SEMESTER - III			
Core IX Computational Biology			
Code : 19PZOC31	**Hrs/Week : 6**	**Hrs/Sem : 90**	**Credits : 4**

Vision

To understand the central concepts of biostatistics and bioinformatics

Mission

To impart interdisciplinary expertise from the biological science, computer science and mathematics

Course Outcome:

CO. No	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	analyse and interpret results of descriptive statistical methods effectively	1, 3	An, Ev
CO-2	apply the methods of hypothesis testing, statistical inference and design	4	Ap
CO-3	appreciate biological data in statistical perspective correctly and contextually	4	Un
CO-4	infuse critical appraisal skills to assess the research data and produce original research	7	Cr
CO- 5	carry out correlation and regression analysis and recognise theoretical distributions	6	Un, An
CO -6	formulate and test using appropriate statistical software	4	Cr
CO-7	implement statistical methods and statistical software programmes to a variety of practical problems	5	Ap
CO- 8	demonstrate the mastery of concepts of bioinformatics	1, 2	Un,

SEMESTER - III			
Core IX Computational Biology			
Code : 19PZOC31	Hrs/Week : 6	Hrs/Sem : 90	Credits : 4

Unit I Biostatistics –Descriptive Statistics

Introduction – measures of central tendency - arithmetic mean, geometric mean, harmonic mean, median and mode – measures of dispersion – range, quartiles, mean deviation, standard deviation, standard error and coefficient of variation – measures of skewness and kurtosis – stem and leaf diagram - box plot.

Unit II Inferential Statistics

Theoretical probability distributions - binomial - Poisson – normal distribution – steps in hypothesis testing procedure – student's t- test – chi – square test – goodness of fit and contingency tables – ANOVA – assumptions - types - one way and two way.

Unit III Correlation and Regression

Computation and interpretation of correlation coefficient – Karl Pearson's correlation coefficient – coefficient of determination - Spearman's rank correlation coefficient – regression – types – regression lines and their properties – fitting linear regression equations and forecasting – relationship between correlation and regression coefficients.

Unit IV Computer Applications

MS Excel – spread sheet – statistical functions calculation of arithmetic mean – t test – ANOVA one way classification– statistical packages –SIGMAPLOT – statistical calculation –SPSS package – Principal Component Analysis(PCA).

Unit V Bioinformatics

Basic concepts and scope - nucleic acid database - GENBANK and EMBL – protein sequence database - NBRF – PIR and SWISSPROT - database similarity searches – BLAST and PSI – BLAST algorithms – Smith – Waterman algorithm – Needleman – Wunsch algorithm – scoring matrices - PAM and BLOSUM – multiple sequence alignment – sum of pairs method and progressive method.

Books for Reference.

1. Jerrold H. Zar. 1984. *Biostatistical Analysis*. 2nd edition, Prentice -Hall International Edition. USA.
2. Snedecor, G.W. and W.G. Cochran. 1991. *Statistical Methods.* (8th edition). Affiliated East West Press, New Delhi,.
3. Gurumani, N. 2005. *An Introduction to Biostatistics*. MJP Publishers, 2nd edition, Triplicane, Chennai-5
4. Agarwal, S.K. 2008. *Bioinformatics.* APH Publishing Corporation. New Delhi.
5. Gautham, N. 2009. *Bioinformatics - Databases and Algorithms*. Narosa Publishing House Pvt Ltd. New Delhi.

6. Thiagarajan, B. and Pa.Rajalakshmi 2009. *Computational Biology,* MJP publishers, Chennai .
7. Rajathi, A and Chandran, P. 2010. *SPSS for you*. MJP Publishers, Chennai.

PRACTICALS

Hrs/ Week : 2 **Credit:1**

1. Computation of mean, median, mode, variance, standard deviation, standard error and coefficient of variation for biological variables.
2. Display of data through stem and leaf diagram.
3. Test of significance using student's t – test.
4. Test of goodness of fit of data with the aid of chi- square test.
5. Analysis of variance of molluscan shells
6. Correlation coefficient between height and weight of students and length and width of leaves.
7. Fitting regression equations for two variables and prediction of values.
8. Seqence alignment and similarity searching - BLAST
9. Statistical calculation using SPSS software package.
10. Retrieving data from EMBL database - Print out.

