

ARULMIGU PALANIANDAVAR ARTS COLLEGE FOR WOMEN, PALANI

(AUTONOMOUS)

RE-ACCREDITED WITH B⁺⁺ GRADE BY NAAC

(Affiliated to Mother Teresa Women's University, Kodaikanal)

PG AND RESEARCH DEPARTMENT OF ENGLISH

**CURRICULUM FRAMEWORK AND SYLLABUS FOR
OUTCOME BASED EDUCATION**

IN

M.Sc., (ZOOLOGY)



UNDER

CHOICE BASED CREDIT SYSTEM

2019-2022

Program Outcomes:

Upon completion of M.Sc., Zoology Degree Programme, the outcomes are expected from the graduates.

PO1	Gaining relevant knowledge of core concept, principles, themes, terminology and classified system in the biology and microbiology disciplines covered in Zoology
PO2	Comprehending the scientific explanation for the unity and diversity of life, genetical and heredity concepts of life in the earth and analyzing this with developmental stages of animal with copious examples.
PO3	Gaining keen awareness on the environment, ecological balance and clean green concepts and develop empathy and love towards the society.
PO4	Doing quantitative, qualitative analysis and interpretation of biological data synthesis of information from the database.
PO 5	Upgrading skills in designing and carryout the research projects using appropriate biological techniques and approaches
PO6	Gaining clear knowledge on the function of physiological system of animals at cell and molecular level and their biological concepts.
PO7	Gaining knowledge of agro based small scale industries like sericulture, fish farming, poultry farming and vermicompost production to aim at self reliance.

COMMON ACADEMIC STRUCTURE

M.Sc., (Zoology) / 2019 - 2022

S.NO	Course code	COURSE TITLE	Lecture/ Practical (Hours/week)	Duration of	Max Marks			Credit points
					Internal	External	Total	
SEMESTER I								
1	MPZC1	Core I – Biological Chemistry	6	3	25	75	100	5
2	MPZC2	Core II - Cell Biology	6	3	25	75	100	5
3	MPZC3	Core III - Microbiology	6	3	25	75	100	5
4	MPZP1	Core Practical I- Biological Chemistry, Cell Biology & Microbiology	6	3	40	60	100	5
5	MPZE1	Elective I – Bioinstrumentation/ Ornamental Fish Culture	6	3	25	75	100	4
SEMESTER II								
1	MPZC4	Core IV - Developmental Biology	6	3	25	75	100	5
2	MPZC5	Core V - Environmental biology & Biodiversity	6	3	25	75	100	5
3	MPZC6	Core VI Bioinformatics	6	3	25	75	100	5
4	MPZP2	Practical II - Developmental Biology, Environmental biology & Biodiversity and Bioinformatics	6	3	40	60	100	5
5	MPZE2	Elective II - Biostatistics & Computer Applications/ Biopharmaceuticals	6	3	25	75	100	4
SEMESTER III								
1	MPZC7	Core VII -Molecular Genetics	6	3	25	75	100	5
2	MPZC8	Core VIII -Sericulture	6	3	25	75	100	5
3	MPZC9	Core IX - Biotechnology	6	3	25	75	100	5
4	MPZP3	Core Practical III - Genetics, Sericulture, Biotechnology	6	3	40	60	100	5
5	MPZE3	Elective III - Evolution/ Food and Nutrition	6	3	25	75	100	4
SEMESTER IV								
1	MPZC10	Core X - Animal Physiology	6	3	25	75	100	5
2	MPZC11	Core XI - Immunology	6	3	25	75	100	5
3	MPZP4	Core Practical IV - Animal Physiology and Immunology	6	3	40	60	100	4
4	MPZPR	Project	12	---	25	75	100	4

Total Credits : 90

Total Marks: 1900

Programme code	PGZOOA	Programme	Zoology
Course code	MPZC1	Batch	2019-2021
Hrs/week	6	Semester	I
Credits	5	Course Title	Core I - Biological Chemistry

Course Objectives:

- To acquire knowledge about the macromolecules
- To analyze and apply biochemical aspects in day today life
- To know biochemistry as a vital branch of Biology

Unit	Content	Hrs
I	Water: Structure – thermal and solvent properties – dissociation of weak acids – Henderson and Hassel bach equation .Water and Electrolytic dissociation : chemical bonds Acid - Base balance, Concept of pH and buffers, Acidosis and Alkalosis.	10
II	Carbohydrates: Classification; Structure, properties and biological importance of ribose, deoxyribose, glucose, fructose, galactose, lactose, maltose, sucrose, starch, glycogen, cellulose and chitin. Metabolism and its regulation: Glycolysis – Kreb’s cycle – gluconeogenesis, glycogenesis, glycogenolysis, HMP shunt. (Including the Energetics of all Metabolic Pathways).Cori’s lactic acid cycle and Blood sugar level.	20
III	Synthesis and metabolism of Amino acids: Basic structure and classification- Physical and chemical properties Biosynthesis of amino acids. Proteins: Biological significance – Classification Levels of organization – primary, secondary, tertiary and quaternary, Ramachandran Plot. Metabolism: Transamination, deamination and transmethylatation. Formation of Ammonia and Urea.	20
IV	Lipids and Lipid Metabolism- Structure and Classification biological importance of lipids. Oxidation of Fatty acids – α Oxidation, β Oxidation & Omega Oxidation. β - Oxidation of Palmitic acid and its Bioenergetics. Ketogenesis, degradation of fatty acids and cholesterol Ketone bodies.	15
V	Nucleic acid structure Watson & Crick model of DNA, Purine Metabolism, Pyrimidine Metabolism, and Replication of DNA.	10
VI	Enzymes and Hormones: Properties, classification, biochemical functions enzyme action and regulation, enzyme kinetics, enzyme inhibitors/activators. Coenzyme, isoenzyme, allosteric enzyme, abzyme and ribozyme.Michael-Menton concept. Chemistry of Hormones: Protein and Steroid Hormones, Mechanism of Protein Hormone Action, Mechanism of Steroid Hormone Action.	15
Total contact hours		90

Reference Books:

3. Conn, E.E., P.K.Stumpf, G.Bruening and R.H.DoI, 1999. Outline of Biochemistry, John Wiley & Sons Inc., New York.
5. Deb, A.C. 2011. Fundamentals of Biochemistry, 10th Edition, New Central Book Agency Pvt. Ltd., Kolkata.
4. Jain, J.L., Sunjay Jain and Nitin Jain. 2010. Fundamentals of Biochemistry, Fifth Edition, S. Chand and Company Ltd, NewDelhi.
5. Morris, J.G. 1974. A Biologist's physical chemistry. II edition. Edward Arnold – A division of Holder and Stoughton, London.
6. Nelson, D.L., and M.M.Cox, 2010, Lehninger Principles of Biochemistry, 5th edition, Worth Publishers, New York.
7. Ramarao, A.V.S.S. and Suryalakshmi, A 2009. Textbook of Biochemistry for Medical Students, 11th UVS Publishers Distributors Pvt. Ltd., New Delhi.
8. Stryer, L., 2000. Fourth edition Biochemistry, W.H. Freeman and Company, New York.
9. Emil.Smith Rober.L.Hill, Principles of Biochemistry Mammalian Biochemistry, VII Ed., Mc G. Raw Hill Book Company, New Delhi.

Course Outcomes:

K2	CO 1	To understand the structural organization and functions of biomolecules.
K2	CO 2	To be able to explain the specificity of enzymes (biochemical catalysts), and the chemistry involved in enzyme action
K3	CO 3	To understand the principles of bioenergetics and enzyme catalysis.
K4	CO 4	To be able to explain how the metabolism of organic compounds leads ultimately to the generation of large quantities of ATP.
K5	CO 5	To understand the types, structure, biochemical properties and functions of hormones.

