

ಡಾ. ಮನಮೋಹನ ಸಿಂಗ್
ಬೆಂಗಳೂರು ನಗರ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ



Dr. MANMOHAN SINGH
BENGALURU CITY UNIVERSITY

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No.MSBCU/BoS/Syllabus-PG/Science/185/2026-27

Date: 24.08.2026

NOTIFICATION

Sub: Syllabus for the Post Graduate Courses in the Faculty of Science–
reg

Ref: 1. Recommendations of the Boards of Studies in the Faculty of
Science
2. Academic Council resolution No.07 dated.24.08.2026
3. Orders of Vice-Chancellor dated.24.08.2026

The Academic Council in its meeting held on 24.08.2026 has approved the syllabus prepared by different Board of Studies for the Post Graduate Courses in the Faculty of Science. Accordingly, the following CBCS Syllabus for the PG Courses of Science Faculty are hereby notified for implementation effective from the academic year 2026-27.

Sl. No.	Programmes
1.	M.Sc. Chemistry – III & IV Semester
2.	M.Sc. Physics – III & IV Semester
3.	M.Sc. Clinical Psychology – I to IV Semester
4.	M.Sc. Zoology – III & IV Semester
5.	M.Sc. Computer Science – III & IV Semester
6.	Master of Computer Applications – III & IV Semester
7.	M.Sc. Biotechnology – I & II Semester
8.	M.Sc. Criminology & Forensic Science – I to IV Semester
9.	M.Sc. Embryology & Reproductive Technology – I to IV Semester
10.	M.Sc. Microbiology – I to IV Semester

The detailed Syllabi for above subjects are notified in the University Website: www.bcu.ac.in for information of the concerned.

REGISTRAR

Copy to;

1. The Registrar(Evaluation), Dr. Manmohan Singh Bengaluru City University
2. The Dean, Faculty of Science, MSBCU.
3. The Principals of the concerned affiliated Colleges of BCU- through email.
4. The P.S. to Vice-Chancellor/Registrar/Registrar (Evaluation), BCU.
5. Office copy / Guard file / University Website: www.bcu.ac.in

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BENGALURU CITY UNIVERSITY

DR. MANMOHAN SINGH BENGALURU CITY UNIVERSITY

Curriculum/Syllabus for Postgraduate Programme

III and IV Semester

Master of Science in Zoology

Choice Based Credit System Faculty of Science
(With Effect from Academic Year 2026-27)

DR. MANMOHAN SINGH BENGALURU CITY UNIVERSITY
BENGALURU- 560001
PROCEEDINGS OF THE MEETING OF BOS (PG) IN ZOOLOGY

Sub: Proceedings of revised Syllabus of 3rd and 4th semester M.Sc., Zoology (PG) for presentation in the academic Council

Ref: 1) BCU/BOS-PG/Revise-Syllabi/34/2025-26 Dated 19-04-2025; 2) Proceedings of the meeting of BOS PG -Zoology held on 10-03-2026

The Chairperson- BOS in Zoology, Dr. Manmohan Singh Bengaluru City University, Bengaluru greeted the BOS Members before the commencement of the meeting.

A meeting of Board of Studies in Zoology of BCU was held on 10th March 2026 (during 10.30Am to 5.30pm) at Department of Zoology, Bangalore University, Jnanabharathi Campus, Bengaluru to scrutinize the drafted syllabus pertaining to 3rd and 4th semester M.Sc., Zoology Dr. Manmohan Singh Bengaluru City University, Bengaluru

Agenda 1: Approval of syllabi for 3rd and 4th semester M.Sc., Zoology

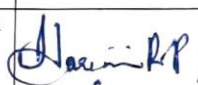
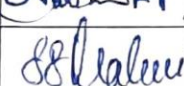
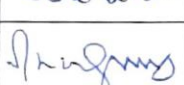
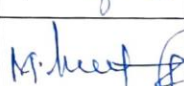
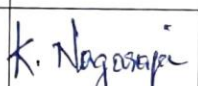
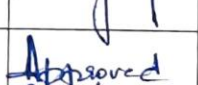
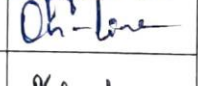
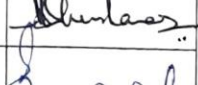
Resolution: The proposed syllabus for 3rd and 4th semester M.Sc., Zoology (both theory and practical) and as well as the scheme of examination were scrutinized thoroughly, finalized with appropriate inclusion(s)and deletion(s) of the contents and finally approved on 10th March 2026.

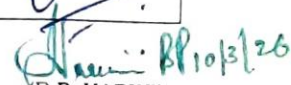
Agenda 2: Approval of panel of examiners for M.Sc., Zoology for the academic year 2026-2027

Resolution: The given panel of examiners for PG Zoology for the year 2026-2027 were scrutinized thoroughly, finalized with appropriate inclusion(s)and deletion(s) of the contents and finally approved.

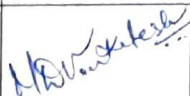
The meeting was concluded with the chairperson thanking all the members for rendering cooperation for the smooth conduct of the meeting.

The following BOS members attended the meeting

Sl. No.	Name of Chairman/Member	Designation	Signature
1.	Dr. B.P. Harini , Professor and Chairperson, Department of Zoology, Bangalore University, Bangalore-560056, Email: dr.bpharini@gmail.com; Phone No.: 9448939066	Chairperson	
2.	Dr. S.S. Malini , Professor & Chairperson, Dept. of Zoology, University of Mysore, Mysuru, Email:ssmalinisri@yahoo.com; Phone.No.96862612	Member	
3.	Dr. M. Shiva Shankar , Professor & Chairperson, Department of Life Sciences, Bangalore University, Bangalore-560056; Phone No.:8722048456; shivashankarseri@gmail.com	Member	
4.	Dr. Sreepriya , Professor & Chairperson, Department of Microbiology/ Biotechnology, Bangalore University, Bangalore-560056; Phone No.: 9448060936; mpriya7@yahoo.com	Member	
5.	Dr. Shakunthala. V , Professor & Chairperson, Department of Studies in Zoology, University of Mysore, Mysore; Phone No.:9483670892; drshakunthalav2@gmail.com	Member	
6.	Dr. K. Nagaraja , Professor & Chairperson, Department of Applied Zoology, Kuvempu University, Jnana Sahyadri, Shankaraghatta, Shimoga - 577 451, Phone No.: 9620485338; Email: knagarajv@gmail.com	Member	
7.	Dr. Mohammed S. Mustak , Professor & Chairperson, Department of Applied Zoology, Mangalagangothri, Mangalore University; Email: msmustak@gmail.com; Phone No.: 9743289671	Member	
8.	Dr. Bhushanam.M , Professor & Chairperson, Department of Zoology, Maharanis Cluster University, Bengaluru; Email: bhushanam.honey@gmail.com; Phone No.: 886192132	Member	
9.	Dr. Annappa Poojari , Professor & Chairperson, Department of Zoology, Nrupathunga University, Bengaluru, Email: annu1967@gmail.com; Phone No.: 8762972974	Member	
10.	Dr. N.G. Raju , Professor & Chairperson, Department of Zoology, Karnataka State Open University, Mukthagangothri, Mysuru Email:raju_119@yahoo.com; Phone No.: 9448267255	Member	


(B.P. HARINI)

BOS- Chairperson in Zoology (PG)
Dr. Manmohan Singh Bengaluru City University
Bengaluru-560001

