D. (2017) An Introduction to Practical Biochemistry (3rd edition) McGraw Hill.
4. Wilson, K. and Walker, J. (2010) Experimental Biochemistry, Cambridge.



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Rajiv Gandhi University
Rono Hills, Doimukh (A.P.)

Semester	Core course	Course Title	Credit
V	ZOO-CC-352	Microbiology, Parasitology and Immunology	Theory:04 Practical: 02 Total: 06

About the course

This is a composite course with remarkable utility and importance. Microbiology being the study of microorganisms such as viruses, bacteria etc., covers theoretical studies and practical proficiency training which may help in their placement at a clinical microbiological laboratory. Parasitology component takes care of the parasites and parasitism, emphasizing the influence of parasites on the ecology and evolution of free living species, and the role of parasites in global, public, health. Immunology part provides the students with the fundamental knowledge of the immune system and its protective roles against diseases.

Learning outcomes

After successfully completing this course, the students will be able to:

- Describe the mechanisms for transmission, virulence and pathogenicity in pathogenic micro-organisms.
- Diagnose the causative agents, describe pathogenesis and treatment for important diseases like malaria, leishmaniasis, trypanosomiasis, toxoplasmosis, schistosomiasis, cysticercosis, filariasis etc.
- Assess the importance of incidence, prevalence and epidemiology in microbiological diagnostic activities.
- Know how resistance development and resistance transfer occur.
- Identify the major cellular and tissue components which comprise the innate and adaptive immune system.
- Understand how are immune responses by CD4 and CD8 T cells, and B cells, initiated and regulated.
- Understand how does the immune system distinguish self from non-self.
- Gain experience at reading and evaluating the scientific literature in the area.

Theory

UNIT-I: Microbiology and Applied Immunology

15 Lectures

Viral diseases: hepatitis, influenza/corona virus, AIDS, chikungunya with emphasis on their causative agents, pathogenesis, diagnosis, prophylaxis and chemotherapy. Bacterial diseases caused by *Streptococcus pneumoniae*, *Salmonella typhi*, *Mycobacterium tuberculosis*, *Vibrio cholerae*. Fungal diseases: Ringworm infection, aspergillosis, candidiasis. Immunity boosters

UNIT-II: Parasitology: an overview of common parasitic infections. 15 Lectures

Introduction to parasites and parasitic diseases. Mode of transmission, portal of entry and implications of parasitism. Parasitic adaptations. Concept of zoonotic diseases. Protozoan diseases of medical importance: amoebiasis, giardiasis, malaria, trypanosomiasis, leishmaniasis and toxoplasmosis. Helminthic diseases of medical importance: Schistosomiasis, taeniasis, echinococcosis, ascariasis, enterobiasis, dracunculiasis and filariasis.

UNIT-III: Immunology: Immune mechanism and related pathways. 15 Lectures

Definition and classification. Cells and organs of immune system- primary and secondary lymphoid organs. Innate immunity: First and second lines of defense. Characteristics of

antigen- antigenicity and immunogenicity, epitopes, haptens, adjuvant. Factors influencing immunogenicity. Classical and molecular structure of immunoglobulin. Classification, properties and functions of immunoglobulins. Antigenic determinants: isotype, allotype and idiotypic. Antigen and antibody interactions, affinity, avidity. Complement system (Classical, and alternative pathways).

UNIT-IV: Acquired immunity, Hypersensitivity and autoimmune disorders. 15 Lectures

Acquired immunity: Humoral and cell mediated immune response. Role of B and T cell in immunity. Receptors, activation and differentiation of B and T cells. Cytokines: Properties and function. MHC complex and molecules with classification and function. Antigen processing and their presentation. Hypersensitivity: Gell and Coomb's classification with mechanism and examples. Autoimmune disorders. Hybridoma technology, monoclonal antibodies, immunotoxins and their applications.

Practical

1. Study of permanent slides and specimens of parasitic protozoans and helminths.
2. Blood: Erythrocyte Sedimentation Rate (ESR), Haematocrit.
3. Staining and identification of Gram positive and Gram-negative bacteria.
4. Preparation of thin and thick blood films to diagnose *Plasmodium* infections.
5. Preparation of temporary and permanent slides of faecal matter by saline preparation and concentration techniques to identify cysts of parasitic protozoans and helminths eggs.
6. Demonstration of antigen-antibody interaction in gel.
7. Separation of γ -globulin by salt precipitation.

Recommended readings

1. Jawetz, M. and Adelberg (2015) Medical Microbiology (27th edition)
2. Chatterjee, K.D (2015) Parasitology (13th edition)
3. Goldsby, R.A.; Kindt, T.J. and Kuby, J. (2006) Immunology (6th edition).
4. Roitt, I.; Brostoff, J. and Male, D. (2012) Immunology (8th edition).



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Jt. Registrar (Acad. & Conf.)
Rajiv Gandhi University
Rono Hills, Doimukh (A.P.)

Semester	Core course	Course Title	Credit
VI	ZOO-CC-361	Biostatistics and Bioinformatics	Theory:04 Practical: 02 Total: 06

About the course

The course is aimed at introducing the application of bioinformatics and statistics in biology. The course gives an insight into the key concepts and methods used in bioinformatics; and computer storage, retrieval, analysis, visualization and distribution of information data related to biological macromolecules like DNA, RNA and proteins. It provides foundation on statistical methods to enable students to compute and interpret basic statistical parameters. As an interdisciplinary field it integrates biology, computer science, chemistry and statistics together sequence analysis structure analysis and functional analysis of biological data.

Learning outcomes

After successfully completing this course, the students will be able to:

- Know the theory behind fundamental bioinformatics analysis methods.
- Be familiar with widely used bioinformatics databases.
- Know basic concepts of probability and statistics.
- Describe statistical methods and probability distributions relevant for molecular biology data.
- Know the applications and limitations of different bioinformatics and statistical methods.
- Perform and interpret bioinformatics and statistical analyses with real molecular biology data.
- Acquire knowledge of various databases of proteins, nucleic acids. Primary, secondary and composite databases. BLAST, FASTA
- Make phylogenetic predictions or prediction of structure of proteins and nucleic acids
- Develop understanding in Primer designing
- Understand data mining tool and its practical application in a case study
- Apply the knowledge in future course of their career development in higher education and research.

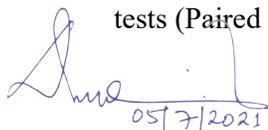
Theory

UNIT I: Data collection, distribution, presentation, authentication and analysis 15 Lectures

Concept of Biostatistics. Sample and sampling methods and classification of data. Data representation: Tabular, Graphical and diagram/chart. Cumulative frequency curve (Ogive), Box plot. Probability theory: Binomial distribution, Poisson distributions. Measures of central tendency: Arithmetic Mean, Median, Mode; Measures of dispersion: Variance, Standard deviation and Standard error, Concept of Coefficient of variation.

UNIT II: Correlation, regression, analysis of variance etc. 15 Lectures

Correlation: Types of correlation, Calculation of correlation in continuous data and ordinal data. Regression: Linear regression, regression coefficient. Hypothesis testing: Parametric tests (Paired and unpaired t-test, z-test, F-test) & Non Parametric tests (Chi-square test)



UNIT III: Basics of IT; Data archiving systems etc.

15 Lectures

Introduction and scope of bioinformatics: concept of digital laboratory. Basics of information technology, computer, operating systems, network. Concept of internet protocol (TCP/IP), hypertext, home-page, web-page and uniform resource locators (URL). Introduction to data archiving systems (FASTA format, Accession, and GI- Number)

UNIT IV: Data base management: software, packages and tools

15 Lectures

Basic features and management systems of following: Nucleic acid sequences databases, Genome databases, Protein sequence, structures and interacting proteins databases, Literature databases, Biodiversity and ecosystem based databases. Introduction to data retrieval systems, Search engines, Entrez, sequence retrieval system (SRS) and protein identification resource (PIR)., Sequence alignments (BLAST) and phylogenetic trees.

Practical

1. Calculation of mean, standard deviation and standard error.
2. Calculation of correlation coefficient values and finding out the probability
3. Calculation of 'F' value and finding out the probability value for the F value.
4. Student's t-test: Independent and dependent. Hand calculation and calculation using MS Excel.
5. Pair-wise alignment of sequences (BLAST) and interpretation of the output

Recommended readings

1. Daniel, W.W. (2012) Biostatistics: A Foundation for Analysis in Health Sciences(10th edition) John Wiley.
2. Milton, J.S. & Tsokos, J.O. (1992) Statistical Methods in the Biological and Health Sciences (2nd edition) McGraw Hill.
3. Zar, J.H. (2013) Biostatistical Analysis (5th edition) Pearson.
4. Barnes, M.R. and Gray, I.C. (2003) Bioinformatics for geneticists, Wiley.
5. Mount, D.W. (2006) Bioinformatics (2nd edition) CBS.



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Semester	Core course	Course Title	Credit
VI	ZOO-CC-362	Applied Zoology	Theory:04 Practical: 02 Total: 06

About the course

The course is unique in highlighting the commercial and industrial significance/value of animals. It discusses the techniques/ methods of rearing of animals for commercial usage and the prerequisites for their successful maintenance and sustenance.

Learning outcomes

After successfully completing this course, the students will be able to:

- Understand the culture techniques of prawn, pearl and fish.
- Understand silkworms rearing and their products.
- Understand the Bee keeping equipments and apiary management.
- Understand dairy animals management, the breeds and diseases of goats and learn the testing of egg and milk quality.
- Learn various concepts of lac cultivation.
- Be aware of a broad array of career options and activities in human medicine,biomedical research and allied health professions.

Theory

UNIT I: Aquaculture

15 Lectures

Aquaculture: Prawn culture: Culture of fresh water prawn; preparation of farm. preservation and processing of prawn. Pearl Culture, protocol followed; Fish Culture, Breeding Pond, Fish Seed, Hatching pond. Transport of fish fry to rearing ponds. Harvesting, preservation of fish. Composite fish farming. By products of fishing industry and common fish diseases.

UNIT II: Apiculture, Lac culture and Sericulture

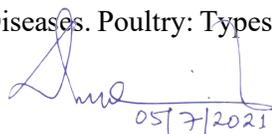
15 Lectures

Apiculture: Species of honey bees in India. Life history of *Apis*. Methods of Bee keeping. Bee products and their uses. Natural enemies and their control. Morphology and Biology of honey bees; social behavior of honey bees. Bee keeping and ancillary industries. Newton's Bee hive Extraction of honey. Medicinal value of honey; bee products. Importance of bee colonies in crop pollination. Lac culture: Lac insect and its life cycle. Cultivation of lac insect, host plants, processing and uses of lac. Sericulture: Types of silk; Silkworms and their host plants; Mulberry silkworm culture; Life history of non-mulberry silkworm; Natural enemies and their control

UNIT III: Dairy management and poultry farming

15 Lectures

Dairy: Introduction to common dairy animals. Techniques of dairy management. Milk and milk products. Cattle Diseases. Poultry: Types of breeds. Rearing method. Diseases and control


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measures. Breeds of fowl, Housing and Equipment. Management of growers, Layers, Broilers; Diseases of fowl. Nutritive value of egg and meet. Incubation and hatching of eggs.

UNIT IV: Vermiculture; Maintenance of reared animals

15 Lectures

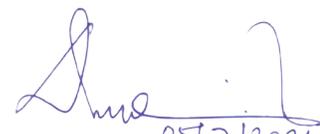
Vermiculture: important vermicomposting species of earthworms and its biology. Rearing of earthworms, Equipments, devices used in vermiculture, Vermicompost Technology. Methods and products, Vermiwash Collection, Composition and use. Introduction and importance. Health care and maintenance of reared animals.

Practical

1. Morphological characterization of common fish species.
2. Identification of two major carps – *Labeo rohita* and *Catla catla* and their life cycles.
3. Mounting of the sting apparatus of honey bee.
4. Castes (through charts/specimens) study of bees
5. Worker honeybee with emphasis on leg modifications (through specimens/charts) and whole mount preparation of the 3 pairs of legs.
6. Life cycle of silkworm.
7. External morphology and nomenclature of dairy animals. Determination of the specific gravity of milk by using a mercury lactometer.
8. Test for good quality eggs (Floating test, cracking test) and for fertilized and unfertilized eggs (Light test, Cracking test).
9. External morphology of poultry birds (model).
10. Morphology of earthworm *Eisenia foetida*
11. Project report on visit to dairy farm and visit to Poultry farm (Poultry management and Poultry breeds).

Recommended readings

1. Shukla, G.S. and Upadhyaya, V.B. (1999-2000). Economic Zoology (Rastogi Publishers).
2. Mani, M.S. (2006). Insects, NBT, India.
3. Jabde, P.V. (2005) Text Book of Applied Zoology: Vermiculture, Apiculture, Sericulture, Lac culture.
4. Jha Keshav Kr. (2010). Aquaculture (Daya Publication House, New Delhi)


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Discipline Specific Elective Courses (DSE)

Semester	Course	Course Title	Credit
V	ZOO-DE-351	Genetic Engineering and Biotechnology	Theory:04 Practical: 02 Total: 06

About the course

This course gives an insight into the direct manipulation of DNA to alter the characteristics of an organism in a particular way. It envisages concepts, mechanisms, biological designs, functions and evolutionary significance of genetic modification or manipulation in special organisms and also discusses the recent advance in recombinant DNA technology.

Learning outcomes

After successfully completing this course, the students will be able to:

- Develop an understanding of the fundamental molecular tools and their applications of DNA modification and cloning.
- Appreciate shifting their orientation of learning from a descriptive explanation of biology to a unique style of learning through graphic designs and quantitative parameters to realize how such research and innovations have made science interdisciplinary and applied.
- Develop future course of their career development in higher education and research with a sound base.
- Apply their knowledge with problem solving approach to recommend strategies of genetic engineering for possible applications in Biotechnology and allied industry.

