

Learning Outcomes-based Curriculum Framework (LOCF) for Post-Graduate Programme



M.Sc. Zoology (Pure and Applied)
(Syllabus effective from 2023 Admission onwards)



University of Kerala

2023

Syllabus for M.Sc. Zoology(Pure and Applied)

Program Outcomes

- PSO1: To acquire advanced knowledge and skills in the area of life science to the students and make them capable of doing independent research and teaching
- PSO2: Learners equip to produce scientific reports and products
- PSO3: Enhance the critical thinking ability and equip learners to do independent thinking and communicate through books, media and technology
- PSO4: Equip learners empathetic to nature, environment and fellow beings and make them aware of a social, economic, political and environmental issue and effectively participate in remedial measures.
- PSO5: To acquire knowledge to learners to carryout excellent ethical standard in doing research, assessment and teaching.
- PSO6: Help the learners to get the ability for problem-solving in the action plan for the particular problem.
- PSO7: Students achieve computational understanding in the area of research, learning and teaching.

Program Specific Outcomes

- PSO1** Understand the nature and basic concepts of Animal Physiology, Ecology, Environmental Science, Developmental Biology, Reproductive Biology, Endocrinology, Cell Biology, Biochemistry, Taxonomy and Entomology and Conservation
- PSO2** Analyse and understand the relationships among invertebrates, vertebrates and microorganisms
- PSO3** Develop procedures and Conduct experiments as per laboratory standards in the areas of Animal Physiology, Ecology, Environmental Science, Developmental Biology, Reproductive Biology, Endocrinology, Cell Biology, Biochemistry, Taxonomy and Entomology.
- PSO4** Understand the applications of biological sciences in Apiculture, Aquaculture, Agriculture, Medicine, Fertilisation, Bioenterprenurship and BioInstrumentation.
- PSO5** Acquire necessary skills in the observation and study of nature, biological techniques, experimental skills and scientific investigations.
- PSO6** Apply ethical principles and commit to professional ethics and responsibilities in delivering his duties in research and teaching.
- PSO7** Enable the students to avail career opportunities in teaching, industry and research.
- PSO8** Students will be able to apply the scientific method to questions in biology by formulating testable hypotheses, gathering data and analysing those data to assess the degree to which their scientific work supports their hypotheses.
- PSO9** Understanding of environmental conservation processes and its importance, pollution control and biodiversity and protection of endangered species.
- PSO10** Create empathy and care towards the Ecosystem and Biomes.
- PSO11** Acquire knowledge about research methodologies, Instrumentation, effective communication and problem solving.
- PSO12** Students will be able to use computational tools for the analysis of relevant biological situations and to communicate acquired knowledge.

Programme Structure

Semester	Course Code	Name of the course	Credits
	CORE COURSE (CC)		
I	ZOO-CC-511	Biostatistics, Instrumentation and research methodology	3
	ZOO-CC-512	Principles of Ecology	3
	ZOO-CC-513	Evolution and Animal Behaviour	3
	ZOO-CC-514	Microbiology and Immunology	3
	ZOO-CC-515	Ecology, Biostatics, Microbiology and Immunology Practical	2
	Discipline Specific Elective (DE)		
	ZOO-DE-511	Regenerative biology and medicine	2
	ZOO-DE-512	Microscopy and Micro techniques	2
	ZOO-DE-513	Institution visits	2
	ZOO-DE-514	Museum/Zoo visit and report preparation	2
	ZOO-DE-515	Industry/startup visits	2
	ZOO-DE-516	Molecular Techniques	2
	ZOO-DE-517	AI and Lifesciences	2
	CORE COURSE (CC)		
II	ZOO-CC-521	Cell and Molecular Biology	3
	ZOO-CC-522	Developmental Biology	3
	ZOO-CC-523	Environmental Pollution and Toxicology	3
	ZOO-CC-524	Animal systematics and Taxonomy	3
	ZOO-CC-525	Cytology, Molecular Biology, Developmental Biology, Pollution, Toxicology and systematics.	2
	Discipline Specific Elective (DE)		
	ZOO-DE-521	Mini Project/Internship/On the Job Training	2
	ZOO-DE-522	Cell Culture Techniques	2
	ZOO-DE-523	Nature Camp/Field study	2
	CORE COURSE (CC)		
III	ZOO-CC-531	Animal Physiology	4
	ZOO-CC-432	Biochemistry and Synthetic Biology	4
	ZOO-CC-533	Endocrinology and Reproductive Biology	3
	ZOO-CC-534	Genetics and Biotechnology	3
	ZOO-CC-535	Animal Physiology, Biochemistry, Endocrinology, Genetics and Biotechnology - Practical	2
	Discipline Specific Elective (DE)		
	ZOO-DE-531	Bio-Entrepreneurship in Life Science	2
	ZOO-DE-532	Regenerative Medicine and Biology	2

	ZOO- DE-533	Toxicity Evaluation in Cosmetics Developments	2
CORE COURSE (CC)			
IV	ZOO-CC-541	Applied Zoology	4
	ZOO-CC-542	Biodiversity and Conservation Biology	4
	ZOO-CC-543	Dissertation	8
GENERIC COURSES (GC)			
A n y semester (	ZOO-GC-501	Biodiversity	2
	ZOO-GC-502	Bio-Entrepreneurship in Life Science	2
	ZOO-GC-503	Skin and hair biology and diseases	2
	ZOO-GC-504	Ayurveda biology	2
	ZOO-GC-505	Cell Culture Techniques	2
	ZOO-GC-506	Regenerative Medicine and Biology	2
	ZOO-GC-507	Wetland Ecology	2
	SKILL ENHANCEMENT ELECTIVE (SE)		
	ZOO-SE-501	Aquarium setting and management	2
	ZOO-SE-502	Nutracosmetology	2
	ZOO-SE-503	Toxicity Evaluation: In vitro and In vivo Methods	2

SEMESTER: I**COURSE CODE:ZOO-CC-511****Credits:3**

NAME OF THE COURSE: **BIostatistics, Instrumentation and Research Methodology**

This course provides an understanding of various instruments and devices used to measure and analyze biological and physiological signals. It covers the principles, applications, and practical use of instrumentation in biomedical research and healthcare. This course focuses on the principles and techniques of research methodology used in biomedical sciences. It covers research design, data collection, analysis, and interpretation methods. This course covers the application of statistical methods in analyzing biomedical and public health data. It focuses on understanding and interpreting statistical results in the context of research and clinical studies.

Course Outcomes

- CO1: Describe the principles and working mechanisms of various instruments used in biological and physiological measurements.
- CO2: Operate and calibrate instruments effectively for accurate data acquisition.
- CO3: Apply instrumentation knowledge to solve practical problems in biomedical research and clinical settings.
- CO4: Analyse and interpret the data obtained from instrumentation.
- CO5: Demonstrate ethical considerations when using instrumentation in research and healthcare.
- CO6: Identify and describe various research designs and their applications in biomedical research.
- CO7: Develop research proposals, including study objectives, methods, and expected outcomes.
- CO8: Apply appropriate data collection methods and tools in biomedical research.
- CO9: Analyse and interpret data using relevant statistical methods.

COURSE CONTENT

MODULE: I

Population, sample, variable, parameter, primary and secondary data, screening and representation of data, frequency distribution. **Measures of Central Tendencies:** Mean, Median and Mode. **Measures of dispersion:** Concepts and applications-measures of dispersion, range, mean deviation, Skewness and Kurtosis, coefficient of variation, variance, Standard deviation, Quartile deviation and standard error. **Testing of hypotheses:** Concepts of Normal, Binomial and Poisson distribution; Student's -t distribution, Concepts of Null hypothesis and alternative hypothesis, degrees of freedom and level of significance. One-way ANOVA-applications in biology. Concepts and applications of correlation and regression, Chi-square test. Major software used in statistical analysis

MODULE II

Principle, structural parts and applications of compound microscope, phase-contrast microscope, fluorescent microscope, Confocal Laser Scanning Microscopy, transmission electron microscope and

scanning electron microscope. Different mechanical and chemical procedures, Centrifugation and ultracentrifugation methods and applications, structural parts of an analytical ultracentrifuge, Cell Culture, Principles and Applications of Flow cytometry.

MODULE III

Spectrophotometry, Colorimetry and its applications, NMR and ESR spectroscopy, Different types of mass spectrometry, Principles of chromatography, paper chromatography, thin layer chromatography, gas chromatography, gel permeation chromatography, ion exchange chromatography, high-pressure liquid chromatography and affinity chromatography

MODULE IV

Principle of electrophoresis, paper electrophoresis, polyacrylamide gel electrophoresis, Disc gel electrophoresis, and SDS-PAGE, gel electrophoresis, 2D gel electrophoresis, Southern transfer, Northern transfer and Western transfer, ELISA. Immunocytochemistry and Immunohistochemistry. OmicsTools. Microarray, Next-generation Sequencing, Protein Array, Genome wide analysis.

MODULE V

Introduction to Research Methodology: Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research Methods. Criteria of Good Research, Problems Encountered by Researchers in India

MODULE VI

Research Problem Defining: What is a Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem An Illustration. **Research Design** :Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Written Examinations
2. Seminars
3. Assignments
4. Poster Presentations
5. Model preparations

LEARNING RESOURCES

References

- Petter Lake, Haakon Breien Benestad, Bjorn Reino Olsen, Research Methodology in the Medical and Biological Sciences, Academic Press Inc; 2015
- John W. Creswell, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE Publications, 2008,
- C R Kothari, Gaurav Garg, Research Methodology: Methods and Techniques, New Age International Publishers, 2014
- N Gurumani, Research Methodology: For Biological Sciences, MJP Publishers, 2011
- Richa Arora, Encyclopaedia of Research Methodology in Biological Sciences, 2004
- Ranjit Kumar, Research Methodology: A Step - by - Step Guide for Beginners, SAGE South Asia edition, 2011,
- William Trochim, James P Donnelly, Kanika Arora Research Methods: The Essential Knowledge, 2015
- Gurumani N Scientific Thesis Writing & Paper Presentation, MJP Publishers 2010,
- Gurumani N An Introduction To Biostatistics, MJP Publishers, 2010

Online sources

<http://lms.keralauniversity.ac.in/moodle/course/view.php?id=10>

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.

SEMESTER: I

ZOO-CC-512

Credits:4

NAME OF THE COURSE: **Principles of Ecology**

Course Outcomes

- CO1: Understands the components and scope of Ecology.
 CO2: Identifies population characteristics.
 CO3: Acquire in depth knowledge on community interactions.
 CO4: Critically evaluate different types of ecological succession.
 CO5: Importance of Biogeochemical cycles in the stability of ecosystem
 CO6: Understands natural calamities and mitigation measures

COURSE CONTENT

MODULE: I

Introduction to Ecology, Habitat and Niche: Subdivision & scope of ecology, Physical environment, biotic environment; biotic and abiotic interactions, concept of habitat and niche; niche width and overlap

MODULE II

Population growth curves; population dynamics, life history pattern, fertility rate and age structure. Population regulation; life history strategies (*r* and *K* selection); Parental investment and offspring, reproductive strategies – ecology and evolution of sex and mating systems, optimal body size, concept of metapopulation-demes and dispersal, extinctions, age structured populations. Competition and coexistence and other ecological interactions.

MODULE III

Community Ecology: Nature of communities; community structure and attributes; community patterns, levels of species diversity and its measurement; community structure, dominance, edges and ecotones. Island communities, colonization, Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.

MODULE IV

Type of life support systems, Ecology of space travel, Space craft as an ecosystem, Biosphere-2, mesocosm. Exobiology, Remote sensing as a tool for the study and management of ecosystems. Physical basis of remote sensing, Process of information extraction.

MODULE V

Environmental problems, Climate change, Green House effect, Acid-rain, Ozone layer depletion, Deforestation, Desertification, Marine pollution, Urbanization. Oceans and plastic pollution

MODULE VI

Natural calamities: Natural hazards, flood, volcanoes, coastal hazards, earth quakes, cyclones, landslides, El Nino, La Nina, Avalanche, Tsunami, and Tornado. Epidemics, pandemics and their management..Remote Sensing as a tool for the study and the management of environment and calamities.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Quiz Seminars
2. Assignments
3. Poster Presentations
4. Survey
5. Souvenir preparation
6. Mentimeter

LEARNING RESOURCES

References

- Ahluwalia & Sunita Malhotra-Environmental Science-Ane books Pvt. Ltd
- Ananthakrishnan, T.N. - Bioresource Ecology- Oxford and IBH.
- Andrewartina- Intriduction to the study of animal population-University of Chicago Press
- Bailey J.A.-Principles of wildlife management -John Wiley and sons, New York
- Beebi& Ann Maria (2006): First Ecology-Oxford university press
- Bouis M.E. Conservation biology- the science scarcity and diversity. Binarer Associates Inc. Publishers, Sunderland, Massachusetts.
- Chiras, D. (2001): Environmental science, Jones and Bartlet publishers
- Collar, N.J. Crooby, M.J. and Shatters field, A.J. (1994): Birds to watch - The world list of threatened birds, Cambridge U. K. bird life international (Bird life conservation series 4)
- Cunningham & Cunningham 2003- Principles of Environmental Science:, Tata McGraw Hill
- Dempster- Animal population Ecology- Academic press
- Ehrlich and Ehrlich- Ecoscience- W.H. Freeman and Co.
- Emlen, J.M Population biology. The co- evolution of population dynamics and behaviour- M c Millan publishing company New York, London.
- Emlew, J.M. Ecology an evolutionary approach.
- Franco K.G-- Man and the changing environment
- Irewarth Horn, An introduction to climate- Mac Graw-Hill
- Krebs, C., Ecology, Harper and Row publishers, New York.
- Lutgens, Frederick, K. and Edward J. Tarbuck (1995): *The Atmosphere*, Prentice Hall, 6th ed., pp 14-17, [ISBN 0-13-350612-6](#)
- National Academy of Sciences (NAS). 2001. "Climate Change Science: An Analysis of Some Key Questions", *National Academies Press*. 42 pp.
- Odum H. T. System ecology, an Introduction- John wilsy& Sons, New york.
- Owen O. S. Natural resources conservation, An Ecological Approach- Mc Millan.
- Percel, J.P. (1968) Wet evergreen forest of the western ghats of India- Pondicherry- India-Institute Francis de Pondicherry.
- Pidwirny, M. (2006). "Causes of Climate Change". *Fundamentals of Physical Geography*, 2nd Edition.
- Intergovernmental Panel on Climate Change (IPCC), 2001. "Working Group I Third Assessment Report." *Cambridge University Press*. Cambridge, UK. 881 pp.
- Preston, Heuveline and Guillot (2001): Demography: Measuring and Modelling

Population Processes

Puri et al.- Forest Ecology- Oxford university press

Ramakrishnan, P. S.-Ecology and sustainable development-National book trust
India

Raymond Dasman- Environmental Conservation- John Wiley

Sagrayia, K. P. – Forest and Forestry- National Book Trust, New Delhi

Smith R.I. - Elements of ecology- Harper and Row

Online sources

<http://lms.keralauniversity.ac.in/moodle/course/view.php?id=423>

<http://www.physicalgeography.net/fundamentals/7y.html>

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.

SEMESTER: I

COURSE CODE ZOO–CC-513

Credits: 3

NAME OF THE COURSE:

Evolution and Animal Behaviour

Course Description:

The interaction between evolutionary processes and animal behaviour is examined in the course Evolution and Animal Behaviour. The evolution of behaviour through natural selection, genetic variety, and environmental conditions will be studied by the students. The course will cover subjects like social behaviour, communication, foraging tactics, behavioural adaptations, mating systems, and parental care. Students will investigate the ecological and reproductive implications of these behaviours as well as the evolutionary forces that led to them. Students will get a thorough grasp of how animal behaviour evolved through a combination of theoretical ideas, empirical research, and field observations.

Course Outcomes

CO1: Understand the principles of evolution and natural selection and their role in shaping animal behavior.

CO2: Understand and Identify the contributions of various evolutionists

CO3: Students will generate a holistic appreciation on the phylogeny and adaptations in animals

CO4: Analyse the origin of Prokaryotic and Eukaryotic organism and parameters helped for the evolving these life forms

CO5: Understand the molecular aspects of evolution including speciation, gene flow, natural selection etc.

CO6: Understand the origins of the earth, mass extinction and evolutionary time scales

CO7: Analyse the primate evolution and incident happened during the evolutionary time scale

CO8: Explore the diversity of animal behaviors and their adaptive significance.

CO9: Analyze the genetic and ecological mechanisms underlying behavioral evolution.

CO10: Investigate mating systems, reproductive strategies, and sexual selection.

CO11: Examine the evolution of social behavior, cooperation, and conflict.

CO12: Discuss the role of communication and signals in animal behavior.

CO13: Explore foraging strategies, predator-prey interactions, and optimal foraging theory.

CO14: Develop critical thinking and analytical skills through the evaluation and interpretation of research papers and field observations.