11.	Dr. Prabhu. B.M , Faculty, Department of Zoology, Dr. Manmohan Singh Bengaluru City University, Bengaluru-560001 Email: prabhubm1@yahoo.com Phone No. 8197226540	Co- opted Member	
12.	Dr. Venkatesh .M.D , Faculty, Department of Zoology, Dr. Manmohan Singh Bengaluru City University, Bengaluru-560001 Email:mandayam.venkatesh@gmail.com Phone No. 9844358420	Co- opted Member	
13.	Dr. V. Kurinji Faculty, Department of Zoology, Dr. Manmohan Singh Bengaluru City University, Bengaluru-560001 Email: kurinjiv7@gmail.com Phone No. 9480452340	Co- opted Member	
14.	Dr. Rakesh. H , Faculty, Department of Zoology, Bangalore University, Bengaluru -560056, Phone No.: 9916311539	Co- opted Member	
15.	Dr. Shalini. M , Faculty, Centre for Applied Genetics, Department of Zoology, Bangalore University, Bengaluru -560056, Email: shalinimoses77@gmail.com Phone No.: 8050663448	Co- opted Member	


(B.P. HARINI)

BOS- Chairperson in Zoology (PG)
Dr. Manmohan Singh Bengaluru City University
Bengaluru-560001

CHAIRPERSON NOTE

The M.Sc., Zoology program aims to provide students with a comprehensive understanding of recent advances in Zoology, ranging from organismic to reductionist biology. It is designed to empower students to address societal and national challenges related to Zoology. The core subjects include the systematics of Chordates and Non-Chordates, Insect Biology, Aquaculture, Endocrinology, Behavioral and Evolutionary Mechanisms, Cancer Biology, Genetics, Genomics, Bioinformatics, Biostatistics, Biophysics, Immunology, Neurophysiology and their roles in health and disease, Applied Zoology, Environmental Biology, Pollutants and Pesticides, among others.

The program also offers a series of elective (softcore) courses, allowing students to specialize in areas of interest within Zoology. In alignment with the choice-based credit system, nearly 40% of the total credits are from elective courses. Core courses are taught in the first and second semesters, with 33% of credits dedicated to laboratory work and hands-on experience, emphasizing skill development.

In the third semester, students can select open elective courses from a variety of disciplines, such as Anthropology, Environmental Studies, and Biomedical Sciences, encouraging interdisciplinary engagement. These courses are intended to inspire research in interdisciplinary fields.

The fourth semester offers one elective course, two core courses, and an 8-credit project, providing students with practical experience in research design and execution. This semester also focuses heavily on skill-based training in socially relevant areas of Zoology.

This program is open to students with undergraduate degrees in Zoology or related Life Sciences.

(B.P. HARINI)
Chairperson - BOS in
Zoology (PG)
Dr. Manmohan Singh
Bengaluru City University

Graduate Attributes

Attribute 1:

Students will have In-depth knowledge and Advanced understanding of zoological concepts, theories, principles and ability to effectively communicate scientific information through written reports, oral presentations, and publications.

Attribute 2:

Critical thinking: Capacity to evaluate scientific evidence, critically analyze data, and draw informed conclusions. Expertise in a specific core area of Zoology, such as Wildlife conservation, Animal behavior, Molecular biology, Immunology, Animal physiology, Endocrinology etc.

Attribute 3:

Laboratory skills: With practical components in each area students achieve Proficiency in laboratory techniques, including microscopy, dissection, and molecular biology methods, clinical physiology, Computational biology, Systematic, knowledge on human disorders, environmental issues, human wild life conflicts etc.

Attribute 4:

Research skills: Ability to design, conduct, and analyze research in zoology, including data collection and statistical analysis and Analytical skills, Capacity to analyze complex data sets, identify patterns, and draw meaningful conclusions.

Attribute 5:

Problem-solving skills: Ability to apply zoological principles to solve real-world problems, such as conservation issues or animal welfare concerns, wildlife-man conflicts, climate change and its consequences.

Attribute 6:

Interdisciplinary understanding: Appreciation of the intersections between Zoology and other disciplines, such as Ecology, Evolution, and Environmental biology that make the students to acquire. Professional skills and preparation for careers in Zoology, including skills in Grants writing, Project management and Science communication. Awareness about the Ethics and Plagiarism.

Programme Details

Name of the Department: Department of

Zoology Subject: Zoology

Faculty: Science

Name of the Course: Master of Science in Zoology (M.Sc.)

Duration of the Course: 2 years - Comprises 4 semesters

Programme Objectives

The main objective of this M.Sc., programme is to provide strong foundation to the students in the subject of Zoology. The programme encompasses various courses spread across the four semesters, which intend to make the students conceptually and practically fit to handle the Classical, Molecular and Cellular aspects of Zoology. To prepare the students to take up teaching and research careers as Faculties in undergraduate colleges, Academic Institutions and Universities

- Researchers in reputed research institutions, Fishery, Animal husbandry, Forest Department Forensic Department
- Entrepreneur to start their own Life Science based company in Animal husbandry
- Biotechnology, Fisheries, Aquaculture etc.,
- Programme Outcomes M.Sc., programme in Zoology is a highly reputed programme among Life sciences in the University.

On successful completion of this programme each student will:

- Have a strong foundation in understanding the Classical and the most modern aspects of Animal sciences.
- Be able to learn Concepts and technology in the field of Genetics, Cell Biology, Human Genetics, Molecular Biology, Immunology, Cancer Biology, Molecular basis of Animal development, Environmental biology, Animal Biotechnology, Biodiversity and Wildlife Biology, Behavioral and Evolutionary biology.
- Develop practical skills along with their theory components, which will help in their research programme both in academic institutions and in R & D programmes of different national and international institutes.
- Inculcate skills for teaching in academic institutions for undergraduate and postgraduate students.
- Develop confidence in taking competitive examination in the field of Life science both in India and abroad so that they can pursue higher education.

Aims:

- Understanding animal structure and function: Studying the Anatomy, Physiology, and Biochemistry of Animals.
- Exploring animal diversity: Discovering the vast range of Animal species, their evolution and classification.
- Understanding animal behavior: Studying animal behavior, including social behavior, communication and migration patterns.
- Conservation and management: Learning about Conservation biology, Wildlife management and Animal welfare.
- Advancing human health: Applying zoological principles to improve human health, such as understanding disease mechanisms and developing new treatment methods.
- Improving animal production: Applying zoological principles to improve Animal farming, such as Breeding and Nutrition, Aquaculture and Bio-prospecting.
- Understanding ecosystems: Studying the interactions between animals and their environments, including Ecology and Biodiversity for sustainable development.
- Developing research skills: Learning scientific methods, Experimental design and Data analysis techniques.
- Preparing for careers: Preparing students for careers in Zoology, Wildlife conservation, Research and related fields.
- Promoting environmental awareness: Fostering an appreciation for the natural world and promoting environmental sustainability.

COURSE TITLES AND SYLLABUS OF III SEMESTER

Sl. No.	Course/ Paper Code	Title of the Paper	Teaching Hours/ week	End Semester Evaluation (Maximum Marks)		Total Marks	Credits
				Formative Assessment	Summative Assessment		
1	HCT-301	Developmental Biology	4	30	70	100	4
2	HCT-302	Endocrinology and Neuro Biology	4	30	70	100	4
3	HCT-303	Immunology and Cancer Biology	4	30	70	100	4
4	OE-304	OE- Economic Zoology	4	30	70	100	4
5	HCP-301	Developmental Biology	4	15	35	50	2
6	HCP-302	Endocrinology and Neuro Biology	4	15	35	50	2
7	HCP-303	Immunology and Cancer Biology	4	15	35	50	2
8	SCP-304	Tools and Techniques	4	15	35	50	2
	Total						24
Note: HCT- Hard Core Theory; SCT-Soft Core Theory; HCP-Hard Core Practical; OE - Open Elective; SCP- Soft Core Practical.							