Programme code	PGZOOA	Programme	Zoology
Course code	MPZC2	Batch	2019-2021
Hrs/week	6	Semester	I
Credits	5	Course Title	Core I - Cell Biology

Course Objectives:

- To understand techniques of microscopes
- To learn the fundamental concepts of cell organelles and its function
- To explain the role of membranes in cell communication

Unit	Content	Hrs
I	Microscopy and Prokaryotes Microscopy: Principles and applications - Electron Microscope (TEM and SEM), Phase Contrast Microscope, X-ray microscope and Fluorescent microscope. Prokaryotic cells - E.coli, Cyanobacteria and Mycoplasma, Structure of Viruses and Virion.	15
II	Bio Membrane Structure and Function Structure of model membranes, lipid bilayer and membrane protein – diffusion, osmosis, ion channels, active transport, ion pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes, cell adhesion-intercellular junction.	15
III	Cell Organelles Structural organization and function of intracellular organelles: Endoplasmic reticulum, Ribosome, Golgi bodies, Lysosomes, Peroxisomes, Glyoxisomes and Centrioles.	15
IV	Nucleus and Chromosomes Nucleus Nuclear envelope, structure and function of Chromatin, organization of Nucleosome, Euchromatin and Heterochromatin. Chromosomes - Ultrastructure and functions, Giant Chromosomes-Polytene and Lampbrush. Cell Division and Cell Cycle- Mitosis, Meiosis, Steps in Cell cycle and Control of Cell cycle.	15
V	Protein Synthesis Protein synthesis – Transcription in Prokaryotes and Eukaryotes, Mechanism of transcription - initiation, elongation and termination. Transcription factors - Zinc fingers, Leucine zippers. Translation - initiation of protein synthesis - activation of amino acids, aminoacylation of tRNA, elongation and termination of polypeptide chain. Enzymes and factors involved in protein synthesis, post translation modification.	15
VI	Gene Expression Regulation of gene expression - Lac operon - components, repressor mechanism. Ara operon, Arabinose metabolism in E.coli. Cancer – Types and properties. Genetics of Cancer, Nanotechnology and Cancer. Oncogenes and Co suppressor gene.	15
Total contact hours		90

Reference Books:

1. De Roberties E.D.P and E.M.F.DeRoberties 2011. Cell and Molecular Biology. 8th edition. B.I. Publicatons Pvt. Ltd., India
2. Powar, C.B. 2010. Cell Biology 3rd Edition, Himalayas Publishing House, Bombay.
3. Lewis J Kleinsmith and Valerie M Kish. 1988. Principles of Cell Biology, Harper and Row Publication, New York.
4. Prakash S. Lohar, 2009, Cell and Molecular Biology, MJP Publishers. Chennai
5. Lodish, Berk, Zipursky, Matsudara, Baltimore and Darnell.1999. Molecular Cell Biology, Fourth Edition, W.H.Freeman and Company, Newyork.
6. Gupta M.L and Jangir M.L. 2009. Cell Biology: Fundamentals and Application, Agrobios Publishers, Jodhpur.

Course Outcomes:

K2	CO 1	To understand techniques of microsopes.
K2	CO 2	To know the structure and functions of cell organelles.
K3	CO3	To Comprehend the role of membranes in cell communication.
K4	CO4	To know about gene organization, expression & regulation.
K4	CO5	To know about gene organization, expression & regulation.

Programme code	PGZOOA	Programme	Zoology
Course code	MPZC3	Batch	2019-2021
Hrs/week	6	Semester	I
Credits	5	Course Title	Core III - Microbiology

Course Objectives:

- To understand scope and importance of microbiology.
- To acquire knowledge of microbial world.
- Be able to do application of microorganism in industrial aspects.

Unit	Content	Hrs
I	<p>History and Microbial Growth</p> <p>History and application of Microbiology</p> <p>Methods in microbiology-Microbial Cultures, methods of culturing anaerobes, methods of isolation and maintenance of pure culture, culture characteristics, microbial growth.</p> <p>Methods of bacterial growth, growth rate, growth curve.</p> <p>Measurement of bacterial growth, factors affecting bacterial growth.</p> <p>Culture medium, sterilization techniques.</p> <p>Staining Techniques - Simple, differential and Gram Staining.</p>	15
II	<p>Fermentors and Fermentative Microbes</p> <p>History and design of fermenters, basic functions of fermenters, types of fermenter, construction of fermenters, design and operation, use of computer in fermenter, achievement and maintenance of aseptic conditions, aseptic operation and contaminant, batch fermentation, fed batch fermentation, continuous fermentation, scale up of fermentations.</p> <p>Industrial microbiological processes, culture preservation, criteria for selection of micro organisms for fermentation, strain improvement.</p>	15
III	<p>Industrial Microbiology</p> <p>Alcohol production – Ethanol</p> <p>Production of Acids - Lactic acid and Vinegar,</p> <p>Production of Antibiotics – Penicillin and Streptomycin</p> <p>Production of Amino acid - L-lysine, L- glutamic acid.</p> <p>Production and Application of Microbial Enzymes and Immobilization of Enzymes.</p>	15
IV	<p>Food Microbiology</p> <p>Dairy Industry ; Dairy Products-Yoghurt, Butter Milk, Butter, Cheese.</p> <p>Microbial Spoilage of food: Microbial Contamination and Spoilage of Poultry, Fish and Sea Foods.</p> <p>Preservation of Food: Preservative Methods - Physical and Chemical Methods.</p>	15
V	<p>Medical Microbiology</p> <p>Bacterial diseases: Air borne diseases- Diphtheria, Meningitis, Pertusis, Streptococcal Pneumonia.</p>	15

	Food and Water Borne Diseases- Cholera and Typhoid. Soil Borne Diseases - Tetanus, Anthrax Sexually Transmitted Diseases - Gonorrhoea and Syphilis Contact Disease – Leprosy. Viral diseases - Influenza, Hepatitis - B, Rabies.	
VI	Agricultural And Environmental Microbiology Role of Ti Plasmid and Nif gene in Agriculture. Biofertilizers and Biopesticides, Bacterial Insecticides - <i>Bacillus thuringensis</i> and Viral Insecticides. Potable water and Sewage treatment. Water Pollution Management – Bioaugmentation and Bioremediation Biodegradation – Microbial degradation of Xenobiotics and Super Bug.	15
Total contact hours		90

Reference Books:

1. Dr.R.C.Dubey .Dr.D.K.Maheswari, (2010), A Text book of Microbiology, S.Chand & CO Ramnager, New Delhi.
2. Ronald , M.Atlas, (1988), Microbiology Macmillan publishing company Newyork.
3. J.Pelczar, D.Reid. (1984), TATA Mc Graw Hill publishing company Ltd. Newyork.
4. Samuel Baron , Medical Microbiology, II Ed., Wesley publishing company, California
5. Prescott-Microbiology.
6. Sathyanarayana-Biotechnology.

Course Outcomes:

K2	CO 1	To compare the traditional and the modern microbiological techniques.
K3	CO 2	To apply the knowledge of microbial industry in crop improvement.
K3	CO 3	To differentiate between beneficial and harmful microorganism
K4	CO 4	To gain knowledge in isolation and identification of microbes.
K5	CO 5	To exploit microorganism in food production.

Programme code	PGZOOA	Programme	Zoology
Course code	MPZP1	Batch	2019-2021
Hrs/week	6	Semester	I
Credits	5	Course Title	Core Practical I- Biological Chemistry, Cell Biology and Microbiology

Course Objectives::

- To impart practical knowledge on biochemical analysis.
- To analyse the cellular components.
- To culture and study the microorganisms.

CONTENT	
Biological Chemistry	
Effect of temperature on salivary amylase activity - Determination of Q 10.	
Effect of pH on salivary amylase activity.	
Effect of Enzyme Concentration on Salivary amylase activity	
Influence of substrate concentration on Salivary amylase activity	
Paper Chromatography – Ascending and Circular chromatography	
Column Chromatography – Separation of pigments from varied leaves or flowers	
Gel Electrophoresis – (Demonstration only)	
Quantitative estimation - Estimation of Carbohydrates, Proteins and Lipids from fresh tissues - Standard graphs.	
Cell Biology	
Microscopy: Optical and Phase Contrast Microscope	
Micrometry - Measurement of cells using Ocular and Stage micrometers - Length and Width	
Counting of blood cells in Human blood - R.B.C and W.B.C	
Identification of mitotic stages in Onion root tip.	
Identification of meiotic stages in Tradescantia	
Observation of Giant chromosome in Chironomous larva. (Visual Aid / Virtual Dissection)	
Observation of osmosis in Onion epidermal cells (Demonstration only)	
Microbiology	
Sterilization of glassware and media	
Preparation of Culture media	
Serial dilution Technique	
Aseptic transfer of Bacteria	
Pure culture of Bacteria	
Preservation and maintenance of Bacterial culture	
Cultural characteristics of bacteria	
Wet mount preparation and Hanging Drop technique	
Microscopic measurement of microbes using Haemocytometer	
Spotters:	
Hot air oven, Autoclave, Pressure cooker, Agar Plate, Inoculation needle, Structure of Bacteria, Structure of Virus	

Course Outcomes:

K3	CO 1	To comprehend the methodologies of biochemistry.
K3	CO 2	To apply modern tools in cell and molecular analysis.
K3	CO 3	To validate metabolic and microbial studies
K4	CO 4	To interpret the applications of biological analysis
K5	CO 5	To remember the biochemical activity at cellular level.

Programme code	PGZOOA	Programme	Zoology
Course code	MPZE1	Batch	2019-2021
Hrs/week	6	Semester	I
Credits	4	Course Title	Elective I - Bioinstrumentation

Course Objectives:

- To provide quality guidance to students to learn basics of research.
- To adopt various biological methods in biological analysis.
- To impart knowledge on handling instruments.

