PGZ 4336 **Biostatistics and Bioinformatics** **(3+1=4h/wk) (3cr)**

This course is designed to impart a fundamental knowledge on data, sources & acquisition, organization & presentation of data. It targets at teaching certain important biostatistical analyses such as measures of central tendencies, dispersion of data and tests of significance. It also gives an introduction to the usage of SPSS package in biostatistical analysis. Second part of the course deals with the information of biological databases and file format. It emphasizes the concept of sequence analysis, sequence alignment tools & algorithm, a special attention given to phylogenetic analysis methods.

Course Outcomes

Upon completion of this course, students will be able to:

i. Identify the sources and methods of data collection, classification and presentation.
ii. Compute the central tendencies, measures of dispersion, standard deviation & error, linear regression and simple correlation.
iii. Analyze the significance, goodness of fit, variance & use SPSS package.
iv. Utilize biological databases for bioinformatics analysis.
v. Analyze biological sequence alignments and create phylogenetic tree.

1. **Introduction, data and collection methods:** Biostatistics - introduction, definition, basic concepts, terminologies. Data - types and sources, collection methods, sampling - random & non-random, classification of data - Sturge's rule. Presentation of data - tabulation, graphical and diagrammatic representation.

2. **Descriptive statistics:** Measures of central tendency - arithmetic mean, median and mode. Measures of dispersion - standard deviation and Standard error - linear regression and simple correlation.

3. **Tests of significance:** Students *t*-test (simple, paired), *F*-test - applications of $\chi 2$ (chi-square) test in biology & testing the goodness of fit - Analysis of Variance (ANOVA). Introduction to statistical software - SPSS - data editor - creating coding variables - output viewer - graphic & diagrammatic representations - Elements of Probit analysis.

4. **Introduction and Bioinformatics Resources:** Computational Biology and Bioinformatics - definition - Biological databases - Nucleic acid sequence databases - GenBank, EMBL and DDBJ. Protein sequence databases - SWISS-PROT, TrEMBL, PIR and PDB. Genome Databases - NCBI, EBI, TIGR and SANGER. Other Databases - Patterns/Motifs/System Biology.

5. **Sequence Similarity Searches:** Basic concepts of sequence similarity, identity and homology. Scoring matrices - PAM & BLOSUM series - local versus global alignment. Needleman-wunsch and Smith-waterman algorithms. Heuristic Methods of sequence alignment - FASTA, BLAST & PSI BLAST, Software tools for pairwise & multiple sequence alignment. Phylogenetic Analysis - Phylogenetic tree, Comparative genomics, orthologs and paralogs. Methods of phylogenetic analysis - UPGMA, WPGMA and neighbour joining method.

Text books

Attwood KT, Pettifer RS and D Thorne (2016) Bioinformatics Challenges at the Interface of Biology and Computer Science: Mind the Gap, First edn, John Wiley & Sons, New York.

Rastogi VB (2015) Biostatistics, Third edn, MEDTECH publishers, New Delhi.

References

Ignacimuthu S (2005) Basic Bioinformatics, Second edn, Narosa Publishing House, New Delhi.
Landau S and Everitt BS (2003) A Handbook of Statistical analyses using SPSS, Chapman & Hall/CRC Press, London.
Le CT and Eberly LE (2016) Introductory Biostatistics, Second edn, John Wiley and Sons, New Jersey.
Lesk AM (2002) Introduction to Bioinformatics, First edn, Oxford University Press, London.
Stanton GA (2002) Primer of Biostatistics, Fifth edn, McGraw-Hill, New York.
Zar JH (2005) Biostatistical Analysis, Fourth edn, Pearson Education Inc., New Delhi.

PGZ 4342 **Poultry Farming (CBCS)** **(4h/wk) (3cr)**

This course aims to develop human resource in the area of poultry farming. It will impart knowledge in poultry industry, farming, breeding, housing, nutrition, disease and management. This course will also help to understand the various aspects of poultry rearing.

Course Outcomes

Upon completion of this course, students will be able to:

i. Discuss the aspects of poultry industry, biology of fowl and nutrition.
ii. Identify the Indian exotic breeds, importance of layers and broilers and to evaluate their efficiency.
iii. Use the poultry equipment for day to day activities to be involved in the farm and explain the rearing system and use them efficiently.
iv. Compile the source of ingredients for the poultry feed stuff and formulate homemade feed for broilers and layers, feed additives and summer and winter management.
v. Analyze the nature and control of bacterial, fungal, viral and parasitic infections.

1. **Poultry industry & biology:** History of poultry industry in India - 5 year plans - NECC - entrepreneurship - funding agencies - role of egg and meat in human nutrition - poultry manure and byproducts. External features - digestive and reproductive systems - egg formation - feather sexing - feather tracts.

2. **Breeds of layers and broilers:** Classification - Indian and exotic breeds - production of commercial laying stock - cross breeds - sexing in one day old chicks - popular breeds of layers and broilers in India.

3. **Housing and Equipment:** Location of the farm - construction of poultry sheds - layout of broiler and layer farms - 1+3 housing system, all in and all out system - deep litter system - cage rearing - incubator - waterer - feeder - nest box - brooder - dropping pit - disposal pit.

4. **Nutrition and Management:** Energy - carbohydrates - fats - proteins - vitamins - minerals - feed stuff - feed formulation - non-nutritive feed additives - feed grinder - home made mineral mixture of feed for chick - grower - layer - broiler and finisher - Incubation - management of growers - layers - summer and winter management - forced moulting - debeaking - culling - marketing.

5. **Diseases and control measures:** Bacterial (Infectious coryza), viral (Newcastle, bird flu), fungal (Mycotoxicosis) and parasitic (Coccidosis) – transmission, symptoms & treatment. Vaccination - antibiotics - nutritional deficiencies.

Text book

Gnanamani MR (2003) Modern Aspects of Commercial Poultry Keeping, Ninth edn, Giri Publications, Madurai.