Program Name	M.Sc.,	Semester	III
Course Title	DEVELOPMENTAL BIOLOGY (Theory)		
Course Code	HCT-301	Credits	4
Contact Hours per Week	4	Duration of Exam	3
Summative Assessment Marks	70	Formative Assessment Marks	30

Course Outcomes	
By the end of the program the students will be equipped with the following aspects:	
COURSE OBJECTIVES: • This course is structured with an intention of giving a contemporary Genetic and Molecular perspective to the classical Developmental Biology, which the students have learnt during their UG classes. It opens up the students to a new branch – The Developmental Genetics, which enables a genetic basis for understanding of animal development. The topics to study are organized in such a way that the student will get to understand the intricate genetic and molecular mechanisms. COURSE OUTCOME: • Understand the molecular basis of Cell autonomous and Conditional developmental decisions made during development. • Learn about the molecular cross talks and genetic pathway that work in setting up the basic body plan through specification of body axis in the early developmental stages in <i>Drosophila</i>, amphibians and mammals • Learn about the inductive and guiding signals which operate during morphogenesis with examples from nervous system and heart development. • Understand the regulation specification, axis formation and the role of cell death during tetrapod limb formation. Study the hormonal and cellular pathways which function during the Post embryonic developmental programs –Metamorphosis and Regeneration.	

Course Title	HCT-301: DEVELOPMENTAL BIOLOGY	52 Hrs
Contents		
Unit 1	Overview of Animal development and cellular differentiation: Animal development: Patterns, Study approaches and Model systems. Molecular events of fertilization, types of cleavage, blastulation, gastrulation, differentiation and derivatives of primary germ layers, neurogenesis and differentiation. Cellular differentiation and organogenesis: Cellular events involved in development – cell division, cell differentiation, cell specification and cell death. Differentiation of blood cells and chondrocytes. Somitogenesis-patterning of vertebrate limb and role of homeobox genes.	13Hrs
Unit 2	Genetic control of development in <i>Drosophila</i>: Early development - Oogenesis, cleavage, gastrulation and segmentation. Patterning embryo and larva - role of maternal genes, zygotic genes, pair-rule genes, segment polarity genes, homeotic selector genes. Imaginal discs and development of adult structures. Developmental mutants -bithorax and antennepedia complexes. <i>Drosophila</i> as a model organism to study development.	13Hrs

Unit 3	Post embryonic development: Metamorphosis, growth, regeneration and ageing: metamorphosis and its regulation in amphibians. Growth-types, mechanisms and regulation (growth hormones and factors). Regeneration-types and mechanisms- epimorphic regeneration of amphibian limb (Salamander), morpholactic regeneration in hydra, compensatory regeneration of mammalian liver. Ageing and senescence-theories on ageing.	13Hrs
Unit 4	Epigenetic and environmental regulation of animal development: – Teratology, Wilson's principles of Teratology, Teratogenesis, Teratogens-Chemicals/pharmaceuticals, alcohol, retinoic acid, radiation, heavy metals, environmental estrogens. Deviations and plasticity in development (polyphenism, environmental sex determination). Effect of xenobiotics on reproductive organs and development.	13Hrs.

Program Name	M.Sc.,	Semester	III
Course Title	DEVELOPMENTAL BIOLOGY (Practical)		
Course Code	HCP-301	Credits	2
Contact Hours Per Week	4	Duration of Exam	4
Summative Assessment Marks	35	Formative Assessment Marks	15

Sl.No.	Practical	52 Hrs
1.	Dissection and mounting of Ovary in silk worm larvae.	
2.	Dissection and mounting of Imaginal discs of <i>Drosophila melanogaster</i> .	
3.	Study of the Models of insect metamorphosis- <i>Drosophila</i> , <i>Periplaneta</i> , <i>Lepisma</i> , <i>Apis</i> .	
4.	Preparation of stained temporary/permanent mounts of larvae (whole mount) eg; larvae of mosquito, nauplius, zoea, megalopa, (any one of the available examples can be chosen)	
5.	Observation of Homeotic mutants of <i>Drosophila</i> –bithorax, antennepedia and Aristapedia complexes.	
6.	Study of developmental stages of frog – Egg, blastula, gastrula, neurula, tadpole external gill and internal gill (slides)	
7.	Study of developmental stages of chick embryo -24, 36, 48 & 72 hours of incubation.	
8.	Demonstration of Staining and mounting of chick blastoderm by vital dye (Nile blue or Neutral red solutions)-window technique method	
9.	Demonstration of impact of a teratogen on larval development in <i>Drosophila melanogaster</i> / silkworm larvae	

REFERENCES:

1. Gilbert S F. (2003): Developmental Biology: John Wiley Publishing
2. Gilbert. S F and Barresi, M J F. (2016). Developmental Biology
3. Wolpert, L, Beddington R., Jessel T. Lawrence P Meyerowitz E Smith J. (2002). Principles of Development: Oxford University Press.
4. Rao V. (1994). Developmental Biology Modern Synthesis: Oxford and IBH, New Delhi
5. Watson, J.D., Baker T. A., Bell S.P., Cann A., Levine M and Losick R. (2004). Developmental biology.
6. Alberts B.A, Johnson, J Lewis, Roff M., Roberts K and Walter P. (2002). Molecular Biology of the Cell IV Edition: Garland Science, New York.

Program Name	M.Sc.	Semester	III
Course Title	ENDOCRINOLOGY AND NEUROBIOLOGY (Theory)		
Course Code	HCT-302	Credits	4
Contact Hours per Week	4	Duration of Exam	3
Summative Assessment Marks	70	Formative Assessment Marks	30

Course Outcomes	
By the end of the program the students will be equipped with the following aspects:	
COURSE OBJECTIVES: Acquisition of the basic knowledge of Endocrinology and Neurobiology and related competences. Applying current research in Endocrinology and Neurobiology to solve biomedical challenges and related competences	
COURSE OUTCOME: - Understand the morphology, anatomy and physiological actions of Neuro and endocrine glands and Hypothalamus, hypophyseal system. - Understand the chemical nature and their biological actions of different hormones along with feedback mechanisms and their significance in homeostasis. - The course also addresses research methods, and critical thinking skills, emphasizing the application of knowledge to scientific research. - To understand the physiological mechanisms of neurosensory structures and their evolutionary perspective in invertebrate and vertebrate systems.	