Books for Reference

1. Gurumani, N. 2005. *An Introduction to Biostatistics*. MJP Publishers, 2nd edition, Triplicane, Chennai-5.
2. Rajadurai, M. 2010. *Bioinformatics – A Practical Manual*, PSB Book Enterprises, Chennai.

SEMESTER – III			
Core X : Aquaculture Practices and Farm Management			
Code : 19PZOC32	**Hrs / week : 6**	**Hrs / Sem : 90**	**Credits : 4**

Vision

To develop a comprehensive knowledge and transferable professional skills for career in aquaculture industry

Mission

To acquaint with technical and general knowledge for competent fisheries management

Course Outcome

CO. No	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	design aquaculture systems	1	Cr
CO-2	develop practical skills for management of culture ponds	3	Ap
CO-3	apply techniques involved in breeding and culture of various organisms	1,2	Cr,Ap
CO-4	demonstrate competency in live feed culture and feed formulation	2,3	Un,Ev
CO-5	evaluate and manage aquaculture diseases, health and safety issues in aquaculture ventures	1,6	Un Ev
CO-6	discuss important factors for performing a sustainable aquaculture	1,3	Un, Ap
CO-7	compare the principles of genetic improvement of fish stock	1	Un
CO-8	analyse aquaculture economics and marketing strategies	1,3	An,Ap

SEMESTER – III			
Core X : Aquaculture Practices and Farm Management			
Code : 19PZOC32	**Hrs / week : 6**	**Hrs / Sem : 90**	**Credits : 4**

Unit I **Aquaculture Basics and Management**

Scope of aquaculture, aquaculture in India, Fishery resources of India in general and Tamil Nadu in particular. Selection of site,construction of fish farm, soil chemistry. Designing layout and construction of different types of fish ponds. Management of culture ponds - fertilization, water quality management, predators and weed management

Unit II **Seed Production and Culture Techniques**

Carp culture : Carp: Brooders care and management seed collection from natural sources, bundh breeding, hypophysation, in-vitro fertilization. Fish seed transport, hatching and rearing techniques. Culture of edible oyster, pearl oyster and seaweed.

Unit III **Nutrition and Health management**

Culture of fish feed organisms: diatoms,cladocerans,rotifers, artemia, artificial feed formulation and management, probiotics in formulated feeds. Bacterial (gill rot & Furunculosis),viral (EUS & Erythrocytic necrosis) fungal diseases (Saprolegniasis & Erythroderma) nutritional deficiency diseases, ectoparasites, endoparasites, principles of fish health management, fish vaccines.

Unit IV **Aquaculture for Stable Environment**

Water pollution, its effect on fisheries and methods of its abatement. Sewage - fed fish culture, sewage treatment , sewage- cum fish culture in India. Integrated fish farming: animal husbandry cum fish culture, paddy cum fish culture, fish culture in cages and pens. Culture of air breathing fishes.

Unit V **Aquaculture Biotechnology and Economics**

Genetic improvement of stock: selective breeding, hybridization, polyploidy, production of monosex, sterile fish, transgenic fish, sex manipulation, gynogenesis, androgenesis, role of biotechnology in conservation of fish. Aquaculture economics, fish marketing, involvement of government organizations in marketing. Role of CMFRI, NIOT,CIBA & NABARD.

Books for Reference

1. Dubey, S. K. and Bandand Ghosh. 2012. *Fish Biotechnology*. Wisdom Press, New Delhi.
2. Amita Saxena, 2011. *Fisheries Economics*. Daya Publishing House, New Delhi.
3. Schonder, S. L. 1980. *Hypophysation in Indian Major Carps*. Sathish Book Enterprises Agra.
4. Pandian, I.D. Abhinandan Kumar and Rajbhushan Prasad. 2009. *Aquaculture and Biotechnology*. A. K. Publ. New Delhi.
5. Agnihotri. S. B. 2013. *Aquaculture Management and Technology*. Swastik Publication, Delhi.