PGZ 4440 **Molecular Biology** **(6h/wk) (4cr)**

This course emphasizes the molecular basis of life and it forms the blueprint of life. It deals mainly with nucleic acids, proteins and their interactions. It covers the detailed molecular mechanisms involved in DNA replication, recombination, transcription and translation. A special emphasize is given to post- transcriptional and -translational modifications. It also includes an in depth study on mutations, DNA damage and repair mechanisms. Current understanding on the gene regulatory mechanisms is also focused.

Course Outcomes

Upon completion of this course, students will be able to:

i. Explain chromatin structure, DNA topology, replication & recombination.
ii. Discuss the events involved in transcription and post transcriptional modifications.
iii. Analyze the different stages of translation and post translational modifications of proteins.
iv. Compare the different gene regulatory mechanisms in prokaryotes and eukaryotes.
v. Evaluate the types of DNA damage, repair, mutation and transposition mechanism.

1. **DNA structure, replication and recombination:** Structure and forms of DNA, Replication - Semi conservative, rolling and D-loop models, mechanisms of replication. Homologous and site specific recombination.

2. **Transcription in prokaryotes and eukaryotes:** Structure and types of RNA - RNA polymerases - stages of transcription - transcriptional factors - Post transcriptional modifications - RNA processing - capping, splicing, polyadenylation and RNA editing.

3. **Translation in prokaryotes and eukaryotes:** Genetic code - properties - deciphering and exceptions to universality - stages of translation - translation factors - aminoacylation of tRNA - aminoacyl tRNA synthetase - translational proofreading - translational inhibitors - Post translational modifications of proteins.

4. **Gene regulation in prokaryotes and eukaryotes:** Inducible and repressible systems - *Lac* operon system - *Lac* positive and negative control mechanisms - *trp* operon - DNA binding proteins - galactose metabolism in Yeast - DNA looping and homeobox - Gene Silencing.

5. **DNA damage, repair mechanisms, mutation and transposons:** Types of DNA damage and repair mechanisms - spontaneous and induced mutations - molecular and biochemical basis of mutation. Transposable elements - Tn3, Tn5, Tn10, *Mu* phage, LINES, SINES, copia and P-element - significance and mechanism of transposition.

Text book

Watson JD, Baker TA, Bell SP, Alexander G and Levine M (2013) Molecular Biology of the Gene, Seventh edn, Benjamin-Cummings Pub Co., San Francisco, USA.

PGZ 4441 **Microbiology** **(4+1=5h/wk) (4cr)**

This course is designed to promote the interest of basic and applied areas of microbiology. It deals with detailed classification of bacteria, algae, fungi, protozoa and viruses. It imparts knowledge of microorganisms in industrial, food and agricultural microbiology. It emphasizes primary and secondary screening of microbes linked with fermentation industry. The course also deals with medically important microbes, diseases and control measures in terms of public health.

Course Outcomes

Upon completion of this course, students will be able to:

i. Analyze the evidences, historical events, diversity and scope of microbiology.
ii. Assess the classification of bacteria, fungi, algae and protozoa and characteristic features of prokaryotic and eukaryotic cells.
iii. Explain various bacterial growth media, sterilization and growth curve.
iv. Apply the knowledge of microorganisms in soil, food and industrial sectors.
v. Evaluate the role of microorganisms in epidemic and communicable diseases in global perspectives.

1. **Introduction, Microbial taxonomy and Microscopy:** Structure & function of bacterial and Archaebacterial cells - Taxonomy ranks - techniques for determining microbial taxonomy - Phylogenic trees - concept of microbial species - Bergey's classification of bacteria - classification of algae, fungi, protozoa and viruses. Components and working principles of microscope - light, phase contrast, electron and fluorescence microscope.

2. **Microbial Physiology and Biochemistry:** Nutritional types - Growth curve - Culture media - Bacterial cell cycle - Measurement of microbial growth - Pattern of microbial death - Chemotaxis and endospore formation - Microbial metabolism - Oxidation-reduction reactions - Physical and chemical methods of sterilization.

3. **Microbial Ecology:** Global climate changes - Assessing microbial diversity - Microbial community activity. Water as a microbial habitat - Marine and freshwater ecosystems - Coliform analysis. Soil as a microbial habitat - Plant-microbe associations - Nitrogen fixation - Mycorrhizae. Water purification and sanitary analysis - Sewage treatment and recycling of wastes.

4. **Food and Industrial Microbiology:** Food spoilage, food poisoning and preservation - food borne diseases - detection of food borne pathogens. Microorganisms used in industry - Downstream processing - Production strains - Primary, secondary screening of microbes and scale up fermentations - Types of fermentors - raw materials. SCP and applications of microbial products in human welfare - Production of antibiotics (Penicillin, Streptomycin), vitamins, enzymes and vinegar.

5. **Medical microbiology and Public health:** Human microbiome - Antimicrobial drugs and chemotherapy - Epidemiology - infectious diseases in human population – Nosocomial infections - Control of epidemics - Bioterrorism - Global health considerations – Air borne,

Zoonotic, Prion, direct, contact and opportunistic diseases and diagnosis. Causative agents, symptoms, transmission and control measures of tuberculosis, typhoid, Aspergillosis, malaria and AIDS.

Text book

Willey JM, Sherwood LM and Woolverton CJ (2016) Prescott's Microbiology, Tenth edn, McGraw Hill International publication, New York.

References

Kapil A and Bhaskaran CS (2013) Ananthanarayan and Paniker's Textbook of Microbiology, Ninth edn, University Press.

Kingsbury DT and Wagner GE (1990) Microbiology, NMS (series), Second edn, National Medical Series.

Pelczar MJJR, Chan ECS and Krieg NR (1993) Microbiology, Fifth edn, Tata McGraw-Hill, New Delhi.

PGZ 5532 Biotechnology (6h/wk) (5cr)

This course emphasizes recombinant DNA technology, the importance of animal and plant tissue culture, production and applications of transgenic animals and plants. Disease diagnosis and therapeutics using biotechnology tools and industrial applications of genetically modified organisms will also be dealt. It also deals with the environmental pollution remedies using recombinant strains and bioethics of biotechnological products.