Theory

UNIT I: Scope of genetic engineering

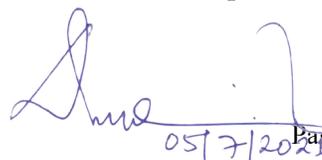
15 Lectures

Introduction to Genetic Engineering and Biotechnology. Enzymes as Tools for Genetic Engineering: Restriction Enzymes, Restriction-Modification System, DNA-modifying enzymes, T4 and *E. coli* DNA Polymerase (Klenow), DNA-methylase, Polynucleotide Kinase, DNA-ligase, Taq DNA polymerase, Reverse Transcriptase, T7 and T3 RNA polymerases. Vehicles for DNA cloning: Plasmid DNA vectors, bacteriophage lambda- derived vectors.

UNIT II: Recombination and cloning

15 Lectures

DNA (Gene) cloning, recombinant DNA, Gene library; cDNA library and genomic library. Isolation of gene from gene library. Screening and identification of recombinant DNA clone from genelibrary. Expression of recombinant protein from a DNA clone in bacteria and purification of the protein. Some examples of the useful recombinant proteins: Insulin, Streptokinase, enzymes, antibodies, vaccines.



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UNIT III: Recent advances in gene technology**15 Lectures**

Polymerase Chain Reaction (PCR) and Site-directed mutagenesis, Restriction enzyme digestion. Transgenic animals, Ligation, Cloning, Transformation. Gene Targeting: Knock-ins and Knock-outs.

UNIT IV: Genomic studies; ethical issues in genetic engineering**15 Lectures**

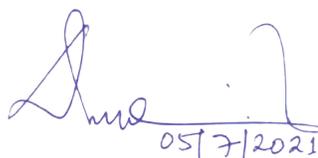
DNA Sequencing and Genome Analysis, Model Genomes (*E.coli*). Human Genome Project and Human Genome Sequences. Applications of Genetic Engineering and Biotechnology in agriculture, medicine and its economic and social implications, Ethical precautions.

Practical

1. Video-graphic demonstrations on the above-mentioned topics.
2. Models and Presentations by students on the topics: Microbial degradation of waste materials, Antibiotics from microorganisms, Transgenic Tomato and Rice, Recombinant Interferon, Growth Hormone, Insulin, Colony Stimulating Factor, Streptokinase, Industrial Enzymes.
3. Restriction enzyme digestion.
4. Separation of molecules using electrophoresis, Cloning.
5. Transformation, Calculation of transformation efficiency.

Recommended readings

1. Primrose, S.B. and Twyman, R. (2006) Principles of Gene manipulation and Genomics (7th edition) Blackwell Publishing.
2. Nicholl, D.S.T. (2008) An introduction to Genetic Engineering (3rd edition) Cambridge University Press.
3. Watson, J.D. (2006) Recombinant DNA (3rd edition) Cold Spring Harbor Laboratory Press.
4. Brown, T.A. (2001) Gene Cloning and DNA Analysis: An Introduction.
5. A PBS Documentary entitled, "Playing God" [History of Genetic Engineering]



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Semester	Course	Course Title	Credit
V	ZOO-DE-352	Evolutionary Biology	Theory:04 Practical: 02 Total: 06

About the course

The present course gives insight into the origin of life and the related evolutionary processes. The evolutionary theories and the process of species formation will be elaborated in view of the natural selection process.

Learning outcomes

After successfully completing this course, the students will be able to:

- Acquire an in-depth knowledge on the diversity and relationships in animal world.
- Develop a holistic appreciation on the phylogeny and adaptations in animals.
- Enable the students to understand the evolution of universe and life.
- Understanding on the process and theories in evolutionary biology.
- Develop an interest in the debates and discussion taking place in the field of evolutionary biology.

Theory

Unit-I: Origin of life and evidences of evolution

15 Lectures

Life's Beginnings: Chemogeny, RNA world, Biogeny, Origin of photosynthesis, Evolution of eukaryotes; Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism. Evidences of Evolution: Fossil record (types of fossils, transitional forms, geological time scale, evolution of horse, Molecular (universality of genetic code and protein synthesising machinery, three domains of life, neutral theory of molecular evolution, molecular clock, example of globin gene family, rRNA/cyt c; Sources of variations: Heritable variations and their role in evolution

Unit-II: How do evolutionary forces operate?

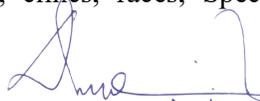
15 Lectures

Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population); Evolutionary forces upsetting H-W equilibrium; Natural selection (concept of fitness, selection coefficient, derivation of one unit of selection for a dominant allele, genetic load, mechanism of working, types of selection, density-dependent selection, heterozygous superiority, kin selection, adaptive resemblances, sexual selection. Genetic Drift (mechanism, founder's effect, bottleneck phenomenon; Role of Migration and Mutation in changing allele frequencies

Unit-III: Products of evolution: speciation mechanisms

15 Lectures

Micro evolutionary changes (inter-population variations, clines, races, Species concept,


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Isolating mechanisms, modes of speciation—allopatric, sympatric, Adaptive radiation / macroevolution (exemplified by Galapagos finches; Extinctions, mass extinctions (causes and effects)

Unit-IV: Origin and evolution of man and the interpretation method **15 Lectures**

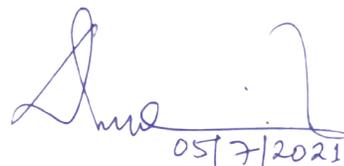
Origin and evolution of man, Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from *Dryopithecus* leading to *Homo sapiens*, molecular analysis of human origin; Phylogenetic trees, Multiple sequence alignment, construction of phylogenetic trees, interpretation of trees.

Practical

1. Study of fossils from models/ pictures.
2. Study of homology and analogy from suitable specimens
3. Study and verification of Hardy-Weinberg Law by chi square analysis.
4. Demonstration of role of natural selection and genetic drift in changing allele frequencies using simulation studies.
5. Graphical representation and interpretation of data of height/ weight of a sample of 100 humans in relation to their age and sex.

Recommended readings

1. Ridley, M (2004) Evolution (3rd edition) Blackwell publishing
2. Hall, B.K. and Hallgrimson, B (2008) Evolution (4th edition) Jones and Barlett Publishers
3. Campbell, N.A. and Reece J.B (2011) Biology (9th edition) Pearson, Benjamin, Cummings
4. Douglas, J.F. (1997) Evolutionary Biology. Sinauer Associates.
5. Pevsner, J. (2009) Bioinformatics and Functional Genomics (2nd edition) Wiley-Blackwell.



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Semester	Course	Course Title	Credit
V	ZOO-DE-353	Endocrinology	Theory:04 Practical: 02 Total: 06

About the course

The course envisages information on endocrine system with emphasis on the structure of hypothalamus and anterior pituitary. The associated hormones and the related disorders will be explained.

Learning outcomes

- Understand neurohormones and neurosecretions.
- Learn about hypothalamo and hypophysial axis.
- Understand about different endocrine glands and their disorders.
- Understand the mechanism of hormone action.

Theory

Unit-I: The chemical messengers and Regulation of Hormone Action 15 Lectures

Definition and classification of hormones. Endocrine, paracrine and autocrine modes of hormone delivery, Feedback mechanism. Hormone action at Cellular level: Hormone receptors; Transduction and regulation of Hormone action at Molecular level; Molecular mediators

Unit II: Hypothalamo-hypophysial Axis 15 Lectures

Structure of hypothalamus, Hypothalamic nuclei and their functions; Regulation of neuroendocrine glands, Feedback mechanisms; Structure of pituitary gland, its hormones and their functions; Hypothalamo-hypophysial portal system; Disorders of pituitary gland.

Unit-III: Structure and Function of Endocrine Glands 15 Lectures

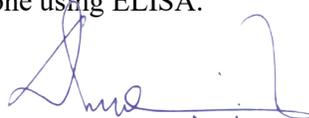
Structure of pineal gland, Secretions and their functions in biological rhythms and reproduction. Structure, Hormones, Functions and Regulation of Thyroid gland; Parathyroid; Adrenal glands; & Pancreas. Hormones in homeostasis; Disorders of endocrine glands.

Unit-IV: Reproductive Endocrinology 15 Lectures

Structure, Hormones, Functions and Regulation of Ovary and Testis; Reproductive Endocrine Disorders, Transgenic and Knock-out animals in reproductive endocrinology. Reproductive cycles in mammals (estrous and menstrual cycles)

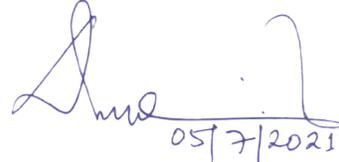
Practical

1. Dissection and demonstration of Endocrine glands in laboratory bred rat.
2. Study of the permanent slides of all the endocrine glands.
3. Compensatory ovarian/ adrenal hypertrophy in vivo bioassay in laboratory bred rat.
4. Demonstration of Castration/ ovariectomy in laboratory bred rat.
5. Estimation of plasma level of any hormone using ELISA.
6. Designing of primers of any hormone.


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Recommended readings

1. Turner, C. D. (1971) General Endocrinology, Pub- Saunders Toppan.
2. Nussey, S.S.; and Whitehead, S.A. (2001) Endocrinology: An Integrated Approach, Oxford: BIOS Scientific Publishers.
3. Hadley, M.E. and Levine J.E. (2007) Endocrinology (6th edition) Pearson Prentice-Hall, New Jersey.
4. David, O.N. (2013) Vertebrate Endocrinology.



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Semester	Course	Course Title	Credit
V	ZOO-DE-354	Mammalian Physiology	Theory:04 Practical: 02 Total: 06

About the course

The course deals with various physiological functions in mammals. It also gives an account of the metabolic/ biochemical pathways and the probable impact of environment on them.

Learning outcomes

After successfully completing this course, the students will be able to:

- Understand the physiology at cellular and system levels.
- Understand the mechanism and regulation of breathing, oxygen consumption and determination of respiratory quotient.
- Understand how mammalian body gets nutrition from different biomolecules.
- Understand the process of digestion and excretion.
- Understand the organization of nervous system and process of nerve conduction.
- Understand the process of vision and hearing.
- Understand the process of muscle contraction.
- Learn the determination of hemoglobin content, blood groups and blood pressure.

Theory

Unit-I: An overview of respiration and circulation in mammals 15 Lectures

Respiration: Mechanism and regulation of breathing; Transport of oxygen and carbon dioxide; Respiratory quotient. Circulation: Blood buffers, blood groups, blood cells, cardiac cycle, Haemopoiesis, homeostasis.

Unit-II: An overview of digestion and excretion in mammals 15 Lectures

Nutrition and Digestion: Balanced diet; Digestion and absorption of carbohydrates, proteins and fats; Gastrointestinal hormones: role in digestion. Excretion: Nephron; urine formation; Regulation of urine formation: role of renin, ADH, aldosterone.

Unit-III: An overview of nervous system and coordination in mammals 15 Lectures

Nervous System: Organization, neuron and glial cells- types and structure; Synapses – types and transmission, resting membrane potential: genesis; Action potential: initiation and conduction. Vision: Structure of eye, retinal components, and photoreceptors: ionic basis of potential generation. Hearing: Structure of ear, mechanoreceptor: ionic basis of potential generation.

Unit-IV: An overview of Muscular system and muscle contraction in mammals 15 Lectures

Muscles: Types, Ultra structure of skeletal, smooth and cardiac muscles, muscle proteins; Neuromuscular junction; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch, tetanus and fatigue, isotonic and isometric contractions.

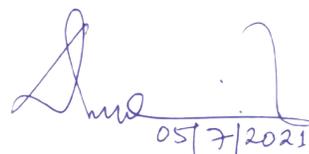

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Practical

1. Preparation of temporary mounts: Blood film, Squamous epithelium, Striated muscle fibres and nerve cells.
2. Counting of white blood corpuscles and red blood corpuscles
3. Preparation of haemin crystals.
4. Estimation of haemoglobin content
5. Determination of blood groups
6. Measurement of blood pressure using sphygmomanometer
7. Determination of oxygen consumption (cockroach)
8. Preparation of casein from milk
9. Recording of simple muscle twitch with electrical stimulation (or Virtual)
10. Demonstration of reflex action
11. Study of permanent histological sections of mammalian oesophagus, stomach, duodenum, rectum, lung, kidney and brain cells

Recommended readings

1. Barret, K.; Brooks, H.; Boitano, S. and Barman, S. (2010) Ganong's Review of Medical Physiology (23rd edition) Lange Medical.
2. Guyton, A.C. and Hall, J.E. (2006) A text book of Medical Physiology (11th edition) Saunders.
3. Keele, C.A. & Neil, E. (1989) Samson Wright's Applied Physiology (13th edition) Oxford.



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Semester	Course	Course Title	Credit
V	ZOO-DE-355	Human Reproductive Biology	Theory:04 Practical: 02 Total: 06

About the course

The major objective of this course is to provide students with a sound coverage of human reproductive biology within the framework of Human Biology. It also envisages the detailed structure and function of the male and female reproductive tracts, gametogenesis, fertilization, early embryogenesis, foetal development and preparation for birth, and maternal adaptations to pregnancy.

Learning outcomes

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

- Explain and contrast the processes of spermatogenesis, oogenesis.
- Demonstrate an understanding of the hormonal control of reproduction in males and how this is regulated;
- Distinguish between the main stages of embryonic, foetal and neonatal development and causes of foetal disorders.
- Understand the origin and characteristics of common congenital malformations;
- Know how sexually transmitted diseases may contribute to altered neonatal or reproductive function.
- Critically assess relevant scientific literature in Human Reproductive Biology and present their argument in oral and written work.

Theory

Unit-I: Human Reproductive system

15 Lectures

Structure and function of male reproduction; Formation of sperm and fertility of individual; Steroids in sports, exogenous and endogenous. Structure and function of female reproduction; Sexual differentiation, Puberty; Formation of the gametes; Formation of ova. Physiology of ovulation, menstrual cycle; Nutrition and stress influences on the ovulatory cycle.