Unit	Content	Hrs
I	Principles and Applications Centrifuges: Low, high and Ultracentrifuge. Spectrophotometer, UV –Visible Spectrophotometer, Mass Spectrometry. X- ray diffraction, PCR. Immuno assay: ELISA	15
II	Separation and Analytical Techniques Chromatography - Thin layer Chromatography (TLC), Column Chromatography, Gas Chromatography and High performance liquid chromatography (HPLC). Electrophoresis - SDS - PAGE, MOLDI, Agarose Gel Electrophoresis, Immunoelectrophoresis. Dosimetry- Geiger- Muller Counter, Scintillation Counter.	15
III	Histological and Histochemical Methods Histochemical Techniques: Protein, Carbohydrates, Lipids and DNA. Histological preparations of Tissues for Light and Electron Microscopy, Immunochemical localization.	15
IV	Instrumental Analysis pH meter- Introduction, Principle and measurement, Calorimeter, Colony hybridization, Cytometry-Cytophotometry, flow cytometry.	15
V	Direct gene transfer techniques-Ultrasonication, liposome fusion, electroporation, Particle Bombardment gen method, pollen transfer, micro and macroinjection. Tracer Techniques: Principle and applications (only). Auto radiography	15
VI	Research Methods and Thesis Writing Identification, Selection and Scope of research problems – Methods of literature collection and review – Planning and execution of investigation – Thesis writing – Preparation and presentation of research paper for Journals, Conferences – Preparation of short communications and review articles.	15
Total contact hours		90

Reference Books:

1. Jayaraman, J - (1972) Laboratory manual in biochemistry New age International Pvt., Ltd., Publisher, New Delhi.
2. Oser, B.L., Hawk's physiological chemistry 14th ed., McGraw – Hill book co., New Delhi.
3. Plummer, T.D., (1971). An Introduction to Biochemistry 3rd ed., Hill book co., New Delhi.
4. Sadasivam, S, & Manickam A, biochemical methods – Wiley Eastern ltd, New Delhi.
5. Daniel, W.W, (1978 – Biostatistics. A foundation for Analysis in the Health Sciences. (Wiley Series in Probability and Statistics) 9th Ed., New York.
6. Willard, HH (1986) Instrumental methods of Analysis, 6th Ed., CBS Publication, New Delhi.

Course Outcomes:

K2	CO 1	To know the importance of instruments in biology.
K3	CO 2	To provide information about principles and applications of instruments.
K3	CO 3	To learn the procedure and protocol of various techniques.
K4	CO 4	To acquire theoretical knowledge about research methodology.
K5	CO 5	To enable the students to prepare project manuscript.

Programme code	PGZOOA	Programme	Zoology
Course code	MPZE1	Batch	2019-2021
Hrs/week	6	Semester	I
Credits	4	Course Title	Elective I : Ornamental Fish Culture

Course Objectives:

- To provide quality guidance to students to learn basics of research.
- To adopt various biological methods in biological analysis.
- To impart knowledge on handling instruments.

Unit	Content	Hrs
I	Aquarium Tank Construction of Home Aquarium: Design and Construction of Aquarium tank, Accessories used in Aquarium, (aerators, filters, types of filters and hand nets), Setting up of Aquarium tank (gravels / pebbles, plants, ornamental objects and fishes, selection of species). Aquarium plants and its importance	15
II	Aquarium Management Cleaning the aquarium - Maintenance of water quality – Temperature, Water change, Ammonia, O ₂ /CO ₂ , Water hardness. Control of Snail and Control of algal growth in Aquarium tank.	15
III	Taxonomy And Biology Taxonomy and Biology of popular Ornamental fishes : Live-bearers (Ovo-viviparous) - Red Swordtail (<i>Labeo bicolor</i>), Platy (<i>Xiphophorus maculatus</i>), Guppy (<i>Poecilia reticulata</i>) and Molly (<i>Black molly</i>). Egg layers (Oviparous) - Gold fish (<i>Carassius auratus</i>), Siamese fighting fish (<i>Betta splendens</i>), Gourami (<i>Trichogaster leeri</i>), Angel fish (<i>Pterophyllumsalare</i>), Oscar (<i>Austronotus ocellatus</i>) and Koi carp (<i>Cyprinus carpio carpio</i>). Breeding and Spawning of Live bearers and Egg layers. Induced breeding and Production of Monosex fish.	15
IV	Nutrition Nutritional requirements of Ornamental fishes - Different kinds of feeds - Artificial and Live food. Culture of live food organisms -Infusorians, Rotifers, Cladocerans, Brine shrimp, Chironomus and Tubifex. Artificial feed - feed formulation. Balanced diets for Aquarium fishes	15
V	Diseases Of Ornamental Fishes Common diseases of aquarium fishes - Protozoan, Fungal, Bacterial and Nutritional diseases. Their diagnosis and treatment, Problems of over feeding.	15
VI	Commercially important Marine Ornamental fishes. Purchase and Transport of Ornamental fishes. Use of Sedatives. Other Ornamental organisms - Anemones, Lobsters and Shrimps. Entrepreneurship development in Ornamental fish culture.	15
Total contact hours		90

Reference Books:

1. J.D. Jameson and R.Santhanam (1996) - Manual of Ornamental fishes and Farming Technologies - Fisheries College and Research Institute TANVASU, Tuticorin
2. Meenakshi Jindal, N.K.Yadava and R.K.Gupta (2000) - Freshwater Ornamental Fishes, Mangalam Publications, Delhi.
3. V.K. Venkataramani et al., (2004). Biodiversity and Stock Assessment of Marine Ornamental fishes. Department of Fisheries Biology and Capture Fisheries, Fisheries College and Research Institute, TANVASU, Tuticorin.
4. A.D.Dholakia, (2009) - Ornamental Fish Culture and Aquarium Management, Daya Publishing House, Delhi
5. H.S.Jagtap and S.N.Mukherjee and S.S.Nanware, (2009) - P.ractical Manual of Pisciculture and Aquarium Keeping, Daya Publishing House, New Delhi.

Course Outcomes:

K2	CO 1	To study the various ornamental fishes and its culture
K3	CO 2	To recollect the general ornamental fishes
K3	CO 3	To understand the scope of fish culture
K4	CO 4	To apply the ornamental fish culture methods for aquarium maintenance
K5	CO 5	To review the different types of cultural methods

Programme code	PGZOOA	Programme	Zoology
Course code	MPZC4	Batch	2019-2021
Hrs/week	6	Semester	II
Credits	5	Course Title	Core IV- Developmental Biology

Course Objectives:

- To describe the embryological processes of different organisms.
- To appreciate and accept the origin of life and evolutionary processes.

Unit	Content	Hrs
I	Theories of Embryology and Gametogenesis Theories of Embryology : Pre formation theories, Epigenetic theory, Von Baer's Law, Germplasm theory, Mosaic theory, Regulative theory, Concept of potency and totipotency, Gradient theory, Gametogenesis : Orgin of primordial germ cells, Spermatogenesis – Formation of Spermatid, Spermioteliosis, Morphology of spermatozoan (mammal), Oogenesis – Proliferatiave phase, Growth phase – Pre-vitellogenesis, Vitellogenesis, Maturation of egg, Types of eggs.	15
II	Fertilization Fertilization : mechanism of fertilization – Encounter of spermatozoa and ova, Capacitation and contact, Acrosome reaction and penetration, Cortical reaction, Activation of ovum – Change in ionic permeability and potential of egg's plasma membrane, Transient intracellular rise in calcium ions, Transient intracellular increase in pH, Monospermy & Polyspermy, Theories of Fertilization, Migration of pronuclei and amphimixis, Ooplasmic segregation ; Significance of fertilization.	15
III	Cleavage & Gastrulation Cleavage – Peculiarities of cell division in Cleavage, Patterns of Cleavage. The Nuclei of Cleaving cells, Distribution of Cytoplasmic substances in the egg during Cleavage, Role of egg cortex, The Morphogenetic gradients in the egg cytoplasm, Effect of yolk on cleavage, Cleavage in Amphioxus, Frog, Chick and Mammal. Gastrulation – The fate map, Morphogenetic movement, Metabolism during gastrulation, Activity of gene during gastrulation, Gastrulation in Amphioxus, Frog, Chick and Mammal.	15
IV	Organogenesis Formation of primary organ rudiments – Methods of organ formation – Tubulation – Neurogenesis, Notogenesis, Mesogenesis and Enterogenesis. Development of eye, brain, ear and heart in Frog, Developmental defects or abnormalities (Teratogenesis).	15
V	Metamorphosis Metamorphosis in Amphibia, Hormonal regulation of Amphibian metamorphosis, Tissue reactivity in Amphibian Metamorphosis.	15

	Metamorphosis in insects. Regeneration in Planarian and Amphibian.	
VI	Experimental & Applied Embryology Embryonic induction, Organizer concept, Theories – Neural induction. Nucleocytoplasmic Interaction. Birth control measures. Assisted Reproductive technology - Artificial insemination – Intra cervical insemination, Intra vaginal insemination and Intra uterin insemination.	15
Total contact hours		90

Reference Books:

1. B.I Balinsky (1981), An Introduction to Embryology, V Ed., Saunders College Publishing, Newyork.
2. Dr.R.C.Delela and R.Verma., (1986 – 87), A Text book of Chordate Embrology, V Ed., Jai Prakashnathan & co, Meerut city, India.
3. P.S.Verma and V.K.Agarwal (1975) Chordate Embryology X Ed., S.Chand & Co Pvt Ltd, Ramnager, New Delhi.
4. Bradley M.Pttern., (1957), Early Embryology of the Chick IV Ed., McGraw – Hill Book company, Newyork.
5. Bradley M.Pattern., (1948), Embryology of the pig III Ed., McGraw – Hill Book Company Newyork.

