ST. ALBERT'S COLLEGE (AUTONOMOUS)
ERNAKULAM

RESTRUCTURED CURRICULUM FOR POSTGRADUATE PROGRAMME UNDER CREDIT SEMESTER SYSTEM (CSS) IN ZOOLOGY

(w.e.f. 2016 admission)

FOR LIGHT AND KNOWLEDGE

Abstract of the CSS Programme of Zoology

	Code	Course	Hours/ Week	Total Hours	Credit
Semester 1	**PZO1CRT01**	Biosystematics and Animal Diversity	5	90	4
	PZO1CRT02	Evolutionary Biology and Ethology	5	90	4
	PZO1CRT03	Biochemistry	5	90	4
	PZO1CRT04	Biostatistics, Computer Application and Research Methodology	5	90	4
	PZO1CRP01	**Practical 1**-Biosystematics and Animal Diversity, Evolutionary Biologyand Ethology, Biochemistry , Biostatistics, Computer Application and Research Methodology	5	90	3
		Total	**2 5**	**450**	**1 9**
Semester 2	**PZO2CRT01**	Ecology- Principles and Practices	5	90	4
	PZO2CRT02	Genetics and Bio-informatics	5	90	4
	PZO2CRT03	Developmental Biology	5	90	4
	PZO2CRT04	Biophysics, Instrumentation and Biological Techniques	5	90	4
	PZO2CRP01	**Practical 1**- Ecology, Genetics and Bioinformatics, Developmental Biology, Biophysics and Instrumentation	5	90	3
		Total	**2 5**	**450**	**19**
Semester 3	**PZO3CRT01**	Animal Physiology	5	90	4
	PZO3CRT02	Cell and Molecular Biology	5	90	4
	PZO3CRT03	Microbiology and Biotechnology	4	72	4
	PZO3CRT04	Immunology	3	54	3
	PZO3CRP01	**Practical 1** - Cell and Molecular Biology, Microbiology and Biotechnology	4	72	2
	PZO3CRP01	**Practical 2** -Animal Physiology, Immunology	4	72	2
		Total	**2 5**	**450**	**1 9**
S	**PZO4CRT01**	General Microbiology and Parasitology	5	90	4
	PZO4CRT02	Bacteriology, Virology and Mycology	5	90	4
	PZO4CRT03	Clinical Microbiology	5	90	4
	PZO4CRP01	General Microbiology, Parasitology and Mycology Practical -I	5	90	2
	PZO4CRP02	Bacteriology, Virology and Clinical Microbiology Practical- II	5	90	2
		Project	-	-	4
		Viva voce	-	-	3

		Total	**2 5**	**450**	**2 3**
Grand Total					**8 0**

St. Albert's College (Autonomous)

PG for Credit Semester System 2016

*Scope, Definitions, Programme Structure, Registration, Admission, Admission Requirements, Examination, Direct Grading System, Grade Card, Award of Degree etc., are given in the PG Programme Regulations for Credit Semester System 2011 as per U.O.No.5386/L/Acad/ PGCSS(R)2011/. Dated 30th September and U.O.No.6581/Ac. A-IX/2011P.G. Dated 7th December 2011.***Available at – www.mgu.ac.in**

Evaluation and Grading in Zoology

1. Evaluation

The evaluation scheme for each course shall contain two parts; (a) internal evaluation and (b) external evaluation. 25% weight shall be given to internal evaluation and the remaining 75% to external evaluation and the ratio and weights between internal and external is 1:3. Both internal and external evaluation shall be carried out using direct grading system.

(a). Internal evaluation

The internal evaluation shall be based on predetermined transparent system involving periodic written tests, assignments, seminars and attendance in respect of theory courses and based on written tests, lab skill/records/viva and attendance in respect of practical courses. The weights assigned to various components for internal evaluation areas follows.

Theory Internal Evaluation- Total weight: 10

Components	Weight
Attendance	1
*Two test paper	2+2
**Assignment	3
*** Seminar	2

Attendance

% of attendance	Grade
> or 90%	A
Between 85and 90	B
Between 80 and 85	C
Between 75 and 80	D
< 75	E

* The test paper must be a minimum of two hour duration.

** **Assignment**- One assignment for each course#. The assignment must be a written or typed 4-6 page document with proper introduction pertaining to the topic, a thoroughly referred subject matter, conclusion and all cited references in the bibliography. While assigning grade take into account the six point's *viz.*, punctuality, introduction, content, conclusion, language and references **(0.5 weight for each point).**

 # During the first semester, for course 2 (ZY1CT02) instead of the course content based assignment students may submit a review of any popular book in biology as an assignment. The format and grading will be the same as given above.

*** **Seminar** – The grading of seminar shall be based on punctuality, content, style of presentation and

response to questions **(0.5 weight for each component).**

Practical Internal Evaluation- Total weight: 5

Components	Weight
Attendance	1
Punctuality and Lab performance	1
Test	2
Record	1

Best of two tests/ one model per semester

Project Internal Evaluation - Total weight: 5

Suggested schedule for project work

Sl.No.	Assigned work	Time
1	Topic selection & review of literature	2nd semester
2	Introduction and methodology presentation and evaluation	3rd semester first month
3	Lab and field experiments (project work)	3rd sem. 1st month to 4th sem. 2nd month
4	Results presentation; report writing	4th sem. 3rd month
5	Final project presentation with power point	4th sem. 4th month

Components	Weight
Punctuality	1
Introduction and Methodology	1
Report and Presentation	2
Viva	1

Theory External Evaluation - Total weight: 30

Theory examination conducted at the end of every semester willbe of Three hours duration

Pattern of question papers

Section	Type	No. to be Answered	Weight	Total weight=30
A	Short answer	10 out of 12	1	10
B	Short essay	5 out of 8	2	10
C	Essay	2 out of 3	5	10

Directions for question setting

While preparingthe question papers for each course, make sure that the questions proportionately cover all units. Earmark 10% of the questions from the ***prerequisite*** topics suggested in each course.

Section A - question should be answered in 5 minutes duration.

Section B - question to be answered in 10 minutes duration

Section C - question to be answered in 30 minutes duration.

Practical External Evaluation - Total weight: 15. Duration 4 Hours

External Practical examination shallbe conducted at the end of each semester. There will be one external examiner and one internal examiner for the conduct of the examination. Records will also be evaluated by the examiners for which the assigned weight is 1 (one). The division of the remaining 14 weights (15-1=14) will be decided by the Chairman of the Board of Examination in consultation with the Chairman of Board of Studies.

Project Evaluation and Viva voce - shall be conducted by a Board of three examiners at the end of the fourth semester, after the conduct of the practical examination. The Project-Viva Board shall have two external examiners and one internal examiner(the HoD or nominee). It can be done on the same day as per the schedule prepared by the Chairman of the Board of Examiners.

Project External Evaluation - Total weight: 15

Components	Weight
Area / Topic Selected	1
Introduction / Review	2
Objectives	1
Materials and Methods	2
Results and Discussion	3
Conclusion	1
Bibliography	1
Presentation and Viva	3+1

Comprehensive Viva voce - Total Weight: 10

The Viva board is expected to be unbiased and very fair. The questions should be subject specific and curriculumoriented. Aminimumof 20-30 minutes shouldbeallowed for each student.

Components	Weight
Questions from subject of special interest	2
Fundamentals of Biology	2
Topics covering all semesters	4
Awareness of current and advanced topics	2

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SEMESTER I

PZO1CRT01 BIOSYSTEMATICS AND ANIMAL DIVERSITY

PZO1CRT02 EVOLUTIONARY BIOLOGY AND ETHOLOGY

PZO1CRT03 BIOCHEMISTRY

PZO1CRT04 BIOSTATISTICS, COMPUTER APPLICATION AND RESEARCH METHODOLOGY

PZO1CRP01 PRACTICAL - 1: BIOSYSTEMATICS AND ANIMAL DIVERSITY, EVOLUTIONARY BIOLOGY

SEMESTER I

PZO1CRT01 BIOSYSTEMATICS AND ANIMAL DIVERSITY

PZO1CRT02 EVOLUTIONARY BIOLOGY AND ETHOLOGY

PZO1CRT03 BIOCHEMISTRY

PZO1CRT04 BIOSTATISTICS, COMPUTER APPLICATION AND RESEARCH METHODOLOGY

PZO1CRP01 PRACTICAL I : BIOSYSTEMATICS AND ANIMAL DIVERSITY, EVOLUTIONARY BIOLOGY AND ETHOLOGY, BIOCHEMISTRY , BIOSTATISTICS, COMPUTER APPLICATION AND RESEARCH METHODOLOGY

PZO1CRT01 BIOSYSTEMATICS AND ANIMAL DIVERSITY

90 Hours (25+65)5 hrs/week **Credit – 4**

Objectives:

- To give a thorough understanding in the principles and practice of systematics
- To help students acquire an in-depth knowledge on the diversity and relationships in animal world
- To develop an holistic appreciation on the phylogeny and adaptations in animals

BIOSYSTEMATICS 25 hrs

Module I. Biological Classification 5 hrs.