Specific Learning Outcome:

At the end of this course, the students will be able to:

- use the tools and techniques in rDNA technology
- understand animal cell culture techniques and transgenesis of animals

- appreciate the gene transfer in plants and their applications
- understand the role of biotechnology in human welfare and industrial products
- explore genetically modified strains in pollution control and bioremediation

1. **Introduction and Recombinant DNA Technology:** History and Scope of Biotechnology - Restriction endonucleases - linkers & adaptors - vectors (*E. coli*, phage yeast, plant & animal viral vectors) - gene transfer methods - gene cloning strategies. Techniques in genetic engineering - blotting techniques - PCR and its types - DNA sequencing - Human Genome Project.

2. **Animal Biotechnology:** Animal cell culture media - Biology and characterization of cultured cells - Primary & secondary cell culture - Tissue and stem cell engineering - Transgenic animals - fish, cattle and gene knockout mice - applications. Cloning - mechanism - Dolly - Ploidy induction method in fish. Hybridoma technology - Monoclonal antibody production.

3. **Plant Biotechnology:** Basic concepts in plant tissue culture - micropropagation - protoplast culture and somatic hybridization - haploid plant production - gene transfer in plants - vector mediated (Ti plasmid) and virus mediated. Transgenic plants - resistance to biotic stress (insect and microbes) and abiotic stress (phosphinothricin and glyphosate) - improvement of crop yield, quality and nutrition.

4. **Pharmaceutical and Industrial Biotechnology:** Gene therapy - *ex vivo* & *in vivo*. DNA assay for disease diagnosis and DNA profiling in forensics. Pharmaceutical products - insulin, tissue plasminogen activator, recombinant vaccines. Bioprocess and enzyme technology - production and immobilization of enzymes - biosensors. Biomass production - citric acid, alcohol, bio-fuel (hydrogen and methane).

5. **Environmental Biotechnology and Society:** Environmental pollution - biotechnological methods for monitoring and management. Biodegradation & Bioremediation - Xenobiotics - Genetically engineered microorganism in bioremediation. Biotechnology - risks, ethics and patenting biotechnology inventions.

Textbook

Satyanarayana U (2012) Biotechnology, First edn, Books and Allied (P) Ltd, Kolkata.

References

1. Dubey RC (2006) A Textbook of Biotechnology, First multicolour illustrative edn, S. Chand & Company Ltd, New Delhi.
2. Glick RB and Pasterneck JJ (2002) Molecular Biotechnology - Principles and Application of Recombinant DNA, Panima publishing corporation, New Delhi.

PGZ 5546 **Biotechnology** **(5+1=6h/wk) (5cr)**

This course emphasizes recombinant DNA technology, the importance of animal and plant tissue culture, production and applications of transgenic animals and plants. Disease diagnosis and therapeutics using biotechnology tools and industrial applications of genetically modified organisms will also be dealt. It also deals with the environmental pollution remedies using recombinant strains and bioethics of biotechnological products.

Course Outcomes

Upon completion of this course, students will be able to:

i. Discuss the importance of enzymes, gene transfer methods and techniques in biotechnology.
ii. Explain the procedures in animal cell culture and applications.
iii. Identify the overall process in plant tissue culture and applications.
iv. Analyze the principles in formulating pharmaceutical industrial products.
v. Evaluate the role of microbes in environmental biotechnology.

1. **Introduction and Recombinant DNA Technology:** History and Scope of Biotechnology - Restriction endonucleases - linkers & adaptors - vectors (*E. coli*, phage yeast, plant & animal viral vectors) - gene transfer methods - gene cloning strategies. Techniques in genetic engineering - blotting techniques - PCR and its types - DNA sequencing - Human Genome Project.

2. **Animal Biotechnology:** Animal cell culture media - Biology and characterization of cultured cells - Primary & secondary cell culture - Tissue and stem cell engineering - Transgenic animals - fish, cattle and gene knockout mice - applications. Cloning - mechanism - Dolly - Ploidy induction method in fish. Hybridoma technology - Monoclonal antibody production.

3. **Plant Biotechnology:** Basic concepts in plant tissue culture - micropropagation - protoplast culture and somatic hybridization - haploid plant production - gene transfer in plants - vector mediated (Ti plasmid) and virus mediated. Transgenic plants - resistance to biotic stress (insect and microbes) and abiotic stress (phosphinothricin and glyphosate) - improvement of crop yield, quality and nutrition.

4. **Pharmaceutical and Industrial Biotechnology:** Gene therapy - *ex vivo* & *in vivo*. DNA assay for disease diagnosis and DNA profiling in forensics. Pharmaceutical products - insulin, tissue plasminogen activator, recombinant vaccines. Bioprocess and enzyme technology - production and immobilization of enzymes - biosensors. Biomass production - citric acid, alcohol, bio-fuel (hydrogen and methane).

5. **Environmental Biotechnology and Society:** Environmental pollution - biotechnological methods for monitoring and management. Biodegradation & Bioremediation - Xenobiotics - Genetically engineered microorganism in bioremediation. Biotechnology - risks, ethics and patenting biotechnology inventions.

Text book

Satyanarayana U (2012) Biotechnology, First edn, Books and Allied (P) Ltd, Kolkata.

References

Dubey RC (2006) A Textbook of Biotechnology, First multicolour illustrative edn, S. Chand & Company Ltd, New Delhi.

Glick RB and Pasterneck JJ (2002) Molecular Biotechnology - Principles and Application of Recombinant DNA, Panima publishing corporation, New Delhi.

Brown, TA (2017) Gene cloning and DNA analysis: an introduction, Seventh edn, John Wiley & Sons, USA.

Brown TA (2017) Genomes 4, Fourth edn, Garland Science (Taylor & Francis Group), New York.

Primrose SB and Twyman R (2006) Principles of Gene Manipulations and Genomics, Seventh edn, Blackwell Publishing, Massachusetts, USA.