Course Title	HCT-302: ENDOCRINOLOGY AND NEUROBIOLOGY	52hrs
Contents		
Unit 1	Endocrinology: Introduction to the endocrine system, Classes of hormones. Synthesis, release, transport of peptide and steroid hormone. Neurosecretory system and hormonal functions in Coelenterates, Helminths, Annelids, Arthropods, Mollusca. Vertebrate types of hormones in Crustaceans X-organ, Y- and associated neurohemal organs. Endocrine control of diapause, growth, colour changes and reproduction.	13Hrs
Unit 2	Endocrine system in Vertebrates: Pituitary gland: Physiological actions of pituitary hormones; Adeno-hypophyseal hormones: Somatotropin and prolactin, Glycoprotein hormones (FSH, LH, and TSH). Neuro-hypophyseal hormones: Oxytocin and vasopressin, Urotensin. Adrenal gland: Physiological role of adrenal hormones, catecholamine storage and release mechanism. Thyroid hormone action in poikilotherms and homeotherms. Hormones of Pineal and Parathyroid glands, Melatonin and circadian rhythm.	13Hrs

Unit 3	Neurobiology: Basic structure and function of human nervous system (CNS, PNS, ANS). Types of neurons and glial cells; Basis and significance of membrane potentials, equilibrium potentials and their changes during stimulation, action potential generation and its propagation, types of synapses, synaptic transmission-electrical and chemical, neurotransmitters, circuits and functions, mechanisms of synaptic inhibition.	13Hrs
Unit 4	Sensory mechanisms: Comparative account on Physiology of sensory mechanisms; Mechanoreception and Phonoreception; Hearing: Physiology of hearing and balance in vertebrates (including lateral line sense organ). Chemoreception in invertebrates and physiology of olfaction in vertebrates, Photoreception –visual pigments, simple eye (ocelli), compound eye (ommatidia) and vertebrate eye- Retinal structure and physiology of vision, color perception.	13 hrs

Program Name	M.Sc.,	Semester	III
Course Title	ENDOCRINOLOGY AND NEUROBIOLOGY (Practical)		
Course Code	HCP-302	Credits	2
Contact Hours per Week	4	Duration of Exam	4
Summative Assessment Marks	35	Formative Assessment Marks	15

Sl.No.	Practical	52 Hrs
1.	Study of Histology slides of Endocrine glands - Pituitary, Thyroid, Parathyroid, Thymus, Adrenal, Pancreas.	
2.	Study on effect of Eye Stalk ablation on Blood Glucose levels in Crabs.	
3.	Study on effect of thyroxin and thiourea (antithyroid agent) on oxygen consumption in fish. (Winkler's method)	
4.	Study on effect of insulin and adrenalin on blood glucose levels in Rat. (Using Glucometer)	
5.	Study on effect of progesterone/ testosterone on Acetylcholine esterase activity in blood /tissue samples.	
6.	Study of human brain (models and charts) identification of different regions with functions.	
7.	Estimation of ATPase activity in the given tissue sample (Fiske -Subbarow method)	
8.	Estimation of Dopamine in tissue samples.	
9.	To identify chemo and mechano sensilla on the appendages of <i>Drosophila melanogaster</i> .	
10.	Study of Behavioural assays in <i>Drosophila melanogaster</i> (olfactory/climbing cues).	

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1. Bolander Jr. F.F (2004) Molecular Endocrinology. Third Edition: Academic Press SanDiago.
2. Goodman, H.M. Basic Medical Endocrinology. Third Edition: Academic Press. Sandiego.
3. Melmed, SPolosky, K, Larsen, P. Kroneberg. H.M (2016): Oxford Textbooks of Endocrinology and Diabetes.
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8. Squires E J 2004. Applied animal endocrinology. CABI Pub.
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12. Highnam K C 1977. The comparative endocrinology of invertebrates. Elsevier.
13. Chapman R F. 2002. The insect structure and function. ELBS pub.
14. Hadley M E 2000. Endocrinology. Pearson education Inc.
15. Bolander F 2006. Molecular endocrinology. Academic Press.
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Program Name	M.Sc.	Semester	III
Course Title	IMMUNOLOGY AND CANCER BIOLOGY (Theory)		
Course Code	HCT -303	Credits	4
Contact Hours per Week	4	Duration of Exam	3
Summative Assessment Marks	70	Formative Assessment Marks	30

Course Outcomes	
By the end of the program the students will be equipped with the following aspects:	
COURSE OBJECTIVES:	
The primary objective of this course is to help students develop an understanding of role of immune system related to health and diseases. The course also emphasizes the research and development opportunities for therapeutic intervention arising from recent advances in immunology. Upon completion of the course students have a sound understanding of the essential elements of the immune system, carcinogens and cancer biology.	
COURSE OUTCOMES:	
- At the end of the course, the students should be able to identify the cellular and molecular basis of immune responsiveness and understand how the innate and adaptive immune responses coordinate to fight invading pathogens. - Understand the immunomodulatory strategies essential for generating or suppressing immune responses as required in hypersensitivity reactions, transplantation, autoimmune diseases and cancer. - Design new methods to improve existing vaccines and other immunotherapeutic strategies. - They will have an enhanced understanding of epidemiology and incidence of cancer in India and the world.	

Course Title		HCT:303- IMMUNOLOGY AND CANCER BIOLOGY	52hrs
Contents			
Unit 1	Cells of the Immune system: Biology of cells of the immune system: Haematopoiesis, Microphages (Neutrophils), Macrophages, T-Lymphocytes, B-Lymphocytes, Dendritic cells and NK cells. Structure of lymph node, spleen, mucosal associated lymphoid tissue and gut associated lymphoid tissue. Types of Immunity: Innate immunity: Anatomic barriers, Physiological barriers, Phagocytic barriers, Microbial antagonism, Inflammation, PRRs, TLRs and PAMPs. Acquired immunity: Naturally acquired, artificially acquired and adaptive, Humoral and cell mediated immunity, Complement system: components, activation and biological consequences.		13Hrs

Unit 2	Antigens, Immunoglobulins and vaccines: Factors influencing immunogenicity, Haptens, Classes of immunoglobulins, Structure of IgG, Kinetics of immunoglobulin synthesis, Genetic basis of immunoglobulin diversity. MHC molecules – Types and structure Vaccines: Principles of vaccination, primary and secondary responses, antibody engineering, Monoclonal antibodies and their applications, antigen-antibody interactions, congenital and acquired immunodeficiency. Autoimmunity and autoimmune diseases (Rheumatoid Arthritis, Psoriasis).	13Hrs
Unit 3	CANCER BIOLOGY: Carcinogens (physical, chemical and biological) and their mechanism of action, Role of viruses in human cancer. Neoplasia, anaplasia, metaplasia and hyperplasia; Types of cancer- benign, malignant. Carcinomas, sarcomas, adenomas, haemopoietin cancers. Biology of tumor progression: Properties of cancer cells, Molecular basis of cancer cell behaviour. Signaling pathways of cancer progression.	13Hrs
Unit 4	GENETIC BASIS OF CANCER AND THERAPIES: Mechanism of carcinogenic transformation by oncogenes and tumor suppressor genes, (a) Oncogenes: Retroviral oncogenes, proto-oncogenes, oncogene in human cancer, functions of oncogene products. (b) Tumor suppressor genes: properties and functions of tumor suppressor genes. Role of immune system in preventing tumor growth. Genetic factors for oncogenesis; DNA damage and DNA repair defects; Knudson's two-hit hypothesis; Mutator hypothesis; Loss of heterozygosity analysis and microsatellite instability. Cancer therapy: early detection and prevention, molecular diagnosis, treatment. Cancer therapies- Immunotherapy, gene therapy, chemotherapy (emphasis on cancer drugs) and radiotherapy.	13Hrs

Program Name	M.Sc.,	Semester	III
Course Title	IMMUNOLOGY AND CANCER BIOLOGY (Practical)		
Course Code	HCP-303	Credits	2
Contact Hours per Week	4	Duration of Exam	4
Summative Assessment Marks	35	Formative Assessment Marks	15

Sl.No.	Practical	52 Hrs
1.	Demonstration of Precipitation reaction: Single radial immunodiffusion	
2.	Demonstration of Enzyme-linked immunosorbent assay (DOT)	
3.	Total Count and Differential Count of blood cells	
4.	Immunological diagnosis of pregnancy	
5.	Isolation of lymphocytes from whole blood sample.	
6.	Study of autoimmune disorders (charts- Rheumatoid Arthritis, Psoriasis, diabetes type I and Systemic Lupus Erythematosus)	
7.	Histological study of spleen, thymus, bone marrow and lymph node	
8.	Demonstration of immunoelectrophoresis	
9.	Study of histological slides/charts of cancer(Prostate adenocarcinoma, Endometrioid adenocarcinoma, Breast cancer and Leukaemia)	
10.	Study of diagnostic tools for cancer detection: Biopsy, CT-scan, and PET scan	
11.	Demonstration of DNA damage by mild carcinogen using fluorescent microscopy	