Hierarchy of categories and higher taxa. Taxonomic Procedures-collection, preservation, curetting and process of identification. Taxonomic characters of different kinds- quantitative and qualitative analysis of variation, Process of typification, different zoological types and their significance.

Prerequisite: *Fundamentals of Systematics*

Module II. Methods of Biosystematics 5 hrs.

Classical and modern methods-Typological, Phenetics, Evolutionary, Phylogenetic, Cladistics and Molecular Taxonomy. Phylocode, Tree of Life and Bar-coding of Life.

Module III. Taxonomic Publications 5 hrs.

Keys, types, use of keys, merits and demerits. International Code of Zoological Nomenclature (ICZN), Rules and formation of Scientific names of different taxa. Homonymy and Synonymy.

Ethics in taxonomy- authorship, suppression of data, undesirable practices in taxonomy.

Module IV. Concepts and Techniques in Systematics 10 hrs.

Three Domain Concept in Systematics, two, five and six kingdom classification. Concept of species- taxonomic diversity within species.

Molecular Phylogeny-use of Proteins, DNA and RNA. Phylogenetic trees.

ANIMAL DIVERSITY 65 hrs.

Module I. Introduction 3 hrs.

Origin of Protists. Prokaryotes and Eukaryotes. Levels of organization in animal kingdom.

Module II. Multi-cellularity 8 hrs.

Edicaran and Burgess Shale fauna. Cambrain explosion- causes and consequences. Cropping and Red Queen principle. Possible theories of metazoan origin.

Symmetry, Coelom and Metamerism-evolutionary advantages.

Module III. Lower Metazoans 6 hrs.

Porifera, Cnidaria-Polymorphism, Ctenophora, Acoelomata, Placozoa, Mesozoa and Pseudocoelomata- evolutionary relationships and adaptive modifications only.

Module IV. Protostomes and Deuterostomes 10 hrs.

Phylogenetic position of Molluscs, Adaptive Radiation in Molluscs and Annelids.

Phylogeny of Arthropod-Monophyly and Polyphyly, Reasons for the success of Arthropods.

Major classes under Arthropoda and adaptive radiation.

Module V. Lesser Protostomes **4 hrs.**

Sipuncula, Echiura, Phoronida, Brachipoda, Onychophora and Chaetognatha- Phylogeny only.

Module VI. Echinoderms **3 hrs.**

Classification and adaptive radiation.

Pre-requisite: *Larval forms of Annelids, Molluscs, Arthropods and Echinoderms. Impact of sedentary life on the organization of invertebrates.*

Module VII. Hemichordates **2 hrs.**

Position in the animal kingdom, phylogeny and evolutionary significance

Module VIII. Ancestry of Chordates **9 hrs.**

Cephalochordates and Urochordates. Vertebrate Phylogeny-Agnatha, Ostracoderms and Gnathostomes-Placoderms, Acanthodians, Chondrichthyes and Osteichthyes. Structural and Functional adaptations of fishes.

Module IX. Terrestrial Vertebrates **8 hrs.**

Tetrapod phylogeny - modern Amphibians, diversity, distribution, status and threats. Reptiles – origin and adaptive radiation. Skull of reptiles and its importance in biosystematics. Mesozoic world of reptiles and extinction.

Module X. Birds and Mammals **12 hrs.**

Origin of birds and mammals. Structural and functional modifications for aerial life. Orders under class Aves.

Class Mammalia: Prototheria, Metatheria and Eutheria. Phylogeny of Mammalian orders. Adaptive radiation in mammals.

Prerequisite **:** *Classification and characteristics of Mammalia.*

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Pough Harvey F, Christine M .Janis and John B. Heiser .2002. *Vertebrate Life* (6th edn). Pearson Education Inc. New Delhi.

Romer, A.S. and T.S. Parsons. 1985. The Vertebrate Body. (6th edn.) Saunders, Philadelphia.

Rupert E.Edward.,R.S.Foxand R.D.Barnes.2006.*Invertebrate Zoology: A Functional Evolutionary Approach.* Thomson/Cole,Singapore

Strickberger, M.W. 2005. *Evolution*. Jones and Bartett Publishers, London.

Waterman, A.J. 1971. *Chordate Structure and Function*. Macmillan Co. London

Winston, J.E.2000. *Describing species: Practical Taxonomic Procedures for Biologists*. Columbia University Press,Columbia, USA.

Young, J.Z. 1950. *Life of Vertebrates*. Clarendon Press, Oxford, UK.

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PZO1CRT02 EVOLUTIONARY BIOLOGYAND ETHOLOGY

90 Hours (55+35) **Credit-4**

Objectives:

- To providean understanding on the process and theories in evolutionary biology
- To help students developan interestin the debates and discussion taking place in the field of evolutionary biology
- To equip the learners to critically evaluate the debates and take a stand based on science and reason
- To expose students to the basics and advances in ethology, and generate an interest in the subject in order to understand the complexities of both animaland human behavior

EVOLUTIONARY BIOLOGY 55 hrs.

Module I. Concepts in Evolution **10 hrs.**

Pre-Darwanian, Lamarck, Darwin and Wallace and Post Darwanian. Concepts of variation, adaptation, struggle, fitness and natural selection-spontaneity of mutation and the evolutionary synthesis. Neutral Evolution, Molecular Evolution. Neutralist versus Selectionist. Contributions of Margulis (Endosymbiotic theory), Eldredge and Gould (Punctuated equilibrium), Rose Mary and Peter Grant (Molecuar evolution inDarwinian finches). Debates in evolutionarybiology.

Prerequisite: *Biography of Lamarck, Darwin and Wallace*

Module II. Origin and Evolution of Life **13 hrs.**

Origin of basic biological molecules, abiotic synthesis of organic monomers and polymers, concept of Oparin - Haldane, Miller-Urey Experiments. The RNA world. Idea of Panspermia. The First Cell. Evolution of Prokaryotes- origin of eukaryotic cells- evolution of unicellular eukaryotes, genome evolution. Anaerobic metabolism- originof photosynthesisandaerobic metabolism.

Module III. Geological Timescale **7 hrs.**

Major eventsin evolutionary timescale. Anthropocene. Toolsand techniques in estimating evolutionary time scale. Mass extinction and its consequences. Fossils- fossilizationand its significance.

Prerequisite*: Geological time scale - eras, periods and epochs*

Module IV. Population Genetics **10 hrs.**

Gene pool, gene frequency, Hardy-Weinberg Law. Rate of change in gene frequency through natural selection, migration andrandom genetic drift. Founder effect. Isolating mechanismsand speciation. Micro Macroand Mega evolution. Co-evolution.

Module V. Developmental and Evolutionary Genetics **5 hrs.**

The idea of Evo-Devo, Heterochrony, Heterotopy, Heterometry and Heterotypy. Developmental genes and gene co-option. Evolution of plasticity and complexity. Evolution of sex.

Module VI. Primate Evolution and Human Origins **10 hrs.**

Stages in Primate evolution- Prosimii, Anthropoidea and Hominids. Factors in human origin, hominid fossils. Cytogenetic and molecular basis of origin of man-African origin of modern man- Mitochondrial Eve, Y chromosomal Adam,- early migration,hunter- gatherer societies. Evolution of human brain-communication, speechandlanguage. Evolution of culture.

ETHOLOGY 35 hrs.

Module 1. Introduction 3 hrs.

Historical background, Stimulus-Response, Causal factors, Quantitativeaspects – Duration, interval frequency. Behaviour bouts. Darwinian Perspective on Animal behaviour, Scope of ethology, Genetic basis ofbehaviour.

Module II. Neurophysiological Aspects of Behaviour 3 hrs.

Reflex action, Kinesis, Taxes, Fixed action patterns. Sherrington's neuro-physiological concepts in behaviour – Latency, summation, fatigue.

Module III. Motivation 4 hrs.

Goal oriented drive, internal causal factor, Homeostaticand Non-homeostatic drives. Hormonesandbehaviour, Psycho-hydrologicmodelofmotivation.

Module IV.Learning 4 hrs.

Short and long term memory, Habituation, Classical conditioning (Pavlov's experiments), Instrumental conditioning, Latentlearning, Trialanderrorlearning, Instinct, Imprinting.

Module V.Communication 5 hrs.

Evolution of communication, Sensory mechanisms: Electrical, Chemical, Olfactory, Auditory and Visual. Dance language of honey bees, Pheromonal communication (Ants and mammals).

Module VI. Reproduction and Behaviour 4 hrs.

Reproductive strategies, Mating systems, Courtship, Sexual selection- patterns, parental care and investment.

Module VII. Complex Behaviour 5 hrs.

Orientation, Navigation, Migration (Fishes and birds), Navigation cues.
Biologicalrhythms–Circadian, Circannual, Lunarperiodicity, Tidalrhythms.
Genetics of biologicalrhythms.

Module VIII. Social Behaviour 5 hrs.

Sociobiology (Brief account only)
Aggregations–schooling in fishes, herding in mammals, Groupselection, Kinselection, altruism, reciprocal altruism, inclusivefitness, co-operation, territoriality, alarm call, socialorganization in insectsandprimates.