PGZ 5549 **Immunology** **(5+1=6h/wk) (5cr)**

This theory course provides a comprehensive coverage of the essential concepts and the current understanding of cellular and molecular events underlying immunity. This course on Immunology deals with cells and organs of immune system, antigen, antibody - structure & diversity and antigen-antibody interactions. It also includes major histocompatibility complex, immunoregulation, immunotolerance and complement. Clinical aspects such as hypersensitivity reactions, autoimmunity, disorders of immune response, transfusion, transplantation and tumour Immunology are also dealt.

Course Outcomes

Upon completion of this course, students will be able to:

i. Explain the lymphoid organs, molecular structure of antibodies and antigen-antibody interactions.
ii. Analyze MHC molecule and differentiation of T & B cells.
iii. Evaluate complement system and immune response.
iv. Explain hypersensitivity and immunodeficiency disorders.
v. Assess the importance of ABO system, transplantation and tumor immunology.

1. **Cells, lymphoid organs, antigens and antibody:** Cells and organs of the immune system - antigens - adjuvants. B cell antigens & B cell epitopes, T cell antigens & T cell epitopes - Distribution and production of antibodies. Molecular structure of antibodies - Ig isotypes - biological properties - Ig super family - multigene organization of Ig genes, gene rearrangements - mechanism of variable region rearrangements, productive and non productive rearrangements - allelic exclusion - generation of antibody diversity - strength of antigen-antibody interactions - affinity - avidity- cross-reactivity - precipitation and agglutination reactions.

2. **MHC, maturation, activation and differentiation of T & B cells:** MHC - General organization, genes, inheritance, molecules, immune responsiveness and MHC & disease susceptibility. T & B cells - maturation, activation and differentiation - T & B cell co-operation - superantigens - T independent B cell activation - cytokines and cytokine receptors.

3. **Antibody and cell mediated effector functions, immunoregulation and complement:** Antibody mediated - neutralization, opsonization, complement fixation and antibody-dependent cell mediated cytotoxicity - cell mediated - cytotoxic T cell response and Natural Killer cell activity. Regulation of immune response - age - nutrition and other factors - immunotolerance - complement system - classical and alternative pathways - complement fixation test and complement deficiency diseases.

4. **Hypersensitivity reactions, autoimmunity, and immunodeficiency disorders:** Gell and Coombs classification - Hypersensitivity reactions – Ig E mediated (Type I), Antibody mediated (Type II), immune complex mediated (Type III), Cell mediated (Type IV). Organ specific and systemic autoimmune diseases - mechanisms - treatment of autoimmune diseases. Primary immunodeficiencies - defects in lymphoid lineage,

myeloid lineage and complement systems - treatment of immunodeficiency - AIDS and other acquired or secondary immunodeficiencies.

5. **Transfusion, transplantation and tumor immunology:** ABO system - ABO antigens - isohaemagglutinins - Rh antigens - transfusion reactions - transfusion transmitted infections - cross-matching. Immunologic basis of graft rejection - clinical manifestations of graft rejections - general and specific immunosuppressive therapy - clinical transplantation. Tumours of the immune system - tumour antigens - immune response to tumours - tumour evasion of the immune system - cancer immunotherapy.

Text book

Punt J, Stranford S, Jones P and Owen J (2018) Kuby Immunology, Eighth edn, W.H. Freeman and Co., New York

References

Coico R and Sunshine G (2009) Immunology: A short course, Sixth edn, Wiley Blackwell, New York.

Delves PJ, Martin SJ, Burton DR and Roitt IM (2006) Essential Immunology, Eleventh edn, Blackwell Publishers Ltd, UK.

Khan FH (2009) The Elements of Immunology. First edn, Pearson Education, New Delhi.

PGZ 5551 **Methods in Biology** **(5+1=6h/wk) (5cr)**

The aim of the course is to give a comprehensive knowledge about the methods used in biology such as histochemical, biophysical, electrophysiological, molecular, radiolabeling and immunotechniques. The course also deals with the methods in recombinant DNA technology and topics related to field biology such as estimation of population, sampling methods in behavior and habitat characterization using remote sensing.

Course Outcomes

Upon completion of this course, students will be able to:

i. Explain the principles and applications of various recombinant DNA methods.
ii. Analyze the immunotechniques of ELISA, RIA, immunoblotting, immunofluoresence microscopy, flow cytometry and cytofluorometry.
iii. Outline the biophysical and radiolabelling techniques.
iv. Evaluate the principle and applications of electrophysiological methods of EEG and Tomography.
v. Compare and evaluate various ecological sampling methods to study animal behaviour.

1. **Molecular biology and recombinant DNA methods:** Isolation and purification of Nucleic acids and proteins - Electrophoresis - one and two dimensional, PAGE and Isoelectric focusing - MALDI TOF - Generation of genomic and cDNA libraries in plasmid, phage, Cosmid, BAC and YAC vectors - *in vitro* mutagenesis - gene knock out - - Transcript and Translation product analysis - Detection of post-translational modifications in proteins - RAPD - RFLP - AFLP - Microarray.

2. **Histochemical techniques and Immunotechniques:** Detection of molecules in living cells - *in situ* localization - FISH and GISH. Antibody generation - detection of molecules using ELISA, RIA, Immuno blot, immunofluorescence microscopy, flow cytometry & cytofluorometry.

3. **Biophysical and radiolabeling techniques:** Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy. Molecular structure determination using X-ray diffraction and NMR - different types of mass spectrometry and surface plasma resonance methods. Detection and measurement of different types of radioisotopes - GM counter, scintillation counter, autoradiography - incorporation of radioisotopes in biological tissues and cells - molecular imaging of radioactive material - safety guidelines.

4. **Electrophysiological and microscopic techniques:** Single neuron recording - patch-clamp recording - EEG - Brain activity recording - lesion and stimulation of brain - Pharmacological testing - tomography (PET, MRI, fMRI, CAT). Visualization of cells and subcellular components by light microscopy - scanning and transmission microscopes - different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods - image processing methods in microscopy.