Course Outcomes:

K1	CO 1	To get acquaintance with the theories of Developmental Biology.
K2	CO2	To gain in-depth knowledge in the developmental stages of Embryogenesis.
K2	CO3	To understand the embryological process of different organisms.
K2	CO4	To comprehend the process of organogenesis.
K3,K5	CO5	To acquire better understanding of scientific reasoning exhibited in experimental life science.
K3,K4	CO6	To han enhanced knowledge and appreciation of life cycle transitions like Metamorphosis and Regeneration.

Programme code	PGZOOA	Programme	Zoology
Course code	MPZC5	Batch	2019-2021
Hrs/week	6	Semester	II
Credits	5	Course Title	Core V - Environmental Biology and Biodiversity

Course Objectives:

- To know the effects of population and its control measures.
- To know about the resources of energy, environmental Pollution and disaster and management.

Unit	Content	Hrs
I	Environment And Ecosystem Environment: Segments of environment, Atmosphere - Structure, Air as an ecological factor. Hydrosphere: Physico- chemical aspects -River and Sea, Hydrological cycle. Lithosphere- Process of soil formation, Soil profile, Soil texture and major soil types of India.Dynamics of Ecosystem: Primary and Secondary productivity, Energy flow and Ecological energetics.	15
II	Population And Community Ecology Population and Community Ecology: The population concept- Natalty, Mortality, Growth rate, Population density and Age distribution, Carrying capacity, Fluctuation and Regulation. Community structure - influence of competition - influence of predation and disturbance. Community succession and Climax stage.	15
III	Resources And Energy Renewable resources – Sola renergy, Biogas, Wind energy, Ocean energy and geothermal energy. Petro plants for future fuel and Bio energy from waste. Non-Renewable resources - Fossil fuels, nuclear fuels, Petroleum and Natural gas	15
IV	Environmental Pollution Environmental Pollution: Types of environmental pollution and their biological effects. Air Pollution, leprosy in Tsj MAhal, Bhopal gas disaster soil and water pollution- causes, effects and control. Minimata disease Environmental awareness. Organizations involved in environmental protection - Principles of conservation: Application of ecological principles - germplasm conservation. Environmental laws.	15
V	Environmental Disaster And Management Environmental Disaster and Management: Effect of climate change, global warming and its effect on living organisms – Tsunami, Cyclone Earth Quake, Flood: Causes, consequences, control and management. War and its impact on environment.Ecoterrorism,Remediation and reclamation of the Environment- Role of microbes in bioremediation.	15
	Biodiversity Definition, Biodiversity-Hot spot, Insitu, Exsitu conservation, indices, levels	15

VI	and loss. Remote Sensing and GIS in Biodiversity, Biodiversity and climate change. Project Tiger and Project Elephant. Wild life management in India. endangered species, Red data book.	
Total contact hours		90

Reference Books:

1. Odum EP (2008) Fundamentals of Ecology, Cengage Learning (Thompson), USA.
2. Asthana, D.K. and Meera Asthana,(1999) - Environment - Problems and Solutions, S.Chand and Company Ltd, New Delhi
3. Sharma, P.D. (1999) - Ecology and Environment, Rastogi Publications, Meerut.
4. Smith TM and Smith RL (2008) Elements of Ecology (7th Edition), Benjamin Cummings.
5. V K Agarwal, P S Verma(2015)- Environmental Biology S. Chand Publisher, New Delhi.
6. Clark RS (2001) Marine Pollution, Clarendon Press Oxford, New York
7. Agarwal, K.C. (1996) - Biodiversity, Agro Botanical Publishers (India).
8. Asish Ghosh, (2008) - Environmental Conservation - Challenges and Actions, APH Publishing Corporation, New Delhi.
9. Kumar, H.D (2003) - Biodiversity and Sustainable Conservation, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

Course Outcomes:

K2	CO 1	To understand the various factors of environment
K2	CO 2	To know the effects of population and its control measures
K3	CO 3	To know about the resources of energy
K4	CO 4	To comprehend environmental pollution and disaster and management
K4	CO 5	To gain knowledge of the various factors of environment.

Programme code	PGZOOA	Programme	Zoology
Course code	MPZC6	Batch	2019-2021
Hrs/week	6	Semester	II
Credits	5	Course Title	Core VI -Bioinformatics

Course Objectives:

- To know the applicability of bioinformatics in various fields.
- To compare and group data in biological meaningful way.
- To gain knowledge of computational analysis of genes and proteins.

Unit	Content	Hrs
I	Basics of Bioinformatics Introduction to Bioinformatics, important contributions, sequence development, aims and tasks, Fields related to Bioinformatics, Applications of Bioinformatics in various fields.	15
II	DNA and Protein Sequencing Analysis Genomics and proteomics, genome mapping, DNA sequencing methods- Maxam and Gilbert method, Sanger's method, automated DNA sequencing. Protein sequencing-Sequence determination from DNA,Edman degradation method,Mass spectrometric method.	15
III	Genomics Human Genome Project – Companies involved in HGP – Potential benefits of HGP. Gene expression analysis – Microarray. Databases Importance of databases, nucleic acid sequence databases EMBL, Gen Bank, protein sequence databases- SWISS PROT, TrEMBL, and PIR, structure of databases, uses of databases. Objectives of biological databases	15
IV	Proteomics Proteomics: Protein structures – Primary, Secondary & Tertiary – Protein Structure Predictions: a). Ab – intio modeling and Identification of conserved and variable regions. b) Comparative modeling – homology modeling and protein threading. Protein. Structure prediction software available in the web.	15
V	Sequence Alignment Algorithn, goals and types of alignment, study of similarities, scoring mutation, depletion and substitutions, sequence alignment methods. Pairwise sequence alignment - Dot matrix, Dynamic Programming & word or K tuple, FASTA, BLAST. Multiple Sequence Alignment- Dynamic programming, progressive and Iterative method CLASTAL W.	15
VI	Pharmacogenomics Molecular Docking : Protein – Protein Docking, Drug designing – Objectives, rational drug design – examples of designed drugs – drug development – Pharmacogenomics – uses of Pharmacogenomics.	15
Total contact hours		90

Reference Books:

1. S.Ignacimuthu ., (2005), Basic Bioinformatics, III Ed., Narosa Publishing House Pvt. Ltd.
2. Prakash S Lohar., (2009), Bioinformatics, I Ed., MJP Publishers.
3. BG Curran., (2010), Bioinformatics , I Ed., CBS Publishers & Distributers.
4. M.Rajadurai (2010) – Bioinformatics A Practical Manual – I Ed., PBS Book Enterprises.
5. T K Attwood & D J Parry Smith., (2008), Introduction to Bioinformatics, I Ed., Himalaya Publishing House.

Course Outcomes:

K2	CO 1	To gain knowledge of the basics of biological concepts.
K3	CO 2	To know to use information technology tools to understand biology.
K3	CO 3	To know to organize and preserve of biological data.
K4	CO 4	To analyze development of resources and interpret the results.
K5	CO 5	To gain knowledge of the immediate needs in pharmaceutical industries.

Programme code	PGZOOA	Programme	Zoology
Course code	MPZP2	Batch	2019-2021
Hrs/week	6	Semester	II
Credits	5	Course Title	Core Practical II- Developmental Biology, Environmental Biology & Biodiversity and Bioinformatics

Course Objectives:

- To introduce practical knowledge about animal development.
- To know about the environment.
- To enable the beginners to know about biological databases.