6. Felix, S. 2010. *Marine and Aquaculture Biotechnology*. Agrobios, Jodhpur, India

7. Santhanam, R., Ramanathan, N. and G. Jegathesan. 1990. *Coastal Aquaculture in India.* 1st edn. CBS Publishers, Delhi.

8. Shagufta. 2012. *Fish Health and Diseases*. APH Publishing.,Corpoartion, NewDelhi

9. Yougesh Kumar and Rajeev Tyagi. 2013. *Aquaculture Fisheries Biotechnology and Genetics*. Mangalam Publishers & Distributors, Delhi

10. ChandraSekar. Y.S . 2012. *Fish Nutrition in Aquaculture*. Swasthik Publishers &Distributers, Delhi.

11. Rajendra Kumar Rath. 2011. *Freshwater Aquaculture*. Scientific Publishers, Jodhpur.

12. Singh, V.B. 2010. *Fish Farming*. ALP Books, New Delhi.

13. *Economics of Fish Culture Operations*. FAO- www.fao.org.docrep

PRACTICALS

Hrs / Week : 2 **Credit: 1**

1. Estimation of dissolved ammonia in water samples
2. Estimation of alkalinity in water samples.
3. Analysis of freshwater plankton
4. Decapsulation technique and hatching of artemia cysts
5. Feed formulation exercise – preparation of compound feed Demonstration
6. Identification of cultivable food fishes
7. Identification of aquatic weeds, predatory fishes and insects.
8. Study of fish parasites and diseases.
9. Visit to aquaculture farm – drawing the layout of ponds, dikes and sluices

Books for Reference

1. Methods in Hydrobiology Manual, *Centre for Advanced Studies in Marine Biology*, Published by Annamalai University, Parangipettai, Chidambaram.
2. Felix, N., Ahilan, B. and S. Athithan. 2004. *Fish Nutrition and Feed Technology Manual.* Fisheries College and Research Institute, Tamilnadu Verteinary & Animal Science University, Thoothukudi.
3. FAO Fisheries Technical Paper. No.361; *Manual on the Production and Use of Live food for Aquaculture.* Laboratory of Aquaculture and Artemia Reference Centre, University of Ghent, Belgium.

SEMESTER – III			
Core XII : Research Methodology			
Code : 19PZOC34	**Hrs / Week : 5**	**Hrs / Sem : 75**	**Credits : 4**

Vision

To inculcate research aptitude in students

To be leaders in making use of various scientific techniques and research methods available to and usable by scholars

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Mission

To introduce the principles and applications of various instruments used in Biology and to prepare them to use these techniques in their own research

Provide an environment to students to participate in consulting and improve their skills

To build scientific teams that can combine various techniques and to create novel approaches to understanding

Strengthen research by assisting students using scientific techniques in the most optimal way.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	demonstrate critical thinking and scientific approach in the design and implementation of an experiment.	1,3	Un, Cr
CO-2	effectively communicate scientific ideas in both written and oral formats	1,2	Un, Ev
CO-3	acquire a broad range of basic laboratory skills to perform experiments and for employment prospects	5	Un, Ap
CO-4	demonstrate and apply a working comprehension of the technical and procedural aspects of laboratory testing, safety and ethical standards of practices	4	Ap
CO-5	write a research report and thesis and Appreciate the components of scholarly writing and evaluate its quality.	6	Cr,Ev
CO-6	verify and test important facts and find solutions to scientific problems	7	An
CO-7	develop new scientific tools, concepts and theories to solve and understand scientific problems	7	Cr
CO-8	design and conduct independent laboratory or field research that is consistent with the highest standards and practices of research	8	Ap

SEMESTER – III			
Core XII : Research Methodology			
Code : 19PZOC34	Hrs / Week : 5	Hrs / Sem : 75	Credits : 4

Unit I Research Designing

Introduction – literature collection-sources – literature citation – manuscript preparation of research report, Internet and e-journals- thesis formating and typing – safety measures in a laboratory – Plagiarism (URKUND)

Unit II Microscopy Types

Principle, construction and applications of Phase contrast- Polarization – Electron microscope– types (SEM,TEM)- fixation and staining techniques for EM (freeze - etching and Freeze fracture), fluorescence - flow cytometry - atomic force and magnetic force microscope – micrometry.