5. **Methods in field biology:** Methods of estimating population density of animals and plants, ranging patterns through direct, indirect and remote observations - sampling methods in the study of behavior - habitat characterization: ground and remote sensing methods.

Textbook

Ghatak, KL (2011) Techniques and methods in biology, Prentice Hall India Learning Private Limited, New Delhi.

References

Brown, TA (2017) Gene cloning and DNA analysis: an introduction, Seventh edn, John Wiley & Sons, USA.

Kandel ER, Schwartz JH and Jessell TM (2000) Principles of Neural Science, Fourth Edn, McGraw-Hill, New York.

Kumar, P (2016) Fundamentals and techniques of biophysics and molecular biology. Pathfinder Publications, New Delhi.

Primrose SB and Twyman R (2006) Principles of Gene Manipulations and Genomics, Seventh edn, Blackwell Publishing, Massachusetts, USA.

Rees PA (2015) Studying Captive Animals: A Workbook of Methods in Behaviour, Welfare and Ecology, First edn, John Wiley & Sons, UK.

Swargiary, A (2017) Biological tools and techniques. Kalyani Publications, New Delhi.

Wilson, K and Walker, J (2010) Principles and techniques of biochemistry and molecular biology, Seventh edn, Cambridge University Press, London.

ZOO 1249 **Poultry Farming** **(3h/wk) (2cr)**
(Life Skill Course)

This is an economically important and job oriented course. It deals with different aspects of poultry biology, breeds, housing equipment, nutrition management, diseases and Entrepreneurial skills.

Course Outcomes

Upon completion of this course, students will be able to:

i. Outline the growth of poultry industry in India and explain the biology of fowl with its economic importance.
ii. Identify Indian and exotic breeds.
iii. Explain various types of housing and poultry farm equipments.
iv. Assess energy requirements, feed formulations and management.
v. Evaluate various poultry diseases.

1. **Biology of Fowl:** External features – digestive and reproductive systems – poultry industry in India – 5 year plans – poultry manure – NECC – role of egg and meat in human nutrition –economic importance.

2. **Breeds of Layers and Broilers:** Classification – Indian and exotic breeds – production of commercial laying stock – cross breeds – sexing in one day old chicks – popular breeds of layers and broilers in India.

3. **Housing and Equipment:** Location of the farm – construction of poultry sheds – layout of broiler and layer farms – 1 +3 – housing system, All – in and all out system – deep litter system – cage rearing – waterer – feeder – nest box – brooders – dropping pit.

4. **Nutrition and Management:** Energy – carbohydrates – fats – proteins – vitamins – minerals – feed stuff – feed formulation – non nutritive feed additives – feed grinder – home made mineral mixture of feed for chick – grower – layer – broiler and finisher – Incubation – management of growers – layers – summer and winter management – forced moulting – debeaking – culling – marketing.

5. **Diseases:** Bacterial, fungal and viral diseases – transmission – symptoms – treatment – vaccination – antibiotics – nutritional deficiencies – Entrepreneurship – funding agencies – visit to poultry farm.

Text book

Gnaanamani MR (2003) Modern Aspects of Commercial Poultry Keeping. 9th Edition, Giri Publications, Madurai.

ZOO 1252 **Forensic Biology** **(3hr/wk) (2cr)**
(Non Major Elective)

This course deals with the scientific methods of crime investigation. It contains collection, identification and preservation of physical evidences. The course dwells on fire arms, tool marks and impressions, finger prints, wounds and sexual offences. Forensic entomology, drugs and food poisons are comprehensively included.

Course Outcomes

Upon completion of this course, students will be able to:

i. Analyze the evidences for crime investigation.
ii. Assess the offences based on firearms, tool marks and impressions.
iii. Explain the common biological techniques adopted in crime investigations and predict the sexual and non-sexual offences.
iv. Identify the insects of forensic importance and explain the methods employed in forensic entomology.
v. Outline the classification and sources of drugs and poisons and to discuss the ill effects and withdrawal symptoms.

1. **Evidences:** Classification – identification – comparison – collection methods – preservation of hair, nail, fiber, paint, glass, soil etc. – socio-economic offences.

2. **Fire arms, tool mark and impressions:** Fire arms – bullet comparisons – cartridge cases – gun powder residues – primer residues – collection and preservation of fire arm evidences – tool marks and impressions.

3. **Finger prints, blood, wounds, lethal and sexual offences:** Dermatoglyphics – henry system – primary classification – computerized prints –digital forensics – types of injuries, wounds and signs in sexual and non-sexual offences – symptoms of death – time of death – post-mortem changes – blood stains – blood grouping – semen analysis – disputed paternity – DNA tests – case study.

4. **Forensic Entomology:** Insects of forensic importance – sarcophagi – venoms and poisons – methods employed for forensic purposes – forensic lab visit.

5. **Drugs and food poisons:** Classification – sources of drugs, narcotics, cosmetics and abortifacients – physiological and psychological effects – withdrawal syndrome – signs of food poisoning – types of poisons – medico legal cases.

Text book

Parikh CK (1999) Parikh's textbook of medical jurisprudence, forensic medicine and toxicology. 7th Edition, CBS Publishing and distributors, New Delhi.

ZOO 1254 **Apiculture** **(3h/wk) (2cr)**
(Non Major Elective)

This course aims to give a basic understanding of the biology, rearing and management of honeybees. It includes the study of interaction of bees with plants, their diseases and prospects of apiculture. It imparts knowledge in various aspects of bee keeping.

Course Outcomes

Upon completion of this course, students will be able to:

i. Compare past and present status of apiculture in India.
ii. Explain the biology of honey bees and their communication.
iii. Discuss the rearing management of different bees and honey extraction.
iv. Identify the different diseases of honey bees and control measures.
v. Evaluate the prospects of apiculture and entrepreneurship.

1. **History**: Bee keeping past and present – present status of apiculture in India – life of Lorenzo Langstroth – bees in warfare – economic importance – Types of honeybees – wild bees.