Content
<p>Developmental Biology</p> <ol style="list-style-type: none"> 1 .Early Embryonic development of Frog – Observation of 2 cell, 4 cell, 8 cell, 16 cell, Blastula,Gastrula and Yolk plug stages. 2. Temporary Mounting of Chick Blastoderm 3. Early Hours of Chick development – Observation of various stages 24,48,72 and 96 hrs of chick blastoderm. 4. Induced Ovulation in Frog. (Demonstration only) 5. Effect of Thyroxine Hormone on Amphibian Metamorphosis (Demonstration only) <p>Spotters :</p> <p>Types of eggs & sperms. Development of Brain, eye, heart and ear in Frog.</p>
<p>Environment Biology</p> <ol style="list-style-type: none"> 1. Estimation of primary productivity by using aquatic plants - Light and Dark bottle method. 2. Analysis of Water samples - Estimation of dissolved Carbon dioxide, Carbonate and Bicarbonate. 3. Analysis of Soil Samples - Determination of Soil moisture, Soil Texture, Humus and Chloride. 4. Measurement of biodiversity – Alpha and Beta diversity Indices. 5. Pollution bioindicators – Chironomus larva, Mosquitoelarva, Leech, Pila and Tilapia.
<p>Bioinformatics</p> <ol style="list-style-type: none"> 1. Accessing EBI website for downloading an entry of human lysosomal alpha glucosidase gene 2. Accessing GenBank website and downloading of file. 3. Accessing DDBJ website and downloading of file. 4. Accessing SWISS-PROT Database and downloading of file. 5. Accessing PDB website and downloading of file of protein structure 6. BLAST similarity search for nucleotide sequence. 7. BLAST similarity search for amino acid sequence. 8. FASTA similarity search for nucleotide sequence. 9. FASTA similarity search for amino acid sequence.

Course Outcomes:

K3	CO 1	To gain knowledge of the basic applications of embryonic development
K3	CO 2	To comprehend the environmental assessment strategies and management systems.
K3	CO 3	To comprehend embryonic formation and developmental stages with suitable example.
K4	CO 4	To analyze the development of rapid sequencing technique.
K5	CO 5	To apply the advancement of computer based technology in life sciences.

Programme code	PGZOOA	Programme	Zoology
Course code	MPZE2	Batch	2019-2021
Hrs/week	6	Semester	II
Credits	4	Course Title	Elective II - Biostatistics & Computer Applications

Course Objectives:

- To study the fundamentals of biostatistics and computer applications.
- To study the application of biostatistics for testing hypothesis.
- To communicate the results of statistical analysis accurately and effectively.

Unit	Content	Hrs
I	Measures of Central Tendency Measures of central tendency- Mean Median, Mode- for individual observations, discrete series and continuous series.	15
II	Measures of Dispersion Measures of dispersion: Range, Standard deviation, Standard error, variance & Coefficient of variation and mean deviation.	15
III	Statistical Methods Probability –Basic concepts, types, addition & multiplication Theorems of Probability (only), Probability distribution – Normal, Binomial & Poisson distribution.	15
IV	Testing of Hypothesis, Student “t” test, Chi – square test& their properties and uses. Correlation – Definition, Types & Methods of studying Correlation, Regression Analysis –Methods, Estimation of unknown value from known value – One way ANOVA	15
V	Computers Introduction to computers, Architecture of computers, mile stones and early development, types of modern computers, Number system – Binary, Decimal and Octal number system. Hard ware and software.	15
VI	Databases Symbols of databases, importance of databases-types, classification ,entries, sequence formats, record, database management system, RDBMS, SQL, data mining Computers and programs, Internet, world wide web, browsers and search engines, statistical software available on web.	15
Total contact hours		90

Reference books:

1. S.P. Gupta - Statistical Methods
2. Norman T.J.Bailey - Statistical Methods in Biology
3. S.S.Palanisamy & M.Manoharan - Statistical Methods for Biologists.

4. Daniel, W.W, (1978 – Biostastics. A foundation for Analysis in the Health Sciences. (Wiley Series in Probability and Statistics) 9th Ed., New York.
5. Biostatistics –P.Ramakrishnan (2010) Saras Publication.
- 6.PC software made simple by R.K.Taxali.

Course Outcomes:

K2	CO 1	To understand the basic concept and application of biostatistics.
K2	CO 2	To know the application of biostatistics for testing hypothesis.
K3	CO 3	To understand the process of statistical analysis accurately and effectively.
K4	CO 4	To gain familiarity with the computer architecture.
K5	CO 5	To apply the knowledge of computer in the field of biology.

Programme code	PGZOOA	Programme	Zoology
Course code	MPZE2	Batch	2019-2022
Hrs/week	6	Semester	II
Credits	4	Course Title	Elective II : Biopharmaceuticals

Course Objectives:

- To enable the students to know the actual path of metabolism of drugs and drug discovery.
- To keep in mind the Routes of administration in biological systems and models

Unit	Content	Hrs
I	Biological Systems And Models: Routes of administration- adsorption enhancement- bioavailability- site specific delivery; Pharmacodynamics of protein therapeutics- Inter species scaling	15
II	Drug Metabolism Oxidation- reduction- hydrolysis- conjugation. Need for developing new drugs: Procedure followed in drug design; Prodrug and soft drugs; Drug toxicity.	15
III	Drug discovery & cardiovascular drugs: Substances derived from bacteria- plants- insects- and animals; Sources of active principles; drugs used in atherosclerosis.	15
IV	Pharmaceutical products: Microbial products - Antibiotics (penicillin- streptomycin- tetracycline)- <i>vitamins</i> -probiotics. Animal vaccines- Anti platelets drugs.	15
V	Pharmaceutical products of DNA technology: Therapeutic proteins – Insulin- human growth hormone- Diuretics- clotting factors-Vector usage strategies for gene therapy; <i>Clinical trials</i> .	15
VI	Mechanism of hormone action Peptide, steroid & thyroid, Hormonal disorders: Pancreas (Diabetes mellitus) Thyroid (Goiter) Pituitary (Gigantism - Dwarfism) Sex hormones (Infertility).	15
Total contact hours		90

Reference Books:

1. Heinrich Klefenz, (2002) “Industrial Pharmaceutical Biotechnology”, WILEY-VCH Publication, Germany.
2. Daan Crommelin, & Robert D Sindelar, (2002) “Pharmaceutical Biotechnology”, Taylor and Francis Publications, New York.
3. Jay P Rho and Stan G Louie, (2003) “Hand book of Pharmaceutical Biotechnology”, Pharmaceutical products press, New York.
4. Lachman L Lieberman, HA, and Kanig, J, (1986) “Theory and practice of industrial pharmacy”, 3rd edition, Varghese publishing & Co, New Delhi.
5. Remington’s Pharamaceutial sciences, (2000) 18th edtion, Mack publishing & Co., Easton, PA.

Course Outcomes:

K2	CO 1	To implement the microbial products in pharmaceutical industry
K2	CO 2	To discuss the DNA technology in Pharmaceutical products
K3	CO 3	To understand the drug metabolism
K4	CO 4	To implement the microbial products in pharmaceutical industry
K5	CO 5	To be an entrepreneur in pharmaceutical.

Programme code	PGZOOA	Programme	Zoology
Course code	MPZC7	Batch	2019-2021
Hrs/week	6	Semester	III
Credits	5	Course Title	Core VII- Molecular Genetics

Course Objectives:

- To understand the inheritance of genetic characters.
- To acquire knowledge on sex determination, Hardy-Weinberg Law and Mutation.

Unit	Content	Hrs
I	Basics of Genetics - Ultra structure of genes-Gene Interaction - Allelic - Incomplete Dominance-Co-Dominance- Lethal Gene - Pleiotropism. Non-allelic - Complementary factors - Supplementary factors - Epistasis - Dominant - Recessive and Duplicate recessive Epistasis - Duplicating factors.	15
II	Polygenic Inheritance - Skin colour in Man. Multiple Alleles ABO, Rh and MN blood group inheritance. Role of Genes in Metabolism – Disorders of Phenyl alanine Metabolism only. Genetic code - Characteristics of Genetic code - Deciphering of Genetic Code - invitro and invivo codon Assignment - Wobble hypothesis.	15
III	Molecular mechanism of mutation -Mutagens - Radiation and Chemical - Mutation Detection: CIB technique - Chromosomal : Change in Structure - Change in Number. Extra Nuclear Inheritance - Kappa Particles in Paramecium - Shell coiling in snail Limnaea.	15
IV	DNA: Denaturation and Renaturation. Replication models - Semiconservative - Evidences - Meselson and Stahl, Tailor and Woods Experiment – Uni and Bi-directional - Rolling Circle. DNA Damage and Repair mechanisms. RNA: Processing of RNA- Types – mRNA-tRNA & rRNA - Structure and Functions.	15
V	The Hardy- Weinberg Law. Algebraic proof for Hardy- Weinberg Equilibrium. Factors affecting Hardy Weinberg Equilibrium: Mutation - Selection - Migration - Meiotic Drive -Non-random Mating - Genetic Drift. Applications of Hardy- Weinberg Law: Calculating Gene Frequencies - Autosomal loci, Two alleles - Co-dominant - Dominant and Recessive - Multiple Alleles. Sex linked loci, Co-dominant - Dominant and Recessive Alleles.	20
VI	Contraction of Pedigree Chart. Mendelian Traits in Man. Human Karyotype Analysis. Sex determination : Sex determination in Man, Drosophila, Fowl, Butterfly, Grasshopper and Honey bee.Sex determination: Sex Linked Inheritance in Man – Colour Blindness and Haemophilia.Sex Limited and Sex Influenced Genes in Man.	10
Total contact hours		90

Reference Books

1. Eldon John Gardner *et al.*, (1991) Principles of Principles of Genetics ,VIII Edition Johnwiley and son's. Inc, Newyork.
2. W.Strickberger, (1976),Genetics ,III Edition , Macmillan Publishing Co.,Newyork.
3. Willium d. Stansfield, (1969), Theory and Problems of Genetics, Mc Craw- Hill Book Company,,(1968) Newyork.
4. Mckusick, V.A.,HumanGenetics, Prentice-Hall of India Private Limited, Newyork.
5. Lewin., (1999) Genes, VI Edition., Oxford University Press, Oxford.