Unit III Spectroscopic Techniques

Absorption and emission principles – construction and applications of UV-visible spectrophotometer, FTIR, spectrofluorometer- flame photometer-atomic absorption and emission spectrophotometer -NMR and Mass spectrometer in Biology

Unit IV Centrifugation and Chromatographic Techniques

Principles of centrifugation— ultra centrifuge, differential centrifugation- density gradient– isopycnic- Principle, instrumentation and application of chromatography – column - gas - liquid - HPLC – ion exchange - affinity- gel filteration.

Unit V Electrophoresis & Radioactive Techniques

Principle and applications of electrophoresis – agrose - PAGE- SDS-PAGE- isoelectric focusing- radioisotopes used in Biology GMcounter, solid and liquid scintillation counters – sample preparation for radioactive counting. Autoradiography - calorimetry – bomb calorimeter, calorific value- applications.

Books for Reference

1. Palanichamy S. and M. Shanmugavelu. 1997. *Research Methods in Biological Sciences*. Palani Paramount Publication, Palani.
2. Gurumani. 2011. *Research Methodology for Biological Sciences*. M.J.P. Publishers, Chennai.
3. Veerakumari. L. 2007. *Bioinstrumentatio*n. M.J.P Publishers, Chennai.
4. Aparna Mathur. 2013. *Laboratory Instrumentation*. Black Prints. New Delhi.
5. Chinmoy Goswami, Abhijit Paintal and Rabindra Narain. 2011. *Hand Book of Bioinstrumentation.* South Anarkali Delhi.

6. Debbie Holmes Peter Moody and Diana Dine, 2006. *Research Methods for the Biosciences.* Oxford University Press, UK.
7. Rabindra Narain . 2012. *Practical Immunology*. Wisdom Press, New Delhi.

PRACTICALS
Hrs / Week - 2 **Credits - 1**

1. Fractionation of rat liver by density gradient
2. Measurement of cell size by micrometry
3. Phase contrast microscopic observation of living cells
4. Estimation of lipids (Bragdon method)
5. Absorption spectra of proteins/ pigments
6. Column chromatographic separation of plant pigments.
7. Calculation of citation index in SCI/ Scopus/ Google scholar/ICI
8. Use of different instruments in research methodology.(Spotters)
    i. Electron microscope
    ii. Spectrophotometer
    iii. Chromatography
    iv. HPLC
    v. SDS - PAGE

Books for Reference

1. Gurumani. 2011. *Research Methodology for Biological Sciences*. M.J.P. Publishers, Chennai.
2. Veerakumari. L. 2007. *Bioinstrumentation.* M.J.P. Publishers, Chennai.

SEMESTER - IV			
Core XV - Commercial Zoology			
Code :19PZOC43	**Hrs /Week: 5**	**Hrs/ Sem : 75**	**Credits : 4**

Vision :

To facilitate self- employment and entrepreneurship in Apiculture and Sericulture.

Mission :

To motivate the students to take up carriers related to agro- based, rural oriented cottage industry through imparting knowledge in apiary management, mulberry cultivation and silkworm rearing.

Course Outcome:

CO. No	upon completion of this course, students will be able to	PSO addressed	CL
CO-1	identify, choose suitable bees and maintain bee hive successfully	2	Ev
CO-2	understand the behavior of bees, prevent swarming and manage bee colonies	3	Un
CO-3	inspect bee colony, identify diseases of bees, recognize their enemies and take necessary control measures	4	An, Ap
CO-4	apply their knowledge to implement the procedure to extract honey and other bee products and to preserve honey	5	Ap
CO-5	demonstrate an understanding of mulberry cultivation, silkworm rearing and silk reeling	1	Un
CO-6	identify diseases, pests of mulberry and silkworm and adapt control measures	4	Ap, Cr
CO-7	utilize their knowledge in harvesting, marketing cocoons and reeling operations	5	Ap
CO-8	develop practical proficiency in apiculture and sericulture from the lab work and visit to the apiary and the department of sericulture	6	Ap