2. **Biology**: Bee colony – castes – morphology – anatomy – division of labour – communication – habit of field bees – queen bee insemination – artificial mating.

3. **Pasturage and Rearing**: Nectar composition – bee foraging – bee flora of India – types of bee hive – queen rearing, management – bee keeping equipment – seasonal maintenance – honey extraction.

4. **Diseases**: Natural enemies – infection – diseases – signs and symptoms– causes – transmission – control.

5. **Prospects of Apiculture**: Bee hive products – uses of honey – wax – bee venom – propolis – royal jelly. Entrepreneurship – preparing proposal for financial assistance – funding agencies – field visits.

Text book

Abrol DP (2013) A comprehensive guide to bees and bee keeping. Scientific publishers, New Delhi, India.

References

Bailey L and Ball BV (1991) Honey bee pathology. 2nd Edition. Academic press, London.
Graham JM (1992) The hive and the honey bee. Dadant & Sons, Illinois.
Mishra RC (1995) Honeybees and their management in India. ICAR pub, New Delhi.

ZOO 1256 **Ornamental Fish Culture** **(3h/wk) (2cr)**
(Life Skill Course)

This course deals with the basic and applied aspects of ornamental fish culture. Various freshwater and marine ornamental fishes, breeding techniques and wild collections are dealt with. Ornamental aquatic plants are also included along with diseases and economic importance.

Course Outcomes

Upon completion of this course, students will be able to:

i. Design the types of fresh water aquaria.
ii. Identify the popular ornamental fishes.
iii. Formulate breeding and hatchery techniques.
iv. Design marine Invertebrate aquaria.
v. Identify the common diseases and control measures in aquarium fishes.

1. **Aquarium keeping:** Types of aquaria–freshwater and marine species–setting up–aquarium plants–accessories–maintenance.

2. **Popular ornamental fishes:** Biology, sexing, courtship, feeds and feeding, breeding and mass production of fresh water fishes–gold fish, gouramy, angel fish and koi carps breeding – rearing of marine anemone fish and damsel fish – wild collections.

3. **Breeding and Hatchery:** Wild seed collection techniques and rearing. Seed production techniques–induced maturation–spawning–rearing.

4. **Ornamental invertebrates:** Marine invertebrates species – culture of corals – keeping and maintenance of echinoderms and molluscs in aquarium – marine aquarium management.

5. **Diseases and economics:** Common diseases – disease control measures and cure – aquarentine tanks – conditioning, packing and transport methods – Entrepreneurship – agencies involved in popularization and extension – maintaining pet shops and purchasing aquarium accessories – field visits.

Text book

Yadav BN (2006) Fish and fisheries. 4th Edition. Daya Publishing house, New Delhi.

References

Axelrod HR (1967) Breeding aquarium fishes. TFH publication Inc., England.

Santhanam R, Sukumaran N and Natarajan P (1990) A manual of freshwater aquaculture. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi

Cato JC and Brown CL eds. (2003) Marine ornamental species: collection, culture and conservation. Blackwell Publishing, Ames, Iowa.

ZOO 1532 **Economic Zoology (Theory cum Lab)** **(3+2=5 hr/wk) (5cr)**

This course is designed to make the students understand the technical and commercial aspects o rearing edible freshwater fish, shrimps, cattle, pig, poultry and earthworms.

Course Outcomes

Upon completion of this course, students will be able to:

i. Explain the aquacultural practices.
ii. Outline shrimp culture methods and hatchery management.
iii. Apply the knowledge of dairy and pig farming.
iv. Analyze the methods of poultry farming, diseases and control measures.
v. Assess the methods and uses of vermicomposting.

1. **Edible Freshwater Fish Culture:** Aquaculture - salient features - types - farming practices cultivable fishes - major carps - exotic carps - minor carps - murrels - cat fishes - por preparation - management. Composite fish culture. Fishery byproducts.

2. **Shrimp farming:** Biology - cultivable species - methods of culture-pond site - artifici breeding - live feeds - hatchery management.

3. **Dairy and Pig farming:** Breeds of cow, buffalo, goat and pig. Breed improvement - cross breeds. Milch cattle - reproduction. Dairy Products - milk processing - Piggery managemer and products.

4. **Poultry Farming:** Breeds - layers - broilers. Methods of poultry keeping - food and feeding management. Egg. Diseases of Poultry - Ranikhet, Coccidiosis, Fowl Cholera an Aspergillosis

5. **Vermiculture:** Earthworm - varieties - biology - optimal conditions for culture - cultu practices - vermicompost - vermicast - vermiwash.

Laboratory exercises include

- Identification of commercially important fresh water fishes.
- Gut content analysis of fish with different feeding habits.
- Morphomertic measurement of fishes.
- Preparation of fish pituitary extract
- Identification of spawn, fry and fingerlings of Rohu, Catla and Mrigal
- Identification of fish diseases and parasites
- Identification of commercially important shrimps.
- Gut content analysis of shrimps.
- Breeds of cattle.
- Natural and artificial feed formulation for cattle.
- Dairy products.

- Breeds of pig.
- Pigsty maintenance- disinfection, vaccination.
- Byproducts of pig farm.
- Breeds of poultry.
- Poultry house maintenance.
- Poultry diseases.
- Varieties of earthworms.
- Analysis of nutrients in vermicompost.
- Effect of vermicompost on the growth of plants.
- Visit to fish, shrimp, pig, dairy and vermiculture farms

Text book

Jaiswal V and Jaiswal KK (2014) Economic Zoology. PHI Learning Private, Limited, Delhi, India.

References

Pandey K and Shukla JP (2005) Fish and Fisheries. Rastogi Publications, Meerut, India.

Gnaanamani MR (2003) Modern Aspects of Commercial Poultry keeping, Giri Publication, Madurai, India.

Nigam HC (1996) Modern Trends in Biology. Shoban Lal Nugin Chand and Co, Jalandhar, India.

Ismail SA (1997) Vermicology – The biology of earthworms. Orient Longman Ltd., Chennai.