Module IX. Stress and Behaviour 2 hrs.

Adaptations to stress-basic concept of environmental stress, acclimation, acclimatization, avoidance and tolerance.

REFERENCES

Evolutionary Biology

Arthur, W. 2011. *Evolution – A Developmental Approach.* Wiley-Blackwell, Oxford, UK

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Web Resources

http://www.talkorigins.org
http://www.ucmp.berkely.edu
http://www.academicearth.org

Ethology

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Lee Alan Dugatkin .2009. *Principles of Animal behaviour* (2nd edn). W.W. Norton and Company.

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Wilson, E.O.2000. *Sociobiology: The new synthesis.* Harvard Univ. Press, Cambridge, Mass. USA.

Web Resources

www.animalbehavioronline.com/modestable.html

PZO1CRT03 BIOCHEMISTRY

90 Hours (5hrs/week) **Credit-4**

Objectives:

- Tounderstand the chemicalnature of life andlife process
- Toprovidean idea on structureand functioningofbiologicallyimportant molecules
- Togeneratean interest in the subject and help students explorethe new developments in biochemistry

Module I. Introduction **2 hrs.**

Atoms, molecules and chemical bonds. Water: biological importance, pH and acid - base balance. Buffers - biologicalimportance.

Module II. Carbohydrates **10 hrs.**

Monosaccharides: Classification and nomenclature**,** Biological importance, Structural representations of sugars-Acetal and hemiacetal, ketal and hemiketal linkages, Glucose, fructose, galactose, mannose and ribose.Isomerism– structuralisomerismandstereoisomerism, opticalisomerism, epimerismandanomerism. Mutarotation and inversion ofsugars.

Reactions of monosaccharides: Oxidation, reduction, ester formation, osazone formation.

Glycosidic bond.

Disaccharides: Sucrose, Lactose, Maltose, Isomaltose, Cellobiose and Trehalose.

Polysaccharides**:** Homopolysaccharides- Starch, Glycogen, Cellulose, Chitin, Dextrans, Inulin, Pectin. Heteropolysaccharides- Hyaluronic acid, Heparin, Chondroitin sulphate, Keratan sulphate, Dermatan sulphate and Agar-agar. Glycoproteins and Mucoproteins.

Module III. Proteins **10 hrs.**

Structure, classification and properties of amino acids. Amphoteric properties of amino acids, p*K* value and iso-electric point ofamino acids. Peptide bond formation and peptides. Reactions (due to carboxyl group, amino group and side chains). Colour reactionsofamino acids and proteins.

Primary structure of protein (*e.g.* insulin).

Classification and properties of proteins. Conformation of proteins- chemical bonds involved, Secondary structure- Alpha helix, Collagen helix, Beta pleated sheet, Ramachandran angles and Ramachandran map. Fibrous proteins- examples (Keratin, Collagen, Elastin, Resilin, Fibrous muscle proteins). Chaperons. Tertiary structure- *e.g.* Myoglobin. Quaternary structure– *e.g.* Haemoglobin.

Module IV. Lipids **10 hrs.**

Classification of lipids: simple, compound and derived lipids. Biological importance of lipids.

Fatty acids: classification, nomenclature.

Simple fats: Triacylglycerol (Triglycerides) - Physical properties. Reactions-Hydrolysis, Saponification, Rancidity. Acid number, Saponification number, Iodine number, Polenske number and Reichert-Meissl number of lipids.Waxes.

Compound lipids: Phospholipids- Lecithin, Phosphatidyl inositol, Cephalins, Plasmologens.

Glycolipids, Sphingolipids. Derived Lipids, Steroids: Biologicallyimportant steroids-cholesterol, Vitamin D, Bileacids, Ergosterol, Terpenes, Lipoproteins.

Prostaglandins- structure, types, synthesis and functions.

Module V. Nucleic Acids **10 hrs.**

Structure of nucleic acids and nucleotides: Structural organization of DNA (Watson –Crick model) Characteristic features of A, B, C and Z DNA. Structural organization of tRNA; Protein-nucleic acid

interaction. DNA regulatory proteins, folding motifs, conformation flexibilities, denaturation, renaturation, DNA polymerases, Restriction endonucleases. Biological roles of nucleotides and nucleic acids.

Module VI. Enzymes 10 hrs.

Classification- (I.U.B.system), co-enzymes, iso-enzymes, ribozyme. Enzyme specificity. Mode of action of enzymes. Formation of enzyme substrate complex. Lowering of activation energy, Various theories, Activesite.

Enzymekinetics: Michaelis-Mentenequation. Km valueand itssignificance. Enzymevelocityand factors influencingenzymevelocity. Kinetics of enzymeinhibition, suicideinhibitionandfeedbackinhibition.

Enzyme regulation: Allosteric regulations- Key enzymes, Covalent modification. Enzyme engineering.

Module VII. Carbohydrate Metabolism 12 hrs.

Major metabolic pathways- Glycolysis– Fate of pyruvate. Citric acid cycle and its significance; Central role of citricacid cycle. Oxidativeand substrate level phosphorylation. Gluconeogenesis, Cori cycle.

Glycogen metabolism- Glycogenesis, Glycogenolysis, Adenylate cascade system, Ca^{+2} Calmodulin-sensitive phosphorylase kinase. Regulation of glycogen synthesis .

Minor metabolic pathways of carbohydrates: Pentose Phosphate pathway, Glucuronic acid metabolism, Galactose metabolism. Inborn errors associated with carbohydrate metabolism. Glycogen storage diseases,Lactose intolerance,Galactosuria.

Module VIII. Metabolism of Proteins 10 hrs.

Aminoacid metabolism-Deamination, Transamination and Trans-deamination. Formation and disposal of ammonia. Urea cycle. Fate of carbon skeletons of aminoacids: glucogenic, ketogenic, partly glucogenic and ketogenic with examples. Synthesis of biologically significant compounds from different aminoacids with specialreferenceto glycine, glutamicacid, phenylalanine, tyrosineandtryptophan.

Module IX. Metabolism of Lipids 8 hrs.

Beta oxidation, alpha oxidation and omega oxidation of fatty acids. *De novo* synthesis of fatty acids. Metabolism of cholesterol, synthesis and its regulation. Biosynthesis of triglycerides. Metabolism of ketone bodies - Ketogenesis, Ketolysis, Ketosis.

Module X. Nucleic Acid and Mineral Metabolism 8hrs.

Catabolism of purines and pyrimidines.

Majorandminornutrients.Role ofCalcium, Phosphorus, Magnesium, Sodium,Potassium,Chloride, Sulphur and Iron.

Freeradicalsandantioxidants, Generation of freeradicals.Reactiveoxygenspecies. Freeradicalscavenger systems. Lipid peroxidation. Preventive antioxidants.

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PZO1CRT04 BIOSTATISTICS, COMPUTER APPLICATION AND RESEARCH METHODOLOGY

90 Hours (40+30+20) **Credit-4**

Objectives:

- To impart concepts, generate enthusiasm and make awareness about the tools/gadgets and accessories of biological research
- To equip the learner to carry out original research in biology
- To help the students to improve analytical and critical thinking skills through problem solving
- To provide hands on training in the use of various tools and techniques suggested in the course

BIOSTATISTICS 40 hrs.

Module 1. Basics of Biostatistics 6 hrs.

Steps in Statistical Investigation, Data and Variable (Collection, Types, Sources).
Population, Sample, Sampling Methods (Random, Cluster, Stratified and Geographical) and Sampling Errors/Bias.
Organization of Data - Editing, Classification, Tabulation (forming a frequency distribution from raw data and types and characteristics of a Frequency table).
Presentation of Data - Types and Characteristics of Tables and Visual aids – Graphs, Charts, Diagrams, Flow charts, Cartographs.
Statistical Analysis Tools - Parametric and Non-Parametric; Bivariate and Multivariate Analysis.
Interpretation and Forecasting.
Prerequisite: *Statistics and Biostatistics – scope and significance.*

Module II. Measures of Central Tendency 4 hrs.

Introduction, Characteristics, Merits and Demerits of Mean, Median and Mode.
Calculations/Problems for different data (raw, frequency table).
Harmonic and Geometric Mean (Brief account only).

Module III. Measures of Dispersion 5 hrs.

Introduction, Characteristics, Merits and Demerits of Range, Quartile Deviation, Mean Deviation and Standard Deviation. Calculations/Problems for frequency table.
Standard Error and Relative Measures of Dispersion, Skewness and Kurtosis (Brief account only).

Module IV. Correlation Analysis 3 hrs.

Correlation - types and methods of correlation analysis, Problems for Karl Pearson's correlation coefficient and Spearman's rank correlation.

Module V. Regression Analysis 7 hrs.

Regression and Line of Best Fit , Types and methods of regression analysis.
Graphic Methods (Scatter method, Curve fitting). Algebraic method (Fitting of straitline through regression equation).
Probit Analysis (Brief account only), Mathematical Models in Biology (Brief account only).
Length - Weight Relationship. Von-Bertalanffy's Growth (VBG) Model.