Course Outcomes:

K1	CO 1	To be acquainted with genetic Terminologies, Mendelian inheritance and gene interaction.
K5	CO2	To know to deploy the role of mutation in genetic disorders and diseases.
K2	CO3	To gain better knowledge on methods of sex determination.
K4,K5	CO4	To be able to do comprehensive and detailed analysis of the structure and function of genetic material.
K3,K5	CO5	To be able to explore the applications of Hardy-Weinberg law.

Programme code	PGZOOA	Programme	Zoology
Course code	MPZC8	Batch	2019-2021
Hrs/week	6	Semester	III
Credits	5	Course Title	Core VIII - Sericulture

Course Objectives:

- To enable the students to learn the basics of silk worm rearing techniques.
- To understand the economic importance of sericulture.

Unit	Content	Hrs
I	General Aspects of Silkworms Taxonomy-Systemic position of Mulberry Silkworm. Types of Silkworms- Mulberry and Non- Mulberry Silkworms. General aspects of Non-Mulberry Silkworms –eri, Muga, Tasar. Races of mulberry silkworms.	14
II	Moriculture Classification of Mulberry, Popular varieties in India, Draught Resistant varieties, Selection of land and Methods of cultivation of mulberry Methods of Propagation, Manuring ,Pruning, Harvesting and Storage of leaves. Pests and diseases – Fungal, Bacterial and Viral diseases and their control.	14
III	Silkworm Biology Morphology –Structure of egg, Structure and Sexual Dimorphism in larva, pupa and adult. Anatomy-Silk gland, Digestive, Respiratory and Reproductive system. Life cycle of <i>Bombyx mori</i> , Role of Hormones in Metamorphosis and Moulting.	14
IV	Grainage Technology General account on grainages, Breeding stations (P4, P3, P2 and P1). Grainages : Procedures in grainages – Rearing of Parental Seed cocoon, Seed Cocoon Preservation, Separation of Sexes, Moth Emergence, Pairing and Ovipositions, Methods of Industrial Egg Production, Mother Moth Examination. Voltinism, Diapausing and Non – diapausing egg, Artificial hatching of Diapause eggs - Hot Acid Treatment and Cold Acid Treatment, Acid treatment after Chilling, Incubation.	16
V	Silkworm Rearing Rearing House and Rearing Appliances. Rearing operations –Disinfection methods, Brushing, bed cleaning and Feeding. Maintenance optimum environmental conditions in the rearing room and Selection of ripe worms, Spinning, Mounting, Harvest, Identification and separation of defective and diseased cocoons, Storage and Transport of cocoons, Cocoon Marketing. Rearing methods: Chawki worms Rearing and Rearing of late age worms. Diseases of Silkworm: Viral, Bacterial, Fungal and Protozoan diseases – Pathogens, Mode of infection, Prevention and Control measures. Pests of Silkworm.	16
VI	Silk Reeling Steps to be followed before Reeling - Stifling, Drying and Storing, Cooking and Boiling, Deflossing and Ridding. Process of Reeling- Reeling appliances,	16

	Methods of reeling - Charka, Cottage basin and Filatures .Re-reeling, Lacing skeining, Booking, Raw silk testing and uses of Silk.	
Total contact hours		90

Reference Books :

1. G.Ganga., (2003), Comprehensive Sericulture, Oxford and IBH Pub., Co., Pvt., Ltd., New Delhi.
2. S.Krishnaswamy *et al.*, (1972), Sericulture manual -1 (Mulberry cultivation), Manual -2 (Silkworm rearing) and Manual -3 (Silk reeling), Food and Agriculture Organization of the United Nations, Rome.
3. Hiroo, Sibuya Ku., (1975) Text book of Tropical Sericulture, Japan Overseas Corporation , Volunteers 4-2, 24, Tokyo, Japan.
4. Venkata Narasaiah (2003), Sericulture in India, Ashish Publishing House, New Delhi.
5. Silk Production, (2004), Dr.N.G.Ojha, Dr.P.N.Panday APH Publishing Corporation, New Delhi.

Course Outcomes:

K2	CO 1	To gain knowledge of the basics of silk worm rearing techniques.
K2	CO 2	To understand the economic importance of sericulture.
K3	CO 3	To gain knowledge on the basic facts about grainages.
K4	CO 4	To know about the silk reeling and cocoon marketing.
K5	CO 5	To obtain knowledge on the basic facts about grainages and silk reeling.

Programme code	PGZOOA	Programme	Zoology
Course code	MPZC9	Batch	2019-2021
Hrs/week	6	Semester	III
Credits	5	Course Title	Core IX - Biotechnology

Course Objectives:

- To facilitate at all levels to develop as outstanding scholars/teachers/Career women/Entrepreneurs and responsible leaders by applying their knowledge in life sciences for betterment of society.
- To know the recent trends in Biotechnology and make the students to understand the integral application of biotechnology in various fields.

Unit	Content	Hrs
I	Tools of Genetic Engineering Restriction endonuclease – Nomenclature – DNA Ligase – Reverse transcriptase – DNA Polymerase. Cloning vectors – Plasmids, Phages, Cosmids and animal viral vector. (S40, BPV and Baccula virus).	15
II	Techniques of Genetic Engineering Gene cloning methods - microinjection, Electroporation, Liposome mediated gene transfer, Retroviral method. PCR – methods and application. Blotting techniques – Southern, Northern and Western Blotting. Construction and Screening of gene libraries.	15
III	Animal Cell Culture Culture technique - Primary and Secondary culture. Cell line, Stem cell Biology – Embryonic stem cell and adult stem cell. Organ culture – methods of organ culture – Artificial Skin and Cartilage. Transgenic animals and its application – Fish, mice, sheep and cow.	15
IV	Industrial Biotechnology Strain improvement for industrial important secondary metabolites – Bioprocess operations – Downstream process, Ore leaching – cellulose utilization – Alcohol production, Antibiotic biosynthesis. Isolation and Purification of Enzymes – Enzyme immobilization.	15
V	Biotechnology and Human Welfare r-DNA protein in medicine – Insulin, Interferon, Blood products – Thrombolytic (tPA) blood clotting factor (factor VIII). Gene therapy – somatic and germline therapy. Vaccines – Recombinant Hepatitis B vaccine and FMD vaccine, Live virus vaccine, Malaria vaccine and DNA vaccine.	15
VI	Applied Biotechnology Use of DNA finger printing in forensic science, role of Micobes in biotechnology. Intellectual property rights and Patent. Nanotechnology –	15

	Nanomaterial synthesis, Characterization and applications. GMO's and their impact on Environment. Ethical, Legal, Social, Environmental and Health issues related to r-DNA technology.	
Total contact hours		90

Reference Books:

1. R.C.Dubey, (1993), A Text book of Biotechnology. III Ed., S.Chand & Company Ltd.
2. H.K.Das, (2004), Text book of biotechnology III Ed., Wiley India (P) Ltd.
3. U.Satyanarayana, (2005), Biotechnology, Arunabha sen (P) Ltd.
4. Mohan P.Arora, (2003), Biotechnology, I Ed., Himalaya Publishing house.
5. V.Kumaresan, (1994), Biotechnology VI Ed., - Himalaya Publishing house.

Course Outcomes:

K1	CO 1	To understand the basic principles and application of Genetic Engineering.
K2,K3	CO2	To comprehend the principles and methods of Gene cloning, understand the Construction of c-DNA library and also the application of PCR, blotting techniques.
K3,K6	CO3	To elucidate transgenesis and invitro culture techniques of animals.
K3,K4	CO4	To gain knowledge about basic principles and applications of Bio techniques in Industry.
K3,K6	CO5	To apply their Knowledge in the production and application of Human Health care products and learn the importance & social implications of Gene therapy.
K3,K4	CO6	To know the basic principles and application of forensic science and also gain knowledge on application of nano structures in Bio medical science.