Edwards CA and Bohlen PJ (1996) Ecology of earthworms. 3rd edition, Chapman and Hall, London.

ZOO 2330 **Molecular Biology Laboratory** **(3/wk) (3cr)**

The laboratory course introduces the basic molecular biological methods of isolation and purification of nucleic acids (DNA and RNA) from prokaryotic and eukaryotic cells. The quantification of DNA, RNA and protein involving both traditional and modern methods are also dealt. Students gain hand-on experience from start to finish in isolation, purification and characterization of nucleic acids and protein.

Course Outcomes

Upon completion of this course, students will be able to:

i. Prepare various reagents and buffers.
ii. Demonstrate isolation of DNA from various sources.
iii. Demonstrate isolation of RNA from various sources.
iv. Utilize the isolated DNA & RNA for quantification.
v. Assess the molecular weight of nucleic acid by Agarose gel electrophoresis.

Laboratory exercises

1. Basic molecular biology lab – Micropipetting exercises, serial dilution, media and reagent preparation.
2. Isolation and purification of DNA from bacteria.
3. Isolation of DNA from blood.
4. Isolation of RNA from liver cells – Acid phenol extraction and Trizol method.
5. Agarose gel electrophoresis for DNA and RNA.
6. Quantification of DNA and RNA by spectrophotometry.
7. Estimation of DNA by diphenylamine method.
8. Estimation of RNA by Orcinol method.
9. Estimation of protein by Bradford microassay.
10. Study of mutagenesis in *E. coli*.
11. Study of *lac* operon – β-galactosidase activity.
12. Visit to university/institutional laboratories.

References

Rajamanickam C (2001) Experimental Protocols in Basic Molecular Biology. Osho Scientific Publishers, Madurai.

Bansal MP (2013) Molecular Biology and Biotechnology Protocols. TERI, New Delhi.

Carson S, Miller HB and Witherow DS (2012) Molecular Biology Techniques: A classroom Laboratory Manual. Third Edition. Academic Press, San Diego, USA.

ZOO 3255 **Medical Laboratory Technology** **(3h/wk) (2cr)**
(Life skill course)

The objective of this course is to introduce various laboratory techniques involved in the analysis of the samples and the interpretation of the results. Further, students will be informed about the setting of a clinical laboratory. This course includes the collection and analysis of samples like urine, stool and sputum to test protein urea, glycemia and the presence of pus cells, parasite and various microorganisms. It also includes the examination of gastrointestinal contents, routine and special haematological tests, histopathology and serological tests.

Course Outcomes

Upon completion of this course, students will be able to:

i. Identify human body conditions, medical instruments and their applications.
ii. Evaluate kidney disorders and analyze clinical samples.
iii. Assess the cell count, ESR, blood group, GTT and diabetic disorders.
iv. Identify the histopathological disorders.
v. Outline the procedures involved in fertility tests.

1. **Biomedical laboratory**: Normal and abnormal conditions of body - Symptoms – Samples to be collected for analysis and diagnosis – Instruments – Rules and regulations to be followed for hazardous chemicals – sterilization methods.

2. **Biosamples:** Urine - Collection and preservation, physical and chemical analysis for kidney diseases, proteinuria, glycemia and hereditary disorders – Stool - Types and collection, microscopic and culture methods, interpreting microbial diseases – Gastro-intestinal contents - digestive enzymes of liver pancreas – Sputum – Collection and staining for microscopic examination for respiratory disorders.

3. **Clinical haematology**: Phlebotomological methods - chemical analysis - cell counting (DC/TC) - estimation of ESR for pathological, physiological and hereditary disorders – Blood banking - Blood grouping and typing – Glucose tolerance test - Impaired glucose tolerance test - diabetic disorders.

4. **Histopathology**: Examination of cells from the body fluids for identifying disorders – Microtome and processing of tissues for tumors.

5. **Fertility test**: Semen analysis - Hormonal changes - Hormonal tests and pregnancy tests – factors affecting fertility.

Text book

Sood, R (1988) Medical Laboratory Technology. Jaypee Pub Ltd., New Delhi.

References

Mukherjee, KL (1989) Medical Laboratory Technology. Vol, I, II & III, Tata McGraw Hill Pub, Co, New Delhi.

Syrey MF, William JM and Elvyn GS (1978) Diagnostic microbiology. The C.V. Mosby Co.

ZOO 3544 **Bioinformatics (Theory cum Lab)** **(3+2=5h/wk) (5cr)**

This course is designed to introduce bioinformatics tools and analysis methods to students. Upon completion of the course, students should feel confidence in dealing with the vast amounts of biomedical and genomic data and online tools that will be relevant to their work in the coming decades.

1. **Operating systems and Internet:** Operating System concept - Windows 98/XP, Windows server NT/2000, UNIX/LINUX - Internet evolution - Working of Internet - Use of Internet - Working with E-mail - An overview of Computer viruses - General Precautions.
2. **Search Engine:** Overview of World Wide Web (Web Server and Client) - Introduction to Search engine and Searching the Web - Searches on MEDLINE, PUBMED and bibliographic databases - Downloading files - Introduction to Web Browsers - Understanding HTML and URL, Domain name, IP Address – Blogging - Overview of available Bioinformatics resource in web.
3. **Bioinformatics and data generation:** Bioinformatics and its relation with molecular biology - Examples of related tools (FASTA, BLAST, BLAT, RASMOL), databases (GENBANK, Pubmed, PDB) and software (RASMOL, Ligand Explorer) - Data generation - Generation of large scale molecular biology data - Applications of Bioinformatics.
4. **Biological Database:** Introduction to data types and Source - Population and sample - Classification and Presentation of Data - Quality of data, private and public data sources - Biological Databases - Nucleic acid databases (NCBI, DDBJ, and EMBL) - Protein databases (Primary, Composite, and Secondary) - Specialized Genome databases (SGD, TIGR, and ACeDB) - Structure databases (CATH and SCOP).
5. **Sequence Alignments:** Introduction to Sequences, alignments and Dynamic Programming - Local alignment and Global alignment (algorithm and example) - Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm) - Methods for presenting large quantities of biological data.