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Program Name	M.Sc.	Semester	III
Course Title	ECONOMIC ZOOLOGY (Theory)		
Course Code	OE-304	Credits	4
Contact Hours per Week	4	Duration of Exam	3
Summative Assessment Marks	70	Formative Assessment Marks	30

Course Outcomes	
By the end of the program the students will be equipped with the following aspects:	
COURSE OBJECTIVE: - Knowledge of Animal welfare and animals as resources. Evaluate the possible rearing and breeding techniques. Explore the in opportunities and address problems of animal farming for sustainability. COURSE OUTCOMES: - Apply the scientific method of Animal welfare and animals rearing techniques. - Use interdisciplinary approaches such as ecology, economics, ethics and policy to devise solutions to use animals as resources. - To make the students aware of alternate occupational and allied agro-based skills. - To create a consciousness regarding pet animals and their role in human welfare.	

Course Title		OE-304: ECONOMIC ZOOLOGY	52hrs
Contents			
Unit 1	VERMICULTURE AND BENEFICIAL INSECTS: Vermiculture and vermicompost. Definition, types of earthworms, methodology, and importance. Apiculture: Honeybee species, Bee forage, Pollen calendar, Modern beekeeping activity, migratory beekeeping, Honey and bee hive products, quality assessment of honey, honeybee diseases, their control and management. Sericulture: Types of silkworms, silkworm races, Life cycle of <i>Bombyx mori</i> in brief, Rearing methods. Bivoltine and multivoltine seed areas, Silkworm diseases and their control. Economic importance. Lac culture: Importance, Lac insects, host plants, Lac culture and by products.		13Hrs.
Unit 2	FISHERIES: Fisheries resources of India: Scope and importance of coastal, deep sea and inland fisheries. Fresh water and marine aquaculture Culturable organisms: Shell fishery: Prawn, Pearl and Oyster culture. Fin fishery: Intensive freshwater fish culture: Carps and Cat fishes, Integrated Fish farming. Composite and polyculture fish farming and fish by products. Ornamental fish culture, algae and sea weeds as bio-fertilizer. Aquarium and terrarium.		13Hrs

Unit 3	ANIMAL FARMING: Poultry: Poultry breeds, hatcheries, broiler, layers and rearing of poultry breeds. Nutritional value of egg and meat. Poultry diseases and their management and poultry by products. Commercial rearing of Duck, Emu farming Dairy: Dairy breeds, breeds of cow and buffalo, dairy farming, dairy management and nutritive value of milk and by products of dairy. Sheep and Goat breeds and their farming. Piggery: Pig species, rearing and by products.	13Hrs
Unit 4	PET ANIMALS: Pet Animals: Maintenance of pet animals (Birds, Cats, and Dogs). Breeds of dogs and cats, dog and cat breeds, Training and important dog breeds in crime investigations and military operations. Pests, diseases of pet animals and their management Institutional animal ethical committee (IAEC).	13Hrs

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Program Name	M.Sc.	Semester	III
Course Title	TOOLS AND TECHNIQUES (Practical)		
Course Code	SCP-304	Credits	2
Contact Hours per Week	4	Duration of Exam	3
Summative Assessment Marks	35	Formative Assessment Marks	15

Course Outcomes	
By the end of the program the students will be equipped with the following aspects:	
COURSE OBJECTIVE: To provide general overview of different tools and techniques applicable in biological research including various types of microscopes, centrifuges, electrophoresis, chromatography etc. The emphasis is on understanding the principles and working mechanisms of different instruments. To Develop skills for usage of advanced instrumentation.	
COURSE OUTCOMES: - Understanding the basic knowledge of some advance techniques and their uses and its potential application in animal biology. - To understand the various techniques used in biological sciences. - To Learn the Applications of various types of Microscope. - To Learn the uses of various analytical techniques like centrifugation, spectrophotometry, pH meter, Chromatography, Electrophoresis.	

Sl.No.	Practical	52 Hrs
1.	To prepare (SOP) standard operating procedure/ good laboratory Practices.	
2.	Study of working principle of analytical instruments: pH meter, Colorimeter, Spectrophotometer and Particles size analyser	
3.	Study of optical instruments: High resolution, Phase contrast and fluorescent microscopes, Cell imaging, TEM, and SEM (demonstration)	
4.	Centrifugation: High speed, Density gradient centrifugation	
5.	Chromatography: Paper chromatography and thin layer chromatography	
6.	Electrophoresis: SDS PAGE, Agarose gel, Immunoblotting	
7.	Demonstration of perfusion technique	
8.	Microtome: Paraffin Block preparation and sectioning. Ultra-microtome (demonstration)	
9.	Media preparation and culture technique: Primary and Cell lines.	

Note: Working principle and applications to be emphasized on instrumentation.

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COURSE TITLES AND SYLLABUS OF IV SEMESTER							
Sl. No	Course/ Paper Code	Title of the Paper	Teaching Hours/ week	End Semester Evaluation (Maximum Marks)		Total Marks	Credits
				Summative Assessment	Formative Assessment		
1	HCT-401	Animal Biotechnology and Genetic Engineering	04	30	70	100	4
2	HCT-402	Toxicology and Advanced Biology	04	30	70	100	4
3	HCT-403	Human Health and Diseases	04	30	70	100	4
4	HCT-404	Research Methodology	04	30	70	100	4
5	PR-404	Project Work	04	30	70	100	4
6	HCP-401	Animal Biotechnology, Genetic Engineering,	4	15	35	50	2
7	HCP-402	Toxicology and Advanced Biology	4	15	35	50	2
8	HCP- 403	Human Health and Diseases	4	15	35	50	2
9	HCP- 404	Research Methodology	4	15	35	50	2
10	PRP-404	Project Work	4	15	35	50	2
Total							24
Note: HCT- Hard Core Theory; HCP-Hard Core Practical; PR-Project work; PRP-Project work Practical							

NOTE:

- ❖ There has been an option provided to offer either HCT-404 and corresponding HCP-404 Research methodology papers or PR-404 Project work and PRP- 404 Project work practical as the 4th paper. The discretion of the choice of paper to be offered is decided by the department chairperson in consultation with the faculty considering all parameters needed for the same.
- ❖ In lieu of offering PR-404 and corresponding PRP-404 the following guidelines are to be followed:
- ❖ **Project assessment (Pattern -A)**, PR-404 shall consider the Project work conducted along with the objectives, review of literature, Methods and methodologies, results and discussions, related aspects (70 marks) while its internal assessment can be based on these parameters and cognate concepts related to the project (30 marks). In case of PRP-404 the assessment can be based on final project presentation (35 marks) and viva-voce (15 marks).
- ❖ **Project assessment (Pattern -B)**, PR-404 shall consider the Project work conducted along with the objectives, review of literature, Methods and methodologies, results and discussions, related aspects (100 marks) In case of PRP-404 the assessment can be based on final project presentation and viva-voce (50 marks).
- ❖ Students project work will be guided by the department faculty members who have qualified with their doctoral degree.