COURSE CONTENT

MODULE: I

Introduction to Evolution: Brief summary of the background to and development of evolutionary theory, Evidence for evolution: fossil record, comparative anatomy, and molecular biology, Theories of inheritance: Mendelian genetics and modern synthesis, Darwin and Natural Selection, Lamarckian inheritance, Earth Changing Atmosphere, movement of continents, Possible site for the origin of early molecules, Origin of basic biological molecules, abiotic synthesis of organic monomers and polymers, Concepts of Oparin and Haldane, experiment of Miller, the first cell, the origin of prokaryotes and eukaryotic cells, anaerobic metabolism, photosynthesis and aerobic metabolism

MODULE II

Eukaryotic Organelles, Genes and Organisms: Organelles, Evolution of Eukaryotic Organelles, Gene Structure, Horizontal gene Transfer and trees of life, Evolution of Eukaryotes, Construction trees of life, Evolution as the development of Individual, different species and relation, similarity and pattern of evolution

MODULE III

Palaeontology and Evolutionary History: The evolutionary time scale, Eras, Periods and Epoch, Major events in evolutionary time scale, Mass Extinction and adaptive radiation, Origin of unicellular and multicellular organisms, Major groups of plants and animals, Stages in primate evolution including Homo sapiens, Human Influences of Evolution, Cultural and Religious Evolution.

MODULE IV

Natural Selection and Molecular Evolution: Evolution by natural selection, Artificial and Natural selection, Selection on small continuous variation, Types of Natural selection, Stabilizing selection, Sexual Selection, Group Selection, Directional Selection, Disruptive Selection, Concepts of neutral evolution, Molecular divergence and molecular clocks, Molecular tools in phylogeny, Origin of new genes and protein, Gene duplication and divergence, Molecular phylogenetics, Methods and examples, Concerted evolution of multigene families, Factors influencing molecular evolution, Role of mutation and selection in molecular evolution, Genome organization and evolution, Evolution of prokaryotes and eukaryotic genomes, C value Paradox, Tandem Repetitive Sequences.

MODULE V

Evolutionary Genetics, Speciation and Applied Evolutionary Biology: Overview of evolutionary genetics and its importance in understanding evolution, Genetic variation and its sources: mutation, recombination, and gene flow, Population genetics: Hardy-Weinberg equilibrium, genetic drift, and gene flow, Adaptive radiation and modification, Isolating mechanism, Convergent Evolution, Co-evolution, Speciation and Macroevolution: The Process of Speciation, Modes of speciation: allopatric, sympatric, and parapatric, Patterns of macroevolution: evolutionary radiations and mass extinctions, Evolutionary medicine: antibiotic resistance, human diseases, and vaccinations, Conservation genetics and evolutionary approaches to biodiversity conservation

MODULE VI

Animal Behaviour: Foundations: Natural Selection, Learning, Cultural Transmission, Conceptual, Theoretical and Empirical Approaches, Proximate and ultimate Perspectives, Social Learning, Altruism, Reciprocal altruism, Mating systems, Kinship, Cooperation, Foraging, Communication, Aggression, Play, Social Dominance, Domestication and behavioral changes, Parental care, Memory, Cognition, Sleep, Biological Clocks, Migration, Orientation and Navigation, Mammalian Brain and coordination, Homing, Biological Rhythms, Behavior in changing environments: responses to climate change and human disturbance, Artificial Intelligence and Machine learning in Behavioral studies

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

- Written Examinations
- Seminars
- Assignments
- Poster Presentations
- Model preparations
- Survey
- Digital Portfolio development
- Flip classroom assignment
- Quiz Visual
- Development of Visual Organiser

LEARNING RESOURCES

References

- Moya, Andres, et al; Evolution: From molecular to ecosystems.- Oxford and IBH publishing, Calcutta 2006.
- Brain H and Hallgrimsson, Benedikt, Strickberger's Evolution, (4th edn). Jones and Bartlett publishers, London 2008
- Bastolla, U., Porto, M., Roman, E., Vendruscolo, M, Structural Approaches to Sequence Evolution: Molecules, networks, populations- Springer vex lay 2007
- Lee Alan, Dugatkin, W.W. Principles of Animal Behaviour, Norton and Company, New York 2004.
- Rastogi V B Organic Evolution, Meditech Publishers 13th Edition 2017
- Agarwal V.K Animal Behaviour, S Chand & Company 2010

Online sources

LMS Link: <http://lms.keralauniversity.ac.in/moodle/course/view.php?id=161>

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.
- Quizzes and Examinations: Assessing understanding of key concepts and theories
- Field Observations and Research Projects: Applying observational and research skills to study animal behavior
- Assignments: Analyzing research papers, conducting literature reviews, and critical evaluation of empirical studies
- Class Participation: Active engagement in discussions, group activities, and presentations
- Final Project: A research paper or presentation on a specific topic in the evolution of animal behavior

SEMESTER: I	COURSE CODE: ZOO-CC-514	Credits:3
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NAME OF THE COURSE: **Microbiology and Immunology**

- CO1: Create awareness on various aspects of microbiology.
- CO2: Develop an understanding of different types of microorganisms and how they affect humans.
- CO3: Demonstrate knowledge pathology of different microorganisms and ways to prevent them.
- CO4: Generate awareness on the importance of Immunology in disease treatment and prevention.
- CO5: Analyse the role of parasites and get a comprehensive knowledge on their life cycle.
- CO6: cycle.
- CO7: Gain insight into how the immune system works and the principle behind vaccines. Critically evaluate on the basics of Antibody Antigen interaction.

COURSE CONTENT

MODULE: I

General Microbiology: Bacteria – Taxonomy, Structure, Recombination, Growth, Nutrition, Culture – Types of Media and Conditions for Culturing. Viruses – Taxonomy, Structure and life Cycle of Viruses – T4 Phage and HIV, Emerging viral diseases, Viroids and Prions.

MODULE II

Medical Microbiology: Infectious Diseases – Causative Agents, Modes of Transmission and control of Polio, Dengue, AIDS, Tuberculosis, Diphtheria, Typhoid. Prevention and control of microorganisms – Physical and Chemical Methods. Antibiotics and Other Anti – microbial Agents and Mechanism of Drug Resistance.

MODULE III

Scope of Immunology – Types of Immunity - Innate and Acquired, Passive and Active. Primary and Secondary Lymphoid Organs – structure and Function of Bone Marrow, Thymus, Spleen, Bursa of Fabricius, GALT, BALT, MALT and Lymph Nodes. Cells of Immune System – Origin and Differentiation of T & B Cells and Macrophage. Antigens – Class Determinants – Reactive Sites and Receptor Sites.

MODULE IV

Antibody – Immunoglobulin – Primary Structure – Classes, Functions, Synthesis. Hybridoma technology Monoclonal Antibodies and their Applications. Genetic Mechanisms in Generation of Antibody Diversity – Regulation of antibody Diversity. Complement – Classical and Alternative Pathways and Immunological Significance – Antigen antibody reaction, Traditional and new generation vaccines.

MODULE V

Major Histo-compatibility Complex (MHC) and its Products in Man. Transplantation Immunology, Tumour Immunology – Immune Deficiency Diseases – AIDS – Autoimmune Diseases – Examples – Concept and Mechanisms – Types of Hypersensitivity

MODULE VI

Parasitology. Parasitic associations, Co-evolution of Parasite and host, Life style of parasite, Useful Parasites, Transmission associated with reproduction, Active parasite transmission, host factors. Parasites of zoonotic importance

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Written examination
2. Assignment
3. Seminar
4. Preparation of video
5. Poster Preparation
6. Mentimeter quiz

LEARNING RESOURCES

References

- Pelczar, M.J., Reid R.D and Chan E.C.S. Microbiology, 5th Ed. Tata McGraw Hill Publishing Co. Ltd. New Delhi. 2002
- Barbara J. Howard. Clinical and pathogenic Microbiology. The C V Mosby Company.1994
- Kuby J. Immunology, W.H. Freeman & Co. New York. 1994
- Roitt, M.I. Essential Immunology, Blackwell Science Ltd. UK, 1994
- Sells, S. Basic Immunology, Elsevier Science Publishing Co. New York. 1987
- Powar, C.B. and Dagainawala, H.F. General Microbiology Volume I & II, Himalayas Publishing House, Mumbai. 1982
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- Kannan, I. Immunology, MJP Publishers, Chennai. 2011
- Nandhini Shetty, Immunology Introduction Text Book New Age International Pvt. Ltd. New Delhi. 1996
- Ovan M. Roitt, Essential Immunology, ELBS, 1988
- Robert M. Coleman, Mary F. Lanbard and Raymond E.S. Card, Fundamental Immunology Wm. C. Brown Publishers. 1992
- Roitt, I.M., Brostoff. J. and Male, D.K., 1985: Immunology Churchill Livingstone.
- Tragger, W., Living Together- The Biology of Animal Parasitism, Plenum Press 1986
- Ruben, L.N. and Gershwin, M.E., Immune Regulation. 1982
- Cooper, E.L., Comparative Immunology, Prentice Hall. 1976
- Burnet, F.M. Immunology W.H. Freeman and Company.
- Cheng, T.C., The Biology of Animal Parasities, W.B. Saunders Co.
- Hayward, A.R. Immunodeficiency.

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.

SEMESTER: I	COURSE CODE: ZOO-CC-515	Credits: 2
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NAME OF THE
COURSE:

ZOO-CC-515 Ecology, Biostatics, Microbiology and Immunology
Practical

AIM: To introduce the various aspects of Ecology, Biostatics, Microbiology and Immunology.

COURSE OBJECTIVES:

The students will be introduced to hands on training of various aspects of Ecology, Biostatics, Microbiology and Immunology practicals.

COURSE CONTENT

ECOLOGY

1. Estimation of dissolved oxygen, Chloride, Ammonia, Phosphate, Nitrate, free carbon-dioxide, pH and alkalinity
2. Area localization with the help of GPS and Google earth.
3. Study of planktons in a pond ecosystem.
4. Study of different census and survey methods.
5. Construction of pyramid of number and biomass.
6. Field Study of any two ecosystems (Riverine/lacustrine/sandy shore/rocky shore/muddy shore) with report.

Microbiology Practical

1. Introduction to laboratory rules and procedures, Laboratory apparatus and equipment
 - i. Laboratory rules and regulations
 - ii. Apparatus used in microbiology
 - iii. Equipment used in microbiology (Autoclave, Microscope, Laminar Air flow chamber, Hot Air Oven, Incubator)
2. Aseptic procedures and culture media preparation
3. Isolation and culturing of microorganisms
 - i. Isolation of microorganism by streak plate technique
 - ii. Isolation of microorganism by spread plate technique
4. Staining and morphological study of bacteria
 - i. Preparation of bacterial smear
 - ii. Staining of microorganisms -Negative staining
 - iii. Staining of microorganisms -Gram staining
 - iv. Staining of microorganisms -Acid fast staining
5. Methods for identification of bacteria
 - i. Colony characteristics
 - ii. Biochemical tests (Starch hydrolysis, Skim milk Agar test, Gelatin hydrolysis, Urease test, Catalase test)
6. Hanging drop technique for demonstrating motility of bacteria
7. Antibiotic sensitivity test

NAME OF THE COURSE: ¹⁵ **REGENERATIVE BIOLOGY AND MEDICINE**

Course Outcomes

- CO1: Understand the various aspects of tissue regenerative and factors regulating the tissue regeneration process
- CO2: Students will achieve knowledge on tissue regeneration in invertebrates and vertebrates
- CO3: Achieve knowledge regarding alternative model systems to study tissue regeneration
- CO4: Understand the role of stem cell in tissue regeneration and development of regenerative medicine
- CO5: Students will get knowledge regarding organoid culture and culturing organoid
- CO6: Achieve the necessary knowledge regarding regenerative medicine and its application

COURSE CONTENT

MODULE: I

An Introduction to Regeneration: What is Regeneration, Physiological Regeneration, Reparative Regeneration, Regeneration by Induction, Hypertrophy, Morphallaxis, Asexual Reproduction.

MODULE II

Tissue Interactions in Regeneration and Aging: The Amphibian Limb, Human Fingertips and the mammalian Limb, Mammalian Skeletal Muscle Regeneration, Aging and Regeneration in Individual Organ Systems; Skin, Liver, Kidney, Lungs.

MODULE III

Stem Cells, Plasticity and Regeneration: What is a Stem Cell? Properties of Adult Stem Cells, Stem Cells in Regeneration and Tissue Reconstruction, Examples of Stem Cell Participation in Regeneration; Heart and Cardiac Muscle, Central Nervous System, Skeletal Muscle.

MODULE IV

Regenerative Medicine: Introduction to Regenerative Medicine, Biomaterials for Regenerative Medicine, Cell Therapy, Tissue Therapy, Regulation and Ethics, Organoids, Elements of organoid design, Kidney organoids, Applications of organoids

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Written Examinations
2. Seminars
3. Assignments
4. Poster Presentations
5. Model preparations
6. Digital Portfolio development
7. Flip classroom assignment
8. Quiz Visual
9. Development of Visual Organiser

LEARNING RESOURCES

References

- Bruce M. Carlson, M.D., PhD, Principles of Regenerative Biology, 2007, Academic Press.

David. L. Stocum, Regenerative Biology and Medicine, 2006, Academic Press.

[Robert Lanza](#) and [Anthony Atala](#), Essentials of Stem Cell Biology, 2013, Academic Press.

[Anthony Atala, Robert Lanza and James Thomson](#), Principles of Regenerative Medicine, 2010, Academic Press.

[Jamie Davies and Melanie Lawrence](#), Organoids and Mini-Organs, 2018, Academic Press.

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.

SEMESTER: I COURSE CODE:ZOO-DE-512 Credits:2

NAME OF THE COURSE: **Microscopy and Microtechniques**

Course Outcomes

- CO1: Developing a practical knowledge on Microscopic techniques.
 CO2: Impart knowledge on different types of Microscopy methods.
 CO3: Gain knowledge on processing of specimens for microscopy.
 CO4: Gain understanding on the techniques of histochemistry, Immunochemistry and cytochemistry.

COURSE CONTENT

MODULE I

Microscopy:- Light microscopy, phase contrast microscopy, Confocal laser scanning microscopy, scanning and transmission electron microscopy. Measurements using microscope and Imaging.

MODULE II:

Microtechniques: Histology- Collection, Preservation, fixation, Section cutting and staining of tissues. Various types of microtome and cryotomes. Techniques in Histochemistry, Immunohistochemistry and cytochemistry.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Field visits
2. Preparation of insect board
3. Preparation and analysis of clinical data
4. Preparation of drawing of specimens
5. Practical skill development
6. Develop expertise in handling lab equipments

LEARNING RESOURCES

References

Veerakumari L, Bioinstrumentation , MJP Publishers, Chennai, 2006

Gurumani N, Research Methodology for Biological Science, MJP Publishers, Chennai, 2006

Upadhyay A, Upadhyay K and Nath N, Biophysical Chemistry: Principles and Techniques, Himalaya Publishing House, 1997

Charles C. R. and Paul. S. R. Biophysical Chemistry: Techniques for the study of Biological Structure and Functions, W H Freeman & Co., New York, 2004

Palanichamy and Shunmughavelu, Research Methods in Biological Sciences, Palani
Paramount Publishers, Tamil Nadu, 1997.

Online sources

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.

SEMESTER: I COURSE CODE:ZOO–DE-513 Credits: 2

NAME OF THE COURSE: **Institution visits**

During the semester period the student/s will have to undertake guided visits to any three research/academic institution of national importance and has to prepare and submit an Institution visit report with proofs (photographs) in bound form and has to get it certified.

SEMESTER: I COURSE CODE:ZOO–DE-514 Credits: 2

NAME OF THE COURSE: **Museum/Zoo visit and report preparation**

During the course the student has to visit a reputed Zoo/Public Aquarium/Marine aquarium/Oceanarium and has to prepare taxonomic details, distribution and conservation status of a minimum of twelve animals with photographs. Bound certified report has to be submitted.

SEMESTER: I COURSE CODE:ZOO–DE-515 Credits: 2

NAME OF THE COURSE: **Industry/Startup visit**

During the course the student has to visit a full functioning industry/startup and has to study the activities and report it in a schematic scientific manner. The student has to involve in some of the activities. He also should acquire a sound knowledge on the procedures for initiating a startup and its operation. Everything has to be documented and bound certified report has to be submitted.

SEMESTER: I COURSE CODE ZOO–DE-516 Credits: 2

NAME OF THE COURSE: **MOLECULAR BIOLOGY TECHNIQUES**

COURSE OUTCOMES

- CO1: Understand the principles and theoretical foundations of molecular biology techniques.
- CO2: Gain practical skills in performing key molecular biology techniques commonly used in research laboratories.
- CO3:
- CO4: Learn to design and optimize experiments using molecular biology techniques.
- CO5: Develop proficiency in data analysis and interpretation of experimental results.
- CO6: Gain knowledge of quality control and troubleshooting in molecular biology experiments.
- CO7: Develop critical thinking and problem-solving skills in the application of molecular biology techniques.
- CO8:

Enhance laboratory safety awareness and good laboratory practices.