Module VI. Theory of Probability **4 hrs.**

Measures of Probability and Theorems in Probability. Probability distributions – Binomial, Poisson and Normal (Brief Account only).

Module VII. Testing of Hypothesis **7 hrs.**

Hypothesis and types, Confidence Interval, Sampling, Methods and Errors.
Tests of significance (For large and small samples – Critical Ratio and P value). Z Test (Problem for small samples), Chi- Square Test (Problem for 2×2 table only).
Student's 't' test (Problem for small samples comparing mean of two variable).
F-test and Analysis of Variance (ANOVA- One way) (Brief account only).
Non-parametric tests: Mc Nemar and Mann Whitney U test (Brief account only).

Module VIII. Vital Statistics **4 hrs.**

Introduction, uses, records and system of classification of vital statistics.
Sample registration system, Sample design, Survey of causes of death and Age classification.
Measures of Vital Statistics and Measures of Population (Mortality rates, Fertility rates).
Life tables (Brief account only).

COMPUTER APPLICATIONS 30 hrs.

Module I. Basics of Computers **6 hrs.**

Types of Computers. Binary Number System, Digital and Analog systems.
Hardware/Software/Firmware. Basics of Computer Functioning- Booting; Formatting;
File, File Extensions; Temporary Files; Folder; GUI, Icon; Installation of Programs, Commands, Bios-setup, Date and Time, Memory Partitions, Registry, Default Operations; Defragmentation (Brief account only).
Prerequisite: *Basics of Computers (Characteristics, History and Generations, Components and Organization).*

Module II. Hardware Basics **7 hrs.**

Memory -Classification and Types of memory; memory devices; Units.
Input Devices -Types, working and functions. Output Devices –Types, working and functions.
CPU components - Processors, Mother boards, SMPS, Accessory Cards– Graphic /Sound/ Networking/ Bluetooth/Wifi (Brief account only).
New Generation Computers - Servers, Laptop; Palmtop; Cyborgs; Robotics, Zoobotics (Brief account only).

Module III. Software Basics **7 hrs.**

System Software/Operating System -System Files; Working of OS; DOS, Widows, Linux and UNIX (Brief account only).
Application Software -Programs and Packages, Calculator, MS Paint, MS Word, MS Excel, MS PowerPoint, Publisher, Acrobat Reader, E Book Reader, Explorer, Photoshop.
Virus and Antivirus (Brief account only).
Statistical Software (MS Excel, PH Stat, SPSS).
Databases -MS Access (Brief account only).

Module IV. Computer Language and Programming **5 hrs.**

Computer language -Classification and types, HTML, C and Java
Programming concepts -Algorithm, Codes (Brief account only).

Module V. Networking, Internet and Information Technology 5 hrs.

Computer Communication - Network Topology, Media of networking, Networking Protocols, PAN, LAN, WAN, MAN, INFLIBNET, Modem and Gateway.

Internet and Internet Services - World Wide Web, Uploading, Downloading, Hosting, Portal, Search Engines, Firewall.

Global Information System - BIOSIS, Medline and Medlars, AGRIS; E Journals and E Books Publishing.

Cyber Crime and Cyber Laws (Brief account only).

RESEARCH METHODOLOGY 20 hrs.

Module I. Science and Life Sciences 2 hrs.

Basic concepts - Knowledge, Information and Data - Science, Pseudoscience.

Life Science - Definition, Laws, Characteristics.

Scientific temper, Empiricism, Rationalism and Units of measurements.

Module II. Concepts of Research 4 hrs.

Basic concepts of research - Meaning, Objectives, Motivation and Approaches.

Types of Research (Descriptive/Analytical, Applied/ Fundamental, Quantitative/Qualitative, Conceptual/ Empirical.

Research methods versus Methodology, Research and scientific method. Research Process.

Module III. Research Formulation 4 hrs.

Research formulation - Observation and Facts, Prediction and explanation, Induction, Deduction.

Defining and formulating the research problem, Selecting the problem and necessity of defining the problem.

Literature review - Importance of literature reviewing in defining a problem, Critical literature review, Identifying gap areas from literature review.

Hypothesis - Null and alternate hypothesis and testing of hypothesis - Theory, Principle, Law and Canon.

Module IV. Research Designs 4 hrs.

Research Design - Basic principles, Meaning, Need and features of good design, Important concepts. Types of research designs.

Development of a research plan - Exploration, Description, Diagnosis, Experimentation, determining experimental and sample designs.

Data collection techniques.

Module V. Scientific Documentation and Communication 3 hrs.

Project proposal writing, Research report writing (Thesis and dissertations, Research articles, Oral communications).

Presentation techniques - Assignment, Seminar, Debate, Workshop, Colloquium, Conference.

Module VI. Information Science, Extension and Ethics 3 hrs.

Sources of Information - Primary and secondary sources.

Library - books, journals, periodicals, reference sources, abstracting and indexing sources, Reviews, Treatise, Monographs, Patents.

Internet - Search engines and software, Online libraries, e-Books, e-Encyclopedia, TED Talk, Institutional Websites.

Intellectual Property Rights - Copy right, Designs, Patents, Trademarks, Geographical indications.

Safety and precaution - ISO standards for safety, Lab protocols, Lab animal use, care and welfare, animal houses, radiation hazards.

Extension: Lab to Field, Extension communication, Extension tools.

Bioethics: Laws in India, Working with man and animals, Consent, Animal Ethical Committees and Constitution.

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PZO1CRP01 PRACTICAL 1: BIOSYSTEMATICS AND ANIMAL DIVERSITY, EVOLUTIONARYBIOLOGYAND ETHOLOGY, BIOCHEMISTRY, BIOSTATISTICS, COMPUTERAPPLICATIONAND RESEARCH METHODOLOGY

90 Hours (5hrs./week) **Credit-3**

Biosystematics and Animal Diversity, Evolutionary Biology and Ethology

Study of museum specimens - 70 invertebrates and 30 vertebrates (List the studied items with brief descriptions. Diagrams not necessary).
Larval forms – any 10 larvae from different taxa
Study of the skull of vertebrates - Varanus, Crocodile, Bird, Dog, Rabbit/ Rat
Preparationof dichotomouskeyof4 specimensup to family(insects/spiders/ fishes/snakes of any three taxa).
Preparation of Cladogram based on the specimens provided (at least five museum specimen).
Calculating gene frequencies and genotype frequencies in the light of Hardy-Weinberg Law in human/ other populations.
Studyof fish in response to three temperatures (Normaland+ 5^0C) of water in a microenvironment and preparationofan ethogram
Study of the grooming behaviour in insects/bird

Biochemistry

Quantitative estimation of blood glucose by Folin-Wu/Anthrone /DNS/O-Toluidine/Enzymatic method
Estimation of proteins by Biuret/ Lowry *et al.* method
Quantitative estimation of bloodurea/ creatine/uricacid
Quantitative estimation of cholesterol in the blood
Estimationofalkalineandacidphosphatases

Biostatistics

(Problems can be solved using scientific calculator).
These exercises can be done as assignments of the theory sessions
Calculation of mean, median and mode from grouped data
Calculation of mean deviation and standard deviation from grouped data
Calculation of Pearsoncorrelation coefficient.
Calculation of regression coefficient andregression equation('x' on 'y' only)
Calculationoflength-weightrelationship
Calculation of 'Z' value (small sample only)
Calculationof Chi square value (2×2 table only)
Calculation of 't' value (for small sample comparing two variable)
Drawline graph, vertical bar diagram, horizontal bardiagram, histogram, frequency polygon, frequency curve, pie diagram and ogives on graph paper for simple grouped data.

ComputerApplications

MS Excel: Preparation of table
MS Excel: Preparation of graphs (bar, pie and ogives)
MS Excel: Formula writing(Addition, Subtraction, Multiplication, Division, Powerand Root)
MS Excel: CorrelationAnalysis
MS Power Point: Preparation of a presentation with minimum 5 slides based on First Semester theory topics

PH Stat: Basic statistics (mean, median, mode, standard deviation)
PH Stat: Chi square test
PH Stat: Students t test
PH Stat : Regression

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SEMESTER II

PZO2CRT01 ECOLOGY: PRINCIPLESAND PRACTICES

PZO2CRT02 GENETICS AND BIOINFORMATICS

PZO2CRT03 DEVELOPMENTAL BIOLOGY

PZO2CRT04 BIOPHYSICS, INSTRUMENTATION AND BIOLOGICAL TECHNIQUES

PZO2CRP01 PRACTICAL 1 - ECOLOGY, GENETICS AND BIO-INFORMATICS, DEVELOPMENTAL BIOLOGY, BIOPHYSICS, INSTRUMENTATION AND BIOLOGICAL TECHNIQUES.

PZO2CRT01 ECOLOGY: PRINCIPLES AND PRACTICES

90 Hours (5hrs/week) **Credit- 4**

Objectives:

- To provide an understanding on the basic theories and principles of ecology
- To help study various disciplines in ecology
- To learn current environmental issues based on ecological principles
- To gain critical understanding on human influence on environment

Module I. Ecology and Environment **15 hrs.**

Physical Environment- biotic and abiotic interactions. Concept of Homeostasis; Concepts of habitats- host as habitat, niche, niche width and overlap, fundamental and realized niche, resource partitioning, character displacement.