Unit-II: Fertilization, foetal development and senescence

15 Lectures

Process of fertilization; Implantation and formation of the foetus and placenta; Pregnancy, foetal development; Labour and birth, lactation and neonatal life; Reproductive Ageing; Menopause.

Unit-III: Evolution of reproductive mechanism and regulation

15 Lectures

Evolution of human reproductive strategy; Evolutionary impact on behaviour; Sexuality hormonal effects on maternal-infant bonding; Parturition; Society's effects on reproduction; Stress, anorexia, steroids in the environment; Endocrine disrupting chemicals.

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Unit-IV: Reproductive Health

15 Lectures

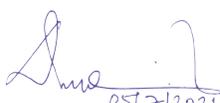
Sexual dysfunctions, sexually transmitted diseases; Cancers of the reproductive system; Adenomyosis: gland-like growth into myometrium; Birth Control; Assisted Reproduction Technologies; Intrauterine devices (IUD), endometriosis, fibroids, Endometritis: chronic infection of uterus, congenital uterine anomalies; Ovarian cysts, pelvic varicosities.

Practical

1. Examination of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems
2. Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina of mammals.
3. Sperm count and sperm motility in rat
4. Study of modern contraceptive devices

Recommended readings

1. Thomas W.S. (2014) Langman's Medical Embryology (13th edition) Lippincott, Williams & Wilkins, Baltimore.
2. Gary C.S.; Steven B.B.; Philip R.B. and Philippa H.F. (2014) Larsen's Human Embryology (5th edition) Elsevier.
3. Gilbert, S.F. (2016) Developmental Biology (11th edition) Sinauer.


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राज्य: कुलसचिव (शैक्षणिक एवं सम्मेलन)
राजीव गांधी विश्वविद्यालय
Jt. Registrar (Acad. & Conf.)
Rajiv Gandhi University
Rono Hills, Dornakur (A.P.)

Semester	Course	Course Title	Credit
VI	ZOO-DE-361	Agrochemicals and Pest Management	Theory:04 Practical: 02 Total: 06

About the course

The course gives insight into the various types of biological pesticides used to control pest and also about their selective mode of action. It also gives an account of eco-friendly biological pesticides.

Learning outcomes

After successfully completing this course, the students will be able to:

- Understand the concept of pests and pest bioecology.
- Gain knowledge and expertise on the pesticides and their modes of action and their fates in the agro-ecosystem.
- Have the knowledge of pesticide families and be able to differentiate among families based on their specific modes of activity.
- Aware of the laws and regulations governing the proper use of pesticides.
- Develop appropriate pesticide management strategies by evaluating specific pest type.
- Understand the factors involved in calibrating equipment for pesticide applications.
- Estimate the potential hazards to humans, wildlife, and the environment.

Theory

Unit-I: Concept of pest

15 Lectures

Definition, classification, morphology and internal systems; Plant pests –weeds, bacteria, fungi, Viruses, nematodes, molluscs, Arthropods, birds, mammals etc.; Causes of outbreak of pest, growth and development; Classification based on nature of damage: Public health pests, Agricultural pests, Domestic pests, Animal husbandry pests, Structural pests

Unit-II: Agrochemicals/ nutrients for increasing the health of plants

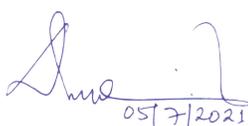
15 Lectures

Manures: types, composition and value, sources of manures, Compost- Different composting technologies- Mechanical compost plants – Vermicomposting - Green manures - Oil cakes, Sewage sludge-Biogas plant slurry. Chemical fertilizers: Classification and value. N-fertilizers: Manufacturing of Ammonium Sulphate, Ammonium Chloride, Ammonium Nitrate and urea; P- fertilizers: sources, processing rock phosphate, bones for bone meal preparation; K- fertilizers: sources, Potassium Chloride, Potassium Sulphate and Potassium Nitrate; Biofertilizers: Classification and value; viz., *Rhizobium*, *Azotobacter*, *AZOOla*, Blue Green Algae, VAM.

Unit-III: Agrochemicals for pest management

15 Lectures

Conventional chemicals/ pesticides based on target species: Acaricides, Fungicides,


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Rodenticides, Nematicides, Molluscicides, Fumigants and Repellents; Based on chemical nature: Organophosphates; Organochlorines, Carbamates etc.; Structure, chemical name, physical and chemical properties; Degradation metabolism, Mode of action, uses, toxicity; Application of Pesticides, devices used; dose estimation for field application.

Unit-IV: Botanicals and other biopesticides

15 Lectures

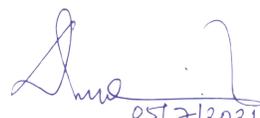
Potential pesticidal plants; Plant extracts and Bio-organisms: Azadirachtin and its role in pest control; Other biopesticides: Pyrethrins, Pyrethroids, Rotenone, Nicotine and Nicotinoids. Growth inhibitors or physiological antagonists, chemo-sterilants; pheromones and attractants; Insect growth regulators, juvenile hormones, moulting hormones; Chitin synthesis inhibitors. Moulting Inhibitors. BT methodology, genetically modified and transgenic plants.

Practical

1. Identification of insect pests of rice, tea, citrus, vegetables.
2. Identification of common natural enemies of crop pests (parasitoids, predators, microbes).
3. Study the damage caused by the commonly occurring insect pests – Infected plant/plant parts.
4. Field trips to bio-control laboratories – IARI, CWC, FCI.
5. Preparation of botanical extract (from citronella, neem etc.) and study of insecticidal property.

Recommended readings

1. Hill, D.S. (1983) Agricultural insect pests of the tropics and their control- Cambridge Univ. Press.
2. Dent, D. (2000) Insect pest management (2nd edition) CAB International.
3. Roberts, D.A. (1978) Fundamentals of Plant Pest Control.
4. De Bach, P. (1964) Biological Control of Insect Pests and Weeds, Chapman & Hall, New York.
5. Koul, O. and Dhaliwal, G.S. (2003) Phytochemical Biopesticides, Harwood Academic Publishers, Amsterdam.
6. Pedigo, L.P. (1996) Entomology and pest management, Prentice Hall, N. Delhi.
7. Atwal, A.S. and Dhaliwal G.S. (2015) Agricultural Pests of South Asia and their Management. Kalyani Publishers, India
8. Hajek A.E. Natural Enemies: An Introduction to Biological Control. Cambridge University Press, UK
9. Shepard BM, Banion AT, Litsinger JA (1995) Rice-feeding insects of tropical Asia. International Rice Research Institute, Philippines.


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Jt. Registrar (Acad. & Conf.)
Rajiv Gandhi University
Rono Hills, Doimukh (A.P.)

Semester	Course	Course Title	Credit
VI	ZOO-DE-362	Wildlife Conservation and Management	Theory:04 Practical: 02 Total: 06

About the course

The course is an introduction to wildlife management and gives an account of the tools used by wildlife managers. Topics covered are to equip students with adequate knowledge of various biodiversity monitoring methodologies, conservation and management issues of vertebrate pests, wildlife conflict and over abundant species, wildlife health and diseases.

Learning outcomes

After successfully completing this course, the students will be able to:

- Develop an understanding of how animals interact with each other and their natural environment
- Develop the ability to use the fundamental principles of wildlife ecology to solve local, regional and national conservation and management issues
- Develop the ability to work collaboratively on team-based projects
- Demonstrate proficiency in the writing, speaking, and critical thinking skills needed to become a wildlife technician
- Gain an appreciation for the modern scope of scientific inquiry in the field of wildlife conservation management
- Develop an ability to analyze, present and interpret wildlife conservation management information.

Theory

Unit-I: Value of wildlife and need for its conservation

15 Lectures

Definition, and importance of wildlife. Causes of depletion of wildlife; Factors responsible for the extinction of animals; Types of protected areas and the concept of zoning within the protected areas; Wildlife Sanctuaries and National Parks in India: general strategies and issues.

Unit-II: Population and prey-predator dynamics

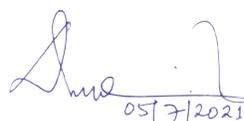
15 Lectures

Wildlife conservation, ethics and importance of conservation; Impact of topography, geology, soil and water on wildlife; Impact of habitat destruction and fragmentation on wildlife; Biological parameters such as food, cover, forage and their impact on wildlife; Population attributes; concepts of exponential and logistic growth rates of wildlife; Density dependent and independent population regulation; Impact of introduced species on preexisting flora and fauna of wildlife. Predator-prey models and impact of predation.

Unit-III: Wildlife Conservation

15 Lectures

Wildlife conservation objectives- strategies and issues; Captive breeding techniques and


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translocation and reintroduction; Inviolate area and critical habitats and their impact on wildlife; Different terrestrial habitats of wildlife in India; Restoration of degraded habitat; Damage caused by wildlife in India and its mitigation; Sick animal refuges in protected areas.

Unit-IV: Rehabilitation and management

15 Lectures

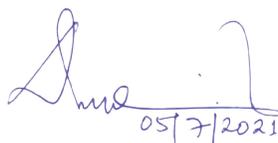
Type of wildlife management-manipulative, custodial; Management of over abundant wild animal populations causing damages to nearby inhabitants and their crops and animals; Tools and techniques to control the menace of wild animals; man wildlife conflict resolution and mitigation; Management of exotic and invasive wetland species in India. Habitat manipulation– control and regulation of grazing. Weed eradication; Major diseases of domestic and wild animals and their control and impact of wild life tourism.

Practical

1. Identification of flora, mammalian fauna, avian fauna, herpeto-fauna.
2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses).
3. Familiarization and study of animal evidences in the field; Identification of animalsthrough pug marks, hoof marks, scats, pellet groups, nest, antlers etc.
4. Demonstration of different field techniques for flora and fauna.
5. Trail / transect monitoring for abundance and diversity estimation of mammals and bird (direct and indirect evidences).

Recommended readings

1. Caughley, G., and Sinclair, A.R.E. (1994) Wildlife Ecology and Management. Blackwell Science.
2. Woodroffe, R., Thirgood, S. and Rabinowitz, A. (2005) People and Wildlife, Conflict or Co-existence? Cambridge University.
3. Bookhout, T.A. (1996) Research and Management Techniques for Wildlife and Habitats (5th edition) The Wildlife Society, Allen Press.
4. Sutherland, W.J. (2000) The Conservation Handbook: Research, Management and Policy. Blackwell Sciences
5. Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008) Problem solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. Blackwell Publishing.
6. Saha, G.K. and Mazumdar, S. (2017). Wildlife Biology: An Indian Perspective. PHI Learning Pvt.Ltd., New Delhi



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Rono Hills, Doimukh (A.P.)

Semester	Course	Course Title	Credit
VI	ZOO-DE-363	Biodiversity and Conservation Biology	Theory:04 Practical: 02 Total: 06

About the course

The course gives insight into the biodiversity and its values, distribution pattern and ethno-biodiversity, threats to biodiversity, biodiversity conservation and protection acts.

Learning outcomes

After successfully completing this course, the students will be able to:

- Gain knowledge and expertise on biodiversity, their use, distribution, threats and conservation
- Have the knowledge of ethno-biodiversity and its importance.
- Aware of the laws and regulations related to biodiversity protection.
- Develop knowledge on protected area network.
- Understand the factors involved in biodiversity distribution.
- Estimate the abundance of species, population size and biodiversity richness.

Theory

Unit I –Biodiversity: Concept and values

15 Lectures

Origin of the concept of biodiversity, Scope of biodiversity, Composition and Scales of biodiversity: Genetic Diversity, Species diversity, Ecosystem diversity, Direct use value: Food, medicine, product values; Indirect use value: Social, Cultural, Religious, Ethical values of Biodiversity. Aesthetic and option values of Biodiversity. Ecological Services provided by biodiversity.

Unit II –Biodiversity distribution and Ethno-biodiversity

15 Lectures

Endemic species. Hotspots of biodiversity of the world. India as a Mega diversity Nation, Indigenous Knowledge System. Biodiversity conservation by ethnic societies. Wildlife as food resources used by the ethnic community in Arunachal Pradesh. Traditional medicine knowledge system and its importance. Biopiracy of medicinal plants & animals.

Unit III - Threats to Biodiversity

15 Lectures

Threats and Loss of Biodiversity and its causes: Habitat Destruction, Fragmentation, Transformation, Degradation, alien invasive species, climate change and over-exploitation. Impact of big river dams on biodiversity. Extinction: Types of Extinctions, Processes responsible for Species Extinction.

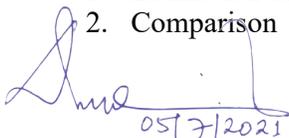
Unit-IV - Biodiversity Conservation and Protection Acts

15 Lectures

IUCN Threatened Categories, Concept of Conservation, Ex-situ and In-situ conservation strategies, Protected areas in Arunachal Pradesh: Wildlife Ecological restoration, Environment protection Act, 1986, The wildlife protection Act, 1972, The forest (conservation) Act, 1980, The Biodiversity Act., 2002. Environmental Impact Assessment, National Biodiversity Authority, State biodiversity board, Village biodiversity committee, Biodiversity register.

Practical

1. Estimation of abundance of animal community using quadrat and transect method.
2. Comparison of species richness and evenness using biodiversity indices (Shannon and

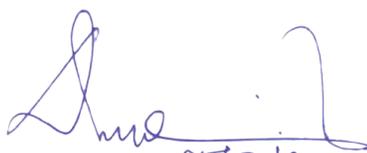

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Simpson index)

3. Identification of economically important animal species (honey bees, silkworm, wild bees, pollinators, edible insect, fishes etc.)
4. Identification of invasive alien species.
5. Identification of ethno-zoological collection.
6. Identification of endangered and threatened animal species using photographs/video.