Develop effective communication skills through scientific reporting and the presentation of experimental findings.

COURSE CONTENT

MODULE: I

Introduction to Molecular Biology Techniques: Overview of molecular biology and its significance in biological research, Basic laboratory safety and good laboratory practices Ethical considerations in molecular biology experiments, Basic principles of data analysis and statistics in molecular biology, Analysis and interpretation of experimental results, Presentation of data through graphical representation and scientific reporting

MODULE II

RNA and DNA Isolation and Analysis: Principles and methods for DNA and RNA extraction from different sample types, Purification and quantification of DNA and RNA samples, Quality control and troubleshooting in DNA and RNA extraction, Principles and applications of PCR in molecular biology research, Principles of gel electrophoresis for separation and visualization of DNA and RNA, Agarose gel electrophoresis, Quantitative PCR (qPCR) and its applications, Reverse transcription-polymerase chain reaction (RT-PCR) and quantitative gene expression analysis, Microarray analysis and RNA sequencing (RNA-seq), Principles and methods of DNA sequencing, Sanger sequencing and next-generation sequencing (NGS) technologies

MODULE III

Protein Isolation and Analysis: Cell Lysis and Protein Extraction, Protein Quantification and Concentration Determination, Protein Quantification and Concentration Determination, Protein Electrophoresis and Gel-Based Analysis, Protein Characterization and Identification, Functional Assays and Protein-Protein Interactions

MODULE IV

Hands-on training and a Molecular Biology Lab visit

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Written Examinations
2. Assignments
3. Seminars
4. Poster Presentations
5. Model preparations
6. Survey
7. Digital Portfolio development
8. Flip classroom assignment
9. Quiz Visual
10. Development of Visual Organiser
11. Specimens Collection

LEARNING RESOURCES

References

- Molecular Cloning: A Laboratory Manual by Michael R. Green and Joseph Sambrook
- Current Protocols in Molecular Biology by Frederick M. Ausubel et al.
- Essential Techniques in Molecular Biology by Stefan Surzycki
- Molecular Biology Techniques: An Intensive Laboratory Course by Susan Carson et al.
- Basic Methods in Molecular Biology by Leonard Davis

- Molecular Biology of the Cell by Bruce Alberts et al. (This book covers a wide range of molecular biology techniques and concepts)
- PCR (The Basics): From Background to Bench by Carl Wittwer
- Gel Electrophoresis: Nucleic Acids by Various Authors (Part of the Methods in Molecular Biology series)
- Protein Expression: A Practical Approach by E. Yvonne Jones et al.
- Western Blotting: Methods and Protocols by Biji T. Kurien and R. Hal Scofield

Online sources

LMS Link: <http://lms.keralauniversity.ac.in/moodle/course/view.php?id=161>

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.
- Practical Laboratory Exercises: Hands-on performance of molecular biology techniques and data analysis.
- Laboratory Reports: Documentation of experimental procedures, data analysis, and interpretation.
- Quizzes and Examinations: Assessing understanding of theoretical concepts and principles.
- Data Analysis Assignments: Analyzing and interpreting experimental data sets.
- Presentation: Communication of experimental findings through oral presentations.

SEMESTER: I COURSE CODE ZOO – DE-517 Credits: 2

NAME OF THE COURSE: **ARTIFICIAL INTELLIGENCE (AI) IN HEALTHCARE AND BIOMEDICAL RESEARCH**

COURSE OUTCOMES

- CO1: Understand the principles and concepts of artificial intelligence and its applications in healthcare and biomedical research.
- CO2:
- CO3: Explore the potential of AI techniques in disease diagnosis, treatment planning, and prognosis.
- CO4: Learn about machine learning algorithms and their applications in healthcare data analysis.
- CO5:
- CO6: Gain knowledge of AI methods for medical image analysis and interpretation.
- CO7: Examine the role of natural language processing in clinical decision support and literature analysis.
- CO8: Understand the application of AI in genomics and personalized medicine.
- Develop critical thinking and problem-solving skills in applying AI techniques to healthcare and biomedical research problems.
- Enhance awareness of ethical considerations and challenges in AI applications in healthcare.

COURSE CONTENT

MODULE: I

Introduction to AI in Healthcare and Biomedical Research: Overview of artificial intelligence and its applications in healthcare and biomedical research, Ethical considerations in AI applications in healthcare, Interdisciplinary approaches in AI and biomedical research, Machine Learning Algorithms in Healthcare, Deep Learning in Medical Image Analysis, Natural Language Processing in Clinical Decision Support

MODULE II

AI Applications in Disease Diagnosis and Prognosis: AI methods for disease diagnosis and prognosis prediction, Clinical decision support systems for treatment planning, Predictive modeling and risk stratification in healthcare

MODULE III

AI Applications in Personalized Medicine: AI applications in genomics and genomic data analysis, Genetic variant interpretation and disease risk prediction, Precision medicine and treatment optimization

MODULE IV

Analysis of case studies demonstrating AI applications in healthcare and biomedical research, Identify the project, compose a proposal, and submit it for evaluation and further processing.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Written Examinations
2. Assignments
3. Seminars
4. Poster Presentations
5. Model preparations
6. Survey
7. Digital Portfolio development
8. Flip classroom assignment
9. Quiz Visual
10. Development of Visual Organiser
11. Specimens Collection

LEARNING RESOURCES

References

- "Artificial Intelligence in Medicine" by Lawrence Hunter and Prakash Nadkarni
- "Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again" by Eric Topol
- Journal Article: "Artificial Intelligence in Healthcare: Anticipating Challenges in Ethics, Accountability, and Bias" by Nundy and Montgomery
- Journal Article: "Deep Learning in Medical Imaging: Overview and Future Promise of an Exciting New Technique" by Greenspan, van Ginneken, and Summer
- Journal Article: "Applications of Artificial Intelligence in Cardiovascular Medicine" by Musunuru and Kullo
- Online Resource: National Institutes of Health (NIH) - Artificial Intelligence in Healthcare and Biomedical Research
- Online Resource: Association for the Advancement of Artificial Intelligence (AAAI) - Healthcare Track
- Online Resource: Stanford Center for Artificial Intelligence in Medicine and Imaging

Online sources

LMS Link: <http://lms.keralauniversity.ac.in/moodle/course/view.php?id=161>

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.

- Practical Laboratory Exercises: Hands-on performance of molecular biology techniques and data analysis.
- Laboratory Reports: Documentation of experimental procedures, data analysis, and interpretation.
- Quizzes and Examinations: Assessing understanding of theoretical concepts and principles.
- Data Analysis Assignments: Analyzing and interpreting experimental data sets.
- Presentation: Communication of experimental findings through oral presentations.

SEMESTER: II	COURSE CODE: ZOO-CC-521	Credits:3
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NAME OF THE COURSE: **CELL AND MOLECULAR BIOLOGY**

CO1: Acquire knowledge about Cell biology , Biological molecule structure and function.

CO2: Generate knowledge on Membrane structure and dynamics , Microfilaments, and Intermediate filaments.

CO3:

CO4: Students become aware of Mitochondria and ATP Formation, Signaling , Chemotaxis and Cell Adhesion.

CO5: Students will get a better understanding of basic elements of Cell cycle and Cell

CO6: Signaling

Learners become aware of basic knowledge about cell structure and cell organelles

Get a better understanding of Central Dogma of Molecular Biology

COURSE CONTENT

MODULE: I

An Introduction to Cell Biology: The Discovery of Cells, Basic Properties of Cells, Two Fundamentally different classes of Cells

MODULE II

Cellular Membranes: An overview of membrane functions, A Brief History of studies on plasma membrane structure, The Chemical composition of membranes, The structure and functions of membrane proteins, Membrane lipids, and membrane fluidity, The dynamic nature of the plasma membrane, The movement of substances across cell membranes. The Extracellular Matrix and Cell Interactions: The Extracellular Space, Interactions of Cells with Extracellular Materials, Interactions of cells with other cells, Tight junctions, Gap junctions, and Plasmodesmata, Cell Walls

MODULE III

Cellular Organelles and Membrane Trafficking: An Overview of the Endomembrane System, A few approaches to the study of Endomembranes, The endoplasmic Reticulum, The Golgi Complex, Types of vesicle transport and their functions, Lysosomes, The endocytic pathway, Peroxisomes, Mitochondria structure and function, Cytoskeleton-Types

MODULE IV

Cell Division: The cell cycle, Mitosis and Cytokinesis, Meiosis. Cell Signaling Pathways: The Basic Elements of Cell Signaling Systems, G Protein Coupled Receptors, and their second messengers, Protein Tyrosine phosphorylation as a mechanism for signal transduction, The role of calcium as an intracellular messenger, The role of NO as an intracellular messenger

MODULE V

Cell death and its Regulation: Apoptosis, Mitochondria and Cell Death, Apoptosome and Caspase activation. Cancer: Basic Properties of a cancer cell, The Causes of Cancer, New Strategies for combating cancer

MODULE VI

History and Central Dogma of Molecular Biology, Introduction to nucleic acids-chemistry and structure of DNA and RNA, DNA Replication, DNA damage and repair, The path to gene expression: The relationship between genes and proteins, An overview of transcription in both prokaryotic and eukaryotic cells, synthesis and processing of mRNA, rRNA, and tRNA, Small regulatory RNAs and RNA silencing pathways, The properties of genetic code, The structure of tRNAs, Translating genetic information. Genome organization: Exons, Introns, Repetitive DNA, Non-repetitive DNA, interrupted gene, nonsense sequences, Tandem gene cluster, satellite DNA.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Written Examinations
2. Seminars
3. Assignments
4. Poster Presentations
5. Model preparations
6. Survey
7. Souvenir preparation
8. Flip classroom assignment
9. Mentimeter quiz

LEARNING RESOURCES

References

Karp G, Cell Biology, Wiley 7th Edition 2013.

[Harvey Lodish](#), [Arnold Berk](#), [Chris A. Kaiser](#), [Monty Krieger](#), [Matthew P. Scott](#), [Anthony Bretscher](#), [Hidde Ploegh](#), [Paul Matsudaira](#), **Molecular Cell Biology**, W. H. Freeman; 6th edition, 2013

[Bruce Alberts](#), [Dennis Bray](#), [Karen Hopkin](#), [Alexander D Johnson](#), [Alexander Johnson](#), [Julian Lewis](#), [Martin Raff](#), [Keith Roberts](#), [Peter Walter](#), **Cell Biology**, Garland Science; 3 edition 2009

Karp G **Cell and Molecular Biology: Concepts and Experiments**, John Wiley & Sons; 5th Revised Edition 2007

[Geoffrey M. Cooper](#) and Robert E. Hausman, **The Cell: A Molecular Approach**, Sinauer Associates, Inc.; 6 edition, 2013

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.

SEMESTER: II	COURSE CODE ZOO– CC-522	Credits: 3
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NAME OF THE COURSE: **Developmental Biology**

Course Description:

The processes and mechanisms underlying the development of multicellular creatures are thoroughly explored in the Developmental Biology course. The students will study the cellular and molecular processes that control embryonic development, from fertilisation through organ formation. Cell differentiation, tissue patterning, morphogenesis, and the genetic control of development are some of the subjects that will be covered in the course. Students will study developmental biology's evolutionary components as well as its applications in sectors like regenerative medicine and evolutionary developmental biology (evo-devo).

COURSE OUTCOMES

- CO1: Learn the cornerstone principles and ideas of developmental biology
- CO2: Familiarise with and evaluate the various techniques and tools of Embryology
- CO3: Get knowledge on early embryological development and comparative analysis of early vertebrate development
- CO4: Examine the cellular and molecular processes that underlie normal embryonic growth.
- CO5: Examine the significance of signalling pathways in development and how they interact with genetic regulation
- CO6: Explore the evo-devo idea and the evolutionary facets of developmental biology.
- CO7: Investigate the ways in which developmental biology can be used in the fields of regenerative medicine and biotechnology.
- CO8: Explore the concepts and process in developmental biology
- CO9: Understand and appreciate the molecular mechanisms and the unfolding of the same during development
- CO10: Understand the mechanism of cellular differentiation and cellular interaction during the development
- CO11: Acquire knowledge regarding postembryonic development and ageing
- CO12: Explore the reason and mechanisms of tissue regeneration and degeneration and the importance of regenerative therapies in the degenerative diseases
- CO13: Understand the biology of stem cell, characteristics and molecular regulation stem cellsExplore the application of stemcells and characteristic features of cancer stem cells
- CO14: Learn to think critically and analyse effectively by dissecting and analysing research articles.

COURSE CONTENT

MODULE: I

Introduction to embryology, early embryonic development: Overview of Animal Development, Asexual and Sexual Reproduction, Types and factors responsible for cellular reproduction, Embryological concept of development, Structure of gametes, Fertilization, Embryo, General and unique features of cleavage, Blastula, Gastrula, Types of gastrula, Germ layer formation, Embryogenesis and Differentiation, Homeoboxes, Early vertebrate developments (Amphibians, Birds, Mammals).

MODULE II

Mechanism of Cellular Differentiation: Genomic equivalence and differential gene expression, Transcriptional Regulation of gene expression during development, Mechanism of differential gene transcription, Control of development by RNA Processing, Translational and posttranslational regulation of Developmental process, Gene Editing and Development

MODULE III

Cell Interaction in Development: Cell communications during development, Cell signaling and development, Inter molecular, Role of ECM in development, Axis formation, Secondary induction, Pattern formation, Patterns of growth and oncogenesis, Sex determination hormonal and environmental

MODULE IV

Post-embryonic development and Systems biology: Metamorphosis, Biology of ageing, Genetic Errors and Environmental Assaults on Development, biotic, abiotic and symbiotic regulation of development, Epigenetics and Development, Medical accepting of developmental therapies, developmental plasticity, Evolutionary Developmental Biology (Evo-Devo), Tissue Regeneration and Degeneration

MODULE V

Stem cell Biology and Characterizations: Types and sources of stem cell (embryonic, adult, haematopoietic, fetal, cord blood, placenta, bone marrow, primordial germ cells, cancer stem cells, induced pluripotent stem cells), stem cell niche, Stem Cell Isolation & characterizations, Importance of growth factors in stem cell culture, Feeder and feeder-free cultures

MODULE VI

Molecular Regulation and Applications of Stem cells: Molecular basis of stem cell renewal AND DIFFERENTIATION, Applications Stem Cells in neurodegenerative diseases, spinal cord injury, heart disease, diabetes, burns and skin ulcers, muscular dystrophy, orthopedic applications, stemcells and gene therapy, Cancer stem cells, and gene therapy, cancer stem cells, Regenerative biology and medicine, Mechanobiology and development, Development organoids and tissue engineering, Human on a chip.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT**Suggested activities**

1. Written Examinations
2. Assignments
3. Model preparations
4. Digital Portfolio development
5. classroom assignment
6. Poster
7. Development of Visual Organiser
8. Survey
9. Flip classroom assignments
10. Quiz Visual
11. Presentations
12. Seminars
- 13.

**LEARNING
RESOURCES****References**

- Gilbert, SF, Barresi, MJF., Developmental Biology, 2000, Sinauer Associates.
- Walbot, V., and Holder, N., Developmental Biology, 1987, Random House, New York.
- Browder, LW., Developmental Biology, 1984, Saunders College, Philadelphia.
- Shostak, S., Embryology-An Introduction to Developmental Biology, 1991, Harper Collins Publishers.
- Saunders, JW., Developmental Biology-Patterns, Problems and Principles, 1982, Collier Macmillan Publishers, London.
- Lanza, R., and Atala A., Essentials of Stem Cell Biology, 2013, Academic Press.
7. Tarik Regad,T., Sayers, TJ., and Rees,R., Principles of Stem cell Biology and Cancer: Future Applications and Therapeutics, 2015, Wiley Black-well.

Online sources

LMS Link: <http://lms.keralauniversity.ac.in/moodle/course/view.php?id=9>

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.
- Quizzes and Examinations: Assessing understanding of key concepts and theories.
- Assignments: Analyzing scientific articles, conducting research on specific developmental processes, and critical evaluation of experimental data.
- Laboratory Work: Hands-on experiments and observations related to developmental biology.
- Class Participation: Active engagement in discussions, group activities, and presentations.
- Final Project: A research paper or presentation on a specific topic in developmental biology.

SEMESTER II Course Code: ZOO–CC-523

Credits: 3

NAME OF THE COURSE: Environmental Pollution and Toxicology

CO1: Understands the impact of water pollutants, their effects and water treatment
 CO2: Identifies oil pollution, thermal pollution, radioactive pollution and their impact on ecosystem.
 CO3: Generate preliminary knowledge on toxicological procedures
 CO4: Gain knowledge on toxicological responses, accumulation and biotransformation reactions.
 CO5: Understands organ toxicity and different toxic effects.
 CO6: Generate awareness on the preliminaries of forensic science and protocols.