SEMESTER - IV			
Core XV - Commercial Zoology			
Code :19PZOC43	Hrs /Week: 5	Hrs/ Sem : 75	Credits : 4

Unit I Bee keeping technology

Apiculture as a cottage industry - choice of species in apiculture- Indian bee, European bee. Bee keeping equipments - Langstroth hive and Newton's hive- Appliances used in apiaries. Swarming – prevention and control. Queen rearing and introduction. Artificial feeding.

Unit II Management of bees & Honey bee products

Diseases of bees- brood diseases, diseases of adult bees - nosema and septicemia, enemies - greater wax moth, lesser wax moth, ants, wasps - control measures. Extraction and uses of honey- bee wax- bee venom and pollen. Preservation and storage of honey.

Unit III Moriculture

Mulberry cultivation – cultivation practices – biofertilizers – foliar spray – triacontanol and seriboost. Diseases of mulberry – white root rot, stem canker, leaf spot, powdery mildew, leaf blight and leaf mosaic - deficiency diseases — symptoms and control measures.

Unit IV Silk worm rearing

Mulberry silk worm development – silk worm rearing – rearing house – rearing appliances rearing operations – chawki rearing – application of sampoorna. Silk worm diseases - flacherie, muscardine, grasserie, and pest- Indian uzifly- symptoms and control measures.

Unit V Cocoon Mounting and Reeling

Mountages- mounting methods - cocoons – harvesting, transport and marketing. Silk reeling – reeling operations, reeling appliances – cottage basin – filature units. By-products of sericulture.

Books for Reference

1. Mishra. R.C. 1997-98. *Perspectives in Indian Apiculture.* Agro Botanica, 4E 176 J.N.Vyas Nagar, Bikaner, H.S.Offset Printers,Daryagunj, New Delhi.
2. Pierre Jean – Prost. 1994. *Apiculture*. Oxford & IBH Publishing Co.Pvt. LTD. New Delhi.
3. Root, R.I. 1985. *Encyclopedia of Bee Culture*. International Books & Periodicals Supply Service. 24 – B/5, Desh Bandhu Gupta Road, New Delhi

4. Raja Instus, E. 1994. *Economics of Bee Keeping Industry*. Rawat Publications, Jaipur and New Delhi.
5. Everett Franklin Phillips. 2010. *Bee Keeping*. Agrobios (India), Agro House, Chopasani Road, Jodhpur – 342 002.
6. Ganga, G. and J. Sulochana Chetty. 1997. *An Introduction to Sericulture*. Oxford & IBH Publishing Co Pvt. Ltd. New Delhi.
7. Krishnaswami, S. 1990. *Improved Method of Rearing Young Age Silkworms*. Central Silk Board – Bangalore.
8. Acharya, J. 1993. *Sericulture and Development*. Indian Publishers Distributers Kamak Nagar – New Delhi
9. Hisao Aruga. 1990. *Principles of Sericulture*. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.

PRACTICALS

Hrs / Week : 2 **Credit: 1**

1. Identification of bee species and casts.
2. Mounting of mouth parts and legs of worker bee.
3. Bee keeping equipments - Newton's hive, hive tool, smoker, uncapping knife, pollen box, honey extractor.
4. Identification of diseases and enemies of honey bees.
5. Mulberry diseases and pests
6. Development of silkworm.
7. Silk gland.
8. Rearing house and appliances.
9. Silkworm diseases and pests.
10. Visit to an apiary and sericulture department.

Books for Reference

1. Alka Prakash. 2001. *Laboratory Manual of Entomology*. New Age International (P) Ltd, 4835/ 24, Ansari Road, Daryaganj, New Delhi – 110002.
2. Tammanna N.Sonwalker.1993. *Hand Book of Silk Technology*. Wiley Eastern Ltd. Chennai.