Recommended readings:

1. Krishnamurthy, K. V. 2003. Textbook of Biodiversity. CRC Press, Taylor & Francis Group.
2. Hamblin, C. 2004. Conservation. Cambridge University Press, UK
3. Groom, M. J., Meffe, G. R. and C. R. Carroll. 2006. Principles of Conservation Biology. Sinauer Associates, Inc., USA.
4. Primack, R. 2006. Essentials of Conservation Biology. Sinauer Associates, Inc., USA.
5. Van Dyke, F. 2008. Conservation Biology Foundations, Concepts, Applications 2nd Edition, Springer.
6. Sinha S.K. and Sinha S. 2001 Ethnobiology (Role of Indigenous and Ethnic Societies in Biodiversity Conservation, Human Health Protection and Sustainable Development)/ Surabhi Publication, Jaipur, India



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Semester	Course	Course Title	Credit
VI	ZOO-DE-364	Aquatic Biology	Theory:04 Practical: 02 Total: 06

About the course

The program of study aims to provide students with a broad-based foundation in science together with extensive subject knowledge in the discipline of aquatic biology. It also aims to develop a range of transferable research, analytical and communication skills.

Learning outcomes

After successfully completing this course, the students will be able to:

- Understand and apply relevant scientific principles in the area of aquatic biology
- Employ scientific methodologies such as experimentation and data analysis in the area of aquatic biology
- Critically analyse, interpret and evaluate information relevant to aquatic biology
- Appreciate the multidisciplinary nature of the study of aquatic biology and engage positively with people and ideas beyond their own discipline.
- Explore some of the unique environmental problems dealing with aquatic environments.
- Develop *employable skills* in freshwater biological water quality analysis.

UNIT – I Water and aquatic biomes

15 Lectures

Physical and chemical properties of water; Introduction with aquatic biomes: Freshwater ecosystem; flood plain lakes and Lakes in higher altitude, wetlands, streams and rivers, estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs.

UNIT II Lotic and Lentic Fresh Water

15 Lectures

Physico-chemical characteristics of Lakes and rivers: Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity: dissolved gases. Origin and classification of lakes; Rivers, streams, and different stages of stream development.

UNIT – III Bioecology of aquatic system

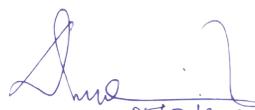
15 Lectures

Lake as an Ecosystem, Nutrient Cycles in Lakes-Nitrogen, Sulphur and Phosphorous; Respiration and Feeding in aquatic organisms; osmoregulation in freshwater and marine organisms; sensory system and Locomotion of aquatic organism, adaptation of hill-stream and cold-water fishes; Adaptation of deep sea organisms, coral reefs continental shelf

UNIT – IV Management of Aquatic Resources

15 Lectures

Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation of aquatic organisms and ecosystem; legislations; Sewage treatment; Water quality assessment - BOD and COD.



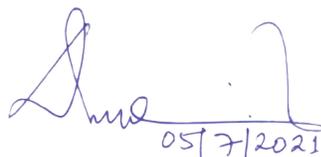
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राज्य: कुलसचिव (शैक्षणिक एवं सम्मेलन)
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Practical

1. Determine the area of a lentic water body using graphimetric and gravimetric method.
2. Identify the important macrophytes, phytoplanktons and zooplanktons present in a lakustrine /riverine ecosystems
3. Determine the amount of dissolved Oxygen, and free Carbon dioxide, in water collected from a nearby lake / stream /water body.
4. Visit to any mountain lake/ freshwater wetlands/ fish raising pond ecosystem and preparation and submission of report.

Recommended readings

1. Goldman, C. (1994) Limnology (2nd edition).
2. Ananthkrishnan, T.N. (1989) Bioresources Ecology (3rd edition).
3. Odum, E.P. and Barrett, G.W. (2004) Fundamentals of Ecology (5th edition).
4. Pawlowski, L. (1980) Physicochemical Methods for water and Wastewater Treatment.
5. Wetzel, R. (2001) Limnology (3rd edition) Elsevier.
6. Trivedy, R.K. and Goyal, P.K. (1986) Chemical and biological methods for water pollution studies.
7. Welch, P.S. (2014) Limnology Vol. I-II.
8. Saikia ,S. and Das , D.N. Laboratory Hand Book on Basic Ecology by Saikia, S.K. & Das, D.N.1st Edition, 2013, Science Publishing Group, UK.
9. Sarma, D., Baruah, D and Das, D.N.Coldwater Lakes and Rivers in Arunachal Pradesh, India (Monograph-19) 1st Edition, 2012, ICAR Publication, New Delhi.



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Semester	Course	Course Title	Credit
VI	ZOO-DE-365	Pisciculture and Aquatic Ecology	Theory:04 Practical: 02 Total: 06

About the course

This is a locally relevant subject having economic importance to the people in connection to livelihood issues. Further, the mountain ecosystem of the state, Arunachal Pradesh is different from other floodplain ecosystem because of high rainfall and drainage system of numerous streams and rivers.

Learning outcomes

After successfully completing this course, the students will be able to:

- Utilize the ecosystem in the context of hill pisciculture development along with sustainable management of aquatic environment.
- generate Self-employment opportunity in the state.

Theory

Unit 1 : Fishes and Pisciculture

15 lectures

Classification of Pisces upto subclass; Cultivable fishes, Culture systems in freshwater, brackish water and Marine ecosystem; Fish capture versus culture in India, Uses of cage and pens, raceways in Pisciculture, Shell fishes and their culture. Composite carp culture: Principle, Definition and various techniques and patterns: Culture of mud Eels, Culture of Catfishes; Trout culture

Unit 2: Pond management

15 lectures

Principles of pond construction, pond types and uses; Management of fish ponds- Predatory organisms and unwanted fishes and their control; Use of fish toxicants; liming and Fertilization; Fish food organisms and their production in the ponds; Stocking of fishes in ponds, Supplementary feeding. Parasitic diseases: Causal organism, symptoms and control of Bacterial, Fungal, Protozoan and worm diseases; Non parasitic diseases and remedial measures; Freshwater pearl culture technique in pond environment.

Unit 3: Brood fish management and seed production

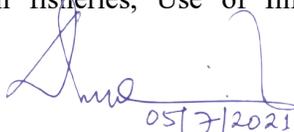
15 lectures

Raising of brood fishes and Fish breeding - Natural and artificial; Induced breeding of Indian major carps; Water quality criteria and climatic factors for induced breeding; Methods of packaging, transport of fish seed and brooders; Use of chemicals in live fish transport - Anesthetic drugs, Antiseptics and Antibiotics; Grow out Culture and breeding of freshwater prawn, larval rearing and juvenile's identity.

Unit 4. Fish harvesting and conservation of wild stock

15 lectures

Harvesting fishes from lotic and lentic waters: Fishing techniques, preservation & processing of fish; Production and marketing of fish and allied products; Sustainable use and conservation approaches for wild fishes in mountain water bodies; Fisheries law and regulations in Arunachal Pradesh; Recirculation technology, Geographic Information System (GIS) technology, passive Acoustics in fisheries, Use of Information Communication Technology (ICT) in fishes.



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Practical

1. Morphometric and meristic characters of locally available fishes along with their identification and classification;
2. Study of different types of scales (through permanent slides/ photographs)
3. Study of crafts and gears used in Fisheries (Photographs/Models)
4. Water quality criteria for Aquaculture: Assessment of pH, alkalinity, Salinity.
5. Identification and diagnostic features of *Petromyzon*, *Myxine*, *Pristis*, *Exocoetus*, *Hippocampus*, *Lates calcarifer*, *Mugil khorsula*, *Gambusia*, *Indian major carps*, *Heteropneustes*, *Anabas*, *Chanda*, *Mahseers*, *Trouts* and *Schizothoracines*, freshwater prawns, *Unio*, *Lamellidens*.
6. Study of air breathing organs in *Channa*, *Heteropneustes*, *Anabas* and *Clarias*
7. Project Report on a visit to any fish farm/ pisciculture unit/Fish seed production unit.

Recommended readings

1. Jingran, V. G. (1983) Fish and fisheries of India , Hindustan pub. corp. New Delhi.
2. Hute, M. and Kahn, H. (2000) Textbook of fish culture, Blackwell Scientific Publication, Australia.
3. Srinivasulu, M., Reddy, K.R.S., Rao, S. (1999) Text book of Aquaculture, Discovery Publishing House New Delhi.
4. Singh, A.D., Abujam, S.K., and Das, D.N. Biodiversity of Fishes in Arunachal Himalaya 1st Editon , 2018, Academic Press, Elsevier, USA
5. Jha, Keshav Kr. (2010): Aquaculture. Daya Pub. House, New Delhi
6. Trivedy, R.K. and Goyal, P.K. (1986) Chemical and biological methods for water pollution studies.
7. Saikia, S. and Das , D.N. Laboratory Hand Book on Basic Ecology by Saikia, S.K. & Das, D.N. 1st Edition, 2013, Science Publishing Group, UK.



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General Elective Courses

Semester	Course	Course Title	Credit
I	ZOO-GE-111	Animal Diversity	Theory:04 Practical: 02 Total: 06

About the course

This course will enhance the learners knowledge regarding diversified life forms of Protista and animals with their characters and classification.

Learning outcomes

The course shall lead students to understand and explore the living resources and its general organization and physiology.

Theory

Unit 1 Protista to Diploblastic Animals

15 lectures

Kingdom Protista: Diversity concept and General characters and classification up to classes; Locomotory organelles and locomotion in Amoeba and Paramecium; Kingdom Animalia and diversity and forms ; Phylum Porifera- General characters and classification up to classes; Canal System in Sycon; Phylum Cnidaria - General characters and classification up to classes; Metagenesis in Obelia; Phylum Platyhelminthes-General characters and classification up to classes; Life history of Taenia solium; Phylum Nematelminthes-General characters and classification up to classes; Life history of Ascaris lumbricoides and its adaptation

Unit 2 Triploblastic Animals

15 lectures

Phylum Annelida- General characters and classification up to classes; Metamerism in Annelida; Phylum Arthropoda-General characters and classification up to classes; Eye in Cockroach, Metamorphosis in Lepidoptera; Phylum Mollusca-General characters and classification up to classes; Respiration in Pila

Unit 3 Chordate Ancestor to Early Gnathostomes

15 lectures

Phylum Echinodermata- General characters and classification up to classes; Water vascular system in Asteroidea; Protochordates- General Characters; Pharynx and feeding mechanism in Amphioxus; Agnatha- General features of Agnatha and classification of cyclostomes up to classes; Pisces-General features and Classification up to orders; Osmoregulation in Fishes.

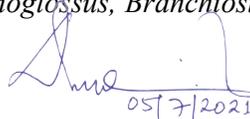
Unit 4 Higher Vertebrates

15 lectures

Amphibia- General features and Classification up to orders; Parental care; Reptiles-General features and Classification up to orders; Poisonous and non-poisonous snakes, Biting mechanism; Aves-General features and Classification up to orders; Flight adaptations in birds; Mammals-Classification up to orders; Hair, Horn & Antler, Nail & claw.

Practical

1. Identification with reasons of the following specimens: *Amoeba*, *Euglena*, *Paramecium*, *Sycon*, *Obelia*, *Aurelia*, *Taenia solium*, *Ascaris lumbricoides* (Male and female), *Aphrodite*, *Nereis*, *Hirudinaria*, *Palaemon*, *Cancer*, *Limulus*, *Apis*, *Chiton*, *Unio*, *Sepia*, *Octopus*, *Echinus*, *Cucumaria* and *Antedon*, *Balanoglossus*, *Branchiostoma*, *Petromyzon*,

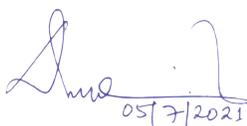

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Torpedo, Labeo rohita, Tor putitora, Schizothorax richardsoni, Exocoetus, Salamandra, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja and Bat.

2. Observation and Key for Identification of poisonous and non-poisonous snakes
3. Study of anatomy of digestive system, salivary gland, mouth parts of *Periplaneta*
4. Study of reproductive system of female cockroach
5. Preparation of “animal album” containing photographs, cut outs, with appropriate write up about the mentioned taxa under Practical 1 (Different taxa/ topics may be given to different sets of students for this purpose)

Recommended Readings:

- Barnes, R. S. K.; Calow, P.; Olive, P. J. W.; Golding, D. W.; Spicer, J. I. (2002) The Invertebrates: a Synthesis, Blackwell Publishing.
- Hickman, C.; Roberts, L.S.; Keen, S.L.; Larson, A. and Eisenhour, D. (2018) Animal Diversity, McGraw-Hill.
- Holland, P. (2011) The Animal Kingdom: A Very Short Introduction, Oxford University Press.
- Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. and Nelson.
- Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
- Bushbaum, R. (1964) Animals without Backbones. University of Chicago Press.
- Young, J.Z. (2004). The Life of Vertebrates .III Edition. Oxford university press.
- Pough H. Vertebrate life, VIII Edition, Pearson International.
- Jordan, E. L. and Verma, P. S. (2015) Chordate Zoology (14th edition).
- Ganguly, Sinha and Adhikari. Biology of Chordates.
- Kotpal, R.L. Vertebrates. Rastogi Publications
- Jordan P.Nigam. Chordates. S.Chand
- Jordan, E. L. and Verma, P. S. (2015) Chordate Zoology (14th edition).



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Jt. Registrar (Acad. & Conf.)
Rajiv Gandhi University
Rono Hills, Doimukh (A.P.)

Semester	Course	Course Title	Credit
II	ZOO-GE-121	Human Physiology	Theory:04 Practical: 02 Total: 06

About the course

The course provides an insight into the structure and function of organ systems in humans and their involvement in body metabolism towards maintenance of homeostasis.

Learning outcomes

After successfully completing this course, the students will be able to:

- Understand the process of digestion and its control
- Develop understanding in muscle structure and contraction mechanism
- Learn the process of respiration and transport of gases
- Understand kidney structure and regulation of urine formation
- Understand heart structure and functioning
- Understand function of endocrine glands and formation of gametes.