COURSE CONTENT

MODULE: I

Water Pollution: Types, sources and consequences of water pollution, Physico-chemical and Water quality Standards- Drinking, Irrigation, Stream, Minimal National Standards bacteriological sampling and analysis of water quality, turbidity, dissolved oxygen, pH, conductivity etc. The Water (Prevention and Control of Pollution) Act of India, Treatment, disposal and recycling of waste waters. Sources of marine pollution and control. Effects and measurements of organic pollution. Source and accumulation of Detergents, Phenols, Plastics, Dioxines and PAHs

MODULE II

Other types of Pollutions: Characteristics and composition of oil, sources of oil in environment, effects of oil on organism, control of oil pollution. Effects of thermal pollution, standards and control of thermal pollution, beneficial use of thermal polluted waters, Acid pollution- effects on aquatic fauna, effects of acid pollution, Isotopes and nature of radiations, sources of radio activity, mechanism and biological effects of radiation, control of radioactive pollution. Classification of air pollutants, source of emission, effects on plants, humans and other animals, prevention and control

MODULE III

Environmental toxicology

Toxicant Analysis: Analytical Methods and Quality Assurance Environmental Sample Collection Methods, Analytical Techniques, Quantification. Environmental Persistence, Sources of Toxicants to the Environment, Transport Processes, Equilibrium Partitioning, Transformation Processes, Environmental Fate Models. Environmental Risk Assessment, Formulating the Problem, Analyzing Exposure and Effects Information, Characterizing Risk, Managing Risk.

MODULE IV

Introduction and Definitions of Toxicology: Dose-response relationships and their importance, basic components of tests generating dose-response data, Frequency response and cumulative response. Factors influencing toxicity- Route of administration, host factors-species, strain, age and sex, Biological factors- Accumulation and storage of chemicals in the organism. Biotransformation reactions, Role and mechanisms of xenobiotic metabolizing enzymes.

MODULE V

Determination of Toxicity: Introduction, screening programmes design, Target organ Toxicity, Liver, Kidney, Nervous system, Immune system and other Organs. Toxicity testing methods-Acute and chronic toxicity tests, LD50, LC50 and ED50. Teratogenicity testing. Reproductive toxicology– Effect of xenobiotics on male and female reproductive organs/cells in mammals. Toxicity of metals (Lead, Mercury, Arsenic, Cadmium). Pesticide toxicity- Acute and Chronic effects of organophosphate, Toxicity of pyrethroids. Bio-magnification. Natural toxins- Import microbial, plant and animal toxins. Treatment of toxicity- Antidotal therapy.

MODULE VI

Foundations of Forensic Toxicology: classification of poisons, sign and symptoms of common poisons, antidotes, collection of samples. Drugs: Drugs of abuse, classification and identification. Narco analysis and brain mapping. Explosives: Classification, composition and characteristics of explosives, pyrotechniques, IEDs, explosion process and affects, types of hazards, effect of blast waves on structure. Investigation of Toxicity-Related Death/Injury, Documentation Practices, Considerations for Forensic Toxicological Analysis, Drug Concentrations and Distribution.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Assignment
2. Seminar
3. Test papers
4. Group discussions
5. Visiting Forensic labs
6. Preparation of reports

LEARNING RESOURCES

References

- Clark R.B. Marine Pollution. II Edition, Oxford Science Publication, 1989.
[Alloway](#) B.J., [D.C. Ayres](#) (Editor) Chemical Principles of Environmental Pollution, Blakie Academic and Professional Publication, Glasgow. 1993
 Prichard S. Z, Oil Pollution Control, Croom Helm Publishers, London, 1987.
 Kovacs M, Pollution Control and Conservation, Ellis Horwood Ltd. Publishers, 1985.
 Goel, P. K, Water Pollution- Causes, effects and Control, New Age International Publishers, New Delhi, 2001.

Ajay Kumar Band Chatwal G. R., Environmental Chemistry, Himalaya Publishing House, 2003.

Botan Luis M (Editor) , Environmental Toxicology . 2018

Sigmund F Zakrzewski, Principles of environmental toxicology, Oxford University Press UK 1991

HumioTsunoda and Ming-Ho Yu (Editors), Environmental Toxicology: Biological and Health Effects of Pollutants, Second Edition, CRC Press2004

David A. Wright Environmental toxicology , Cambridge University Press 2002

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.

SEMESTER II	Course Code: ZOO–CC-524	Credits: 4
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NAME OF THE COURSE: **Animal Systematics and Taxonomy**

COURSE OUTCOME

CO1: To introduce the nature and scope of various aspects of Systematics, Animal Taxonomy, and Classification practiced in biological science with special reference to Animal Science.

CO2 :To help understand the different classification methods.

CO3 :To impart an awareness on the process of taxonomic field work.

CO4 :Develop a comprehensive knowledge on taxonomic identification of specimens.

CO5 :Demonstrate an understanding on preservation techniques of specimens.

CO6 :Create a thorough knowledge on the specimen collection techniques for different organisms.

COURSE CONTENT

MODULE: I

Introduction to taxonomy: History of taxonomy- Aristotle's Contribution, The Pre Linnaean period, Linnaeus contribution. The post Linnaean period, Darwin's contribution.. Basic Concepts of Animal Taxonomy, Systematics, Hierarchical classification, categories, taxa, Rank, species, Genus, family, Order, class, Phylum and Kingdom. Synonymy, Nomina dubia, Nomen nudum, Taxonomic characters and importance of Taxonomy.

MODULE II

Types of Classification: Principles of Zoological classification, Features of classification, Types of classification, Ecological classification, Natural Classification. Morphology, Homology, Population, Cladistics, Phenetics, Phyletics, Merits of natural classification, Biological classification, Evolutionary classification and Phylogentic classification.

MODULE III

Modern trends in taxonomy: Chemotaxonomy, numerical taxonomy, serotaxonomy, cytotaxonomy, molecular taxonomy- DNA Markers, RFLP, RAPD, AFLP, mt DNA, and DNA bar coding. Zoological Nomenclature: Binomial nomenclature, Linnaean Hierarchy, Trinomial nomenclature. General Principles of nomenclature, Availability and validity of names, Publication of names. Kinds of types of specimens: Primary type, Holotype, Syntype, Lectotype, Neo type and Paratype.

MODULE IV

Species Concepts: Species Category, Different types of species concepts, biological species. Cladogenesis, Role of reproductive isolation in speciation, Pattern of speciation, Allopatric speciation, Parapatric speciation, and Sympatric speciation. Polytypic species, race, variety, cline, subspecies, semi species, super species. Typological species concept, Nominalistic species concept, biological species concept, evolutionary species concept.

MODULE V

Taxonomic Keys and Publications: Features of Taxonomic keys, Types of taxonomic keys, Dichotomous keys, Diagnostic keys, Nested keys, Linked Keys, Bracket keys etc. Taxonomic Publications: Taxonomic Literature, catalogue, checklist, Field guide, field Book, handbook, Manual, Monographs, Synopsis and Revision. Features of Taxonomic publications and ICZN.

MODULE VI

Collection and Preservation of Natural History Specimens: Collection Procedure, Time of collection, Place of Collection, Terrestrial Collection, Aquatic Collection, Collecting Equipments, Dip Net, Seine, Dredge net, aerial Net, Sweep Net, beat Sheet, Aspirator, Recording of Data, Traps, Pitfall traps, Light traps, Bait traps, Berlese funnel, Paper bags, Killing bottle etc. Preservation of collected specimens, Preservation in liquid, Preservation of insects, relaxing the collected specimens, Mounting of Insects, Pinning of Insects and labelling of specimens.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT***Suggested activities***

1. Assignment
2. Seminar
3. Test papers
4. Group discussions
5. Visiting Museums
6. Quiz

**LEARNING
RESOURCES*****References***

1. Dellala and Sharma ,Animal Taxonomy and Museology, Jai PrakashNath Co, Meerud, 1975
2. Ernst Mayr and Peter D Ash Lock, Principles of Systematic Zoology. Mcgraw Hill, Singapore, 1991
3. Gerge Gaylord Simpson , Principles of Animal Taxonomy, Oxford &IBH, India, 1969
4. Kapoor V. C., Theory and Practice of Animal Taxonomy, Oxford &IBH, India, 1998
5. Narendran T. C. An Introduction to Taxonomy. Zoological Survey of India, 2006
6. Verma A, Principles of Animal Taxonomy, 2015, Alpha Science International Ltd 2015

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.

SEMESTER: II	COURSE CODE: ZOO–CC-525	Credits:2
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NAME OF THE COURSE: **Cytology Molecular Biology, Developmental Biology, Pollution, Toxicology and Systematics – PRACTICAL**

- CO1: Estimates LC50 and LD50 for different compounds for fish.
- CO2: Develop expertise in the handling of analytical equipments.
- CO3: Develop skill and experience in microbiology lab protocols.
- CO4: Become expert in embryological preparations.
- CO5: Become expert in zebra fish breeding technology
- CO6: Develop expertise in the identification of larval stages.

COURSE CONTENT

Pollution and Toxicology

1. Determination of LC50/LD50 of selected toxicant (bioassay method)
2. Effect of toxicant on Glycogen, Glucose and Amino acids in fish
3. Estimation of SGOT and SGPT as a marker enzyme for hepatotoxicity or Renal toxicity
Micronuclei test
4. Effect of toxicant on sperm morphology
5. Estimation of H₂S.

Cytology

1. Fixation of tissue with Bouin's fixative and stain using haematoxylin – eosin stain for histochemical studies

Developmental Biology

1. Sea urchin fertilization and development - demonstration
2. Zebrafish fertilization and Development- Demonstration (Gametogenesis, Fertilisation and Different stages in development)
3. Embryoteratogenesis studies using Zebra fish Embryo
4. Identification of different stages of chick embryos (24 hours, 48 hours and 72 hours). Collection, Identification and Preparation of slides of different stages of development of chick embryo.
5. Study of developmental stages in amphibian/ mammals with the help of permanent slides
6. Identification of different larval stages in Arthropod/ Echinoderms
7. Estimation of SDH activity in the chick embryo
8. Estimation of LDH activity in the chick embryo

Taxonomy

1. Collection, Identification and submission of :
 - a) Any six species of invertebrates
 - b) Any six species of fishes.

LEARNING RESOURCES***References***

Forensic Medicine & Toxicology Practical Manual, Bakkannavar, Shankar M., Elsevier
 Modern Medical Toxicology 2013, V.V. Pillay.
 Manual of Practical Physiology, A.K. Jain.
 Practical Manual of Hematology 2011, by Girish Kamat.
 Dacie and Lewis Practical Haematology 12th Edition 2017, Barbara Jane Bain

Online sources

https://global.oup.com/uk/orc/biosciences/biomed/fbs/01series/videos_techniques/haematology/

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.

SEMESTER: II COURSE CODE:ZOO–DE-521 Credits: 2

NAME OF THE COURSE: Mini Project/Internship/On the Job Training

Mini project is the submission of the project research plan including all the research components of the project work planning to do during the course. This will be evaluated by the Department Council. Internship and on the Job training may be done for a period of one month during the vacation period of the first year attached to a reputed research institution or a firm.

SEMESTER: II**COURSE CODE ZOO – DE-522****Credits: 2**

NAME OF THE COURSE:

**CELL CULTURE TECHNIQUES
COURSE OUTCOMES**

- CO1: Understand the basics of tissue culture.
- CO2: Students will be able to do tissue culture for their experimental purposes.
- CO3: Achieve the skills for setting up a tissue culture lab for their research.
- CO4: Understand the cell culture application for research purposes.
- CO5: Students will gain knowledge and experience with cell culture instruments like CO₂ incubators, Type 2 Biosafety cabinets, etc.
- CO6: Students will get an overall idea of the types of cells and their culturing protocols.

COURSE CONTENT**MODULE: I**

Introduction to Cell Culture: Historical Background, Advantages of Tissue Culture, Limitations of Tissue Culture, Types of Tissue Culture, Biology of Cultured Cells

MODULE II

Cell Culture Lab Design and Equipment: Requirements, Design and layout, Major and Minor Equipment's essential for Tissue Culture, Safety considerations, Aseptic techniques, Eradication of infections, Media and Supplements.

MODULE III

Animal Cell cultures: Primary cell cultures, Cell lines, Subcultures, Cell quantification, Cryopreservation, Authentication of Cell lines, Cell Sorting, Cell line Characterization, Cell Differentiation.

MODULE IV

Cell Culture Applications: Three-Dimensional Culture, Principles and Applications of Flow Cytometry, MTT assay, Angiogenic Assay, Wound Healing Assay, Sphenoid Invasion Assay, Matrigel Invasion assay, Centrifugation, Ultracentrifugation Methods & Applications.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT**Suggested activities**

1. Written Examinations
2. Assignments
3. Seminars
4. Poster Presentations
5. Model preparations
6. Survey
7. Digital Portfolio development
8. Flip classroom assignment
9. Quiz Visual
10. Development of Visual Organiser
11. Specimens Collection

**LEARNING
RESOURCES**

References

- Bisen, Prakash S., Laboratory protocols in applied life sciences, CRC Press.2014
- Veerakumari L, Bioinstrumentation, MJP Publishers, Chennai, 2006
- R. Ian Freshney, Seventh Edition, Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 2017

Online sources

LMS Link: <http://lms.keralauniversity.ac.in/moodle/course/view.php?id=161>

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.
- Practical Laboratory Exercises: Hands-on performance of molecular biology techniques and data analysis.
- Laboratory Reports: Documentation of experimental procedures, data analysis, and interpretation.
- Quizzes and Examinations: Assessing understanding of theoretical concepts and principles.
- Data Analysis Assignments: Analyzing and interpreting experimental data sets.
- Presentation: Communication of experimental findings through oral presentations.

SEMESTER: II COURSE CODE:ZOO-DE-523 Credits: 2

NAME OF THE COURSE: Nature Camp/Field study

Requirement of this course is participation in a Nature camp organized by the Kerala Forest and Wild life Department/any reputed NGOs with attendance/participation. Certified report may be submitted with attendance certificate and photographs.

SEMESTER: III	COURSE CODE: ZOO-CC-531	Credits: 4
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NAME OF THE COURSE: **Animal Physiology**

Course Outcomes

- CO1: Acquire fundamental knowledge and in basic principles in physiology
 CO2: Students will get knowledge regarding their body and physiological systems and urge them
 CO3: to take precautionary measures to safeguard their health
 CO4: Students become aware of the structure and function of each system in the human body
 CO5:
 CO6: Students will get a better understanding of body orientation and organisation
 Learners become aware of the protective and strengthening system of the body
 CO7: pathophysiological conditions affecting these systems.
 CO8: Apply ethical principles and commit to professional ethics and responsibilities in delivering his duties in research and teaching
 CO9: Attained knowledge of body coordination system, cardiovascular system, respiration and excretion and understood the mechanism of transport of the different body fluids
 CO10 : Students will get better knowledge in the area of environmental and stress physiology and mechanisms used to adapt the body to cope up with environmental changes
 Students can understand the physiology at cellular and system levels

COURSE CONTENT

MODULE: I

Orientation, Organization of the Body: Body organization, Planes of reference, Body regions and body cavities, Chemical Composition of the body, Classification of tissues.

MODULE II

Physiology of Integument, Skeletal and Muscular System: Integument as an Organ, Layers of Integument, Physiology of Integument, Epidermal Derivatives (Hair, Nails, Glands), Disorders of Integumentary system, Organization of Skeletal System, Functions of Skeletal System, Physiology of Bone tissue, Negative feedback control of calcium and phosphate, Axial Skeleton, Organization of Muscular System, Ultrastructure of muscle fibre, the molecular mechanism of muscle contraction, muscle metabolism, Role of actin and myosin in eukaryotic cells, Neuronal Control of skeletal Muscle, Vertebrate smooth and cardiac muscle and their metabolism.

MODULE III

Physiology of Neuron and Integration: Classification of Neurons, Genesis of membrane potential and action potential, Sodium-potassium pump, Neurotransmitters of the central nervous system, Synaptic integration, Peripheral Nervous system. Characteristic and categories of Sensory receptors, Somatic sensory systems, olfactory system, Equilibrium, photoreception, mechanoreceptor, echolocation, Chromatophores and bioluminescence.