- ❖ Student is given option to conduct their project work outside the department, complete the work and submit the project report as a dissertation within the last working day of the semester. However, the student has to have correspondence with the designated faculty or coordinator providing the relevant details.
- ❖ Students must visit the institute/laboratory only at the schedule time given in the time table.
- ❖ A permission letter from the Department chairperson is needed to be obtained and a consent letter from the institute/laboratory should also be produced to the department.
- ❖ Chit system of guide selection should be adopted to select the Mentor.

Program Name	M.Sc.	Semester	IV
Course Title	ANIMAL BIOTECHNOLOGY AND GENETIC ENGINEERING (Theory)		
Course Code	HCT -401	Credits	4
Contact Hours per Week	4	Duration of Exam	3
Summative Assessment Marks	70	Formative Assessment Marks	30

Course Outcomes
COURSE OBJECTIVES: - The objective of this course is to provide a comprehensive knowledge of animal breeding, its concepts and techniques of manipulation of embryos, animal cell culture, gene cloning and analysis of recombinants and transgenic technologies. COURSE OUTCOMES: - Understand basic principles and concepts of livestock improvement, manipulation of embryos, techniques used in gene transfer. - To gain knowledge on cell culture, culture media, cell culture techniques and cell lines. - To gain knowledge on cloning vectors and their uses in gene cloning, cloning strategies and screening analysis of recombinants. - To apply principles and concepts of Biotechnology in various branches of research and development including veterinary sciences.

Course Title	HCT 401: ANIMAL BIOTECHNOLOGY AND GENETIC ENGINEERING	52hrs
Contents		
Unit 1	Animal tissue culture requirements and methods: Introduction, Types of culture- Organ culture, cell culture, organotypic culture, histotypic culture. Design and layout of animal tissue culture laboratory, maintenance of sterile condition Equipments – Essential, beneficial and useful equipments, consumable items. Culture medium- Physico-chemical properties, complete media, serum, serum free media, balanced salt solutions, selection of medium and serum. Preparation and sterilization – Apparatus, Reagents and media, storage Contamination- Source and types of contamination. Primary culture- Types (Primary explant and primary cell cultures). Primary explant culture method (mouse/chick embryo tissues). Primary cell culture method- disaggregation (enzymatic, mechanical) and culturing. Lymphocyte culture method (Suspension culture)	13Hrs

Unit 2	Cell-lines, Organ culture, large scale cultures and applications of animal tissue culture: Cell lines: Definition, Types of cell lines, Cell line banking, cryopreservation. Organ culture - Raft and grid methods, Watch glass technique, Maximow single slide technique, agar gel technique, histotypic culture; Gel and sponge technique, hollow fibres, spheroids Large scale cultures – Fermentor design, scaleup in suspension and monolayer. Downstream processing. Use of animal cells as replacement for whole animal in toxicity testing. Commercial application of animal tissue culture – Uses of animal cells in vaccine production, Cell cultures in the production of medicinally important compounds –pharmaceuticals, enzymes, hormones, interleukins, interferons.	13Hrs
Unit 3	Animal Breeding: Introduction, Scope and Development of Animal Biotechnology. Livestock improvement: Manipulation of reproduction in animals- Artificial Insemination and Germ Cell Storage, <i>In-vitro</i> Fertilization (IVF), Zygote intra fallopian transfer (ZIFT) and Embryo Transfer; Superovulation: Physiological Basis, Influencing Factors, Freezing of embryos, Embryo sexing, Micromanipulation of Embryos - Embryo Splitting, Nuclear Transplantation and Gene injection techniques (Microinjection, electroporation, lipofection and viral mediated gene transfer techniques), Advantages of Cell Manipulation.	13Hrs
Unit 4	Genetic Engineering: Introduction, Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase. Cloning vectors: Plasmids, Phages, M13 vectors, Cosmids, Phagemids, Bluescript vectors. Artificial chromosomes (YAC, BAC, HAC), Expression vectors- Animal Virus derived vectors-SV-40, vaccinia/baculovirus expression system. Cloning strategies and analysis: Construction of Genomic and cDNA libraries, Identification of Recombinants-Genetic selection, Use of chromogenic substrates, Insertional activation. Analysis of recombinant DNA clones- Characterization of clones. Transgenic Technology: Introduction, genetically modified organisms; gene knockouts and mouse disease models, Transgenic animals; Gene editing- Gene silencing-CRISPR-associated protein-9 nuclease (Cas9) technology.	13Hrs

Program Name	M.Sc.,	Semester	IV
Course Title	ANIMAL BIOTECHNOLOGY, GENETIC ENGINEERING, (Practical)		
Course Code	HCP-401	Credits	2
Contact Hours per Week	4	Duration of Exam	4
Summative Assessment Marks	35	Formative Assessment Marks	15

Sl.No.	Practical	52 Hrs
1.	Packing and sterilization of glassware for cell culture	
2.	Preparation of media and reagents for animal cell culture	
3.	Primary culture technique: Chicken embryo fibroblast/ Animal hepatocytes	
4.	Cell viability and counting by trypan blue method	
5.	Estimation of lipid peroxidase (malonaldehyde in cytotoxicity induced cells)	
6.	Isolation and purification of plasmid DNA	
7.	Genetic transformation by Blue white screening	
8.	Genome editing by CRISPR/Cas9 (Demonstration / Institute visit)	
9.	Isolation and characterization of high purity DNA by spectrometric assay and melting temp	
10.	Isolation of RNA from liver sample by Phenol method	

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Program Name	M.Sc.	Semester	IV
Course Title	TOXICOLOGY AND ADVANCED BIOLOGY (Theory)		
Course Code	HCT -402	Credits	4
Contact Hours per Week	4	Duration of Exam	3
Summative Assessment Marks	70	Formative Assessment Marks	30

Course Outcomes	
By the end of the program the students will be equipped with the following aspects:	
COURSE OBJECTIVES:	
To understand the basics of toxicology and toxicants. Knowledge of Xenobiotics and metabolic impact, biochemical and cellular responses. Introduction to nanoworld, use of nanotechnology in health and research. To have a basic knowhow of clinical research, understanding the concepts of Pharmacodynamics and kinetics, clinical trials.	
COURSE OUTCOMES:	
- Students can comprehend the concepts of toxicology, their impact on human health and remedial measures. - A deeper understanding of the biochemical aspects and metabolic outcomes due to toxicants including drug studies. - Develop inquiry into nanoparticles and their usage in biological and health research and treatment regimes. - Explore opportunities in evaluation of drugs from pharmaceutical perspective and idea of clinical trials.	