Theory

UNIT I: How are processes of digestion and excretion accomplished in man? 15 Lectures

Digestive glands: Structure and function. Digestion and absorption of nutrients: carbohydrates, fats and proteins. Neural and hormonal control of digestion. Excretory system: Functional anatomy of kidney. Mechanism of excretion and regulation of urine formation.

UNIT II: An overview of muscular function and respiration in man 15 Lectures

Structure of smooth, skeletal and cardiac muscles. Neuromuscular junction. Mechanism of muscle contraction. Respiration: Ventilation, External and internal respiration. Transport of carbon dioxide and oxygen in blood and tissues. Factors affecting gaseous transport.

UNIT III: Cardiovascular functions in man 15 Lectures

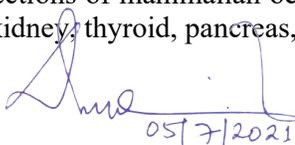
Structure of heart. Coordination of heartbeat; control of heart beat (neural and hormonal) Blood cells and blood vessels. Cardiac cycle. ECG. Lymph and lymph vessels.

UNIT IV: Endocrine and reproductive physiology 15 Lectures

Structure and function of endocrine glands viz., pituitary, thyroid, parathyroid, pancreas, adrenal, ovaries and testes. Processes of spermatogenesis and oogenesis. Fertilization and implantation. Menstrual cycle. Pregnancy and Parturition.

Practical

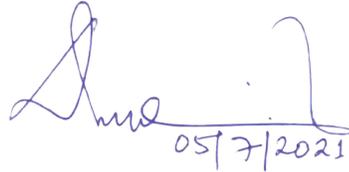
1. Temporary mount preparation of Neurons and Blood film.
2. Preparation of haemin and haemochromogen crystals.
3. Haemoglobin estimation using Sahli's haemoglobinometer.
4. Study of permanent histological sections of mammalian oesophagus, stomach, duodenum, rectum, lung, adrenal, kidney, thyroid, pancreas, testis, ovary.



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Recommended readings

1. Tortora, G.J. and Derrickson, B.H. (2009) Principles of Anatomy and Physiology (15th edition) John Wiley and Sons, Inc.
2. Widmaier, E.P., Raff, H. and Strang, K.T. (2008) Vander's Human Physiology (9th edition) McGraw Hill.
3. Guyton, A.C. and Hall, J.E. (2011) Textbook of Medical Physiology (15th edition) Harcourt Asia Pvt. Ltd/ W.B. Saunders Company.
4. Marieb, E. (1998) Human Anatomy and Physiology (4th edition) Addison-Wesley.
5. Kesar, S. and Vashisht, N. (2007) Experimental Physiology, Heritage Publishers.



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Semester	Course	Course Title	Credit
II	ZOO-GE-122	Food, Nutrition and Health	Theory:04 Practical: 02 Total: 06

About the course

The course covers the basic concepts of balanced diet for people of different ages besides focusing on the consequences of malnutrition and the deficiency diseases and the diseases caused due to poor hygiene.

Learning outcomes

After successfully completing this course, the students will be able to:

- Understand the role of food and nutrients in health and disease.
- Provide culturally competent nutrition services for diverse individuals.
- Implement strategies for food access, procurement, preparation, and safety that are relevant for the culture, age, literacy level, and socio-economic status of clients and groups.
- Perform food system management and leadership functions that consider sustainability in business, healthcare, community, and institutional arenas.

Theory

Unit 1: Nutrition and dietary nutrients

15 Lectures

Basic concept of Food: Components and nutrients. Concept of balanced diet, nutrient requirements and dietary pattern for different groups viz., adults, pregnant and nursing mothers, infants, school children, adolescents and elderly people.

Unit II: Macro nutrients and micronutrients

15 Lectures

Nutritional Biochemistry: Macronutrients. Carbohydrates, Lipids, Proteins- Definition, Classification, their dietary source and role. Micronutrients. Vitamins- Water-soluble and Fat-soluble vitamins- their sources and importance. Important minerals viz., Iron, Calcium, Phosphorus, Iodine, Selenium and Zinc: their biological functions.

Unit III: Malnutrition and nutrient deficiency diseases

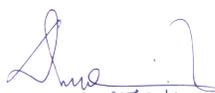
15 Lectures

Definition and concept of health: Common nutritional deficiency diseases- Protein Malnutrition (e.g., Kwashiorkor and Marasmus), Vitamin A deficiency, Iron deficiency and Iodine deficiency disorders- their symptoms, treatment, prevention and government initiatives, if any. Life style dependent diseases- hypertension, diabetes mellitus, and obesity- their causes and prevention. Social health problems- smoking, alcoholism, narcotics. Acquired Immuno Deficiency Syndrome (AIDS): causes, treatment and prevention. Other ailments viz., cold, cough, and fever, their causes and treatment.

Unit IV: Diseases caused by microorganisms

15 Lectures

Food hygiene: Potable water- sources and methods of purification at domestic level. Food and Water-borne infections: Bacterial diseases: cholera, dysentery; typhoid fever, viral diseases: Hepatitis, Poliomyelitis etc., Protozoan diseases: amoebiasis, giardiasis; Parasitic diseases: taeniasis and ascariasis their transmission, causative agent, sources of infection, symptoms and prevention. Causes of food spoilage and its prevention.

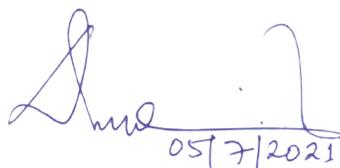

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Practical

1. Detecting adulteration in a) Ghee b) Sugars c) Tea leaves and d) Turmeric.
2. Estimation of Lactose in milk.
3. Titrimetric method for Ascorbic acid estimation.
4. Estimation of Calcium in foods by titrimetry.
5. Study of the stored grain pests from slides/ photograph (*Sitophilus oryzae*, *Trogoderma granarium*, *Callosobruchus chinensis* and *Tribolium castaneum*): their identification, habitat and food sources, damage caused and control. Preparation of temporary mounts of the above stored grain pests.
6. Project- Computer aided diet analysis and nutrition counselling for different age groups.

Recommended reading

1. Mudambi, S.R. and Rajagopal, M.V. (2007). Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed;; New Age International Publishers
2. Srilakshmi, B. (2002). Nutrition Science; New Age International (P) Ltd.
3. Srilakshmi, B. (2007). Food Science; Fourth Ed; New Age International (P) Ltd.
4. Swaminathan, M. (1986). Handbook of Foods and Nutrition; Fifth Ed; BAPPCO.
5. Bamji, M.S.; Rao, N.P. and Reddy, V. (2009). Text Book of Human Nutrition; Oxford & IBH Publishing Co. Pvt Ltd.
6. Wardlaw, G.M. and Hampl, J.S. (2007). Perspectives in Nutrition; Seventh Ed; McGraw Hill.
7. Lakra, P. and Singh M.D. (2008). Textbook of Nutrition and Health; First Ed; Academic Excellence.
8. Manay, M.S. and Shadaksharaswamy, M. (1998). Food-Facts and Principles; New Age International (P) Ltd.
9. Gibney, M.J. et al. (2004). Public Health Nutrition; Blackwell Publishing.



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Semester	Course	Course Title	Credit
II	ZOO-GE-123	Basics of Systematics and Classification	Theory:04 Practical: 02 Total: 06

About the course

The course will provide a comprehensive survey of the theory and methodology of systematics as they are applied today to all groups of organisms. The course is directed at those students interested in studies of evolutionary biology, biodiversity, conservation biology, and/or systematics.

Learning outcomes

At the end of the course the students will be able to;

- Comprehend the basic concepts of animal taxonomy and zoological nomenclature
- Evaluate the significance of museum specimens
- Analyze the implications of biometrics, numerical taxonomy and cladistics.
- Understand the historical development of systematic biology from the 18th century to the present.
- Gain a basic grasp on the rules and philosophy of nomenclature.
- Question what you know, and need to know, to do systematic.
- Develop the capacity to critically evaluate the primary literature.

Theory

Unit I: Introduction to systematic and classification

15 Lectures

Kinds and diversity of living forms. Biogeographical zones; Endemism. Importance of collections/ museum specimens of the world and India; Documentation of biodiversity. Systematics and taxonomy. Importance and basis of classification. Hierarchy of classification and classification systems. Types of classification-artificial, natural and phylogenetic.

Unit II: Taxonomic treatment and phylogenetics

15 Lectures

Systematic data: kinds of data. Taxonomic treatment of allopatric variation, homology; Reproductive isolating mechanisms; Hybridization and introgression; Polyploidy; Modes of speciation. Principles and criteria of taxonomic treatment: Taxonomic evidence: Characters and character states. Phenetics, Evolutionary taxonomy, Cladistics. Constructing trees/ dendrograms: Phenogram, phylogram and cladogram and turning them into classifications.

Unit III: Molecular phylogenetics

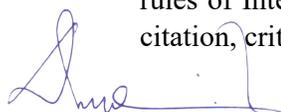
15 Lectures

Molecular phylogenetics: Gene structure, mutation and rates and patterns of nucleotide substitutions. Mitochondrial genome. Molecular "clock" hypothesis. Phylogeny estimation methods: Distance data, Maximum-parsimony, Maximum-likelihood etc. Cladogram reliabilities, Molecular characterization versus morphological characterization: Conflict or compromise?

Unit IV: International code of Nomenclature

15 Lectures

Identification, Description, Naming of taxa. Keys: indented and raked keys. Principles and rules of International Code of Nomenclature (ICN), binominal system, type material, author citation, criteria for publication, types of names, principle of priority and its limitations.



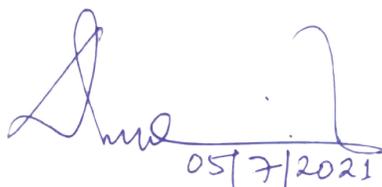
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Practical

1. General discussion, distinguishing characters and classification of selected animals.
2. Preparation of identification keys for select specimens of non chordate (e.g., insects) and chordates (e.g., birds)
3. Generation of a character-state matrix by selecting and scoring diagnostic taxonomic characters.
4. Interactive software for exploring phylogeny and analyzing character state to construct dendrogram.
5. Distance-based methods of phylogenetic reconstruction using manual and computer methods.
6. Molecular data analysis by aligning sequences and constructing trees using PAUP

Recommended readings

1. Mayr, E. and Ashlock, P.D. (1991). Principles of Systematic Zoology. (2nd edition) New York: McGraw Hill, Inc.
2. Quicke, D. L. J. (1993). Principles and Techniques of Contemporary Taxonomy. New York: Chapman and Hall



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Semester	Course	Course Title	Credit
III	ZOO-GE-231	Global Climate change	Theory:04 Practical: 02 Total: 06

About the course

This course provides an overview of the Earth's climate system, the various forcing and feedbacks controlling the Earth's climate variability in short and long timescale. It will give a brief introduction to the atmosphere and ocean circulation.

Learning outcomes

After completing this course, the student will be able to:

- Develop understanding on the concept and issues of global environmental change.
- Analyse the causes and effects of depletion of stratospheric ozone layer.
- Examine the climate change and its effect on living beings.
- Understand the physical basis of natural greenhouse effect on man and materials.
- Evaluate human influenced driver of our climate system and its applications.

Theory

Unit I: An overview of earth system

15 lectures

Global Environmental change issues. Paleoclimate – what can we learn from the past? Concept of earth system, climate forcing, responses, feedback loops, equilibrium states, Daisy world model, Solar Flux at Earth's Orbit, Stratospheric ozone layer.

Unit II: Causes and consequences of Ozone layer depletion

15 lectures

Greenhouse gases and their sources; Greenhouse effects; Causes of depletion of ozone layer and consequences; Climate change: Effects of enhanced UV-B on plants, microbes, animals, human health and materials; global energy infrastructure and GHG emissions.

Unit III: Other adverse impacts on climate

15 lectures

Atmospheric deposition: Past and present scenario; Causes and consequences of excessive atmospheric deposition of nutrients and trace elements; Acid rain and its effects on plants, animals, microbes and ecosystems. Eutrophication, Consequences on climate, oceans, agriculture, natural vegetation and humans.

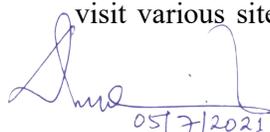
Unit IV: International summits and agreements

15 lectures

International efforts on climate change issues. Global efforts for mitigating ozone layer depletion. Climate modeling and climate change feedbacks. International Agreements: the United Nations Framework Convention on Climate Change, Kyoto Protocol, Paris Agreement. Integrated Assessment, Decisions under uncertainty: Abate now, or delay? Emissions budgets.

Practical

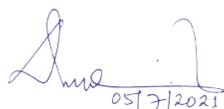
There are no structured class lab experiments involved. However, the students are expected to visit various sites on the web, make teams for group-discussion indulge in debates, collect


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justifiable information from various sources, make historical report on the science, impact, future and politics behind climate change.

Recommended readings

1. Adger, N.; Brown, K. and Conway, D. (2012). Global Environmental Change: Understanding the Human Dimensions. The National Academic Press.
2. Turekian, K.K. (1996). Global Environmental Change-Past, Present, and Future. Prentice-Hall.
3. Matthew, R.A.; Barnett, J. and McDonald, B. (2009). Global Environmental Change and Human Security. MIT Press., USA.
4. Hester, R.E. and Harrison, R.M. (2002). Global Environmental Change. Royal Society of Chemistry.


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Semester	Course	Course Title	Credit
III	ZOO-GE-232	Natural Resource Management	Theory:04 Practical: 02 Total: 06

About the course

The course provides information regarding the status of environment, the depletion of its resources, the loss of biodiversity and the remedial efforts undertaken by various agencies. The course is also focused to creating environmental awareness among learners.