MODULE IV

Physiology of Cardiovascular System: Anatomy of heart, myogenic heart, specialized tissue, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation, Cardiac output and the factors that affect cardiac output, microcirculation, blood pressure,

the chemistry of blood components and their functional significance and molecular regulation, Respiratory Pigments, Lymphatic system, the Defense mechanism

MODULE V

Physiology of Respiratory and Excretory system: Functions and divisions, Concept of respiration, mechanism of breathing; biochemistry of respiratory exchange; Transport of respiratory gases; Regulatory mechanisms (humoral and neural) of respiration, Water and salts in the cell environment, the resistance of cells to changes in pH, Oxygen availability and temperature, Transport of Oxygen, Cellular response to acidosis and ketosis, hypercapnia, Respiratory control of acid-base balance, Gas transport. Comparative physiology of excretion, Concept of excretion and nitrogenous wastes; functional anatomy of the renal unit; biophysical and chemical mechanisms of ultrafiltration, reabsorption and secretion, transport mechanisms, urine formation and regulatory control of sugar, urea, Na⁺, K⁺, and H⁺ Role of kidneys in the regulation of acid-base balance and osmoregulation.

MODULE VI

Environmental Physiology and Stress Physiology: Physiological homeostasis, Environmental and Biological factors: (Temperature, pH and hypoxia on physiological processes), Adaptive Physiology: Homeothermy and Poikilothermy, Salinity adaptation, Biochemical basis of physiological adaptation, Osmoregulation in freshwater and estuarine and marine and terrestrial animals, sodium pump. Environmental effects on ion regulation, Bioenergetics and energy partitioning, Environmental perturbations of growth and reproduction, Environmental influence on growth and metabolism, hormonal and biochemical aspects, Concept of stress, stressors, integrated stress response, eustress, distress, stress adaptation and tolerance, mechanism of stress tolerance, stress acclimation, stress proteins, endocrinology of stress, endocrine stress axis, Hormonal regulation of stress adaptation.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Written Examinations
2. Seminars
3. Assignments
4. Poster Presentations
5. Model preparations
6. Survey
7. Digital Portfolio development
8. Flip classroom assignment
9. Quiz Visual
10. Development of Visual Organiser

LEARNING RESOURCES

References

Edward and Hassal Biochemistry and Physiology of Cells, McGraw Hill, London, 1980
 A.G. Giese, Cell Physiology, W.B. Saunders & Co. New York
 Hoar W S General and Comparative Physiology, Printice Hall, New York, 1983
 Guyton A C. Text Book of Medical Physiology, W.B. Sanders & Co. 1996
 Eckart. Animal Physiology, David Randall, Warren Burggren and Kathleen French
 Freeman, W. H. & Company, 2001
 Rankin J. C. and Jensen F.B. Fish Ecophysiology, Chapman and Hall, London, 1993.
 David. H. Evans, The Physiology of Fishes, CRC Press, London, 1993
 Animal Physiology, Richard W. Hill, Gordon A. Wyse, Margaret Anderson Hill, Wyse,
 Anderson Sinauer, Associates, Sunderland, 2004
 Sherwood, Human Physiology: From cells to systems, 5 Ed, Thomson, Australia, 2004

Online sources

LMS link: <http://lms.keralauniversity.ac.in/moodle/course/view.php?id=10>
<https://www.studyblue.com/notes/b/animal-physiology-second-edition/2856/0>
http://wps.aw.com/bc_moyes_animalphys
http://www.jblearning.com/samples/0763740411/Ch%202_Seaward_Managing%20Stress_5e.pdf

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.

SEMESTER: III	COURSE CODE: ZOO-CC-532	Credits:3
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NAME OF THE COURSE: **BIOCHEMISTRY AND SYNTHETIC BIOLOGY**

CO1: To introduce the classification of biomolecules.
 CO2: Introduces the concept of Bioenergetics.
 CO3: Understands the important metabolic pathways.
 CO4: Impart awareness on the kinetics, mechanism and action of various enzymes.
 CO5: Generate awareness on the biochemical parameters.
 CO6: Introduces synthetic biology and its applications.

COURSE CONTENT

MODULE: I

Introduction to Biomolecules: Carbohydrate-Classification, structure, general properties and functions of polysaccharides and complex carbohydrates; amino sugars, proteoglycans and glycoproteins.

Lipids-Classification, structure, properties and functions of fatty acids, essential fatty acids, fats, phospholipids, sphingolipids, cerebrocides, steroids, bile acids, prostaglandins, lipoamino acids, lipoproteins, proteolipids, phosphatidopeptides, lipopolysaccharides.

Proteins-Peptide synthesis: chemical and Merrifield synthesis. Primary (peptide conformation, N- and C- terminal, peptide cleavage), Secondary (α -helix, sheet, random coil, Ramachandran plot), Tertiary and Quaternary structures of proteins.

Enzymes-Historical perspective, general characteristics, nomenclature, IUB enzyme classification, measurement and expression of enzyme activity, enzyme assay. Definitions of IU, Katal, enzyme turnover and specific activity.

Nucleic acids-Nucleic acids as genetic information carriers, experimental evidence e.g., genetic transformation, Hershey-Chase experiments, action spectrum, etc. Structure and function of nucleotides. Primary, secondary and tertiary structure of nucleic acids, DNA forms and conformations, Denaturation of DNA, Protein Folding.

MODULE II

Concepts of Bioenergetics: Introduction and Concept of free energy, standard free energy, Relationship between equilibrium constant and standard free energy change, biological oxidation-reduction reactions, redox potentials, relation between standard reduction potentials & free energy change, High energy phosphate compounds, phosphate group transfer, free energy of hydrolysis of ATP and sugar phosphate, Energy charge, Role and mechanism of action of NAD⁺ /NADP⁺, FAD, lipoic acid, thiamine pyrophosphate, tetrahydrofolate, biotin, pyridoxal phosphate, B12 coenzymes and metal ions with specific examples.

MODULE III

Metabolism: Glycolysis, citric acid cycle, pentose phosphate pathway and its regulation, Gluconeogenesis, glycogenesis and glycogenolysis, glyoxylate and Gamma aminobutyrate shunt pathways, Cori cycle, Metabolism of disaccharides, Energetics of metabolic cycle, Introduction to amino acid metabolism-Transamination, decarboxylation, oxidative and non-oxidative deamination of amino acids, Urea cycle and its regulation. Introduction to Lipid Metabolism– Introduction, hydrolysis of tri-acylglycerols, α -, β -, ω - oxidation of fatty acids, degradation of complex lipids. Fatty acid biosynthesis, Acetyl CoA carboxylase, fatty acid synthase, ACP structure and function, Lipid biosynthesis, biosynthetic pathway for tri-acylglycerols, phosphoglycerides, sphingomyelin and prostaglandins. Metabolism of cholesterol and its regulation. Energetics of fatty acid cycle. Introduction to Nucleotides- Biosynthesis and degradation of purine and pyrimidine, Role of ribonucleotide reductase, Biosynthesis of deoxyribonucleotides and polynucleotides.

MODULE IV

Kinetics, Mechanism and Action of Enzyme: Kinetics of enzyme action: Concept of ES complex, active site, specificity, Kinetics of zero and first order reactions, Reversible and irreversible inhibition. Competitive, noncompetitive, uncompetitive, linear-mixed type inhibitions and their kinetics, Suicide inhibitor. Mechanism and Regulation of Enzyme Action: Acid-base catalysis, covalent catalysis, proximity, orientation effect, Chemical modification of active site groups. Site directed mutagenesis of enzymes, General mechanisms of enzyme regulation, product inhibition. Reversible (glutamine synthase and phosphorylase) and irreversible (proteases) covalent modifications of enzymes, Allosteric enzymes, Protein-ligand binding measurement.

MODULE V

Medical Biochemistry: Diabetes mellitus, glucose and galactose tolerance tests, factors influencing blood glucose level, glycogen storage diseases, Plasma lipoproteins, cholesterol, triglycerides & phospholipids in health and disease, hyperlipidemia, hyperlipoproteinemia, Gaucher's disease, Tay-Sach's disease, Enzymes in health, diseases and diagnosis assays (SGOT, SGPT, CPK, cholinesterase, LDH), Phenylketonuria, alkaptonuria, albinism, tyrosinosis, maple syrup urine disease, Lesch-Nyhan syndrome, sickle cell anemia, Histidinemia.

MODULE VI

Synthetic Biology, Microarrays, Proteomics and the Proteome: Gradual maturation of Genomics and Proteomics into Biology, Convergence of Genomics, Proteomics,

Transcriptomics and Metabolomics into Phenomics. Concept of gene expression, Comparative Genomics; Making, Microarrays-Spotted Microarrays, *In situ* synthesized oligonucleotide arrays, RNA synthesis and splicing, Protein synthesis, Protein Engineering, Protein traffic in cells, Protein sorting and signal sequences. Genetic mapping, Detection of mutation in human genes and pro-drug activation therapy.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Written Examinations
2. Seminars
3. Assignments
4. Poster Presentations
5. Model preparations
6. Souvenir preparation

LEARNING RESOURCES

References

- Berg, Jeremy M, et al., Biochemistry 5thed, W. H. Freeman and Company, New York, 2002.
- David W. Martin, Jr., Peter A. Mayes, Victor W. Rodwell, Harper's review of biochemistry, Lange Medical Publications, 1983.
- Eric E Conn; Paul K Stumpf; George Bruening, Outlines of Biochemistry, John Wiley & Sons, 1987.
- Hames, B .D.; Higgins, Instant notes Biochemistry, N .M., Viva Books Pvt. Ltd., New Delhi, 2001.
- Lehninger, Albert L, et al., Principles of biochemistry, W H Freeman & Co., New York. 2000.
- Ochs, Raymond S., Biochemistry, Jones & Bartlett Publishers, London, 2013.
- Rafelson, Max E, et al., Basic biochemistry, Macmillan College publishing Co., New York, 1980.
- Singh, S P, Practical manual of biochemistry/ 5th ed., CBS Publishers & Distributors, New Delhi. 2014.
- Stryer, Lubert, Biochemistry, W H Freeman & Co., New York, 1995.
- Textbook of biochemistry, Harrow, Benjamin & Mazur, Abraham, W B Saunders Co., Philadelphia, 1962.
- Van Holde, Kensal E, et al., Principles of biochemistry, Pearson Education, New Jersey, 2006.
- Voet, Donald, et al., Fundamentals of biochemistry, John Wiley & Sons Inc., New York, 2002.
- Wilson, Keith and Walker, John, 5th ed., Practical biochemistry: Principles and techniques, Cambridge University Press, 2005.
14. Zubay, Geoffrey L, et al., Principles of biochemistry, Wm C Brown Publishers, 1995

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.

SEMESTER: III	COURSE CODE: ZOO-CC-533	Credits:4
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NAME OF THE COURSE:	ENDOCRINOLOGY AND REPRODUCTIVE BIOLOGY
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COURSE OUTCOME

- CO1: Understands different endocrine glands and their functions
- CO2: Articulate different deficiency symptoms with hormone
- CO3: Identifies the hormones responsible for reproduction
- CO4: Analyze the hormonal imbalances and symptoms.
- CO5: Understands the molecular mechanism of hormone action.
- CO6: Understands the hormonal influence on development of cancer
- CO7: Help in advancing knowledge on endocrine pathology employing molecular tools and techniques.
- CO8: Comparative Endocrine Physiology will equip the students to know how residue of pharmaceuticals, estrogenic compounds from indiscriminate use of plastics severely affecting the hormone secretion and thereby, terrestrial and aquatic biomes.

COURSE CONTENT

MODULE: I

Introduction to Endocrinology and Vertebrate Endocrine systems: Concept of Endocrinology, Historical perspective, classes of chemical messengers, peptide hormones, steroid hormones, bioamines, eicosanoids, chaperones, neurotransmitters, neuropeptides, neurosteroids, neurohormones, phytohormones, synthetic hormones, prohormones, paracrine, merocrine, cytogenic secretion. Vertebrate endocrine glands, Morphology and anatomy of endocrine glands, evolution of endocrine glands, Biosynthesis of hormones, hypothalamus and hypophyseal, secretion, hypothalamo-hypophyseal interaction, endocrine axes, function, of hormones, disorders of hormonal imbalance, Regulation of hormone secretion, synthesis and metabolism of hormones, half-life of hormones, metabolic clearance rate, miscellaneous hormones, eicosanoids, prostaglandins, prostacyclins, thromboxanes, leukotrienes.

MODULE II

Mechanism of Hormone action: General and molecular mechanism of action of amines, polypeptide and steroid hormones, Mechanism of signal transduction in vertebrates, hormone receptors-as mediation of endocrine signals, classes of endocrine receptors, receptor-ligand interaction, cell surface receptors-structure and regulation of receptor units. Second messengers of hormonal action, cyclic nucleotides, inositol triphosphate, cAMP as second messengers, genomic action of cAMP, G protein and its dual control on adenylate cyclase, receptor crosstalk, ligand-gated ion channels, non-genomic actions of steroid hormones.

MODULE III

Physiology of Neuron and Integration: Classification of Neurons, Genesis of membrane potential and action potential, Sodium-potassium pump, Neurotransmitters of central nervous system, Synaptic integration, Peripheral Nervous system. Characteristic and categories of Sensory receptors, Somatic sensory systems, olfactory system. Equilibrium, photoreception, mechanoreceptor, echolocation, Chromatophores and bioluminescence.

MODULE IV

Insect and Crustacean Endocrine organs: Endocrine organs- Structure, Chemistry, Mechanisms of actions in Insects, Growth, Moulting, Differentiation, Juvenile Hormone, Ecdysone, Neuro hormones, Neuro peptides. Endocrine control of vitellogenesis, Spermatogenesis, Diapause-Ecdlosion, Cuticular tanning, Excretion. Sinus gland, X-organ, Androgenic glands-Maxillary glands-Mandibular glands-Hormonal principles-Chemistry-Action Hormonal control of sex Differentiation, Gonadal activity, Colour change, Retinal pigment Movement control, Heartbeat.

MODULE V

Reproductive Physiology, Male and Female Reproduction: Development of Gonads, Differentiation of testes, and ovary, morphological, biochemical and hormonal aspects, Development and morphogenesis of male and female sex organs. Male reproductive tract, testes, structure, spermatogenesis. Accessory sex organs, prostate, seminal vesicles, bulbourethral gland, structure function and regulation. Female reproductive tract, ovary structure, folliculogenesis. Ovulation, Steroidogenesis endocrine, Paracrine, Autocrineregulations. Fallopian tube structure, Function, hormonal regulation, Sex cycles. Hypothalamo-Hypophysial regulation of reproductive function, Neuroendocrine perspectives of mammalian reproduction, Reproductive pheromones.

MODULE VI

Pregnancy, Foetal Development and Sexual Physiology: Process of Fertilization, Mechanism of fertilization, Cell division and Implantation of blastocyst, Placenta-its role, Hormonal and physical changes during pregnancy, Developmental stages of foetus, Parturition, Lactation-its hormonal control. Sex determination and differentiation, Abnormalities of sexual Differentiation, Human sexual response, Sexual dysfunction– Infertility, Anatomical, Hormonal, chromosomal, immunological and Physiological factors. Contraceptive methods and ART.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT**Suggested activities**

1. Preparation of multimedia presentations
2. Seminars
3. Quiz
4. Discussions
5. Lab and hospital visits
6. Assignments

**LEARNING
RESOURCES****References**

Chandra S. Neji, Introduction to Endocrinology, PHI learning Pvt Ltd, New Delhi, 2009.

James Squires E, Applied Animal Endocrinology 2nd Ed., CAB International, 2010.

[Shlomo Melmed MBChB MACP](#) , [Kenneth S. Polonsky MD](#) , [P. Reed Larsen MD FRCP](#) , [Henry](#)

[M. Kronenberg MD](#) , Williams Text Book of Endocrinology, 11th Edn ,Elsevier , 2015

David Norris, Vertebrate Endocrinology, 4th edn , Elsevier Academic Press, 2007.

Benty, P J, Comparative Vertebrate Endocrinology, 3rd edn, Cambridge University Press 1998.

Barrington E.J.W, An introduction to General and Comparative Endocrinology, (2nd edn) Oxford University Press, London ,1975.

Tombes. A. S., An Introduction to Invertebrate Endocrinology, Academic Press. 1970

Highnam K.C & L. Hill L, The Comparative Endocrinology of the Invertebrates by Edward Arnold Publishers, 1977

Novak VJA, Insect Hormones, Chapman and Hall 1975

Nayar .K. K , Insect Endocrinology , Prentice Hall India 1974

Gupta a P, (Editor) Morphogenetic Hormones of Arthropods Vol 2&3. Rutgers University Press 1993

Gilbert L I and Frieden E .Metamorphosis, Plenum Press, 1997

Molecular Biology of Steroid and Nuclear Hormone receptors, ed. Freedman L. P., (1998), Birkhauser, Boston, USA

Biochemical actions of hormones, ed. Litwack, G. (1985), Academic press, New York, USA

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.