Course Title		52hrs
HCT 402: TOXICOLOGY AND ADVANCED BIOLOGY		
Contents		
Unit 1	Toxicology and Tissue damage - General toxicology, risk and hazard, Threshold and non-threshold dose responses, classification of toxic agents and mutagens. Use of human tissue in toxicology. Reversible and irreversible tissue damage. Tissue responses to toxic injury, Environmental toxicology, food toxicology, clinical toxicology. occupational toxicology-hazardous chemicals, disorders from chemical exposure at work, assessment of occupational hazards. Effects of exposure to heavy metals (lead, mercury and arsenic), non-metals (fluorine), gases (carbon monoxide, chlorine), radioactive waste.	13Hrs
Unit 2	Xenobiotic metabolism: Xenobiotics and their classes, xenobiotic metabolism and kinetics, Introduction to phase I and Phase II reactions, enzymes involved in xenobiotic metabolism, cytochrome P450, flavin containing enzymes and others (phase I enzymes) and Glutathione, S transferases, glucuronyl transferases, sulfotransferases, enzymes involved in ROS production and breakdown and their polymorphism. Elimination of xenobiotics, variation in metabolism due to endogenous and exogenous factors. Effects of xenobiotics on reproductive organs and developmental toxicants.	13Hrs

Unit 3	Biochemical Toxicology- Enzymes involved in ROS production and breakdown and their polymorphism. Oxidative stress, disruption of cellular calcium Lipid peroxidation, protein, and DNA damages. Antioxidant enzymes and molecules, mechanism of their action. Measurement of toxicity- Acute and chronic toxicity tests. The Ames test, gene mutation tests using mammalian cell, chromosome aberration test, micronucleus assay, Green screen HC, The skin reconstructed micro nucleus assay. In vitro toxicology, Pig A assays, <i>Drosophila</i> sex linked recessive lethal gene test (SLRL). Dominant lethal test (rodent), Heritable translocation test (rodent). DNA damage measurement.	13Hrs
Unit 4	Introduction to Nanobiology and Clinical research: Nano biology: introduction to nanoscience, Nanomaterial in biology, overview of Biological nanoparticles production, Biosensors, Nano biosensors in diagnosis, Lab-on-a-chip concept. Introduction to pharmacology, principles of pharmacokinetics, features of ADME, Pharmacodynamics, drug toxicity and poisoning. Nanobiotechnological applications in health and disease, Advantages of nanotechnology in drug delivery. Clinical Research: An Overview, types of Clinical Research. Drug Development Process: Preclinical trail, Human Pharmacology (Phase-I), Therapeutic Exploratory trail (Phase-II), Therapeutic Confirmatory Trail (Phase-III) and Post marketing surveillance (Phase-IV). Account of different roles in clinical research, overview of Clinical data management and medical writing.	13Hrs

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Program Name	M.Sc.,	Semester	IV
Course Title	TOXICOLOGY AND ADVANCED BIOLOGY, (Practical)		
Course Code	HCP-402	Credits	2
Contact Hours per Week	4	Duration of Exam	4
Summative Assessment Marks	35	Formative Assessment Marks	15

Sl.No.	Practical	52 Hrs
1.	To prepare (SOP) standard operating procedure/ good laboratory Practices.	
2.	Detection of adulterants in food samples.	
3.	Analysis of presence of toxicants like pesticides etc., from vegetable samples and Detection of organophosphates by chromatographic method.	
4.	Determination of LC ₅₀ and LD ₅₀ of selected toxicants	
5.	Estimation of antioxidants (SOD, Catalase)	
6.	Estimation of Biomarkers (Lipid peroxidation& Protein Carbonylation)	
7.	Detection of mercury chloride by enzyme inhibition technique.	
8.	Demonstration of genotoxicity of a chemical in an animal model - <i>Drosophila melanogaster</i> or <i>Bombyx mori</i>	
9.	Preparation of metal oxide ZnO nanoparticles (non-aqueous route) and observe its luminescence under UV lamp or UV-VIS absorption properties of ZnO nanoparticles and estimation of particle size using Brus equation/ green nano particle.	
10.	Case studies (any one) i) Role of nanomedicine in improving the efficacy and safety of cytotoxic drugs: Abraxanem/ Doxil / Daunosome. ii) Methods of targeting multiple cancer mechanisms using single nanomedicines: Core-shell systems for leukemia and liver cancer. iii) Report on Endosulphan tragedy.	

Program Name	MSc.,	Semester	IV
Course Title	HUMAN HEALTH AND DISEASES (Theory)		
Course Code	HCT -403	Credits	4
Contact Hours per Week	4	Duration of Exam	3
Summative Assessment Marks	70	Formative Assessment Marks	30

Course Outcomes	
By the end of the program the students will be equipped with the following aspects:	
COURSE OBJECTIVES:	
To give a conceptual basis of nutrition, health and disease in relation to each other. To understand the disease and their impact on human population with significance of health care. To have an overview of the diagnostic methods and investigative techniques.	
COURSE OUTCOME:	
- Student would be able to classify disease and disorder and understand the role of nutrients and pathogens from disease perse. - Preparedness for addressing the issues related to global research with reference to diseases like Diabetes, cancer, heart problems. - Have a perspective on pathological basis of many diseases. - A birds eye view into diagnostic techniques that can be helpful in exploring and understanding of healthcare with technology.	

Course Title	HCT 403: HUMAN HEALTH AND DISEASES	52 hrs
Contents		
Unit 1	General information on food and nutrition: Basic terms used in study of food and nutrition, an interrelationship Food, nutrition and health. Influence of food on Physiological, neurological and psychological aspects. essentials of nutrients: sources functions disease related to deficiency/excess of the following nutrients-proteins, lipids and carbohydrates, fat soluble vitamins-A, D, E and K, water soluble vitamins-B and C and their disorders. Minerals-calcium, iodine and iron.	13Hrs

Unit 2	General Information on Human health: WHO definition of health, disease, disorder; classification of diseases based on source, global distribution of diseases. General information on Human health & disease; heart diseases — Hypertension, thrombosis (blocks), heart attack (angiogram, angioplasty and open-heart surgery) Diabetes mellitus — Causes and treatment (normal blood sugar level), Liver cirrhosis and Hepatitis — Types, causes and treatment, Bronchitis, Allergy. Genetic diseases — Introduction to genetic disorders, Neurological disorder - Alzheimer's and Parkinson's, Psychiatric disorders - Depression, schizophrenia, Behavioral disorders - attention	13Hrs
	deficit hyperactivity disorder, Eugenics - and Positive and negative Eugenics.	
Unit 3	Disease diagnostics: Physical examination and laboratory testing for disease diagnosis: Pulmonary function tests. Diagnosis of Diabetes mellitus and Glucosurea. VDRL/ Widal test for bacterial infections. Methods to diagnose viral infection; Scanning Procedure (CT, MRI) Understanding EEG and ECG. DNA utilization in Disease diagnosis.	13Hrs
Unit 4	Enzymes in diagnosis of human diseases and health care: Acetylcholinesterase, angiotensin converting enzyme (ACE), Pseudocholinesterase, 5'- nucleotidase (5NT), Glucose-6-phosphate dehydrogenase (GPD) and other red blood cell enzymes; Immuno reactive trypsinogen (IRT) and Chymotrypsin; Amylase isoenzymes, Macroamylase, Isoenzymes (CK, LDH, ALP). SGOT and SGPT.	13Hrs

Program Name	M.Sc.,	Semester	IV
Course Title	HUMAN HEALTH AND DISEASES (Practical)		
Course Code	HCP-403	Credits	2
Contact Hours per Week	4	Duration of Exam	4
Summative Assessment Marks	35	Formative Assessment Marks	15

Sl.No.	Practical	52 Hrs
1.	Planning, preparation and nutritional evaluation of diets in relation to age, activity levels and physiological state, hypertension/Diabetes/renal failure.	
2.	Estimation of SGOT, SGPT, in human/animal blood/serum/tissue samples.	
3.	Estimation of LDH in human/animal blood/ serum/CSF /tissue samples.	
4.	Estimation of Creatinine in human/animal serum/urine samples.	
5.	Estimation of glucose in human/animal serum/urine/ tissue samples.	
6.	Estimation of Ascorbic acid levels in urine sample.	
7.	Estimation of Bilirubin in human serum/urine samples.	
8.	Immunoassay for detection of microbial infection (kit method). STD detection by agglutination method (kit method).	
9.	CT and MRI - Principle, outlines of construction and scope.	
10.	A report submission on a field visit to Diagnostic center.	