Learning outcomes

After successfully completing this course, the students will be able to:

- Develop understanding for the environment which is largely degraded in the current scenario.
- Understand the importance of biodiversity and the consequences of biodiversity loss
- Learn about the judicious utilisation of natural resources
- Follow the concept of green technology and the eco-friendly practises and other prospects of environment protection
- understand and practice appropriate legal/regulatory and ethical issues in the contextof the work environment.
- design research projects to collect information to assess the effectiveness of current practices, and interpret the results of a statistical analysis of data, and use this to make informed decisions.

Theory

Unit I: Anthropogenic impact on environment

15 Lectures

Man as an animal species in the ecosystem. Population explosion. carrying capacity, exploitation of resources due to urbanization, industrialization and agricultural practises. Generation of agricultural, municipal, industrial waste; Pollution of air, water, soil and noise; radioactive pollution. Eutrophication. Deforestation; Threats to biodiversity, Extinction of species.

Unit II: Depletion and contamination of resources

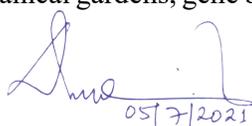
15 Lectures

Natural resources: Land resources. Air and water resources. Bioresources. Conventional Fuel, wood, fossil fuels. Non-conventional or alternate sources of energy: sun, wind, bio-energy, geothermal, ocean, nuclear etc. Green house effect and global warming; climate change; Shrinking of glaciers. Threats to sustainable development.

Unit III: Biodiversity and resource conservation programmes

15 Lectures

Management of wastes and disposal. Concepts of three Rs: reduce, reuse and recycle. Methods of prevention and control of Eutrophication. Bioremediation. Biodiversity conservation– In-situ e.g., Sanctuaries, National Parks, Biosphere Reserves, World Heritage Sites; Ex-situ e.g., botanical gardens, gene banks, cryopreservation etc. Contour farming, reforestation; Rainwater


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harvesting, groundwater water recharge. Green technologies, Eco-cities, Social and Joint forestry.

Unit IV: Sustainable development and green technology

15 Lectures

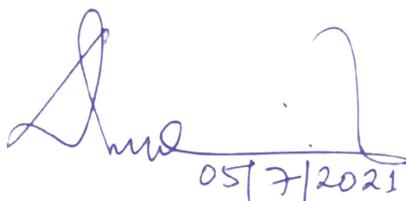
Sustainable Development; Brundlandt Report. Biosafety of GMOs and LMOs. Environmental movements. Public awareness of Environment problems. Role of Government, NGO's, Ecological footprint, International treaties and conventions. organizations, International efforts (Vienna Convention, Montreal Protocol, UNFCCC, Kyoto Protocol, Copenhagen Summit, etc.; IPCC; Environmental laws and acts. National Environmental Policy. NBPGR, BSI, ZSI, WWF, IUCN, Convention on Biological diversity; Ramsar Convention, other conservation efforts.

Practical

1. Visit to an area to document environmental assets including natural resources/flora/fauna, etc.
2. Identification and study of common insects, fish, birds, mammals of a particular area.
3. To determine the physical conditions of water: Depth, Viscosity, Density, Buoyancy.
4. To determine the chemical conditions of water: pH, dissolved oxygen and carbon-di-oxide, hardness etc.
5. To determine Cl, SO₄, NO₃ in soil and water samples from different locations.
6. To study acidity and alkalinity of sample water by methyl orange and phenolphthalein
7. Visit to a local polluted site (Urban/Rural/Industrial/Agricultural).

Recommended readings

1. Joseph, B. (2008) Environmental studies, Tata McGraw Hill.
2. Miller, G.T. (2002). Sustaining the earth, an integrated approach. (5th edition) Books/Cole, Thompson Learning, Inc.
3. Chapman, J.L. and Reiss, M.J. (1999). Ecology: Principles and applications (2nd edition) Cambridge University Press.
4. Ghosh, S.K. and Singh, R. (2003). Social forestry and Forest Management. Global Vision Pub.
5. Wilson, E.O. (1986) Biodiversity, Academic press Washington
6. Wagher, R.H. (1974) Environment and Man. (Second Edition), Norton, New York.



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Semester	Course	Course Title	Credit
IV	ZOO-GE-241	Environmental Biotechnology	Theory:04 Practical: 02 Total: 06

About the course

This course will provide details about the environmental problems, interaction of microbes with animals, microbial diseases, xenobiotic compounds, and role of enzymes in degradation of toxic compounds.

Learning outcomes:

On the completion of the course, the students shall be able to

- Understand different causes of environmental pollution and their remedies
- Analyze microbiology of waste water and its implications
- Examine the role of immobilized cells/enzymes in treatment of toxic compounds
- Reflect upon various sustainable environmental protection strategies
- Evaluate the implications of international legislations, policies for environmental protection

Theory

Unit-I: Environmental Problems

15 Lectures

Basic concepts and issues, global environmental problems - ozone depletion, UV-B, greenhouse effect and acid rain due to anthropogenic activities and their impacts. Environmental pollution: types and sources of pollution, levels of pollutants, fate of pollutants in the environment, Bioconcentration, bio/geomagnification.

Unit-II: Types of interaction with microbes

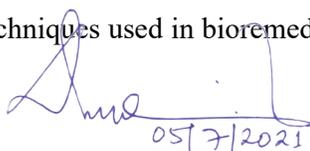
15 Lectures

Types of interaction between animals and microbes, Microbes and public health: Brief account of microbial diseases in humans (water and air borne disease). Microbiology of water: Aerobic process - activated sludge, oxidation ponds, trickling filter, towers, rotating discs, rotating drums, oxidation ditch. Anaerobic process - anaerobic digestion, anaerobic filters. Treatment schemes for waste-waters of dairy, distillery, tannery, sugar and antibiotic industries.

Unit-III: Xenobiotic compounds and microbial remediation

15 Lectures

Xenobiotic compounds: Organic compounds (Chlorinated hydrocarbons, Polyaromatic hydrocarbons, Pesticides, Surfactants etc.) and inorganic compounds (metals, radionuclides, phosphates, nitrates etc.). Xenobiotic bioremediation: decay behaviour and degradative plasmids, molecular techniques used in bioremediation.


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Unit-IV: Environmental Awareness and Management

15 Lectures

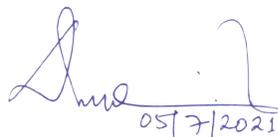
Biopesticides, bioreactors, bioleaching, biomining, biosensors, biotechniques for airpollution abatement and odour control., WTO and Environment, Environmental Education and awareness programmes; Environmental Ethics. Regulation of the safety of biotechnology procedure and products: Deliberate release and fate of genetically modifiedmicroorganisms.

Practical

1. Soil/ Water analysis - pH,DO, salinity, chloride, hardness, alkalinity, acidity, dissolved substances viz., nitrate, calcium, magnesium and phosphorus.
2. Gravimetric estimation-Total solid, dissolved solid, suspended solid in an effluent
3. Microbial study of air (open plate and air sample) and water

Recommended readings

1. Metcalf and Eddy Inc. (1978) Waste engineering - treatment, disposal and reuse (2nd edition) Tata McGraw Hill, New Delhi.
2. Baaker, K.H. and Herson, D.S. (1994) Bioremediation, Mc.GrawHill Inc, NewYork.
3. Ahmed, N., Qureshi, F.M. and. Khan, O.Y. (2006). Industrial and Environmental Biotechnology - Horizon Press.
4. Rochelle, P.A. (2001). Environmental Molecular Biology, Horizon Press.
5. Pepper I.; Gerba, C.; Gentry, T. and Maier, R. (2008) Environmental Microbiology. Academic Press.



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Semester	Course	Course Title	Credit
IV	ZOO-GE-242	Systematics and Evolutionary biology	Theory:04 Practical: 02 Total: 06

About the course

The course provides information about the patterns and processes of evolution above the species level. Besides elaborating the process of speciation, it also categorically differentiates between the three methods of phylogenetic analysis viz., evolutionary systematics, phonetics and cladistics.

Learning outcomes

At the end of the course the students will be able to

- Understand the historical development of systematics from 18th century to the present.
- Understand the complexities of character coding.
- Understand the similarities and differences of different types of data.
- Understand the uses and limitations of phylogenetic trees.
- Appreciate the complexities and difficulties of various species concepts.
- Gain a basic grasp on the rules and philosophy of nomenclature.
- Know about the steps required to do systematic.

Theory

Unit I: Systematic and biological classification

15 Lectures

Systematics and taxonomy. Levels of taxonomy: alpha, beta and gamma taxonomy. Micro and macro taxonomy. Scope and application of taxonomy. Systematics. Relevance of Systematics in Biology and Biological Classification. Phenetic and Cladistics concepts.

Unit II: Species concept

15 Lectures

Biological Species concept, Subspecies, Monotypic and Polytypic species, Sibling species. Reproductive and geographical isolation and their role in speciation process (pre-mating and post mating). Speciation modes–Sympatric, Allopatric and Parapatric. Type concept –name bearing types (primary and secondary) and their applications.

Unit III: Natural selection, genetic drift etc.

15 Lectures

Natural selection: Concept of selection: stabilizing, directional and disruptive changes, Hardy-Weinberg equilibrium; estimating allele and genotype frequency, frequency changes in mutation and migration. Genetic drift, founder effect and population bottleneck.

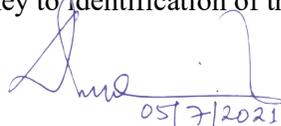
Unit IV: Species distribution and adaptive radiations

15 Lectures

Bathymetric and discontinuous distribution. Barriers and dispersals -types and their impact on animal distribution. Zoogeographical realms –names and distribution of animal according to Wallace scheme, Avian and Mammalian faunal distribution in different realms. Some distinct events in evolution: Adaptive radiations with special reference to Darwin's finches.

Practical

1. Compilation of a data matrix using characters, character states and construction of classifications which reflect the "relationships" among the taxa
2. The data matrix to be used to construct a key to identification of the taxa.


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3. Phylogeny Inference Package (PHYLIP): Programs for distance and character-state data; making consensus trees; DNA sequence programs; and maximum likelihood.
4. Selection of five species (preferably invertebrates, insects) belonging to a clade. A project work on their identification, illustration and assessment of their relationship by constructing a cladogram using characters and character states.
5. Comparison of two species of birds belonging to same species but different subspecies (Intraspecific difference).

Recommended readings

1. Futuyama, D. J. (1986). Evolution, Systematics and Animal Behaviour. Evolutionary Biology. Sinauer Associates Inc.
2. Strickberger, M. W. (2007). Evolution. CBS Pub.
3. Colbert, E. H.; Morales, M. & Minkoff, E. I. (2001). Evolution of the Vertebrates, Science.
4. Moody, P. A. (2002). Introduction to Evolution, Kalyani Pub.
5. Dobzhansky, T.; Ayala, F. J.; Stebbins G. L. and Valentine, J. W. (1979). Evolution, Surjeet Pub.
6. Mayr, E. & Ashlock, P. D. (1991) Principles of Systematic Zoology (2nd edition) McGraw Hill Int.
7. Simpson, G. G. (1962) Principles of Animal Taxonomy, Oxford IBH.
8. Darlington, P. J. (1966) Zoogeography (4th edition) John Wiley.



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Jt. Registrar (Acad. & Conf.)
Rajiv Gandhi University
Rono Hills, Doimukh (A.P.)

Ability Enhancement Courses

Semester	Course	Course Title	Credit
I	ENG-AE-111	Communicative English	Theory: 04 Tutorial: 01 Practical: 00

Credit: L4:T1:P0

Lecture Hour: 40

Course Objective: *The course aims to train learners to be more effective at communicating successfully in interviews, public speaking, letter writing, report writing, presentations, and inter-personal debates and conversations. The learner also imbibes the fundamentals of communication and the art of persuasive speaking and writing which depends crucially on clarity of thought and contextual understanding expressed through appropriate vocabulary.*

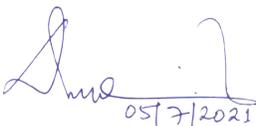
Course Outcome: *After completion of the course, learners will be able to master the art of persuasive speech and writing, the art of listening, reading, and analysing; spend the bulk of their time in class in practical exercises of reading and writing; develop critical thinking skills; and they will be introduced to established principles of academic reading and writing. Other specific outcomes:*

- *Identify deviant use of English both in written and spoken forms*
- *Recognize the errors of usage and correct them and write simple sentences without committing errors of spelling and grammar*
- *Developing own competence in using the language*
- *Understand and appreciate English spoken by others*
- *Use language for speaking with confidence in an intelligible and acceptable manner*
- *Understand the importance of reading for life and develop an interest for reading*
- *Read independently unfamiliar texts with comprehension*
- *Understand the importance of writing in academic life and career.*

Module – 01: **Poetry:** William Shakespeare – All the World is a stage; William Wordsworth – I wondered lonely as a Cloud; Ralph Waldo Emerson – The Mountain and the Squirrel; Emily Dickinson – Success is Counted Sweetest; Robert Frost - Stopping by Woods on a Snowy Evening; Rabindranath Tagore – Where the Mind is without Fear; A. K. Meherotra – Songs of the Ganga.

Module – 02: **Short Stories:** R.K. Narayan – Lawly Road; Mulk Raj Anand – Barbar’s Trade Union; Somerset Mangham – The Luncheon; Guy De. Maupassant – The Necklace; Anton Chekhov – The Lament; O’ Henry – The Last Leaf; Manoj Das – The Submerged Valley.

Module – 03: **One-Act Plays and Short Fiction:** (a) Norman Mckinnell - The Bishop’s Candle Sticks; Anton Chekov – A Marriage Proposal; Eugene Lonesco – The Lesson; August Strandberg – Miss Jullie; Fritz Karinthy–


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Refund; (b) Harper Lee – To kill a Mocking Bird, (Or) R. K. Narayan – Vendor of Sweets.

Module – 04: **Fundamentals of Grammar:** Parts of speech, Articles and Intensifiers, use of tense forms, Use of Infinitives, Conditionals, Adjectives and Adverbs, Prepositions, Making Affirmative, Negative and Interrogative, Making Question Tag.