SEMESTER: III COURSE CODE: ZOO–CC-534 Credits:4
NAME OF THE COURSE: GENETICS AND BIOTECHNOLOGY
Course Outcomes

- CO1: Acquire knowledge about Genetics and Gene Regulation. Students will get knowledge about Human Genetics and Genetic Abnormalities
- CO2: Aware of Biotechnology, various vectors in biotechnology and rDNA technology.
- CO3: Get a better understanding of Cancer Genetics.
- CO4: Aware of basic knowledge about cell DNA fingerprinting and its applications
- CO5: Understanding of genetic disorders
- CO6: Acquire knowledge of Patenting, gene editing etc
- CO7: Understanding of genetic disorders, gene therapy gene libraries etc.
- CO8: Students will get better knowledge about Human genome project understand Pedigree and Karyotype analysis, rDNA technology etc.

COURSE CONTENT
MODULE: I

Introduction to the Genetics and Gene Regulation: Mendelism, Modern Mendelism, Non-Mendelian pattern of inheritance, Gene mapping, Chromosome mapping, Genetic variation, Polymorphism, polyploidy, gene pool, Gene distribution, pattern and frequency, Hardy –Weinberg equilibrium, disequilibrium, patterns disrupting gene equilibrium. Induction and repression, Sigma factor, TATA Box, CAAT Box, enhancers.

MODULE II

Human Genetics and Genetic Abnormalities: Pedigree analysis, Karyotype analysis, Lyon Hypothesis, Genetics of ABO system, Rh disease and inheritance, Sickle haemoglobin and inheritance, Thalassemias, Human Genome Project, Gene therapy, DNA fingerprinting, Genetic disorders- Patan, Edward's, Chriduchat syndrome, Philadelphia Chromosome.

MODULE III

Tools and Techniques in Genetic Engineering: History and concept of biotechnology, Vectors, Plasmids, Bacteriophage, Cosmids, Shuttle vectors, Yeast vectors, Minichromosomes, Artificial chromosomes, Probes and molecular markers, Properties and type of Isozymes, RFLP, RAPD, AFLP, VNTR, Minisatellites, Microsatellites. Selection and isolation of desired genes, Gene splicing, Introduction of rDNA into the host, Selection of clone containing DNA insert, PCR, DNA, DNA sequencing, Chromosome jumping, Genomic library, cDNA library.

MODULE IV

Gene cloning: Cloning techniques in animals, gene cloning, cloning bacteria and eukaryotes, Amplification of DNA by PCR, gene transfer technology, Genome editing and CRISPR-CAS9 system

MODULE V

Applications Biotechnology: Medicine, Diagnosis of diseases, Detection of genetic disorders, and Production of transgenic animals. Social, cultural, economic and legal problems, safety in biotechnology, Intellectual Property Rights, and Patenting.

MODULE VI

Cancer Genetics: Introduction to cancer, Characteristics of cancer cells, Chromosomes in neoplasias, Cancer as a genetic disorder, Loss of cell cycle control; Inherited versus sporadic cancers, Molecular changes in proto-oncogenes, tumour suppressor genes-Knudson's Hypothesis, breast, ovarian and prostate cancer, epigenetic mechanisms for cancer, genomic instability,, Cancer and environment: physical, chemical and biological carcinogens, Role of genetic biomarkers in diagnosis and prevention of Cancer, Importance of Omics in Cancer.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Written Examinations
2. Seminars
3. Assignments
4. Poster Presentations
5. Model preparations
6. Survey
7. Souvenir preparation
8. Flip classroom assignment

LEARNING RESOURCES

References

Molecular Genetics Part I and II – H. Herbert Taylor
 Eldon John Gardner, Michael J. Simmons, D. Peter Snustad, Principles of Genetics- 3rd Edition, Wiley, 2005 E.J. Gardner
 Hawkin J. D ,Gene Structure and Expression-, Cambridge University Press 1991
 Shull, A.F.4thEdition,Heredit- McGraw Hill Book Company, London 1938
 Strick Berger Genetics, Printice Hall International, 1995
 Benjamin Lewin, Genes V , Oxford University Press, New York.1994
 Dubaey, R. C. A ,Text book of Biotechnology, S. Chand & Co. New Delhi1993
 von [Sandy B. Primrose](#), [Richard M. Twyman](#), [R. W. Old](#) Principles of Gene Manipulations: An Introduction to Genetic Engineering, Blackwell Sci. Publ.2001
 Sing B.D and Singh R.P ,Biotechnology, Kalyani Publishers, New Delhi, 2010
 Ranga M M Animal Biotechnology, Agrobios Publishers, India, 2003

Online sources

<http://lms.keralauniversity.ac.in/moodle/course/view.php?id=10>

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.

SEMESTER: III	COURSE CODE: ZOO–CC-535	Credits:2
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NAME OF THE COURSE: Animal Physiology, Biochemistry,
Endocrinology, Genetics and Biotechnology
- Practical

AIM: To introduce the various aspects of Physiology, Ecology and Animal Taxonomy

COURSE OBJECTIVES: The students will be introduced to hands on training of various aspects of Physiology, Ecology and taxonomy practicals.

COURSE CONTENT

Genetics

1. Study of Polytene chromosomes from Chironomous larva/Drosophila
2. Determination of barr body from buccal smears.
3. Culture media preparation and Drosophila culture
4. Preparation of Dendogram of Human Evolution.
5. Karyotyping of Human Chromosomes from microphotograph

Endocrinology

1. Dissection of mouse/ rat for identification and demonstration of different endocrine glands.
2. Histology slides of Endocrine glands - Pituitary, Thyroid, Parathyroid, Thymus, Adrenal, Pancreas, Ovary and Testis, and Uterus.

Biochemistry

1. Colorimetric determination of protein (Lowry's method), Somogi / Anthrone method, lipids by Vanlin method, glycogen by Kemp's method
2. Estimation of cholesterol
3. DNA(diphenyl amine method) and RNA.
4. Thin layer/paper chromatography- separation of molecules.
5. Preparation of buffer
6. Preparation of molal solution.
7. Preparation of Agarose and Polyacrylamide gel.
8. Demonstration of PAGE and Agarose gel electrophoresis.
9. Hemogluttination
10. Collection of plasma and serum
11. Quantitative determination of blood sugar.

Cytology

1. Fixation of tissue with Bouin's fixative and stain using haemotoxylin – eosin stain for histochemical studies

LEARNING RESOURCES

References

Forensic Medicine & Toxicology Practical Manual, Bakkannavar, Shankar M., Elsevier
Modern Medical Toxicology 2013, V.V. Pillay.

Manual of Practical Physiology, A.K. Jain.

Practical Manual of Hematology 2011, by Girish Kamat.

Dacie and Lewis Practical Haematology 12th Edition 2017, Barbara Jane Bain

Online sources

https://global.oup.com/uk/orc/biosciences/biomed/fbs/01series/videos_techniques/haematology/

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.

SEMESTER: 4 COURSE CODE ZOO– DE-531 Credits: 2

NAME OF THE COURSE: Bio-Entrepreneurship in Life Science

Course Outcomes

- CO1: Students will understand the basic concepts of Bio-Entrepreneurship and University spinoff
 Understand the history and significance of university spinoffs started the world over
- CO2: Students will achieve knowledge in outcomes of University spinoffs
- CO3: Students will get an idea regarding the Career Opportunities in the Life Science Industry
- CO4: Achieve the ability to prepare startup proposals and file Intellectual property rights
- CO5: Understand the funding opportunities to initiates university spinoffs.

COURSE CONTENT

MODULE: I

Introduction to the Bio-Entrepreneurship: The definition of a university spinoff, Examples of university spinoffs, Importance, Historical perspective of spinoffs, Reasons to establish university spinoffs. Significance of Biotechnology Entrepreneurship, Biotechnology Entrepreneurship versus General Entrepreneurship.

MODULE II

Outcomes of Bio-Entrepreneurship: Factors influencing University spinoffs, Types of technologies initiates University spinoffs, Intellectual Property and Spinoffs, Spinoffs and company creation, Financing and Marketing University Spinoffs. Performance and Problems with Bio-Entrepreneurship.

MODULE III

Career Opportunities in the Life Science Industry: Role of Intellectual properties and Patents, Corporate IP Managements, Biologics and Biosimilars, Overview of the many different vocational areas in the Life Sciences Industry, Finding Jobs in Life science Industry, Major Biotech parks, Startup Funding Opportunities in Bio-Entrepreneurship

MODULE IV

Preparation of proposals leading to Bio-Entrepreneurship

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Written Examinations
2. Seminars
3. Assignments
4. Poster Presentations
5. Digital Portfolio development
6. Flip classroom assignment
7. Quiz Visual
8. Development of Visual Organiser

LEARNING RESOURCES

References

- Scott Shane, Academic Entrepreneurship University Spinoffs and Wealth Creation, New Horizons in Entrepreneurship, 2005
- Craig Shimasaki, Biotechnology Entrepreneurship Starting, Managing and Leading Management Companies, Academic Press, 2014

Online sources

LMS Link:

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.

SEMESTER:	COURSE CODE ZOO-DE-532	Credits: 2
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NAME OF THE COURSE: **REGENERATIVE BIOLOGY AND MEDICINE**

COURSE OUTCOMES

- CO1: Understand the various aspects of tissue regeneration and the factors regulating the tissue regeneration process.
- CO2: Students will gain knowledge on tissue regeneration in invertebrates and vertebrates. Achieve knowledge regarding alternative model systems to study tissue regeneration.
- CO3: Understand the role of stem cells in tissue regeneration and the development of regenerative medicine.
- CO4: Students will gain knowledge regarding organoid culture and culturing organoid
- CO5: Achieve the necessary knowledge regarding regenerative medicine and its application

COURSE CONTENT

MODULE: I

Introduction to Regenerative Biology and Medicine: Definition and scope of regenerative biology and medicine, Historical perspective and milestones in regenerative medicine, Principles of regenerative processes and their differences from conventional healing

MODULE II

Stem Cells and Their Role in Regeneration: Overview of stem cell biology and classification, Endogenous stem cells in tissue repair and regeneration, Induced pluripotent stem cells (iPSCs) and their application

MODULE III

Tissue Engineering and Biomaterials in Regenerative Medicine: Scaffold design and biomaterial selection, Tissue engineering approaches for organ regeneration

MODULE IV

Applications of Regenerative Biology and Medicine: Regeneration of different Organs, Ethical implications of regenerative medicine research, Regulatory guidelines and approval processes for regenerative therapies

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Written Examinations
2. Assignments
3. Seminars
4. Poster Presentations
5. Model preparations
6. Survey
7. Digital Portfolio development
8. Flip classroom assignment
9. Quiz Visual
10. Development of Visual Organiser
11. Specimens Collection

LEARNING RESOURCES

References

- Bruce M. Carlson, M.D., PhD, Principles of Regenerative Biology, 2007, Academic Press.
- David. L. Stocum, Regenerative Biology and Medicine, 2006, Academic Press.
- [Robert Lanza](#) and [Anthony Atala](#), Essentials of Stem Cell Biology, 2013, Academic Press.
- [Anthony Atala, Robert Lanza and James Thomson](#), Principles of Regenerative Medicine, 2010, Academic Press.
- [Jamie Davies and Melanie Lawrence, Organoids and Mini-Organs, 2018](#), Academic Press.

Online sources

LMS Link: <http://lms.keralauniversity.ac.in/moodle/course/view.php?id=161>

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.
- Practical Laboratory Exercises: Hands-on performance of molecular biology techniques and data analysis.
- Laboratory Reports: Documentation of experimental procedures, data analysis, and interpretation.
- Quizzes and Examinations: Assessing understanding of theoretical concepts and principles.
- Data Analysis Assignments: Analyzing and interpreting experimental data sets.
- Presentation: Communication of experimental findings through oral presentations.

SEMESTER: 4 COURSE CODE ZOO– DE-533 Credits: 2

NAME OF THE COURSE: **TOXICITY EVALUATION IN COSMETIC AND NUTRACOSMETIC DEVELOPMENTS**

COURSE OUTCOMES

- CO1: Understand the principles and importance of toxicity evaluation in cosmetic and nutracosmetic developments.
- CO2:
- CO3: Learn about the different toxicity endpoints and testing methods used in safety assessment.
- CO4:

CO5: Gain knowledge of the regulatory requirements and guidelines specific to cosmetics and nutraceuticals.

CO6: Develop proficiency in performing in vitro toxicity assays for skin irritation, sensitization, and genotoxicity.

CO7:

CO8: Understand the principles and methods for evaluating the oral toxicity and safety of nutraceutical ingredients.

Learn about risk assessment approaches and safety thresholds for cosmetics and nutraceuticals.

Enhance critical thinking skills in interpreting and analysing toxicity data in the context of product development.

Develop an understanding of ethical considerations and animal testing alternatives in safety assessment.

COURSE CONTENT

MODULE: I

Introduction to Toxicity Evaluation : Importance and objectives of toxicity evaluation in product development, Ethical considerations and animal testing alternatives, Regulatory frameworks and guidelines specific to cosmetics and nutraceuticals

MODULE II

Testing Skin Irritation and Sensitization: Principles and methods for assessing the skin irritation potential of cosmetic and nutraceutical ingredients, In vitro and in vivo testing methods for skin sensitization evaluation, Interpretation and classification of skin irritation and sensitization data

MODULE III

Genotoxicity, Mutagenicity, Oral Toxicity and Eye irritation Testing: Principles and methods for assessing the genotoxicity and mutagenicity of cosmetic and nutraceutical ingredients, In vitro genotoxicity assays, including the Ames test and micronucleus assay, Principles and methods for evaluating the oral toxicity and safety of nutraceutical ingredients, In vitro and in vivo methods for ocular irritation assessment

MODULE IV

Guidelines and Case Studies: OECD Guidelines, Principles of risk assessment in safety evaluation, Analysis of case studies highlighting toxicity evaluation in cosmetic and nutraceutical development, Practical exercises in performing in vitro toxicity assays

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Written Examinations
2. Assignments
3. Seminars
4. Poster Presentations
5. Model preparations
6. Survey
7. Digital Portfolio development
8. Flip classroom assignment
9. Quiz Visual
10. Development of Visual Organiser
11. Specimens Collection

LEARNING RESOURCES

References

- Book: "Toxicology and Risk Assessment: A Comprehensive Introduction" by Helmut Greim and Robert Snyder
- Book: "Cosmetic Regulation in a Competitive Environment" by Howard I. Maibach
- Journal Article: "Cosmetic Toxicology: An Overview" by H. A. van Loveren and P. W. Wester
- Journal Article: "In Vitro Methods for Cosmetic Safety Evaluation" by Paul J. W. ten Berge et al.
- Scientific Publication: "Safety Evaluation of Cosmetic Ingredients: The Role of In Vitro Alternatives to Animal Testing" by Helena Kandárová and Vera Rogiers
- Scientific Publication: "In Silico Toxicology for the Cosmetic Industry" by Léonard et al.
- Online Resource: European Commission's Scientific Committee on Consumer Safety (SCCS)
- Online Resource: Personal Care Products Council (PCPC)

Online sources

LMS Link: <http://lms.keralauniversity.ac.in/moodle/course/view.php?id=161>

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.
- Practical Laboratory Exercises: Hands-on performance of molecular biology techniques and data analysis.
- Laboratory Reports: Documentation of experimental procedures, data analysis, and interpretation.
- Quizzes and Examinations: Assessing understanding of theoretical concepts and principles.
- Data Analysis Assignments: Analyzing and interpreting experimental data sets.
- Presentation: Communication of experimental findings through oral presentations.

SEMESTER: 4 COURSE CODE ZOO–CC-541 Credits: 4

NAME OF THE COURSE: APPLIED ZOOLOGY

COURSE OUTCOMES

- CO1: Understand and explore the applied aspects of Zoology
- CO2: Students will generate a holistic approach to the translational aspects of Zoology, and it will uplift the job potential of the learners
- CO3: Students will achieve knowledge in the area of insects classification, Phylogeny, Morphology Anatomy and Physiology
- CO4: Understand the applied aspects of entomology and acquire skills to control vector born diseases
- CO5: Students will get knowledge in the area aquaculture
- CO6: Achieve the skill and knowledge of Commercial Dairy Farming
- CO7: Students will acquire the skill to start entrepreneurship activity in the area of zoology
- CO8:
- CO9:

Achieve knowledge in the area Ornithology, mammology and primatology
 Students will able to describe primate movement and cultural development
 Achieve to learn the fundamentals and factors in applied zoology

COURSE CONTENT

MODULE: I

Entomology, Anatomy and Physiology of Insects: Origin of Insects, classification, Phylogeny, Morphology and Anatomy. Structure and Function of Insects, integument, nervous system, muscular system, alimentary canal and nutrition, reproduction & development, sensory mechanisms, locomotion, behaviour and ecology, circulatory system, insect populations and their physical-chemical and biotic environment, insect –host plant reaction, Growth and metamorphosis, Insects Adaptations.

MODULE II

Applied Entomology: Beneficial and harmful insects, Insect products, Use of insects in medicine, Insects in biological research, Pollination by insects, Forensic Entomology, Agricultural Entomology, Aquatic Entomology, Harmful insects, Insecticides. Role of biotechnology in Plant resistance to insects. Biological control, Genetic control, Ecological control, Physical control, Regulatory control, integrated pest management.