Laboratory component includes exercises as follows:

- Types of biological databases and using it - Genbank, Protein Data Bank, Uniprot.
- Sequence Analysis Tools: BLAST, FASTA (Nucleic acids & Proteins), Clustal W and EMBOSS.
- Sequence Comparisons (Pairwise Sequence Alignments).
- To identify an unknown nucleotide sequence using the NCBI search tool BLAST
- Phylogenetic Analysis - Phylip.
- Molecular Modeling: Homology Modeling – Swiss modeller.

ZOO 3641 **rDNA Technology (Theory cum Lab)** **(4+2=6h/wk) (6cr)**

This course is intended to introduce gene cloning and DNA analysis. It deals with extraction, purification and manipulation of DNA by restriction and other enzymes. An outline about the conventional and modern methods of rDNA transfer into living cells, the biology of cloning and expression vectors and the methods of gene analysis are also dealt. The course also provides a detailed account on the applications of gene cloning in the welfare of mankind. The laboratory course includes experiments on isolation and purification of genomic DNA and plasmids from bacteria, restriction digestion and ligation of DNA. It also includes exercises on the isolation of DNA from higher organisms and transformation of bacteria using rDNA by conventional competent cell transformation.

Course Outcomes

Upon completion of this course, students will be able to:

i. Analyze various techniques used in DNA extraction and the methods involved in DNA manipulation.
ii. Compare the conventional and modern methods of rDNA transfer into living cells.
iii. Design experiments involving gene cloning using vectors and compare the different vectors for bacteria, plants and animals.
iv. Evaluate different methods of gene analysis.
v. Apply gene cloning methods in recombinant vaccine and insulin production and stem cell therapy.

1. **Isolation, purification and manipulation of DNA:** Isolation of genomic DNA from bacteria, plant and animal cells – Purification of plasmid DNA and bacteriophage DNA – DNA manipulation - restriction endonucleases and other DNA manipulative enzymes – restriction digestion and ligation techniques – *in vitro* mutagenesis.

2. **Introduction of rDNA into living cells:** Transformation of bacteria with rDNA – competent cell transformation – Methods of gene transfer in higher organisms - electroporation, biolistics, microinjection and liposome mediated gene transfer.

3. **Biology of cloning and expression vectors:** *E. coli* based vectors – λ and M13 based vectors – Cosmids – Phagemids – Yeast vectors – Ti and Ri plasmids – Plant and animal viral vectors – P element cloning vector – Cloning vectors for mammals - SV40 and adenoviruses – Expression vectors - types of promoters for expression vectors.

4. **Analysis of cloned gene:** Obtaining the clone of specific gene - direct selection and gene libraries – Studying gene location and structure - Southern transfer, *in situ* hybridization and FISH – Transcript and translation product analysis – DNA sequencing – PCR.

5. **Applications of gene cloning:** Transgenesis – production of recombinant proteins, vaccines, human insulin, diagnostic probes and other pharmaceutical compounds – Gene therapy and Stem cell therapy.

The laboratory component includes exercises as follows:

- Isolation and purification of Genomic DNA from *E.coli.*
- Isolation and purification of genomic DNA from plant and animal tissues.
- Purification of plasmids from *E. coli.*
- Restriction digestion of DNA.
- Ligation of DNA.
- Agarose gel electrophoresis of DNA samples.
- Competent cell preparation of bacteria.
- Transformation of competent cells using rDNA.

Text book

Brown, TA (2010) Gene Cloning and DNA Analysis – an Introduction. 6th Edition. Blackwell Science Publishers Ltd., Oxford, UK.

ZOO 3838 **Biotechnology** **(5+3=8h/wk) (8Cr)**

Students will be trained in various aspects of biotechnology such as animal, plant, microbial and environmental biotechnology. The course also imparts biosafety, bioethics and intellectual property rights, issues related to biotechnology. The laboratory course integrates theory with extensive practical training on plant and animal cell culture, fermentation technology, vermicomposting, biodecolourization and environmental monitoring.

1. **Animal Biotechnology**: Animal cell and Tissue culture - Media - Suspension culture - Fibroblast culture - Development and maintenance of cell line - Hybridoma technology - Monoclonal antibody production - Application of animal cell and tissue culture - Transgenic animals – Cloning - Cell banking - Downstream processing.
2. **Plant Biotechnology:** History and scope of plant biotechnology - *in vitro* culture techniques of explants - Organogenesis and micropropagation - single cell culture - protoplast culture - Plant genetic engineering using *Agrobacterium* - Transgenic plants and Bt based genetically modified crops.
3. **Microbial Biotechnology:** History and scope of microbial technology – microbial biomass – microbial metabolites – range of fermentation products – aerobic and anaerobic fermentation – culture media – immobilization – scale up of bioprocess – primary and secondary screening of production strains – fermentation economics.
4. **Environmental Biotechnology:** Environmental monitoring - Sampling analysis - Biosensor - Bioindicators - Biomarker - water quality criteria - Alternative energy sources - Renewable sources of energy - Oil recovery - Biofuels - Bioremediation - Biocontrol - Biofertilizer.
5. **Biosafety and Bioethics:** Definition - Requirement - Biosafety - Bioethics - social issues, Bioweapons and Patent laws - Patent rights – Case studies - Biopiracy – Ice minus bacteria - Monsanto

Laboratory component includes the following exercises

- Initiation of embryonic cell culture of frog.
- Mouse embryo Fibroblasts mono layer culture.
- Chick embryo Fibroblasts mono layer culture.
- Surface sterilization of explants.
- Initiation of callus on MS medium.
- Formation of shoot and roots of *Oryza sativum.*
- Formation of callus by phytohormones.
- Screening of microbes for metabolites.
- Aerobic and anaerobic fermentations of grape wine.
- Factors affecting fermentations.
- Biogas from animal wastes.
- Role of vermicompost on plant growth.
- Decolourisation of dyes employing microbes.
- Biodiversity indices in environmental monitoring.