REFERENCES:

1. Atul B M, Hoffbrand A V, Haematology at a glance- Medical -2005.
2. Gibney et al. Public Health Nutrition; Blackwell Publishing, 2004.
3. Hoffbrand V, Moss P. A. H, Roberts E, Essential haematology- Medical -2006.
4. Lakra P, Singh M.D. Textbook of Nutrition and Health; First Ed; Academic Excellence Publications, 2008.
5. Mudambi, SR and Rsjagopal, M.V. Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed; New Age International (P) Ltd, Publishers, 2012.
6. Srilakshmi B. Nutrition Science; New Age international (P) Ltd, Publishers, 2012.
7. Sudhir V S, Diseases of The Brain and Nervous System: A Health Education Guide. Team Spirit (India) Pvt. Ltd. Publishers, 2008.
8. Sun S. and Malhotra A. Food Science, Nutrition & Food Safety Pearson India Ltd.,2014.
9. World Health Organization (WHO), No. 2, p. 100.,1948.
10. Zelman M, Tompary E, Raymond J, Holdaway P and Mullybill M.L.E. Human Diseases: A Systemic Approach, 7TH Ed; Pearson Prentice Hall, 2009.

Program Name	M.Sc.	Semester	IV
Course Title	RESEARCH METHODOLOGY (Theory)		
Course Code	HCT 404	Credits	4
Contact Hours per Week	4	Duration of Exam	3
Summative Assessment Marks	70	Formative Assessment Marks	30

Course Outcomes	
By the end of the program the students will be equipped with the following aspects:	
COURSE OBJECTIVE:	
To give an overview of the research methodology and explain the technique of defining a research problem. To carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review. Learn the art of interpretation and the art of writing research reports.	
COURSE OUTCOME:	
- Able to formulate research problem and analyze literature review and find gaps to finalize research objectives. - Identify the need of ethics in research. - Apply basic data analytics techniques like probability distribution, correlation linear regression and ANOVA. - Ability to develop skills to draft a research paper.	

Course Title		HCT 404: RESEARCH METHODOLOGY	52hrs
Contents			
Unit 1	Introduction to Research: Meaning of research, objectives, and motivation in research. Types of research: Descriptive vs analytical research, applied vs fundamental research, Conceptual vs empirical research. Methods vs methodology. Research process, criteria for good research. Research funding in India and problems encountered by researchers in India. Prospects for research in India. Intellectual Property, Research Ethics: Patent act of 197, Protection of animal and plant species and Farmers Right Act 2001. World Intellectual Property Organisation (WIPO), Research ethics-ethical issues, Institutional guidelines of Govt. of India for using biological and human samples.		13 Hrs

Unit 2	Defining the Research Problem and Reviewing the Literature: Formulating the research problem, selecting the problem, necessity of defining the problem. Techniques in defining the problem. Preparation and presentation of research problem. Role of literature review in research topic. How to review the literature, searching the existing literature, Broadening the knowledge base in research area. Developing a theoretical framework, conceptual framework and presenting the literature reviewed. Scholarly publishing- IMRAD concept and design of research paper, citation and acknowledgement, plagiarism, reproducibility, and accountability.	13 Hrs
Unit 3	Research Design and Sample Surveys: Meaning and need for research design. Types-historical, descriptive, explorative, and experimental. Concepts relating to research design, different research designs, and features of good design. Basic principle of experimental design Introduction to sample design, sampling, and non-sampling errors. Sample survey vs census survey and types of sampling design. Formulation of hypothesis, sources of hypothesis, characteristics, and role of hypothesis. Tests of hypothesis.	13Hrs
Unit 4	Data Collection and Report Writing: Experimental and survey-collection of primary and secondary data. Methods in data collection-observation method, interview, through questionnaires and case study method. Processing and analysis of data: statistics in research-descriptive and inferential statistics. Analysis and interpretation of data. Report writing: Significance of report writing, different steps in writing reports, layout of research report, mechanics of writing research report, necessary precautions in writing research reports, conclusions.	13Hrs

REFERENCES:

1. Bordens, K. S. and Abbott, B. B. (2011). Research Design and Methods – A Process Approach, 8th Edition, McGraw-Hill.
2. C R Kothari, Research Methodology – Methods and Techniques, 2nd Edition, New Age International Publishers.
3. Davis, M., Davis K., and Dunagan M. (2012). Scientific Papers and Presentations, 3rd Edition: Elsevier Inc.
4. Michael P. Marder. (2011). Research Methods for Science: Cambridge University Press.
5. T. Ramappa. (2008). Intellectual Property Rights Under WTO: S. Chand.
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley. (2012). Intellectual Property in New Technological Age. Aspen Law & Business; 6th edition.
7. Tony Greenfield and Sue Greener. (2016). Research Methods for Postgraduates, 3rd Edition: John Wiley & Sons Ltd.,

Program Name	M.Sc.,	Semester	IV
Course Title	RESEARCH METHODOLOGY (Practical)		
Course Code	HCP-403	Credits	2
Contact Hours per Week	4	Duration of Exam	4
Summative Assessment Marks	35	Formative Assessment Marks	15

Sl.No.	Practical	52 Hrs
1.	Criteria involved in selection of research topic and modalities of exhaustion, Importance of scientific surveys.	
2.	Designing the project, Defining Objectives.	
3.	Preparing Questionnaire, Opinionnaire, conducting Interview.	
4.	Literature survey, Primary data and secondary data in research, protocols.	
5.	Selecting a title for the paper, writing the abstract and key words.	
6.	Conclusions and Results, Writing the Discussion, Citation of references using different styles.	
7.	Use of MS Excel in data presentation.	
8.	Use of SPSS soft-ware for scientific approach, Examples of some common statistical tests.	
9.	IPR – in India- case studies; Turmeric, Glivec cancer drug (Novartis), Nexavar (Bayer) Vs Union of India.	
10.	Making an ICT enabled scientific presentation.	

Scheme of Examination for III and IV Semester (M.Sc., Zoology)

Rigorous Assessment and Evaluation: Formative and Summative Assessments

Formative Assessment for Theory	
Assessment Occasion / Type	Marks
Test – 1	10
Test – 2	10
Seminars/Presentations/Assignment	05
Attendance	05
Total	30
Formative Assessment for Practical	
Assessment Occasion / Type	Marks
Test – 1	10
Record	05
Total	15

PATTERN OF SEMESTER END EXAMINATION QUESTION PAPER

SECTION – A	Comprises 4 Compulsory questions. Each question carries 2 marks	(2X 4 = 08 Marks)
SECTION – B	Comprises 4 questions with internal choice within a unit. Each question carries 8 marks	(8 X 4 = 32 Marks)
SECTION – C	Comprises questions from each unit with choices among units. Each question carries 15 marks	(15 X 2 = 30 Marks)
TOTAL		70 Marks

PATTERN OF SEMESTER END - PRACTICAL EXAMINATION QUESTION PAPER

SECTION – A	Comprises 1 major experiments with choice. Each question carries 12 marks	(1 X 12 = 12 Marks)
SECTION – B	Comprises 1 Minor experiments with choice. Each question carries 8 marks	(1 X 8 = 8 Marks)
SECTION – C	Comprises of Spotters/specimen	(10 Marks)
SECTION – D	Viva	05 marks
TOTAL		35 Marks

**PATTERN -A OF PROJECT ASSESSMENT similar to other papers with Theory
(70+30 marks)
And Practical (35 +15 marks) pattern**

OR

PATTERN -B OF PROJECT ASSESSMENT

	ASSESSMENT TYPE	MARKS
SECTION -A	Project work and submission	100
SECTION- B	Project presentation+ Viva-Voce	50
	TOTAL	150