MODULE III

Aquaculture Technology: Freshwater, brackish water, marine aquaculture, the culture of fish food organisms, Water Quality Requirements for Aquaculture.

MODULE IV

Integrated farming, aquaculture engineering, Nutrition of aquatic animals, Genetics in aquaculture, Environmental impact of aquaculture.

MODULE V

Animal Husbandry Practices: General problems of sheep, goat, pigs and poultry management, Milk Product Technology, Breeding systems Heritability, Native breeds, Genetically modified breeds.

MODULE VI

Aquarium Science: Fabrication of aquarium, Aquarium accessories, Different filtration systems, Setting, maintenance and management of Aquarium. Indigenous and exotic aquarium fishes, Breeding of exotic aquarium fishes- Guppies, goldfish, angelfish and Gouramies. Aquarium plants and their multiplication. Quarantine, water quality management and algal and snail control. Food and feeding management of aquarium fishes. Disease and health management.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Written Examinations
2. Assignments
3. Seminars
4. Poster Presentations
5. Model preparations
6. Survey
7. Digital Portfolio development
8. Flip classroom assignment
9. Quiz Visual
10. Development of Visual Organiser
11. Specimens Collection

LEARNING RESOURCES

References

- . Robert E. Pfadt (ed). Fundamentals of Applied Entomology Mac Millan Company, New York 1962
- Fenemore P G , Applied Entomology. Newagepublishers Delhi .2006
- Chapman R. F, The Insects: Structure and Function.. 4 thEd. Cambridge University Press. 2012.
- Elzinga, R. J , Fundamentals of Entomology. 5 thEd. Prentice Hall College, New Jercey.2004
- Romoser W. S and Stoffolano Jr J G, The Science of Entomology.. 4 thEd Mac Graw Hill. 1998
- Little V A , General and Applied Entomology . Oxford & IBH Publishing Co.1972
- Ananthakrishnan T A and B.V. David. General and Applied Entomology. Tata McGraw - Hill Publishing Co. New Delhi, 2004

Online sources

LMS Link:

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.

SEMESTER: II COURSE CODE: ZOO–CC-542 Credits:3

NAME OF THE
COURSE:

BIODIVERSITY AND CONSERVATION BIOLOGY

COURSE OUTCOME

- CO1: Generate interest in biodiversity and its conservation among the young minds.
- CO2: Understand the methods of quantifying biodiversity of a particular area.
- CO3: Develop a comprehensive knowledge on values and uses of biodiversity/ nature.
- CO4: Demonstrate the usefulness of Conservation Laws and how they can be improved.
- CO5: Gain expertise into ways of conserving biodiversity among local community.
- CO6: Outline Wildlife management strategies for the threatened wildlife of Kerala.
- CO7: Analyse the importance of different wildlife management methods practicing today

COURSE CONTENT

MODULE: I

Introduction to Biodiversity Definition, History and Importance of Biodiversity and Biodiversity resources of India. Biodiversity documentation and species identification, Species concepts and molecular taxonomy. Relevance of Systematics to biodiversity and conservation. Genetic diversity, Species diversity and ecosystem diversity

MODULE II

Quantifying biodiversity: Assessing, Inventory, Monitoring, Faunal assessment and sampling techniques. Distribution and gradients of biodiversity, species area relation, Megadiverse countries, Hotspots, Depth gradients, marine realms and freshwater regions. Latitudinal and Altitudinal gradients of biodiversity, Zonation in seas and mountains. Endemism and Biodiversity. Ecological relations, keystone species and endangered animals, endemism and Red data list, Global biodiversity information system, Intellectual Property Rights (IPR) and Sovereignty rights.

MODULE III

Values and uses of biodiversity: Economic evaluation, Natural resource loss, Direct, indirect, Ecological services and ethical values of biodiversity. Threats to biodiversity: Extinction- past mass extinction, current human caused extinction, extinction rates in islands, local extinctions, vulnerability to extinction, endemic species and extinction, habitat destruction, fragmentation, Overexploitation, Invasive species and diseases, Overview and causes of recent extinctions, problems of Western Ghats biodiversity conservation. Genetic erosion and degradation of aquatic ecosystems and pollution. Species extinction, metapopulation, Genetic consequences of fragmented population and minimum viable population. Effects of global warming to biodiversity.

MODULE IV

Conservation of Biodiversity: Ex-situ and in-situ methods of conservation strategies, Captive breeding, zoo and captive breeding, Botanical gardens and gene banks. Evaluation of priorities for species and habitats: Choosing species to protect, Hotspots for conservation, Major tropical wilderness areas and Eco regions, World heritage sites. Application of genetics in Conservation of biodiversity. Indigenous knowledge, Biodiversity and sustainable development.

MODULE V

Conservation Organizations and laws: International and national conventions for the conservation of biodiversity: CBD, Ramsar Convention, IUCN, WWF, Biodiversity Board, TRAFIC, CITES, UNEP, Greenpeace etc. People's participation in the conservation of biodiversity, local issues, sacred groves, mangrove protection and Traditional farming practices.

MODULE VI

Wildlife Management: Principles and practices of wildlife management. Management of special habitats; riparian zones. Grasslands etc. Analysis of wildlife management problems in plantations and exploited forests; Indian and Kerala scenario. Species conservation projects; tiger, lion, rhino, and elephant. Role of Biology in management. Management plan for Protected Areas: Forest working plans and wildlife management plans. Need for wildlife management planning. Human wildlife conflicts. Principles of planning, objectives, resource surveys, analysis of surrounding region, management zones, theme plans, communications, staff and visitor amenities, monitoring. Financing protected areas.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Written examination
2. Assignment
3. Seminar
4. Preparation of video
5. Poster Preparation
6. Mentimeter quiz

LEARNING RESOURCES

References

- Lloyd J R, Man and the Ecosystem, Macmillan Education Ltd. 1984.
 Ian Deshmukh. Ecology and Tropical biology,, Blackwell Scientific Publication, 1986.
 Odum E P, Ecology-A Bridge Between Science and Society, Sinauer Associates Inc. Publishers, 1996.
 Chaudhary A B and Sarkar D D, Mega Diversity Conservation,, Daya Publishing House, 2003.
 Sinha R.K and Singh D. Global Biodiversity, INA Shree Publishers, India, 1997.
 Sharma. B.D. Indian Wildlife-Threats and Preservations. Anmol Publications Pvt. Ltd. India, 2002.
 Ormond F. G John D. Gage, and Martin V. Angel. Marine Biodiversity, Cambridge, 1997

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.

SEMESTER: IV COURSE CODE:ZOO-CC-543 Credits:6

NAME OF THE COURSE: PROJECT WORK AND VIVA

Course Outcomes

- CO1: Able to conduct literature survey and identify their research area.
 CO2: Identify a research hypothesis and prepare research plan.
 CO3: Standardise their research methodology
 CO4: Organised data collection will be done.
 CO5: Data will be analysed and interpreted.
 CO6: Dissertation will be prepared

COURSE CONTENT

The student will undertake an independent time bound research project under the supervision of a faculty in the Department. The periodic progress of the project may be monitored. The project planning may be initiated from the third semester onwards. A dissertation of about 30-60 pages may be submitted.

ASSESSMENT

The evaluation will be based on the valuation of dissertation, presentation and viva voce.

SEMESTER:I-IV COURSE CODE:ZOO–GC-501 Credits:2

NAME OF THE COURSE: **BIODIVERSITY**

Course Outcomes

- CO1: Develop an understanding on biodiversity.
- CO2: Analyse different biodiversity conservation methods.
- CO3: Demonstrate the need for conserving the biodiversity.
- CO4: Understand the ways of population estimation.
- CO5: Gain an insight into the working of an ecosystem.
- CO6: Create a thorough knowledge on conservation laws.

COURSE CONTENT

MODULE: I

Definition, History and Importance of Biodiversity and Biodiversity resources of India. Biodiversity documentation and species identification, Species concepts. Relevance of Systematics to biodiversity and conservation. Genetic diversity, Species diversity and ecosystem diversity.

MODULE II

Quantifying biodiversity, Assessing, Inventory, Monitoring, Methods for the assessment of biodiversity. Distribution and gradients of biodiversity, species area relation, Megadiverse countries, Hotspots, Endemism and Biodiversity. Ecological relations, keystone species and endangered animals, endemism and Red data books.

MODULE III

Values and uses of biodiversity: Natural resource loss, Direct, indirect, Ecological services and ethical values of biodiversity. Threats to biodiversity: Extinction- past mass extinction, current human caused extinction, extinction rates in islands, local extinctions. habitat destruction, fragmentation, Overexploitation, Invasive species and diseases, Overview and causes of recent extinctions, problems of Western Ghats biodiversity conservation.

MODULE IV

Global Climate Change: Green house gases, Effects of global warming to biodiversity, agriculture, Oceans and other ecosystems.

MODULE V

Conservation of Biodiversity: Ex-situ and in-situ methods of conservation strategies, Captive breeding, zoo and captive breeding, Botanical gardens and gene banks.

MODULE VI

Biodiversity laws, Indigenous knowledge and national and International conventions for the conservation of biodiversity: CBD, Ramsar Convention, IUCN, WWF, Biodiversity Board, TRAFIC,

CITES, UNEP, Greenpeace etc. People's participation in the conservation of biodiversity, local issues, conservation of sacred groves.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Written Examinations
2. Assignments
3. Model preparations Classroom assignment
4. Poster
5. Development of Visual Organiser
- 6.

LEARNING RESOURCES

References

- Lloyd J R, Man and the Ecosystem, Macmillan Education Ltd. 1984.
 Ian Deshmukh. Ecology and Tropical biology, Blackwell Scientific Publication, 1986.
 Odum E P, Ecology-A Bridge Between Science and Society, Sinauer Associates Inc. Publishers, 1996.
 Chaudhary A B and Sarkar D D, Mega Diversity Conservation, Daya Publishing House, 2003.
 Sinha R. K and Singh D. Global Biodiversity, INA Shree Publishers, India, 1997.
 Sharma. B.D. Indian Wildlife-Threats and Preservations, Anmol Publications Pvt. Ltd. India, 2002.
 F. G John D. Gage, and Martin V. Angel. Marine Biodiversity, Cambridge, 1997

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.

SEMESTER: I-IV

COURSE CODE ZOO– GC-502

Credits: 2

NAME OF THE COURSE:

Bio-Entrepreneurship in Life Science

Course Outcomes

- CO1: Students will understand the basic concepts of Bio-Entrepreneurship and University spinoff
- CO2: Understand the history and significance of university spinoffs started the world over
- CO3: Students will achieve knowledge in outcomes of University spinoffs
- CO4: Students will get an idea regarding the Career Opportunities in the Life Science Industry
- CO5: Achieve the ability to prepare startup proposals and file Intellectual property rights
- Understand the funding opportunities to initiates university spinoffs.

COURSE CONTENT

MODULE: I

Introduction to the Bio-Entrepreneurship: The definition of a university spinoff, Examples of university spinoffs, Importance, Historical perspective of spinoffs, Reasons to establish university spinoffs. Significance of Biotechnology Entrepreneurship, Biotechnology Entrepreneurship versus General Entrepreneurship.

MODULE II

Outcomes of Bio-Entrepreneurship: Factors influencing University spinoffs, Types of technologies initiates University spinoffs, Intellectual Property and Spinoffs, Spinoffs and company creation, Financing and Marketing University Spinoffs. Performance and Problems with Bio-Entrepreneurship.

MODULE III

Career Opportunities in the Life Science Industry: Role of Intellectual properties and Patents, Corporate IP Managements, Biologics and Biosimilars, Overview of the many different vocational areas in the Life Sciences Industry, Finding Jobs in Life science Industry, Major Biotech parks, Startup Funding Opportunities in Bio-Entrepreneurship

MODULE IV

Preparation of proposals leading to Bio-Entrepreneurship

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Seminars
2. Assignments
3. Poster Presentations
4. Digital Portfolio development
5. Flip classroom assignment
6. Quiz Visual
7. Development of Visual Organiser

LEARNING RESOURCES

References

- . Scott Shane, Academic Entrepreneurship University Spinoffs and Wealth Creation, New Horizons in Entrepreneurship, 2005
- Craig Shimasaki, Biotechnology Entrepreneurship Starting, Managing and Leading Management Companies, Academic Press, 2014

Online sources

LMS Link:

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.

SEMESTER: I-IV	COURSE CODE ZOO– GC-503	Credits: 2
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NAME OF THE COURSE: **SKIN AND HAIR BIOLOGY AND DISEASES**

Course Outcomes

- CO1: Understand the physiology and anatomy of the cutaneous system
 CO2: Students will achieve knowledge of the unique features of the Integumentary system in different organisms
 CO3: Understand the pathophysiological conditions affecting the cutaneous system
 CO4: Students will get knowledge regarding the diagnosis tools using for identifying the diseases
 CO5: Achieve the treatment options in diseases affecting skin and skin appendages
 Students will get an idea regarding the research and job opportunities in cutaneous biology.

COURSE CONTENT

MODULE: I

Cutaneous System: Integument as an Organ, Layers of Integument, Physiology of Integument (Physical Protection, Hydro regulation, Thermoregulation, Cutaneous Absorption, Communication) Epidermal Derivatives (Hair, Nails, Glands), Physiology of Wound Healing, Inflammatory Conditions, Skin Grafting and Therapies

MODULE II

Tropical Cutaneous biology, Diseases, Diagnosis and Treatment: Papular lesions (Insects bits, Onchocerciasis), Subcutaneous Lesions, Bacterial skin infections, Parasite and Ectoparasite infections, Fungal Infections, Diseases Caused by Virus, Non-infectious skin problems in the tropics (Acne vulgaris, Eczema, Psoriasis, Atopic dermatitis, Lichen Planus, Pigmentary Disorders, Melanoma, Urticaria, Leprosy, Lymphedema), Hair disorders (Scarring and Non-Scarring Alopecia), Nail Disorders

MODULE III

Role of Omics and Stem cells: Genomics, Proteomics and Metabolomics using biomarker analysis, Stem cell therapy, Role of Environmental Factors, Oxidative stress, Mitochondrial Dysfunction, Comorbidity diseases

MODULE IV

BASICS, CLINIC AND INDUSTRY RESEARCH IN CUTANEOUS BIOLOGY: Researches in skin and hair research, Centers in cutaneous biology, Industry related to skin and hair, Nutraceuticalology

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Written Examinations
2. Seminars
3. Assignments
4. Poster Presentations
5. Digital Portfolio development
6. Flip classroom assignment
7. Quiz Visual
8. Development of Visual Organiser

**LEARNING
RESOURCES**

References

- . Bologna Joseph Jorizzo Julie Schaffer Bologna, L. J, Jorizzo L. J. Dermatology, Saunders, 2012.
- Thomas Habif James Campbell M. Shane Chapman James Dinulos Kathryn Zug, Skin Disease: Diagnosis and Treatment, Saunders, 2001.
- Chiang, Z.Y.N, Verbov J. Dermatology: Handbook for Medical Students and Junior Doctors. 2014.
- Darmon. M, Blumenberg M. Molecular Biology of the Skin: The Keratinocyte. Academic Press Inc. New York, 2012
- Epstein. E, Common skin Disorders, Glassfrog Books, 1979
- Lahiri. K, Chatterjee M., Sarkar R. Pigmentary Disorders: A comprehensive Compendium, 2014.
- Sacchidanand. S, Savitha A. S., Lakshmi D. V. Hair and Hair Disorders: Diagnosis and Management. 2015.
- [Woodley](#). D.T, The Biology of the Skin. Part

Online sources

LMS Link:

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.

SEMESTER I-IV COURSE CODE ZOO– GC-504 Credits: 2

NAME OF THE COURSE: **AYURVEDA BIOLOGY**

Course Outcomes

- CO1: To create a knowledge interface between Ayurveda and modern life sciences
- CO2: To integrate theoretical and practical aspects of life sciences and technology with Ayurveda
- CO3: Ayurveda for applications in the contemporary healthcare research and industry need
- CO4: To train students in the basics of Shastra and Science for logic synthesis and application of knowledge systems of Ayurveda and Biology.
- CO5: To build skill and capacity in students to take up industry/academic-based research jobs
- CO6: in the area of Life Sciences/Biomedicine/Ayurveda
- Understand about lab experiments and protocols helpful for Ayurveda Biology Research

COURSE CONTENT

MODULE: I

Basics of Biology: Introduction to Basic biology, Biology of cells, Functions of Organ System, Genetics and Molecular biology, Biology of diseases, Immunology and micro biome

MODULE II

Basics of Ayurveda: Introduction to Ayurveda Basic Principles, Ayurvedic Concepts of 3 Humours, Concept of Disease Causation, Ayurvedic Pharmacology, Mode of action of Ayurvedic formulations,

Understanding wellness and disease in Ayurveda, Ayurvedic Therapeutic Procedures, Concepts of drug design in Ayurveda and biomedicine, Ayurgenomics.