Cybernetic nature of ecosystem, stability through feedback control and through redundancy of components; resistance and resilience stability. Gaia hypothesis.

Concept of limiting factors- Liebig's law, Shelford's law.

Ecological indicators.

Prerequisite: *Definition, history and scope of ecology, sub divisions of ecology, Ecology Vs Environmental science.*

Module II. E**cosystem - Structure and Function** **15 hrs.**

Ecosystem and Landscapes, pathways in ecosystem, energy in the environment- Laws of thermodynamics, energy flow in the ecosystem. Primary productivity, Biomass and productivity measurement. Food chain, food web, trophic levels. Ecological efficiencies, Ecological pyramids, Biogeochemical cycles- patterns and types (CNP).

Tropical versus Temperate Ecology.

Module III. Population Ecology **15 hrs.**

Population group properties, density and indices of relative abundance, Concept of rate.

Natality and mortality. Population age structure, Growth forms and concept of carrying capacity.

Population fluctuations, density dependent and density independent controls. Life history strategies, *r & k* selection.

Population structure, aggregation, Allee's principle, isolation, dispersal and territoriality.

Population interactions- types, positive and negative, interspecific and intraspecific interactions. Ecological and evolutionary effects of competition.

Concept of metapopulation. Levin's model of metapopulation. Comparison of Metapopulation and Logistic population model. Metapopulation structure.

Module IV. Community Ecology **10 hrs.**

Concept of community - community structure and attributes, ecotone and edge effect. Development and evolution of the ecosystem, concept of climax. Species diversity in community and it's measurement- Alpha diversity, Simpson's diversity index, Shannon index, Fisher's alpha, rarefaction. Beta diversity- Sorensen's similarity index, Whittaker's index, Evenness, Gamma diversity, Guild and its functioning in the community.

Drivers of species diversity loss and conservation.

Prerequisite: *Community interactions*

Module V. Resource Ecology **15 hrs.**

Natural Resources: Soil-soil formation, physical and chemical properties of soil. significance of soil fertility.Mineral resources with reference to India. Impact of mining on environment; Forest resources-deforestation,forest scenario of India.Aquaticresources - Freshwater and water scarcity, water conservation measures - case studies from India; Wetlands and its importance, international initiatives for wetland conservation - Ramsar sites. Sand mining and its impacts. Wetland reclamation- causes and consequences. Depletionofresourcesandimpactson qualityoflife.

Energy Resources- solar, fossil fuels, hydro, tidal, wind, geothermal and nuclear.Energy use pattern in different parts of the world, recent issues in energyproductionandutilization; Energyaudit, Greentechnology andsustainable development.

Ecosystem monitoring- GIS, Physics of remote sensing, role of remote sensing in ecology, GPS and its application; EIA- tools and techniques, Ecosystem Modelling (Brief account only).

Module VI. Applied Ecology **10 hrs.**

Environmental Pollution-types, causes and consequences.Concept of waste, types and sources of solid wastesincludinge-waste; Environmental biotechnologyand solid wastemanagement- aerobicandanaerobic systems. Concept of bioreactors in waste management. Liquid wastes and sewage. Bioremediation- need and scope of bioremediation in cleaningup of environment. Phytoremediation, bio-augmentation, biofilms, biofilters, bioscrubbersandtricklingfilters.

Radiation Biology - natural and man-made sources of radioactive pollution; radioisotopes of ecological importance; effects of radioactive pollution; nuclear disasters (two case studies), Disposal of radioactive wastes.

Toxicology- Principles, toxicants- types, dose and effects, toxicity of heavy metals.

Module VII. Biogeography and Conservation **10 hrs.**

Major terrestrial Biomes, theoryof island biogeography, bio-geographical zones of India; Western Ghats andits significance.

Principlesand majorapproaches to conservation and environmental management.Role of UN- conventions, protocols; Climate change and the emerging discussions – mitigation and adaptation; Role of UNFCC and IPCC. Country specific laws- mention major environmental/ conservation laws and rules in India-Wildlife Protection Act 1972 amended 1991, Forest Conservation Act, 1980, Air (Prevention and Control of Pollution)Act 1981, Water(Preventionand Control of Pollution)Act 1974, amended 1988, The Environment Protection Act, 1986 and Rules, 1991. The Biological DiversityAct 2002, Rules 2004.

Restoration Ecology- need and policies, case studies and success stories - global and national; Global environmental problems and debates - past and present; Participatory resource management, communityreserves, sacred groves, biovillages.

Role of Intergovernmental and Non-governmental organizations in conservation-IUCN, WCMC,WRI,WWF, CI and Green Peace.National and Local NGOs.

Prerequisite: *Ecological foot print, carbon footprint, carbon credit and eco-taxes.*

REFERENCES

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PZO2CRT02 GENETICS AND BIO INFORMATICS

90 Hours (65+ 25) **Credit: 4**

Objectives:

- To give an in-depth understanding on the principles and mechanisms of inheritance
- To help study the fine structure and molecular aspects of genetic material
- To provide an opportunity to learn the importance of inheritance in Man
- To expose the learners to the emerging field of bioinformatics and equip them to take up bioinformatics studies

GENETICS 65 hrs.

Module I. Principles of Genetic Transmission 5 hrs.

Extension of Mendel's principles: allelic variation and gene function- incomplete dominance and co-dominance. Gene action-from genotype to phenotype-penetrance and expressivity, gene interaction-epistasis, pleiotropy, genomic imprinting, phenocopy.

Prerequisite: *Mendel's works and Mendelian Principles*

Module II. Molecular Organization of Chromosomes 6 hrs.

Genome size and C-value Paradox. Structure of eukaryotic chromosome, nucleosome model. Chromosome condensation - euchromatin and heterochromatin. Repetitive nucleotide sequences in eukaryotic genomes, kinetics of renaturation: Cot and Cot curve. Unique and repetitive sequences. Mini and micro satellites. Molecular structure of centromere and telomere. Polytene chromosomes and Lampbrush chromosomes. Chromosome banding techniques.

Prerequisite**:** *Sex determination, sex linkage, sex limited and sex influenced characters in Man*

Module III. Gene Fine Structure 10 hrs.

Evolution of the concept of gene function and structure. The definition of gene. The standard genetic code, redundancy and Wobble. DNA Structure- alternate forms of the Double Helix. Gene synthesis (in vitro synthesis) – works of Khorana and Kornberg. Modern findings on the nature of gene: Interrupted genes in eukaryotes, exons and introns-R loops, significance of introns. Genes-within-genes (overlapping genes) Bacteriophage Ö X174.

Transposable elements in Bacteria –IS elements, composite transposons, Tn3 elements, medical significance. Transposable elements in Eukaryotes-P elements, Retrotransposons, significance of transposons.

Prerequisite: *Works of Watson and Crick and Experiments by B. MacClintock*

Module IV. Genetic Linkage, Recombination and Chromosome Mapping 12 hrs.

Chromosome theory of heredity, Linkage and recombination of genes in a chromosome, crossing over as the physical basis of recombination, Stern's Experiment; molecular mechanisms of recombination (Holliday model), Gene conversion, Recombination mapping with two-point and three–point testcross in *Drosophila*, Coincidence and Interference.

Genetic mapping by tetrad analysis in *Neurospora*. Mitotic recombination.

Genetic recombination in Phage, rII locus, complementation test, deletion mapping, conjugation mapping, mapping by interrupted mating, mapping with molecular markers and mapping using somatic cell.

Prerequisite: *Recombination in bacteria- transformation, transduction, conjugation and sex- duction.*

Module V. Gene Mutation **6 hrs.**

Molecular basis of gene mutation; mutant types- lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants. Induced mutation, The Amestest for mutagen/carcinogen detection.

DNA damage and repair mechanisms

Prerequisite: *Chromosomal mutations – structural, numerical and genetic implications.*

Module VI. DNA Replication **9 hrs.**

The Meselson-Stahl experiment, semiconservative replication of DNA in chromosomes, Theta replication, rolling-circle replication, molecular mechanisms of eukaryotic replication.

Module VII. Human Genetics **5 hrs.**

Karyotype, pedigree analysis, Lod score for linkage testing, genetic analysis of complex traits - complex pattern of inheritance, quantitative traits, threshold traits; human genome and mapping.

Pre requisite: *Chromosome anomalies : autosomal and sex chromosomal disorders.*

Module VIII. Extra Chromosomal Inheritance **2 hrs.**

Inheritance of mitochondrial and chloroplast genes, maternal inheritance.

Module IX. Epigenetics **5 hrs.**

Epigenetics - from phenomenon to field, a brief history of epigenetics - overview and concepts; chromatin modifications and their mechanism of action, concept of 'histone-code' hypothesis, epigeneticsin *saccharomyces cerevisiae,* position effect variegation, heterochromatin formation and gene silencing in *Drosophila.*

Module X. Quantitative and Population Genetics **5 hrs.**

Polygenic inheritance, analysis of quantitative traits, quantitative traits and natural selection, estimation of heritability, QTL mapping, genotype-environment interactions, molecular analysis of quantitative traits, phenotypic plasticity.