Programme code	PGZOOA	Programme	Zoology
Course code	MPZP3	Batch	2019-2021
Hrs/week	6	Semester	III
Credits	5	Course Title	Core Practical III- Molecular Genetics, Sericulture and Biotechnology

Course Objectives:

- To obtain practical knowledge in genetics, sericulture and biotechnology.
- To keep in mind about the basic technologies applied in Biotechnology.
- To understand the concepts of genetics through experiments.

CONTENT

Molecular Genetics

1. Mendel's Law of Segregation with Beads of Two different Colours.
2. Mendel's Law of Independent Assortment with Beads of Four different Colours
3. Probability- Tossing of Coins.
4. Correlation of Length and Width of leaves.
5. Observation of Simple Mendelian Traits.

Spotter

- Chromosomal Disorders in Man – Down's Syndrome, Turner's Syndrome, Klinefelter's Syndrome
- Sex Linked Inheritance in Man -Colour Blindness and Haemophilia.
- Extra Nuclear Inheritance - Kappa Particles in Paramecium - Shell coiling in snail Limnaea.
- Multiple Alleles - ABO, Rh blood group.
- Barr body.
- Twins – Mono and Dizygotic Twins
- Pedigree Chart

Sericulture

- Morphology of Egg, larva. Pupa and adult moth
- Life cycle of Silk worm
- Mouth parts of Silkworm
- Silk gland of Silkworm
- Digestive system of Silk worm
- Rearing House
- Rearing appliances
- Egg card
- Mountages
- Identification of Diseased worms
- Identification of Non Mulberry Silkworm

- Reeling appliances: three pan system, Jettebout, Croissure,
- Field visit Report

Biotechnology

1. Extraction of DNA
2. Extraction of RNA
3. Agarose gel Electrophoresis
4. PAGE
5. PCR (Demonstration only).
6. Transgenic techniques-Micro injection and Electroporation (Demonstration only).

Course Outcomes:

K3	CO1	To understand the Mendelian Laws through Experiments
K4	CO2	To be able to perform, analyze and report on experiments and observations in Genetics
K5	CO3	To understand safe laboratory practices and to conduct independent work in a laboratory.
K5	CO4	To understand the procedure for Silkworm rearing
K5	CO5	To analyze the biotechnological areas.

Programme code	PGZOOA	Programme	Zoology
Course code	MPZE3	Batch	2019-2021
Hrs/week	6	Semester	III
Credits	4	Course Title	Elective III - Evolution

Course Objectives:

- To understand the unity of life with the rich diversity of organisms and their ecological and evolutionary significance.
- To know about the basic concepts of Evolution.

Unit	Content	Hrs
I	Theories Historical development and concept of evolution - Theory of special creation. Theory of spontaneous generation or Abiogenesis, Biogenesis. Biochemical Origin of Life, Urey and Miller's Experiment.	15
II	Evidences and Fossils Evidences from Morphology, Comparative anatomy and Palaeontology. Fossils – Definition, formation of Fossils, Fossilization – Petrification, preservation – foot prints or trails, moulds and casts, impressions, preservations in resins and ambers, dating of fossils – radioactive clock methods. Radioactive Carbon method, Potassium – Argon method. Significance of study of fossils.	15
III	Theories of Evolution Lamarckism, criticism of Lamarckism, Neo – Lamarckism, Darwinism, criticisms of Darwinism, Neo- Darwinism, certain generalizations about Evolution – Atavism, Williston's Rule, Cope's Rule and allometry.	15
IV	Mechanism of Evolution Variations - kinds of variation, sources of variation. Hybridization in Evolution – Introgressive hybridization. Polyploidy in Evolution. Isolating mechanisms – Prematic mechanisms and posmating mechanisms. Role of isolation in Evolution. Natural selection – Nature of natural selection – differential reproduction, Types of Natural selection. Mutation as raw materials for Natural Selection.	15
V	Speciation Species – Morphological, Genetic and biological species concept, sibling species, monotypic and polytypic speciation. Subspecies categories – Clines and Demes, Orgin of species – factors causing Genetic Divergence in the population of species Patterns of speciation – Allopatric, Sympatric, Quantum and Parapatric speciation	15
VI	Evolution of Man Human Evolution- place of origin, time of origin, causes of Evolution of Man, characteristics of Man. Evolutionary trends, Evolution of Man as seen in fossil record - Propliopithecus, Dryopithecus, Oreopithecus, Ramapithecus and Australopithecus (first Man – Ape), Homoerectus – Java and Peking Man. Homosapiens – Heidelberg Man, Neanderthal Man, Solo man,	15

	Rhodesian Man, Cro- Magnon Man (Homo sapiens sapiens) Culture and Control of Evolution – learning society and culture, relative rates of culture of Biological Evolution and Social Darwinism.	
Total contact hours		90

Reference books:

1. Paul Amos Moody, 1978, Introduction to Evolution, Kalyani Publishers, New Delhi.
2. Theodosius Dobzhansky, Francisco J. Ayala, G. Ledyard Stebbins, James W. Valentine, 1973, Evolution, Surject Publications, New Delhi. E.Peter Volpe, 1989, Understanding Evolution, Universal Book Stall, New Delhi.
3. Mohan, P. Arora, 2000, Organic Evolution Himalayan Publishing House, New Delhi.
4. G.L Stebbins, 1979, Process of Organic Evolution, Prentice Hall India, New Delhi.
Monroe.W.Strickberger,2000 Evolution, Jones & Barlett publishers, Boston

Course Outcomes:

K2	CO1	To understand the concepts of origin of life and their evolution in different Past Eras
K3	CO2	To understand different theories of evolutionary concepts
K5	CO3	To know well about the Adaptations, Adaptive Radiations with appropriate examples
K4	CO4	To Understanding of genetic basis of evolution, human karyotyping and speciation.
K2	CO5	To have a knowledge about the origin and evolution of Human and mile stones of cultural evolution

Programme code	PGZOOA	Programme	Zoology
Course code	MPZE3	Batch	2019-2021
Hrs/week	6	Semester	III
Credits	4	Course Title	Elective III : Food and Nutrition

Course Objectives:

- To understand the nutritive Values of various foods.
- To recollect the concept of nutritive foods.

Unit	Content	Hrs
I	The scope of food and nutrition. Composition of food (Protein –Carbohydrate – Fat-Vitamins and Minerals).	15
II	Measurement of energy and energy values of various food. Nutritional requirements – children, adolescence, old age. Balances diet.	15
III	Milk – Types – importance in the diet. Eggs – Structures and composition – importance in the diet. Meat – Types – importance in the diet.	15
IV	Fish – Types - importance in the diet. Vegetables – Types - importance in the diet. Fruits – Types - importance in the diet. Cereals and pulses – Types- importance in the diet.	15
V	Food spoilage. Food poisoning- food borne diseases. Food adulteration.	15
VI	Function and sources of food. Digestion and absorption. Methods of purification of potable water. Food laws Food grading <i>fassi, agmark</i> .	15
Total contact hours		90

Reference Books:

1. Anita Tull, (1987) 1st edition. Food and nutrition – Oxford University press. Cambridge.
2. Srilakshmi, B. (2012) 5th edition. Food Science, New age International Publishers, New Delhi.
3. Swaran Pasran Pasricvha, (2000) 1st edition. Count what you eat – NIN – Hyderabad.
4. Tripathy, S. N. (2004) 1st edition. Food Biotechnology. Dominant Publishes and distributors, New Delhi. 110002.
5. Srilakshmi, B. (2012) 6th edition. Dietetics, New age International Publishers, New Delhi

Course Outcomes:

K2	CO1	To understand the energy values of various foods.
K3	CO2	To apply the importance of food chart.
K5	CO3	To analyze the food deficiency diseases.
K4	CO4	To know about the food borne diseases.
K2	CO5	To avoid malnutrition.

Programme code	PGZOOA	Programme	Zoology
Course code	MPZC11	Batch	2019-2021
Hrs/week	6	Semester	IV
Credits	5	Course Title	Core X : Animal Physiology

Course Objectives:

- To understand the structural organization and functions of different organ systems within the body.
- To impart knowledge of the various metabolic and physiological mechanisms of the human body.