Module – 05: **Composition Practice:** (a) Comprehension, Précis Writing, Paragraph Writing (150 words), Letter writing – Personal, Official, Demi-official, Business, Public speaking, Soft Skills, Interviews, Preparing Curriculum Vitae, Report (Meetings and Academic) writing; (b) Communication Practice – Introducing yourself, Introducing people to others, Meeting People, Exchanging Greetings, Taking Leave, Answering the Telephone, Asking Someone for Some Purpose, Taking and Leaving Messages, Call for help in emergency.

Module	Weightage of Marks	Theory	Practical / Numerical
Module – 01	20%	✓	
Module – 02	20%	✓	
Module – 03	20%	✓	
Module – 04	20%	✓	✓
Module – 05	20%	✓	✓

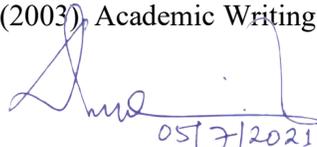
Practical Exercises:

The students are required to:

1. know dictionary and its types, mapping a dictionary to locate words, and multiple uses of dictionaries.
2. know the uses of Thesaurus/Lexicon/Activator/Encyclopaedia
3. know Note making/taking
4. know information transfer exercises
5. know the usage library resources properly
6. know citing references or developing a bibliography
7. Edit a piece of self and peer writing, writing and revising the drafts and preparing the final draft
8. Understand and appreciate the principle of politeness in relation to the speaker/ listener, debating, ex-tempore speeches, and other discourses.

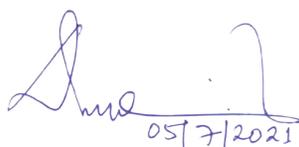
Suggested Readings:

1. For reading the texts available sources of texts and help of the Web source may be taken.
2. Crystal, David (1985) Rediscover Grammar with David Crystal. Longman.
3. Hewings, M. (1999) Advanced English Grammar. Cambridge University Press.
4. Bakshi, R. N. A course in English Grammar, Orient Longman
5. Krishnaswamy, N. Modern English – A Book of Grammar, Usage and Composition. MacMillan India Ltd.
6. Bailey, Stephen (2003), Academic Writing. London and New York, Routledge.


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7. Grellet, F (1981). Developing Reading Skills: A Practical Guide to Reading Skills. New York, CUP
8. Hedge, T. (2005). Writing. London, OUP
9. Kumar, S and Pushp Lata (2015). Communication Skills. New Delhi, OUP
10. Lazar, G. (2010). Literature and Language Teaching. Cambridge, CUP
11. Nuttall, C (1996). Teaching Reading Skills in a Foreign Language. London, Macmillan
12. Raman, Meenakshi and Sangeeta Sharma (2011). Technical Communication: Principles and Practice. New Delhi, OUP

Note: Students are advised to use latest edition of text books.



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Semester	Course	Course Title	Credit
I	HIN-AE-111	हिंदी शिक्षण	Theory: 04 Tutorial: 01 Practical: 00

Credit: L4:T1:P0

Lecture Hour: 40

(यह प्रश्नपत्र प्रथम सत्र में हिन्दी कौशलाधारित पाठ्यक्रम चुनने वाले सभी विद्यार्थियों के लिये हैं। यह पत्र चार इकाइयों में विभक्त है। प्रत्येक इकाई के लिये अंक अलग-अलग निर्धारित हैं।)

उद्देश्य: सामाजिक, व्यवसायिक, कार्यालयी तथा शैक्षणिक परिप्रेक्ष्य में विद्यार्थियों के भाषा-कौशल में निखार लाना। विद्यार्थियों में प्रतिस्पर्धात्मक परीक्षाओं एवं साक्षात्कार हेतु आत्मविश्वास उत्पन्न करना। विद्यार्थियों में रचनात्मक कौशल विकसित करना। भाषा-ज्ञान के माध्यम से विद्यार्थियों को रोजगारोन्मुख शिक्षा प्रदान करना।

इकाई: 1 राष्ट्रीय एवं अन्तरराष्ट्रीय परिप्रेक्ष्य में हिन्दी का महत्त्व; मानक हिन्दी और बोलचाल की हिन्दी में अन्तर; स्वागत भाषण, भाषण, विषय प्रवर्तन तथा धन्यवाद ज्ञापन।

व्याख्यान – 10

इकाई: 2 आलेख रचना: सम्पादक के नाम पत्र, सम्पादकीय लेखन, स्तम्भ लेखन, पत्र-पत्रिकाओं के लिये आलेख रचना; आकाशवाणी एवं दूरदर्शन हेतु वार्ता, साक्षात्कार एवं परिचर्चा तैयार करने की विधियाँ।

व्याख्यान – 10

इकाई: 3 व्यावहारिक लेखन: कार्यालयी पत्राचार; प्रेस विज्ञप्ति; सूचना; ज्ञापन; कार्यसूची; कार्यवृत्त; प्रतिवेदन; सम्पादन; संक्षेपण; आत्मविवरण तथा ईमेल लेखन-, फेसबुक, ब्लॉग और ट्वीटर लेखन।

व्याख्यान – 10

इकाई: 4 सृजनात्मक लेखन: कविता, कहानी, नाटक तथा एकांकी, निबंध, यात्रावृत्त का स्वरूप विवेचन।

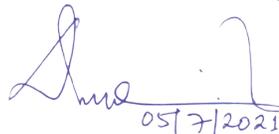
व्याख्यान – 10

कार्य : पद्धति -सम्पादन-व्याख्यान, विचारविमर्श-, समूहचर्चा-, सामग्री-समीक्षा और प्रस्तुतीकरण आदि।

Module	Weightage of Marks	Theory	Practical / Numerical
Module – 01	25%	✓	✓
Module – 02	25%	✓	✓
Module – 03	25%	✓	✓
Module – 04	25%	✓	

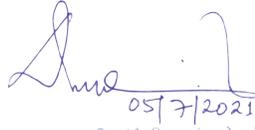
सहायक ग्रन्थ:

1. अच्छी हिन्दी : रामचन्द्र वर्मा।
2. व्यवहारिक हिन्दी व्याकरण और रचना : हरदेव बाहरी।
3. हिन्दी भाषा : डॉ. भोलानाथ तिवारी।
4. रेडियो लेखन : मधुकर गंगाधर।
5. टेलीविजन: सिद्धान्त और टैकनिक : मथुरादत्त शर्मा।
6. प्रयोजनमूलक हिन्दी : डॉ. दंगल झाल्टे।
7. सरकारी कार्यालयों में हिन्दी का प्रयोग : गोपीनाथ श्रीवास्तवदिल्ली।, राजकमल ,
8. टेलीविजन लेखन : असगर वजाहत / प्रेमरंजन ; राजकमलदिल्ली। ,


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9. रेडियो नाटक की कला
10. रेडियो वार्ताशिल्प-

: डॉसिद्धनाथ कुमार ., राजकमलदिल्ली ,।
: सिद्धनाथ कुमार, राजकमलदिल्ली ,



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Semester	Course	Course Title	Credit
II	EVS-AE-121	Environmental Studies (EVS)	Theory: 04

Learning outcomes

On completion of this course, the students will be able to:

- Learners will be able to understand environment science and its importance.
- Learners will understand the various types of pollution and hazards caused by them.
- Learners will understand ways to monitor environment and the various green technologies.
- Learners will know the various Acts enacted for the protection of the environment

Unit I: Basic Concept of Environment

12 Lectures

Environment: Definition, scope and importance; Multidisciplinary nature of environmental studies. Concept of sustainability and sustainable development.

Ecosystem – Concept, Structure and function; Energy flow in an ecosystem: food chains, food webs, ecological pyramid. Ecological succession. Ecosystem services.

Unit II: Natural Resources

12 Lectures

Land: Land use patterns, degradation, soil erosion and desertification.

Forest: Use of forest resources, over-exploitation; deforestation - causes and impacts on environment, biodiversity and tribal populations.

Water: Use and over-exploitation of surface and ground water; floods, droughts, Case studies on conflicts over water (international & inter-state).

Energy resources: Renewable and non-renewable energy sources, growing energy needs, use of alternate energy sources.

Unit III: Biodiversity and Conservation

12 Lectures

Biodiversity: Definition, levels (genetic, species and ecosystem diversity) and values; Biogeographic zones of India; Biodiversity hot spots. Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions.

Conservation of biodiversity: *In-situ* and *Ex-situ* conservation of biodiversity.

Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

Unit IV: Environmental Issues and Policies

24 Lectures

Environmental pollution: types, causes, effects and controls of Air, water, soil, noise, solid waste and nuclear pollution.

Global environmental issues: Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture.

Salient features of Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD). Paris agreement, Nagoya Protocol.

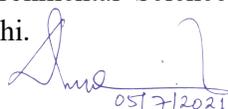
Human Communities and the Environment: Human population growth: Impacts on environment, human health and welfare.

Disaster management: floods, earthquake, cyclones and landslides.

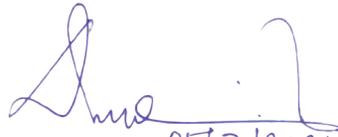
Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan.

Recommended readings

1. E. Bharucha. 2020. Textbook for Environmental Science for undergraduate students. University Grants Commission, New Delhi.


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2. Abhik Gupta and Susmita Gupta. Environmental Studies: Principles and Practices. 2021, 344 pages, SAGE Texts.
3. V.K. Ahluwalia. Environmental Studies. 2nd Ed. TERI Press.
4. Anubha Kaushik, C.P. Kaushik. Perspectives in Environmental Studies. New Age International Pvt. Ltd.
5. K. V. Krishnamurthy, An advanced textbook on Biodiversity: Principles and Practice. 2020. CBS Publisher and Distributors
6. R. S. Ambasht and P.K. Ambasht. 2017. Environment and Pollution an Ecological Approach 5th Ed. CBS Publisher and Distributors.
7. R. S. Ambasht and N.K. Ambasht. 2017. A textbook of Plant Ecology. 15th Ed. 2017.
8. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.



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Skill Enhancement Courses

Semester	Course	Course Title	Credit
I / III	ZOO-SE-001	Apiculture	Theory=01 and Practical :01 = 02 Credits

About the course

This course tells the students what tools and equipment will be needed, the main activities in the beekeepers year, the laws and by laws governing keeping bees; discover the principles of sustainable beekeeping and how these principles can guide your beekeeping into an enduring practice.

Learning outcomes

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

- Explain what the prerequisite are to get started in beekeeping.
- Describe the laws around beekeeping in Vancouver.
- Discuss the responsibilities of urban beekeepers.
- Identify where to purchase equipment and demonstrate how to assemble it
- Name and identify major parts of the honeybee such as the stinger or mandibular parts
- Describe bee biology and anatomy from the perspective of managing bees
- Describe the importance of wax and identify what to look for in comb during hive inspections.

Theory

Apiculture and Apiary Management

15 Lectures

Systematics and Beekeeping, Bee species, Bee morphology, Colony organization, Polymorphism, Caste system, Division of labour, Bee flora, Extent of Beekeeping in India, Limitations on the development of beekeeping, Advantages of extensive Beekeeping. Beekeeping equipments: Bee box and tools, how to manage a colony, the manipulation of a colony. Bee products: Honey, Bees wax, Pollens, Royal Jelly, Propolis and Bee venom. taking care of bee diseases and enemies, Routine management, Harvesting and marketing of bee products. Important Institutions pertinent to Apiculture: National Bee Board, Bee research and Training Institute, Apiaries. Economics and extension of Bee keeping.

Practical (30 Hours)

1. Identification of honey bees: *Apis laboriosa*, *Apis dorsata*, *Apis cerana*, *Apis mellifera*, *Apis florea*, *Apis andreniformis*
2. Identification of comb of honey bees.
3. Detailed study of wing venation, legs and antenna of *Apis cerana* and *Apis mellifera*.
4. Identification of different parts of movable beehive and beekeeping equipments.
5. Identification of major pollen and nectar plants.
6. Demonstration of swarm capture and honey harvesting.

Recommended readings

1. Abrol, D. P. (1997) Bees and Beekeeping. Kalyani Publisher, New Delhi.
2. Abrol, D. P. (2010) A Comprehensive guide to Bees and Beekeeping. Scientific Publisher, New Delhi.
3. Withhead, S. B. (2010) Honey bees and their management Axis books Publisher, Jodhpur.
4. Nagaraja, N. and Rajagopal, D. (2015) Honey bees: Diseases, Parasites, Pests, Predator and their management. M.J.P Publisher, Chennai.
5. Dharamsing and Singh, D. P. A Handbook of Beekeeping, Agrobios India (Publisher), Jodhpur.


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Semester	Course	Course Title	Credit
I / III	ZOO-SE-003	Sericulture	Theory=01 and Practical :01 = 02 Credits

About the course

The course gives insight into the principles of sustainable sericulture and how these principles can guide your silkworm rearing into an enduring practice. The students will know about the laws and by laws governing keeping silkworm.

Learning outcomes

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

- Generation of skilled manpower in the field of sericulture,
- To impart training in extension management and transfer of technology,
- To impart training in Post Cocoon Technology, and
- To provide field exposure

Theory

Biology of silkworm and its Prospects in India

15 Lectures

Mulberry and non-mulberry Sericulture. Silkworm rearing technology. Types of mountages, Spinning, harvesting and storage of cocoons. Introduction and classification of silkworm diseases. Protozoan disease, Bacterial, Viral and Fungal diseases: causative agents, symptoms, transmission prevention and control. Sericulture Types- natural and synthetic fibres- types of silk produced in India; Importance of mulberry silk. Silk industry in different states, employment, potential in mulberry and non- mulberry sericulture. Employment generation in sericulture: Role of women in sericulture.