BIOINFORMATICS 25 hrs.

Module 1. Introduction to Bioinformatics **2 hrs.**

Definitions of bioinformatics, applications of bioinformatics and scope of bioinformatics.

Module II. Biological Databases **7 hrs.**

Primary databases - Nucleotide sequence databases: GenBank, EMBL, DDBJ ; Protein sequence databases: SWISSPROT, PIR; Structure databases: PDB, NDB; Secondary databases: PROSITE, Pfam, CATH; Composite databases: OWL; Literature database: PubMed; Database searching – Entrez; Database sequence submission – BankIt.

Module III. Sequence Analysis **6 hrs.**

Types of sequence alignment, methods of sequence alignment, scoring schemes, gaps and gap penalties, construction of phylogenetic trees.

Module IV. Genomics and Proteomics **7 hrs.**

Structural genomics, functional genomics, comparative genomics, data mining in proteomics– Microarrays, significance of proteomics and drug design.

Module V. Systems Biology **3 hrs.**

Introduction , metabolomics, gene network, synthetic biology.

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PZO2CRT03 DEVELOPMENTAL BIOLOGY

90 Hours (5hrs/week) **Credit - 4**

Objectives:

- To introducethe concepts and process in developmental biology
- To help studentsunderstandand appreciate the genetic mechanisms and the unfolding of the same during development
- To expose the learner to the new developments in embryology and its relevance to Man

Module I. Introduction: Basic Concepts of Development **14 hrs.**

Potency of embryonic cells, Commitment, Specification (Autonomous and Conditional), Induction, Competence, Determination and Differentiation, Morphogenetic gradients, Cell fate and cell lineages.Genomicequivalenceand Cytoplasmicdeterminants.

Module II. Gametogenesis,Fertilizationand Early development **12 hrs.**

Spermatogenesis,Oogenesis.Fertilization-(biochemicaland molecularaspects), Polyspermy. Mechanisms andsignificance of cleavage.BlastulationandGastrulation, Parthenogenesis.

Module III. Early Development of Model organisms **5 hrs.**

Early development and axis specification in *Caenorhabditis elegans*. Early development and axis specification in*Drosophila* (cleavage, midblastulatransition, gastrulation).

Module IV.Axisand Pattern Formation inAnimals **15 hrs.**

Anterior-posterior patterning in*Drosophila*(Maternal effect genes,zygotic genes, gap genes, pair rule genes,segmentpolarity genes; homeotic selector genes,realisator genes),Dorsal-ventral patterningand left rightpatterning, Dorsal proteingradient.

Axis formation in amphibia -Anterior-posterior patterning inAmphibia.Hox code hypothesis.

Module V.Cellular Interactions in Development **14 hrs.**

Nieuwkoopcentreandmesodermalpolarity. Molecularbasis of mesoderminduction.Transcription factors inducedinthe organizer.Neuralinduction,Regionalspecificityofinduction,Geneticspecificityofinduction (Paracrine factors - Hedgehog family, Wnt family, TGF, BMP). Surfacereceptors and signaltransduction pathway - RTK pathway,Smad pathway,Wnt pathway, Hedgehog pathwayand cell deathpathway.

Module VI. Differential Gene Expression **13 hrs.**

Differential genetranscription - exonsand introns, promotors, silencers, enhancers, transcription factors, DNAmethylation, genomicimprinting, dosagecompensation, differentialRNAprocessing;

Control of gene expression: translational and post translational control of gene expression.

Module VII. Metamorphosis and Regeneration **8 hrs.**

Metamorphosis of Amphibiansand Insects; Hormonal control of metamorphosis.Heterochrony- neoteny, progenesis (Briefaccounts); regeneration - different types of regeneration; Histological processes during regeneration; Polarity and Metaplasia in regeneration; Lens regeneration in amphibia; Bone and neural regeneration(Medical -Advances in regeneration).

Module VIII. Teratogenesis **4 hrs.**

Malformations and disruptions,Gene – phene relationship, Autophene, Allophene and Pleiotrophy; Teratogenicagents (Retinoicacid, pathogens, alcohol, drugs and chemicals, heavy metals); Environmental oestrogens.

Module IX. Human Welfare and Developmental Biology **5 hrs.**

Infertility-Testtubebabies(*Invitro*fertilizationandembryotransfer).Cloningexperiments-(Amphibians, MammalsandHuman). Stemcellsandtheirapplications, ethicalissues.

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PZO2CRT04 BIOPHYSICS, INSTRUMENTATION AND BIOLOGICAL TECHNIQUES

90 Hours (42+38+10) **Credit-4**

Objectives:

- To learn the biophysical properties and functioning of life processes
- To introduce the tools and techniques available for studying biochemical and biophysical nature of life
- To equip the learner to use the tools and techniques for project work/ research in biology

BIOPHYSICS 42 hrs.

Module I. Diffusion and Osmosis 8 hrs.

Diffusion -Kinetics of diffusion, Fick's law of diffusion and diffusion coefficient, Biological significance in animals and plants, Electrochemical gradient, Stokes-Einstein equation and Graham's law, Facilitated diffusion, Gibbs-Donnan equillibrium.

Osmosis- osmotic concentration and osmotic pressure, Van't Hoff's laws.

Biological significance of osmosis in animals and plants.

Module II. Biophysics of Cell Membrane 10 hrs.

Physico-chemical properties of cell membrane, conformational properties of cell membranes, Membrane Transport – endocytosis, exocytosis, Nutrient transport across membranes, porins facilitated diffusion, porter molecules; Facilitated transport: symport, antiport, uniport, anion porter, glucose porter; Active transport: proton pumps, $Na^+ K^+$ pumps and Ca^{++} pumps, ionic channels. Functions of cell membrane. Artificial membranes.

ModuleIII. Bioenergetics 14 hrs.

Thermodynamics- Laws of thermodynamics, Entropy, Enthalpy, Free energy.

Reversible thermodynamics and irreversible thermodynamics; Systems – open, closed and isolated.

Photo bioenergetics. Photosynthesis – light and dark reactions, Redox couple and redox potential.

Chemo-bioenergetics: electron transport and oxidative phosphorylation, Chemiosmotic theory and binding change mechanism of ATP synthesis.

Module IV. Radiation Biophysics 10 hrs.

Ionizing radiation, units of radioactivity, exposure and dose.

Interaction of radiation with matter – Photoelectric effect, ion pair production, absorption and scattering of electrons.

Biological effects of radiation: effect on nucleic acids, proteins, enzymes and carbohydrates. Cellular effects of radiation: somatic and genetic.

Nuclear medicine: Internally administered radioisotopes. Radioiodine in thyroid function analysis. Renal, liver and lung function analysis.

Application of radioactive tracers, Radiation protection and therapy.

INSTRUMENTATION & BIOLOGICAL TECHNIQUES 38hrs.

Module I. Microscopy 6 hrs.

Differential Interference contrast (Nomarsky) microscopy, Confocal microscope, Electron microscope – TEM, SEM, Scanning Tunnelling and Atomic Force Microscopes.

Prerequisite: *Light microscope and dark field microscope, Phase contrast microscope, Polarizing microscope, birefringence fluorescence microscope and camera lucida*

Module II. Chromatography **7 hrs.**

Paper chromatography,Thin layer chromatography, Ion exchange chromatography.
Gel permeation chromatography,Affinity chromatography,Gas chromatography
High pressure liquid chromatography(HPLC).

Module III. Electrophoresis **6 hrs.**

Paper electrophoresis,Gel electrophoresis, Polyacrylamide gel electrophoresis (PAGE) – SDS and non SDS , Agarose gel electrophoresis , Disc electrophoresis, High voltage electrophoresis, immuno-electrophoresis, isoelectricfocusing.

Module IV. Colorimetry, Spectrophotometry and Spectroscopy **8 hrs.**

Principle and applications of colorimetry and spectrophotometry.
Spectroscopy :Flame emission spectroscopy, Atomic absorption spectroscopy, Nuclear Magnetic-resonance spectroscopy (NMR), Circular dichroism spectroscopy, ESR spectroscopy, Mass spectroscopy.

Module V. Centrifugation **3 hrs.**

Basicprinciples of sedimentation,Types of centrifuges,AnalyticalandPreparativecentrifugation, Differential anddensitygradientcentrifugation.

Module VI. Radioisotope Detection and Measurement **2 hrs.**

Dosimetry: Ionization chamber, GM counter, Solid and liquid scintillation counters,Autoradiography.

Module VII. Nanotechnology **3 hrs.**

Introduction to Nanobiology. Nanosensors and Nanomedicines.

Module VIII. Assays **2 hrs.**

Radio ImmunoAssay, Enzyme Linked Immuno SorbantAssay (ELISA).

Module IX. pH meter **1 hr.**

Principle and working. Types of pH meters.