Unit	Content	Hrs
I	Cell Membrane, Homeostasis, Nutrition and Digestion Properties of Cell Membrane: Transport across cell membrane and Ionic basis of Cellular Excitability. Nutritive Patterns: Origin of Nutritive Type, Feeding Pattern. Digestion and Absorption	15
II	Respiration & Circulation Respiration: Respiratory organs, Respiratory pigments, Transport of Respiratory Gases, Oxygen as a limiting factor in the environment. Circulation: Circulating fluids – Cytoplasm, Hydrolymph, Hemolymph, Lymph and Blood, Mechanism of Blood coagulation and Hemodynamic Heart - Structure, Origin and Conduction of Heart beat.	15
III	Excretion, Osmoregulation and Thermoregulation Excretion: Organs of Excretion, Structure of Nephron - Juxtaglomerular apparatus of Nephron. Physiology of Urine Formation & Counter Current mechanism. Renal regulation of Acid - Base balance. Urine Composition. Osmoregulation: Maintaining Water and Electrolyte balance – Living in Isosmotic, Hyposmotic, Hyperosmotic and Terrestrial Environments. Hormonal regulation of water and Electrolytes. Thermoregulation: Temperature and rate of biological activities, Temperature compensation in Poikilotherms and Homeotherms.	15
IV	Nervous Integration Structure of Neuron, Fundamentals of nerve impulse – Resting potential, Action potential, Role of Ion channels. Transmission of nerve impulse: Excitation, Conduction Interneuronal transmission - Ephatic and Synaptic transmission, Chemical synapses and Neuro muscular junction. Neurotransmitters.	15
V	Muscle and Receptors Muscle system- Ultra structure of Muscle Fibres, Mechanism of Muscle Contraction - Biochemical changes during Contraction, Energetic of Muscular contraction. Receptors : Photoreceptor, Chemoreceptor, Mechanoreceptor and Thermo receptor .	15

VI	Endocrine Regulation on Reproduction Vertebrate controls: Hypothalamic hormones – Gonadotrophins, Gonadal steroids – Estrogen & Progesteron. Regulation of Breeding cycle – Oestrous & Menstrual cycles. Placental Hormones , Relaxin and the hormones associated with Parturition.	15
Total contact hours		90

Reference Books:

1. William S. Hoar, General and Comparative Physiology Prentice - Hall of India (private) Ltd, New Delhi.
2. C.Ladd. Prosser, Frank A. Brown, Comparative Animal Physiology , II Ed., W.B. Saunders company, London.
3. Kunt sachmidt- Nielsen, (2013), Animal physiology: Adaptation and Environment- III Ed., Press syndicate of the University of Cambridge, London.
4. Elaine ,N. Marieb,(2006), Human Anatomy & physiology, VI Ed., Dorling Kindersley (India) Pvt.Ltd.,
5. Christopher D. Moyes & Patricia M.Schulte., (2007), Principles of Animal Physiology, Dorling Kindersley (India) Pvt.Ltd.,

Course Outcomes:

K2	CO 1	To gain knowledge of the feeding mechanism, Internal transport and gas exchange and discerning acid – base balance.
K2	CO 2	To know about the regulation of heart beat and blood pressure, neural and chemical regulation of respiration and transfer of air,
K2	CO 3	To perceive the osmoregulation , kidney function and pattern of excretion
K4	CO 4	To understand the concept of Thermoregulation – Heat balance in animals, Adaptations to temperature extremes, Aestivation and Hibernation and Counter current Heat exchangers,
K2	CO 5	To be able to sense the environment through Receptors.

Programme code	PGZOOA	Programme	Zoology
Course code	MPZC11	Batch	2019-2021
Hrs/week	6	Semester	IV
Credits	5	Course Title	Core X : Immunology

Course Objectives:

- To acquire knowledge on immunity and immune system.
- To understand the significance of the organs and cells and their functions during the immune reactions.

Unit	Content	Hrs
I	Basics of Immunology History and scope of immunology. Types of immunity – innate, acquired, passive and active. Physiology of immune response – humoral and cell mediated immunity. Lymphoid organs – primary and secondary. Cells of immune system – ontogeny and development of cells in innate and adaptive immune system. Hematopoiesis and stem cells.	15
II	Cells And Tissues of the Immune System Histology of Lymphoid organs - Primary and Secondary lymphoid organs. T and B lymphocytes. T- lymphocytes – T cell types, T cell Receptors, T cell surface markers -T cell regulation- T- cell maturation. B- lymphocytes - B cell types - B cell receptors- B- cell activation –proliferation –maturation. Difference between T and B lymphocytes. Null cells, Macrophages, Polymorphonuclear leucocytes (PMN).	15
III	Immune Responses of Antigen and Antibody Antigens – characteristics, types, cross reactivity, hapten, adjuvant, immunogenicity and antigenicity. Immunoglobulins – structure, types and functions. Synthesis of Immunoglobulin, Genetic basis of Class Switch.	15
IV	Antigen and Antibody Reactions Immuno diagnosis based on antigen and antibody interaction: Precipitation – Precipitation reactions in gel (Immunodiffusion) – Applications of Precipitation. Agglutination, - Agglutination reactions – Coombs test, Positive Agglutination, Agglutination inhibition. Immunofluorescence and Flow cytometry. Complement System -Complement Fixation - Role of Complements in Immune Response. Hypersensitivity Reactions.	15
V	Vaccines and Health Major Histocompatibility Complexes (MHC) in man. Immune deficiency disorders – T cells, B cells, phagocytic, natural killer cell associated diseases and AIDS. Vaccines: Types– inactivated, subunit, synthetic, DNA and live attenuated vaccines.	15
VI	Immunity to Infectious Diseases Tumour antigens, immune responses to tumour and immunotherapy of malignancy. Immunity to infectious diseases – bacterial (Tuberculosis), viral (AIDS), protozoan and parasitic diseases (Malaria and Leishmaniasis). Western Blotting. Hybridoma Technology - Monoclonal Antibodies.	15
Total contact hours		90

Reference Books:

1. Kuby ., (1992), Immunology, IV Ed., - W.H. Freeman and company.
2. Evan M.Roitt., (1988), Essentials Immunology- VI Ed., ELBS imprint.Shailendra Kumar Sinha., (2009) Serial dilution Technique.
3. Immunology and Medical Zoology- I Ed., - Oxford Book Company.
4. 4. David male., (2008), Immunology VII Ed., Elsevier Health sciences.
5. I.Kannan., (2007), Immunology I Ed., - MJP Publisher .

Course Outcomes:

K1	CO 1	To gain knowledge of the immune system, principles of innate and adaptive immunity.
K2	CO 2	To understand the antigen recognition by immune cells
K2	CO 3	To know the illustration of Antigen processing and presentation to T Lymphocytes by antigen presenting cells and understanding the role of MHC Complex.
K5	CO 4	To analyze the consequence of immunodeficiency leading to diseases such as inherited acquired immunodeficiency disease, hypersensitivity diseases, autoimmunity and Transplant rejection.
K5	CO 5	To gain understanding of manipulation of immune responses for the benefit of mankind - vaccines

Programme code	PGZOOA	Programme	Zoology
Course code	MPZP4	Batch	2019-2021
Hrs/week	6	Semester	IV
Credits	4	Course Title	Core Practical IV-Animal Physiology & Immunology

Course Objectives:

- To study the basis for various systems in the Animal kingdom.
- To understand about Immunity, Antigen, Antibody, Cells of the immune system and their functions and regulations.

CONTENT	
Animal Physiology	
<ol style="list-style-type: none"> 1. Effect of Temperature on Oxygen consumption of fish & calculation of Q10 2. Effect of Temperature on Opercular movements of fish & calculation of Q10 3. Effect of salinity on Oxygen consumption of fish 4. Effect of salinity on Opercular movement of fish 5. Estimation of Salt loss in a fish 6. Estimation of Salt gain in a fish 7. Mounting of Haemin crystals. 8. Blood pressure recording 9. Estimation of Blood sugar. 	
Immunology	
<ol style="list-style-type: none"> 1. Virtual dissection and Display of Lymphoid organs 2. Isolation of Lymphocytes and enumeration from Human Blood 3. Bleeding and preparation of complement and antisera. 4. Electrophoretic separation of serum proteins 5. Haemagglutination (or) Haemolysin titration assay 6. Ammonium Sulphate Precipitation- Method of Antibody Production. 7. Ouchterlony technique – Immunodiffusion (Demonstration only). 8. Immuno Electrophoresis of Human serum and Anti-Human Serum (Demonstration only). 9. ABO Blood Grouping and Rh typing. 10. Serum separation. 11. Qualitative detection of Antibodies to HIV-1 & HIV-2 in Human serum/ Plasma (Visit to immunology Lab) 	

Course Outcomes:

K5	CO 1	To apply functional knowledge on various organs and its status
K4	CO 2	To comprehend physiological activity of organ systems
K6	CO 3	To understand the concepts and methodology to various immunological techniques
K5	CO 4	Knowledge of immune system by isolating of Lymphocytes and Antibodies

Programme code	PGZOOA	Programme	Zoology
Course code	MPZPR	Batch	2019-2022
Hrs/week	12	Semester	IV
Credits	4	Course Title	Core I : Project Writing

Course Objectives:

- To investigate the development of students' ability in research field.
- To supply the students basic information on literature survey.

Course Outcomes:

K5	CO 1	To prepare the students for further research.
K4	CO 2	To inculcate innovative ideas for modern science and technology development.
K6	CO 3	To be capable of writing research proposals for funding.
K5	CO 4	To become technically knowledgeable students