Practical (30 Hours)

1. Identification of moths of mulberry and non-mulberry silkworms.
2. Identification of host plants of silkworms.
3. Identification of cocoons of silkworms
4. Identification of different larval stages of silkworms
5. Diagnosis of diseases of silkworm.
6. Demonstration of rearing technique of silkworms.
7. Demonstration of silk-reeling and spinning

Recommended readings

1. Manual on sericulture (1976). Rome: Food and Agriculture Organization of the United Nations, Agricultural Services Division.
2. Ullal, S.R. and . Narasimhanna, M.N. (1987) Handbook of Practical Sericulture: CSB, Bangalore
3. Silkworm Rearing and Disease of Silkworm (1956) Ptd. By Director of Ptg., Stn. & Pub. Govt. Press, Bangalore
4. Jolly, M. S. (1986) Appropriate Sericultural Techniques; Ed., Director, CSR & TI, Mysore.
5. Handbook of Silkworm Rearing: Agriculture and Technical Manual-1 (1972) FuziPub. Co. Ltd., Tokyo, Japan.
6. Narasimhanna, M. N. (1988) Manual of Silkworm Egg Production, CSB, Bangalore.
7. Sengupta, K. (1989) A Guide for Bivoltine Sericulture. CSR & TI, Mysore.

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Semester	Course	Course Title	Credit
II/IV	ZOO-SE-002	Dairy Production and Technology	Theory=01 and Practical :01 = 02 Credits

About the course

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

Learning outcome

After successfully completing the course, the students will be able to

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

Theory

Dairy cattle breeds, its Management, and Biosecurity

15 Lectures

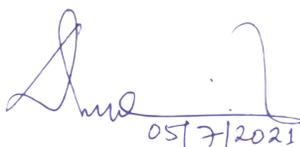
Breed selection: Breeds of cattle and buffalo, Native cow varieties, Indian exotic breeds their popularity and performance. Source of Feed and its composition– nutrients for milk production, Water Energy, Protein, Fibre, Vitamins, Energy and digestibility. Distribution map of dairy farming areas/ major milk producing regions in India. Dairy Products (Milk, cheese, yoghurt, gluten etc) and their nutritive value.; Dairy farm planning Management. Managing Dairy Cattle and its Housing and health. Cooling strategies, Cow comfort Management; Cleaning Management. Animal signs Management. Dairy herd Management and growth; Cow health and reproductive performance. Breeding Dairy Cattle. Artificial insemination and conception; Maternity management, The Lactation Cycle. Calf management, Calf diseases; Common management procedures. Vaccination, dehorning, weaning etc. Milking Management. Gathering cow for milking; Milking machines for smallholders; cleaning and sanitizing dairy equipment; Milking procedure. Dry cow therapy; Milk filtration Management. Milking Hygiene; Post-harvest milk quality. Dairy business profit strategies. Common disorders in Dairy Cattle. Mastitis, metabolic disorders, hypermagnesemia, ketosis and fatty liver, Ruminal acidosis, metritis; Hoof management. Manure-handling. Cow Longevity; Dairy buffalo Production Management, Biosecurity; Farm level economics affecting productivity and profitability.

Practical (30 Hours)

1. Studying various breeds of cattle
2. Process of Setting up of a Dairy farm
3. Studying preparation of various milk products, Cheese, yogurt, gluten etc

Recommended readings

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



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Semester	Course	Course Title	Credit
II/IV	ZOO-SE-004	Medical Laboratory Diagnostics	Theory=01 and Practical :01 = 02 Credits

About the course

This course was designed to improve knowledge and understanding of the requirements with the diagnosis, treatment and prevention of disease using clinical laboratory tests.

Learning outcomes

After completing this course, the students will be able to:

- Apply practical skills with the understanding of Medical Laboratory Diagnostics
- Use various micro techniques used in Medical Sciences
- Apply various techniques to study animal tissues
- Explore various research issues and their solutions

Theory

Human diseases and diagnosis

15 Lectures

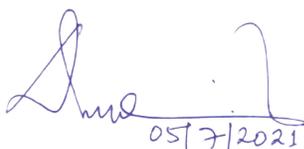
Anaemia, hypertension, Diabetes mellitus, AIDS., DLC, TLC, Total count of RBC, Lipid profile – Cholesterol and Triglycerids, Liver function test (bilirubin, SGOT, SGPT, Alkaline Phosphatase), Platelet count, blood sugar, urea, creatinine, Endocrine diseases in humans. Microscopes used in clinical examination, X-ray, CT scan, Magnetic Resonance Imaging (MRI), ELISA, RIA, spectrophotometry, amniocentesis.

Practical (30 Hours)

1. Calculation of weight
2. Calculation Height
3. Calculation of BMI (Body Mass Index)
4. Estimation of Hb
5. ESR
6. TLC & DLC
7. Examination of Peripheral blood smear
8. Examination of Sugar, Protein & Ketone body in Urine
9. Calculation and Examination of pulse rate.
10. Calculation of blood pressure.
11. Spirometry
12. Colour Vision Test
13. Visual acuity
14. First Aids

Recommended readings

1. Robins & Cotran (2020). Pathologic bases of diseases. Elsevier
2. Chen , M.Y., Pope, T. and Ott, D. J. (2020). Basic Radiology, Mc Grow Hill
3. Park, K. (2020). Preventive and social medicine, Bhanot Pub
4. Ghai, C. L. (2019). T. B. of Practical physiology, J. P. Publication.
5. Vasudevan, D. M. and Dsa, S. K. (2019). Practical book of biochemistry, J. P. publication.
6. Harshmohan (2020). Practical Pathology, J. P. Publication


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Semester	Course	Course Title	Credit
I / III	ZOO-SE-005	Freshwater Ornamental fishery	Theory=01 and Practical :01 = 02 Credits

About the course

To make the students aware of the vast potentials involved in ornamental fish farming and trading besides making them learn the diseases in fishes and other constraints in their culturing.

Learning outcomes

After completing this course the learners will be able to

- To learn the scientific method of setting an aquarium
- To learn the culture breeding and marketing techniques of common indigenous ornamental fishes

Theory

Aquarium Fish Keeping and its Management with all accessories 15 Lectures

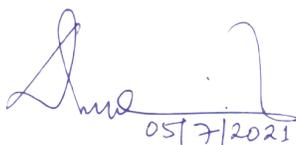
Design and construction of aquaria and its accessories. Water quality management in aquarium systems and plants for Aquarium. Identification and biology of Important Fresh water and indigenous ornamental fishes. Sexual dimorphism in ornamental fishes. Breeding and rearing of common ornamental fishes. Conditions for breeding- pH, temperature and sex ratio. Brood stock management- selection of brooders, maintenance and management of brood stocks. Modern breeding techniques. Colour enhancement techniques. Food and feeding habits of ornamental fishes. Preparation and culture of live feed (Artemia, Infusoria, Spirulina). Control of algal growth, snails and other predators. Common disease of ornamental aquarium fishes and its symptoms, treatment and prophylactic measures.

Practical (30 Hours)

1. Identification of common aquarium fishes
2. Groupings of light-bearers and egg-scatterer ornamental fish
3. Physico-chemical analysis of aquarium water
4. Identification of aquarium plants
5. Culture of live fish food and use of commercial formulated feed
6. Aquarium management using aquarium devices

Recommended readings

1. Axelord, H.R. (1967). Breeding aquarium fishes, T F H Publications.
2. Mills, D. (1981). Aquarium Fishes, Arco publishing.
3. Mills, D. and Vevers, G. (1982). The Practical encyclopedia of fresh water, Tropical Aquarium fishes, Salamander Books limited, London.
4. Gahlawat, S.K., *et.al.* (2007). Manual of experimental Ichthyology, Daya publishing House, Delhi.
5. Brunner, G. (1973). Aquarium plants, T F H Publications, Inc. Ltd., Hongkong.
6. Hansen, J. (1979). Making your own aquarium, Bell and Hyman Ltd., London.
7. Lovell, T. (1998). Nutrition and feeding of fish second Ed. Kluwer Academic publishers.
8. Talwar, P.K., and Jhingran, A.G. (1991). Inland fishes Oxford and IBH Publishing Co. PVT LTD, New Delhi.



सयुक्त कुलसचिव (शैक्षणिक एवं सम्मेलन)
राजीव गांधी विश्वविद्यालय
Jt. Registrar (Acad. & Conf.)
Rajiv Gandhi University
Rono Hills, Doimukh (A.P.)

Semester	Course	Course Title	Credit
I / III	ZOO-SE-007	Livestock management and Animal Husbandry	Theory=01 and Practical :01 = 02 Credits

About the course

The course provides intensive study in livestock production, management, marketing, nutrition, breeding, production records, selection, animal health, waste management, and conservation practices.

Learning outcomes

After successfully completing this course, the students will be able to:

- Understand skills and requirements necessary to find and maintain a job.
- Select and develop a breeding system for a livestock enterprise.
- Understand the importance of genetic improvement in animal production.
- Formulate feed rations for different classes of livestock.
- Identify common problems associated with livestock and horse herd health and solutions.
- Identify current and future issues relating to animal husbandry.
- Understand different marketing opportunities available for livestock production.

Theory

Animal breeding systems and its Management

15 Lectures

Reproduction and Breeding in animals: Reproductive Systems, Common Breeding Systems including cattle Breeding, Swine, Sheep and Goat Breeding, Hormones and Cycles and effect of environment. Reproductive Technologies. Nutritional requirements: Energy requirements for maintenance, growth, milk, egg, wool, and meat production. Carbohydrates & Fats, Protein, Minerals & Vitamins, Water etc. Animal Products: Importance of Animal Products; Beef; Pork; Lamb; Poultry Products. Common Feedstuffs Systems for expressing energy value of foods in ruminants, pigs and poultry. Common Breeds of Livestock: Breeds of Cattle, swine, sheep, goat and poultry: Selecting live stocks; Facilities and Equipment; Housing, Maintenance and health care; Management of breeding stocks and products. Vaccination programmes and Deworming programmes. Planning and Marketing; Culling, Forward Contracting, Backgrounding. Quality control; Future prospects. Basic principles of Genetics and tools for genetic improvement. Current issues affecting the livestock industry.

Practical (30 Hours)

1. Estimation of amino acids, proteins and fatty acids in feed.
2. Virtual demonstration of endocrine glands and their influence on growth of livestock.
3. Estimation of albumen and yolk quantity in eggs.
4. Estimation of calcium in eggshell.
5. Estimation of cholesterol and peroxides in meat.

Recommended readings

1. Taylor, R.E and Field, T.G. (2004). Scientific Farm Animal Production: An Introduction to Animal Science. Prentice-Hall



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Rono Hills, Doimukh (A.P.)

2. Acker, D. and Cunningham, M. (1998). Animal Science & Industry. Prentice-Hall.
3. Blakely, J. and Bade, D. (1985). The Science of Animal Husbandry. Prentice-Hall.
4. Cambell, J. and Lasley, J. (1975). The Science of Animals that Serve Mankind. McGraw-Hill.
5. Cooper, E. L. (1990). Agriscience: Fundamentals & Applications Delmer: Albany.
6. American Youth Horse Council (1999) Handbook: A Guide to Equine Care and Management.
7. Morrison, F. (1949). Feeds and Feeding (8th edition) Morrison: Ithaca.



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Semester	Course	Course Title	Credit
II/IV	ZOO-SE-006	Public Health and Hygiene	Theory=01 and Practical :01 = 02 Credits

About the course

The course designed for public health and hygiene at graduation level will give understanding for health hygiene, dietary issues, diseases related to malnutrition, communicable and non-communicable diseases.

Learning outcomes

After successfully completing the course, the students will be able to

- Identify current national and global public health problems.
- Aware about the issues of food safety, water safety, vaccination, exercise and obesity, exposure to toxins.
- frame a public health plan during any epidemic or spread of infectious disease etc.
- Analyze case studies of infant mortality and obesity.
- Assess the health inequalities with regard to gender, race, ethnicity, income etc.

Students may make an oral presentation and compare the health care system of India with a country having advanced one.

Theory

Human personal hygiene and diseases

15 Lectures

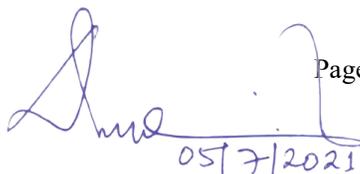
Introduction to public health and hygiene. Pollution and health hazards; water and air borne diseases. Radiation hazards. Role of health education in environment improvement and prevention of diseases. Balanced diet, dietary plan and its importance for an infant, normal adult, pregnant woman and old person. Significance of breast feeding. Malnutrition anomalies – Anaemia (Iron and B15 deficiency), Kwashiorkar, Marasmus, Rickets, Goiter (cause, symptoms, precaution and cure). Substitution of diet with required nutrients to prevent malnutrition disorders. Infectious agents responsible for diseases in humans. Communicable (fungal, bacterial, viral, sex-related) and non-communicable (hypertension, stroke, coronary heart disease, myocardial infarction). Health education and preventive measures for communicable and non-communicable diseases. . Osteoporosis, osteoarthritis and rheumatoid arthritis-cause, symptom, precautions. Diabetes- types and their effect on human health. Gastrointestinal disorders- acidity, peptic ulcer, constipation, piles (cause, symptoms, precaution and remedy) etc. Obesity (Definition and consequences). Mental illness (depression and anxiety) and lifestyle diseases. Oral and lung cancer and their preventive measures.

Practical (30 Hours)

1. Blood glucose measurement using glucometer.
2. Study of malnutrition diseases in nearby areas.
3. Measurement of temperature and oxygen level using thermometer and pulse oxymeter
4. Survey of diseases from nearby health centre
5. Study of dental diseases from a nearby population

Recommended readings

1. Mary Jane Schneider (2011) Introduction to Public Health.
2. Muthu, V.K. (2014) A Short Book of Public Health.
3. Detels, R. (2017) Oxford Textbook of Public Health (6th edition).
4. Gibney, M.J. (2015) Public Health Nutrition.
5. Wong, K.V. (2017) Nutrition, Health and Disease.


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