Module X. Biological and Histological Techniques **10 hrs.**

Fixation, preparationof temporary and permanent slides, whole mounts, smears, squashes and sections.
Specimen preparation for TEM, SEM, shadow casting, freeze fracturing, freeze etching,negative staining.Microphotography.
Cytochemical and histological methods- Microtome techniques, fixation, staining.
Cytochemistry of nucleic acids, detection of carbohydrates, proteins and lipids.

REFERENCES

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PZ02CRP01 PRACTICAL 1: ECOLOGY, GENETICS AND BIO-INFORMATICS, DEVELOPMENTAL BIOLOGY, BIOPHYSICS, INSTRUMENTATION AND BIOLOGICAL TECHNIQUES.

90 Hours(5 hrs./week) **Credit-3**

Ecology

Study of Pond/ wetland/ River ecosystem- Food web and food chain (no museum specimen). Record the date, time, methodology, and observations in the record book.

Determination of soil organic carbon and chlorides.

Separation and identification of soil arthropods using Berlese funnel.

Qualitative and Quantitative study of marine/freshwater planktons.

Estimation of primary productivity.

Quantitative estimation of salinity, phosphates and nitrates in water samples.

Study of pH and conductivity using pH and conductivity meter (2different samples).

Principles and application of the following instruments: Rain Guage, Plankton Net, Secchi Disc, GPS.

Field Study Report: Three days field study covering River/ Wetland/ Marine and forests/ grassland. Record ecosystem components (Soil, water, flora, fauna) and interactions. Viva based on Field study.

Developmental Biology

Identification of different developmental stages of frog (egg, blastula, gastrula, neurula, tadpole, with external gill and internal gill).

Vital staining of early gastrula of chick – window method.

Blastoderm mounting of chick embryo using vital stains.

Morphological and histological studies of different types of placenta in mammals.

Study of serial sections of embryo (tadpole and chick).

Regeneration studies in fish (Zebra Fish/ Earth worm).

Genetics and Bioinformatics

Culture, sexing and etherization of *Drosophila*.

Study of Mutants in *Drosophila*.

Genetics problems (Di hybrid cross, test cross and sex linked inheritance).

Abnormal human karyotypes(any five).

Data base search and data retrieval-using NCBI, SWISS-PROT, PDB, Expasy.

Methods of sequence alignment-BLAST and ClustalW.

Phylogenetic tree using PHYLIP.

Gene Prediction using GENSCAN/GRAI.

Protein structure visualization using RASMOL.

Biophysics/Instrumentation/Biological Techniques

Micrometry- principle and measurement of microscopic objects: Low power and high power.

Camera Lucida drawing with magnification and scale.

Principle and working of phase contrast microscope, micro-photographic equipment and pH meter.

TLC using aminoacids from purified samples and biological materials.

Study of Enzyme kinetics- Salivary amylase on maltose standards- influence of temperature and Substrate concentration on enzyme activity(Lineweaver Burk Plot) on enzyme activity.

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SEMESTER III

PZO3CRT01 ANIMAL PHYSIOLOGY

PZO3CRT02 CELLAND MOLECULAR BIOLOGY

PZO3CRT03 MICROBIOLOGYAND BIOTECHNOLOGY

PZO3CRT04 IMMUNOLOGY

PZO3CRP01 PRACTICAL - 1: CELL AND MOLECULAR BIOLOGY, MICROBIOLOGYAND BIOTECHNOLOGY.

PZO3CRP01 PRACTICAL – 2: ANIMAL PHYSIOLOGY AND IMMUNOLOGY

PZO3CRT01 ANIMAL PHYSIOLOGY

90 Hours. (5hrs/week) **Credit-4**

Objectives:

- To study and compare the functioning of organ systems across the animal world
- To give an overview of the comparative functioning of different systems in animals
- To learn more about human physiology

Module I. Nutrition, Digestion and Absorption **8 hrs.**

Nutrition in animals, mechanisms of food intake in different animals.
Physiology of digestion and absorption. Structural and biochemical adaptations to special dietary pattern, symbiotic digestion.
Neuronal and hormonal regulation of nutritional intake, hunger drive, thirst.
Obesity- causes and consequences, outline of hormonal involvement, Leptin: synthesis, secretion and its role in adipogenesis.
Prerequisite: *Human digestive system: structure and function, gastro-intestinal and nutritional disorders.*

Module II. Circulation **10 hrs.**

Circulatory mechanisms and fluid compartments, movement of body fluids by somatic muscles, open system, closed system, lymph channels.
Circulatory shock, Circulatory arrest.
Types of hearts- chambered heart, tubular heart, ampullar heart, lymph heart, neurogenic and myogenic heart. Pace makers and specialized conducting fibers. Cardiac cycle, cardiac output, blood pressure, effect of drugs on heart beat, effects of exercise on cardiaovascular physiology. ECG - its principle and significance. Blood buffers**,** Human congenital heart diseases.
Prerequesite: *Anatomy of human heart, composition of blood. Haemopoiesis*.

Module III. Respiration **8 hrs.**

Respiration in invertebrates and vertebrates.
Pulmonary ventilation, respiratory muscles, surfactants. Respiratory centers and periodic breathing. Regulation of respiration. Respiration in unusual environment– foetal and neonatal respiration, high altitude, diving. Structure and functioning of respiratory pigments. Metabolic rate : basal metabolic rate and its measurement.
Pre-requisite: *Respiratory organs with special reference to arthropods and vertebrates.*

Module IV. Osmoregulation and Excretion **6 hrs.**

Osmoregulation in fresh water, marine and terrestrial animals.
Excretion invertebrates. Physiology and regulation of urine formation, Hormonal regulation of urine formation. Regulation of water balance, electrolyte balance and acid-base balance. Dialysis, artificial kidney, kidney transplantation.
Prerequisite*: Vertebrate kidney, Structure of nephron, excretory products, kidney disorders.*

Module V. Nerve Physiology **10hrs.**

Neuroanatomy of the central and peripheral nervous system. Electrical and chemical transmission. Synaptic transmission. Modifications of synaptic transmission during fatigue, acidosis, alkalosis, hypoxia and drugs. Mechanism of excitatory and inhibitory pathway. Neuromuscular Junction: organization and properties of neuromuscular junction, neuromodulators. Neural control of muscle tone and posture.

***Prerequisite**: Structure of neuron. Neurotransmitters. EEG, MRI, memory, neural disorders in man.*

Module VI. Sensory and Effector Physiology 12 hrs.

Classification of somatic senses and somatic receptors, exteroceptors, interoceptors, modality of sensation, secondary sense cells, transduction, relationship between stimulus, intensity and response, sensory coding.

Chemical senses: taste, smell, mechanism of reception.

Mechanoreceptors: hair cell, organs of equilibrium, vertebrate ear, mechanism of hearing, electro and thermoreceptors.

Vision: Structure of invertebrate and vertebrate eye. Physiology of vision.

Pain: pain receptors, headache and thermal senses, pain suppression (analgesia).

Tactile sensation: touch receptors, transmission of signals, special problems of premature infants, Physiological role of touch and environment in premature infants - Kangaroo care, infant massage, supportive environment.

Prerequisite: *structure of skin, eye and ear.*

Module VII. Muscle Physiology 8 hrs.

Comparative physiology of skeletal, smooth and cardiac muscles. Skeletal muscle- ultra structure and molecular organization. Red and white muscles, muscle proteins. Mechanism of muscle contraction and relaxation. Energetics of muscle contraction. Effect of exercise on muscles. Catch muscle and fibrillar muscle.

Prerequisite: *simple muscle twitch, latent and refractory periods, tetanus, tonus, fatigue, oxygen debt.*

Module VIII. Thermoregulaion 5 hrs

Comfort zone, body temperature– physical, chemical, neural regulation, acclimatization.

Impact of temperature on the rate of biological functions. Arrhinius equilibrium, Q 10.

Temperature compensation and temperature regulation in poikilotherms and homiotherms. Adaptations for extreme environments, aestivation and hibernation.

Module IX. Endocrinology 15 hrs.

Invertebrate and vertebrate endocrine system. Endocrine glands. Synthesis, physiologic role, control and mechanisms of hormone action. Neuro-endocrine regulation of hormone action. Bioamines, Ecosanoids, Chalones, Lumones, Phytohormones, Synthetic hormones.

Prerequisite: *Hormones as messengers, hormonal control of homeostasis. Disorders of hormonal imbalance in Man.*

Module X. Reproductive physiology 8 hrs

Anatomy and histology of adult testis and ovary. Reproductive cycles of mammals and their hormonal control. Physiology of implantation, pregnancy, parturition, and lactation.

Impact of senescence and age on reproduction.

Prerequisites: *spermatogenesis, Oogenesis, egg-sperm interaction*

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PZO3CRT02 CELL AND MOLECULAR BIOLOGY

90 Hours(5 hrs/week) **Credit-4**

Objectives:

- To help study the structural and functional details of the basic unit of life at the molecular level
- To motivate the learner to refresh and delve into the basics of cell biology
- To introduce the new developments in molecular biology and its implications in human welfare

Module I. Cellular Membranes **6 hrs.**

Membrane structure and chemistry, dynamic nature of the plasma membrane, membrane functions, membrane potentials, ion channels.