MODULE III

Research Methodology and Statistics, Clinical and Public Health, Scientific and logic concepts in Indian Philosophy, Principles of nutrition and health.

MODULE IV

Lab and Field Trip: Lab Session, Visit Ayurveda College and Interaction with experts, Preparation of a Research Proposal

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Written Examinations
2. Seminars
3. Assignments
4. Poster Presentations
5. Model preparations
6. Digital Portfolio development
7. Flip classroom assignment
8. Quiz Visual
9. Development of Visual Organiser

LEARNING RESOURCES

References

- . Sushruthasamhitha
- Ashtangahridaya
- Charakasamhitha

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.

SEMESTER: I-IV COURSE CODE ZOO– GC-505 Credits: 2

NAME OF THE COURSE: CELL CULTURE TECHNIQUES

Course Outcomes

- CO1: Understand the basics of tissue culture
- CO2: Students will be able to do tissue culture for their experimental purpose
- CO3: Achieve the skills for setting up tissue culture lab for their research
- CO4: Understand the cell culture application for research purpose
- CO5: Students will get knowledge and working of cell culture instruments like CO₂ incubator, Type 2 Biosafety Cabinet etc.
- CO6: Students will get an and overall idea regarding the types of cell and their culturing protocols

COURSE CONTENT

MODULE: I

Introduction to Cell Culture: Historical Background, Advantages of Tissue Culture, Limitations of Tissue Culture, Types of Tissue Culture, Biology of Cultured Cells

MODULE II

Cell Culture Lab Design and Equipment: Requirements, Design and layout, Major and Minor Equipment's essential for Tissue Culture, Safety considerations, Aseptic techniques, Eradication of infections, Media and Supplements.

MODULE III

Animal Cell cultures: Primary cell cultures, Cell lines, Subcultures, Cell quantification, Cryopreservation, Authentication of Cell lines, Cell Sorting, Cell line Characterization, Cell Differentiation.

MODULE IV

Cell Culture Applications: Three-Dimensional Culture, Principles and Applications of Flow Cytometry, MTT assay, Angiogenic Assay, Wound Healing Assay, Sphenoid Invasion Assay, Matrigel Invasion assay, Centrifugation, Ultracentrifugation Methods & Applications.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Written Examinations
2. Seminars
3. Assignments
4. Poster Presentations
5. Model preparations
6. Digital Portfolio development
7. Flip classroom assignment
8. Quiz Visual
9. Development of Visual Organiser

LEARNING RESOURCES

References

- . Bisen, Prakash S., Laboratory protocols in applied life sciences, CRC Press.2014
- Veerakumari L, Bioinstrumentation, MJP Publishers, Chennai, 2006
- R. Ian Freshney, Seventh Edition, Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 2017

Online sources

LMS Link:

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.

SEMESTER:I-IV	COURSE CODEZOO– GC-506	Credits: 2
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NAME OF THE COURSE: Regenerative Medicine and Biology

Course Outcomes

- CO1: Understand various aspects of tissue regenerative and factors regulating the tissue regeneration process
- CO2: Students will achieve knowledge about tissue regeneration in invertebrates and vertebrates
- CO3: Achieve knowledge regarding alternative model systems to study tissue regeneration
- CO4: Understand the role of stem cell in tissue regeneration and development of regenerative medicine
- CO5: Students will get knowledge organoid culture and culturing organoid
Achieve the necessary knowledge regarding regenerative medicine and application

COURSE CONTENT

MODULE: I

An Introduction to Regeneration- What is Regeneration, Physiological Regeneration, Reparative Regeneration, Regeneration by Induction, Hypertrophy, Morphallaxis, Asexual Reproduction.

MODULE II

Tissue Interactions in Regeneration and Aging -The Amphibian Limb, Human Fingertips and the mammalian Limb, Mammalian Skeletal Muscle Regeneration, Aging and Regeneration in Individual Organ Systems; Skin, Liver, Kidney, Lungs.

MODULE III

Stem Cells, Plasticity and Regeneration: What is a Stem Cell? Properties of Adult Stem Cells, Stem Cells in Regeneration and Tissue Reconstruction, Examples of Stem Cell Participation in Regeneration; Heart and Cardiac Muscle, Central Nervous System, Skeletal Muscle.

MODULE IV

Regenerative Medicine: Introduction to Regenerative Medicine, Biomaterials for Regenerative Medicine, Cell Therapy, Tissue Therapy, Regulation and Ethics, Organoids, Elements of organoid design, Kidney organoids, Applications of organoids

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Written Examinations
2. Seminars
3. Assignments
4. Poster Presentations
5. Digital Portfolio development
6. Flip classroom assignment
7. Quiz Visual
8. Development of Visual Organiser

LEARNING RESOURCES

References

- Bruce M. Carlson, M.D., Ph.D, Principles of Regenerative Biology, 2007, Academic Press.
- David. L. Stocum, Regenerative Biology and Medicine, 2006, Academic Press.
- [Robert Lanza](#) and [Anthony Atala](#), Essentials of Stem Cell Biology, 2013, Academic Press.

[Anthony Atala, Robert Lanza and James Thomson](#), Principles of Regenerative Medicine, 2010, Academic Press.

[Jamie Davies and Melanie Lawrence](#), Organoids and Mini-Organs, 2018, Academic Press.

Online sources

LMS Link:

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.

SEMESTER I-IV COURSE CODE:ZOO–GC-507 Credits:2

NAME OF THE COURSE: **WETLAND ECOLOGY**

COURSE OUTCOMES

- CO1: To develop a knowledge on wetland ecology and conservation.
 CO2: Analyze the diversity of wetland ecosystems in India with special reference to Kerala.
 CO3: Demonstrate an understanding of wetland management especially the conservation aspects.
 CO4: Create awareness about the Wetlands in Kerala and the Wetland Policy of the nation.
 CO5: Assess the problems and solutions to Wetland degradation in Kerala

COURSE CONTENT

MODULE: I

Wetlands: an overview: Definition and distributions, wetland classification, wetland types, Wetland functions, Zonation and Succession: shorelines as a prism, Shorelines as a model system for the study of wetlands, Mechanisms of zonation.

MODULE II

Diversity: Flora and fauna of wetlands, Dominance and diversity factors controlling the number of species in wetlands, Biomass and diversity: a general plant communities, Species and biodiversity.

MODULE III

Wetland conservation, management and research: Change in wetlands, perspectives on conservation, Priorities for action, Indicators.

MODULE IV

Wetlands in India, Wetland management, Wetland policy and law, Ramsar Wetlands. Future prospects of wetlands. Wetlands of Kerala, Wetland agriculture –Problems and prospects, Back waters of Kerala, Management of river wetlands, Wetland pollution, Constraints, management and conservation of wetlands.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Bird watching
2. Fish counting
3. Flora study
4. Animal interaction study
5. Specimen collection and preservation
6. Report preparation

LEARNING RESOURCES

References

- Paul Keddy, Wetland ecology principles and conservation ., Cambridge University press, 2000.
- Westlake D. F, Kvet, J K and Szczepanski A, Production & Ecology of Wetlands. Cambridge University press.2009
- Ralph W. Tiner, Wet land Indicators –CRC Press 1999
- Sinha P. C and Mohanty R, Wetland Management Policy and Law, Kanishka Publishers Distributors 2002

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.

SEMESTER I-IV	COURSE CODEZOO– SE-501	Credits: 2
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NAME OF THE COURSE:NUTRACOSMETOLOGY

Course Outcomes

- CO1: Understand the basic biology of cutaneous appendages
- CO2: Achieve a basic understanding of Cosmetology
- CO3: Students will attain knowledge regarding natural herbal formulation helpful for maintaining skin and hair health
- CO4: To integrate theoretical and practical aspects of cutaneous biology and cosmetology for developing skin and hair cosmetics products
- CO5: Helpful for developing his cosmetic recipe
- CO6: Get an idea of how to Initiate a start-up opportunity in the area of herbal cosmetics

COURSE CONTENT

MODULE: I

Module 1. Introduction to basics of the biological organ systems-Skin, Gut and Brain

MODULE II

Identification and Production of Nutracosmetics from plant and animal compounds, Introduction to an Assay system for Nutracosmetic Production.

MODULE III

Proposal preparation for product development

MODULE IV

Hand-on training and Product development

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Written Examinations
2. Seminars
3. Assignments
4. Poster Presentations
5. Digital Portfolio development
6. Flip classroom assignment
7. Quiz Visual
8. Development of Visual Organiser

LEARNING RESOURCES

References

Bologna Joseph Jorizzo Julie Schaffer Bologna, L. J, Jorizzo L. J. Dermatology, Saunders, 2012.

Thomas Habif James Campbell M. Shane Chapman James Dinulos Kathryn Zug, Skin Disease: Diagnosis and Treatment, Saunders, 2001.

Chiang, Z.Y.N, Verbov J. Dermatology: Handbook for Medical Students and Junior Doctors. 2014

Online sources

<https://formulabotanica.com/diploma-in-organic-skincare-formulation/>
<https://www.schoolofnaturalskincare.com/>

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam

SEMESTER:	COURSE CODE ZOO– 502	Credits: 2
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NAME OF THE COURSE: **TOXICITY EVALUATION IN COSMETIC AND NUTRACOSMETIC DEVELOPMENTS**

COURSE OUTCOMES

- CO1: Understand the principles and importance of toxicity evaluation in cosmetic and nutracosmetic developments.
- CO2: Learn about the different toxicity endpoints and testing methods used in safety assessment.
- CO3: assessment.
- CO4: Gain knowledge of the regulatory requirements and guidelines specific to cosmetics and nutracosmetics.
- CO5: Develop proficiency in performing in vitro toxicity assays for skin irritation, sensitization, and genotoxicity.
- CO6:
- CO7:

CO8: Understand the principles and methods for evaluating the oral toxicity and safety of nutraceutical ingredients.

Learn about risk assessment approaches and safety thresholds for cosmetics and nutracosmetics.

Enhance critical thinking skills in interpreting and analysing toxicity data in the context of product development.

Develop an understanding of ethical considerations and animal testing alternatives in safety assessment.

COURSE CONTENT

MODULE: I

Introduction to Toxicity Evaluation : Importance and objectives of toxicity evaluation in product development, Ethical considerations and animal testing alternatives, Regulatory frameworks and guidelines specific to cosmetics and nutracosmetics

MODULE II

Testing Skin Irritation and Sensitization: Principles and methods for assessing the skin irritation potential of cosmetic and nutraceutical ingredients, In vitro and in vivo testing methods for skin sensitization evaluation, Interpretation and classification of skin irritation and sensitization data

MODULE III

Genotoxicity, Mutagenicity, Oral Toxicity and Eye irritation Testing: Principles and methods for assessing the genotoxicity and mutagenicity of cosmetic and nutraceutical ingredients, In vitro genotoxicity assays, including the Ames test and micronucleus assay, Principles and methods for evaluating the oral toxicity and safety of nutraceutical ingredients, In vitro and in vivo methods for ocular irritation assessment

MODULE IV

Guidelines and Case Studies: OECD Guidelines, Principles of risk assessment in safety evaluation, Analysis of case studies highlighting toxicity evaluation in cosmetic and nutracosmetic development, Practical exercises in performing in vitro toxicity assays

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Written Examinations
2. Assignments
3. Seminars
4. Poster Presentations
5. Model preparations
6. Survey
7. Digital Portfolio development
8. Flip classroom assignment
9. Quiz Visual
10. Development of Visual Organiser
11. Specimens Collection

LEARNING RESOURCES

References

- Book: "Toxicology and Risk Assessment: A Comprehensive Introduction" by Helmut Greim and Robert Snyder
- Book: "Cosmetic Regulation in a Competitive Environment" by Howard I. Maibach
- Journal Article: "Cosmetic Toxicology: An Overview" by H. A. van Loveren and P. W. Wester
- Journal Article: "In Vitro Methods for Cosmetic Safety Evaluation" by Paul J. W. ten Berge et al.
- Scientific Publication: "Safety Evaluation of Cosmetic Ingredients: The Role of In Vitro Alternatives to Animal Testing" by Helena Kandárová and Vera Rogiers
- Scientific Publication: "In Silico Toxicology for the Cosmetic Industry" by Léonard et al.
- Online Resource: European Commission's Scientific Committee on Consumer Safety (SCCS)
- Online Resource: Personal Care Products Council (PCPC)

Online sources

LMS Link: <http://lms.keralauniversity.ac.in/moodle/course/view.php?id=161>

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.
- Practical Laboratory Exercises: Hands-on performance of molecular biology techniques and data analysis.
- Laboratory Reports: Documentation of experimental procedures, data analysis, and interpretation.
- Quizzes and Examinations: Assessing understanding of theoretical concepts and principles.
- Data Analysis Assignments: Analyzing and interpreting experimental data sets.
- Presentation: Communication of experimental findings through oral presentations.

SEMESTER:

COURSE CODE ZOO–SE-503

Credits: 2

NAME OF THE COURSE:

Healthy Ageing

COURSE OUTCOMES

- CO1: Understand the principles and significance of healthy ageing and its impact on individuals and society.
- CO2: Identify and assess factors influencing healthy ageing and age-related health conditions.
- CO3: Implement lifestyle interventions and preventive measures to promote healthy ageing.
- CO4: Recognize and address psychological and social aspects of ageing for improved well-being.
- CO5: Analyze healthcare systems and policies that support healthy ageing in the population.

COURSE CONTENT

MODULE: I

Introduction to Healthy Ageing: Definition and Significance of Healthy Ageing, The biology of ageing: cellular and molecular mechanisms, Factors influencing healthy ageing: genetics, lifestyle, and environment

MODULE II

Age-Related Health Conditions and Prevention: Common age-related health conditions: cardiovascular diseases, diabetes, neurodegenerative disorders, etc. Lifestyle interventions for

healthy ageing: Physical activity, nutrition, and stress management Preventive measures and early detection of age-related diseases

MODULE III

Psychological and Social Aspects of Ageing: Psychological Well-Being and Resilience in Elder Adults, Social Support, and Community Engagement for Healthy Ageing

MODULE IV

Ageing and Healthcare Systems: Challenges and Opportunities in Healthcare for the Ageing Population, Age-Friendly Healthcare Environments, and Services

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested activities

1. Written Examinations
2. Assignments
3. Seminars
4. Poster Presentations
5. Model preparations
6. Survey
7. Digital Portfolio development
8. Flip classroom assignment
9. Quiz Visual
10. Development of Visual Organiser
11. Specimens Collection

LEARNING RESOURCES

- 1. López-Otín C, Blasco MA, Partridge L, Serrano M, Kroemer G. The hallmarks of aging. *Cell*. 2013;153(6):1194-1217. doi:10.1016/j.cell.2013.05.039
- 2. Rowe JW, Kahn RL. Successful aging. *The Gerontologist*. 1997;37(4):433-440. doi:10.1093/geront/37.4.433
- 3. World Health Organization. Global Status Report on Noncommunicable Diseases 2014. Geneva: WHO Press; 2014. <https://www.who.int/nmh/publications/ncd-status-report-2014/en/>
- 4. Rizzuto D, Orsini N, Qiu C, Wang HX, Fratiglioni L. Lifestyle, social factors, and survival after age 75: population based study. *BMJ*. 2012;345:e5568. doi:10.1136/bmj.e5568
- 5. World Health Organization. World Report on Ageing and Health. Geneva: WHO Press; 2015. <https://www.who.int/ageing/publications/world-report-2015/en/>
- 6. Hajek A, Bock JO, Saum KU, et al. Frailty and healthcare costs-longitudinal results of a prospective cohort study. *Age Ageing*. 2018;47(2):233-241. doi:10.1093/ageing/afx174
- 7. Steptoe A, Shankar A, Demakakos P, Wardle J. Social isolation, loneliness, and all-cause mortality in older men and women. *Proc Natl Acad Sci USA*. 2013;110(15):5797-5801. doi:10.1073/pnas.1219686110
- 8. Jeste DV, Lee EE, Cacioppo S. Battling the modern behavioral epidemic of loneliness: suggestions for research and interventions. *JAMA Psychiatry*. 2020;77(6):553-554. doi:10.1001/jamapsychiatry.2020.0027

Online sources

LMS Link: <http://lms.keralauniversity.ac.in/moodle/course/view.php?id=161>

ASSESSMENT

- 40% Continuous / Formative Assessment (see PG Regulations).
- 60% End-semester/Summative Assessment: 3 hour written Exam.
- Practical Laboratory Exercises: Hands-on performance of molecular biology techniques and data analysis.
- Laboratory Reports: Documentation of experimental procedures, data analysis, and interpretation.
- Quizzes and Examinations: Assessing understanding of theoretical concepts and principles.

- Data Analysis Assignments: Analyzing and interpreting experimental data sets.
- Presentation: Communication of experimental findings through oral presentations.