SEMESTER - IV			
Elective - I B	**Ornamental Fish Culture**		
Code : 19PZOE41	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Vision

Impart basic understanding for operating an ornamental fish farm and improve the quality of fisheries education, research and extension activities. Instill competence and confidence among the students for self employment.

Mission

Generate technically skilled man power to work in ornamental fish farms

Augment ornamental fisheries trade and export earnings

Course Outcome:

CO.No	Upon completion of this course, students will be able to	PSO addressed	CL
CO - 1	explain the construction, fabrication and accessories required for setting up an aquarium tank	2,3	Un
CO - 2	apply the knowledge and skills in aquarium management	1	Ap
CO - 3	evaluate the types and culture of live feed organisms and formulate the artificial feed	3	Ev
CO - 4	describe the factor related with taxonomy and biology of ornamental fish	3	An
CO - 5	choose the commercially important fresh water and marine ornamental fishes and their transport	8	Ev, Cr
CO - 6	analyse the different varieties of ornamental fish	2,3	An
CO - 7	acquire confidence to become an entrepreneur in ornamental fish culture	3	Un
CO - 8	develop entrepreneurial skills and make aware of National and International export earnings	2,7	Cr

SEMESTER - IV			
Elective - I B	Ornamental Fish Culture		
Code : 19PZOE41	Hrs / Week : 4	Hrs / Sem : 60	Credits : 4

Unit I Construction of fish tanks

Design and Construction of fish tanks - setting up of tanks - accessories for aquarium tanks - hood, light source, hand net, suction tube, scrapper tool, aerator, gravels, filters and ornamental objects - aquarium plants and its importance.

Unit II Aquarium maintenance

Maintenance of water quality - temperature, water hardness, ammonia, pH, O_2, CO_2. Control of snail and algal growth. Diseases - protozoan - fungal - bacterial and nutritional diseases - diagnosis and treatment.

Unit III Nutritional requirements of ornamental fishes

Different types of feed - artificial and live feed - culture of live feed organisms - infusorians - zooplankton - rotifers - copepods - cladocerans - spirulina - brine shrimp - chironomous - tubifex. Artificial feed - principles of feed formulation - preparation of artificial feed - balanced diets.

Unit IV Popular ornamental fishes

Taxonomy and biology of egg layers - siamese fighting fish, gourami, gold fish, koi, rosy barb, neon tetra, zebra cichlid and angel fish. Live bearers - molly, guppy, sword tail and platy. Breeding and spawning of egg layers and live bearers .

Unit V Marine ornamental organisms

Commercially important marine ornamental fishes - butterfly fish, parrot fish, clown fish, marine angel fish. Transport of ornamental fishes - use of sedatives.

Books for Reference

1. Jameson. J.D. and R. Santhanam, 1996. Manual of Ornamental Fishes and Farming Technologies – Fisheries College and Research Institute TANUVAS, Tuticorin.
2. Santhanakumar. R. and A.M. Selvaraj. 2007. Manual of Freshwater Ornamental Fish Culture, Department of Fisheries Extension, Fisheries College and Research Institute, TANUVAS, Tuticorin .
3. Venkataramani V.K. and N. Jeyakumar. 2004. Biodiversity and Stock Assessment of Marine Ornamental Fishes. Department of Fisheries Biology and Capture Fisheries, Fisheries College and Research Institute, TANUVAS, Tuticorin
4. Tharadevi, C.S. and K. V. Jayashree. 2009. Home Aquarium. Saras Publications, Nagercoil.
5. Santhanam R., Sukumaran N.and P. Natarajan 1990. A Manual of Fresh Water Aquculture. Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.
6. Gupta, S. K. and P. C. Gupta. 2006. General and Applied Ichthyology 1st Edn. Chand and Company Ltd, New Delhi.
7. Dholakia, A.D. 2009. Ornamental Fish Culture and Aquarium Management. Daya publishing House, Tri Nagar, Delhi.
8. Amita Saxena. 2003. Aquarium Management. Daya Publishing House, Tri Nagar, Delhi.