Prerequisite: *membrane transport – Diffusion and osmosis, Facilitated diffusion, Active transport, Bulk transport. Nucleus and nuclear membrane*

Module II. Cell junctions, Cell adhesion and Extracellular matrix **10 hrs.**

Extracellular matrix: Basal membrane and laminin, Collagen, Proteoglycan, Fibronectin. Interaction of cells with extracellular matrix: Integrins. Focal adhesion and hemidesmosomes. Interaction of cells with other cells: Selectins, Immunoglobulins, Cadherins, Adherens. Junctions and desmosomes. Tight junctions, Gap junctions and Plasmodesmata.

Module III. Cell Organelles **6 hrs.**

Endoplasmic reticulum, Golgi complex, Ribosome, Mitochondria.

Prerequisite**:** *Lysosome, Chloroplasts, Peroxisomes and Glyoxysomes*

Module IV. Cytoskeleton and Cell Motility **5 hrs.**

Microtubules, Microfilaments, Intermediate filaments, Molecular motors, Non muscle motility and contractility.

Module V. Cell Signaling **15 hrs.**

Extracellular messengers (signaling molecules), role of Calcium and Nitric oxide (NO) as intracellular and intercellular messengers.

Receptors: G- Protein coupled receptors, Receptor tyrosine kinases (RTK), Ion channel receptors, Cytokine receptors (Tyrosine kinase linked receptors).

Second messengers: Cyclic-AMP, Cyclic-GMP, Inositol 1,4,5-trisphosphate (IP3), Di-acyl glycerol (DAG).

Signaling pathways: G-protein coupled receptor (GPCR) and cyclic AMP pathway – role of protein kinase A (PKA), GPCR pathway in rod cells, Receptor protein tyrosine kinase and Ras-MAP kinase pathway, JAK-STAT pathway, Calcium phosphatidyl- inositol pathway, Phospho Inositide 3-kinase (PI-3 kinase), Transforming growth factor (TGF) signaling pathway. Regulation of signaling pathways. Convergence, divergence and crosstalk among different pathways.

Prerequisite: *Basic principles of cell communication*

Module VI. Cellular Reproduction **5 hrs.**

Cell cycle: Steps in cell cycle, Control of cell cycle, Checkpoints in cell cycle. Control of cell division and cell growth.

Apoptosis- extrinsic and intrinsic pathways, significance

Prerequisite: *Mitosis, meiosis and Structure of chromosome.*

Module VII. Cancer **8 hrs.**

Basic properties of a cancer cell, Types of cancer, Causes of cancer, Genetics of cancer, Tumoursuppressor gene, Oncogene.

New strategies for combating cancer: Immunotherapy, Genetherapy, Inhibiting cancer promoting proteins, Inhibiting formation of new blood vessels.

Module VIII. Gene Expression **20 hrs.**

Relationship between genes and proteins. Transcription in prokaryotes and eukaryotes-rRNA, tRNA and mRNA, RNA processing in prokaryotes and eukaryotes, Translation in prokaryotes and eukaryotes, initiation, elongation and termination, post transcriptional modifications, protein sorting, signal sequences andsignalhypothesis.

Pre- requisite: *Gene and Genetic code*

Module XI. Gene Regulation **15 hrs.**

Regulation of gene expression in *E. coli* : Catabolite repression, *Trp* operon in *E.coli*-repression and attenuation, *Ara* operon in *E.coli*-positive and negative controls. Riboswitches. General introduction to gene regulation in eukaryotes at transcriptional, post transcriptional and translational levels, transcription factors, enhancers and silencers, Chromatin-remodelling complexes, RNA interference(RNAi).

Pre-requisite: *Fundamentals of gene regulation, Lac operon*

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PZO3CRT03 MICROBIOLOGY AND BIOTECHNOLOGY

72 Hours(30+42) (4hrs/week) **Credit-4**

Objectives:

- To provide an over view of the microbial world, its structure and function
- To familiarize the learner with the applied aspects of microbiology
- To give students an intensive and in-depth learning in the field of biotechnology
- To understand the modern biotechnology practices and approaches with an emphasis in technology application, medical, industrial, environmental and agricultural areas
- To familiarize the students with public policy, biosafety, and intellectual property rights issues related to biotechnology

MICROBIOLOGY 30hrs.

Module I. Introduction to Microbiology 3 hrs.

Methods of Microbiology, Main group of microorganisms, general characters. Classification, approaches to microbial classification, outline classification, Bergey's manual.

Prerequisite: *Discovery of microorganisms. Contributions of Scientists to the field of Microbiology- Anton Von Leewenhoek, Edward Jenner, Lazaro Spallanzani, Louis Pasteur, Joseph Liter, Robert Koch and Alexander Flemming.*

Module II. Functional Anatomy of Prokaryotic Cells 3 hrs.

Cell structure, plasma membrane, cytoskeleton, cytoplasm, nucleoid, cytoplasmic inclusions. The prokaryotic cell envelope, peptidoglycan structure, gram positive and negative cell walls. Components outside the cell wall: capsules, slime layers and s-layers, pili and fimbriae, flagella and motility. The endomembrane system, mitochondria and chloroplasts, cell wall and pelliclein protists.

Prerequisite: *Morphology, size, shape and cell arrangement.*

Module III. Microbial Metabolism 4 hrs.

Energy acquisition by chemotrophs and phototrophs, glycolysis (Embden- Meyerhof pathway). Fermentation, anaerobic oxidations, chemosynthesis. Photosynthesis, carbon assimilation. Regulation of metabolism.

Module IV. Nutrition and Growth 3 hrs.

Common nutrient requirements, nutritional types, growth factors, uptake of nutrients by the cell. Culture media. Reproduction and exponential growth, the growth curve. Physical requirements for bacterial growth and influence of environmental factors on growth.

Module V. Microbial Interactions and Microbial Ecology 4 hrs.

Symbiosis, commensalism. Mutualism between microbes, microbes and plants, microbes and animals. Cooperation, competition, predation, antagonism. Parasitism, plant parasites, animal parasites.

Module VI. Virology 3 hrs.

Properties of viruses**,** structure and chemical composition, genetic composition eclipse, host interaction and specificity**.** Classification, RNA virus , DNA virus, plant virus, animal virus ,bacteriophage, lysis and lysogeny, Viral replication. Virioids and prions. Nature and significance. Pathogenic virus, oncovirus.

MODULE VII. Applied Microbiology **10 hrs.**

Bacteria of air, water and soil. Microbes associated with food production and spoilage, microbiology of milk and dairy products. Epidemiology of human diseases, Mechanism of microbial pathogenicity. Normal microbial population on human body, microbial diseases, Nosocomial infections.
Medical mycology. Control of microorganism- physical, chemical and antimicrobial agents.
Biological weapons and bioterrorism.

BIOTECHNOLOGY 42 hrs.

Module 1. Introduction to Biotechnology **2 hrs.**

Historical aspects, definitions and scope of Biotechnology. Biotechnology in India.

Module II. Tools and Techniques in Recombinant DNA Technology **12 hrs.**

Vectors: cloning and expression vectors - Plasmids, Ti and Ri plasmids, cosmids, phasmids, phagemids, bacteriophage, SV40, vectors with combination features; PUC19 and Bluescript vectors, shuttle vectors, viral vectors, BAC and YAC vectors. Restriction enzymes and DNA modifying enzymes.
Polymerase chain Reaction- different types and applications. Chromosome walking, chromosome jumping, DNA foot printing. Molecular Markers and Probes-SNP, VNTR, RAPD, RFLP, SSR, STMS, FISH and GISH. DNA sequencing methods- Maxam and Gilbert schemical degradation method, Sanger and Coulson method, Automated DNA sequencers. Site directed mutagenesis, molecular chimeras.
Cloning Methodologies - Gene isolation : Shot gun method, Genome libraries, cDNA libraries, Chemical synthesis. Splicing and integration of isolated gene- cohesive end ligation, homopolymer tailing, extending linkers. Methods of rDNA transfer to host cells- $CaCl_2$ treatment, Virus delivery. Selection and screening of the transformed cells, Blue-white screening, Colony hybridization methods, Reporter genes, Fusion proteins.
Prerequisite: *Blotting techniques- Southern, Northern, Western, Dot Blot, DNA finger printing.*

Module III. Animal Biotechnology **12 hrs.**

Cell and Tissue culture: Basic techniques of mammalian cell culture, disaggregation of tissue and primary culture, maintenance of cell culture and cell separation. Growth media: Physicochemical properties, natural and artificial, Balanced salt solutions, Complete Media, Serum, Serum-Free Media and protein free media and their applications. Biology and characterization of cultured cells, measurement of viability and cytotoxicity. Manipulation of cultured cell and tissues- scaling up of animal cell culture, cell synchronization, cell transformation, organ and histotypic culture. Tissue engineering: strategies and developments in tissue engineering, Biomaterials. Contamination: Source of contamination, Type of microbial contamination, Monitoring, Eradication of contamination, Cross-Contamination. Cryopreservation - importance and process of cryopreservation, cryopreservation of embryos, Cryogenics.
Transfection Methods: $CaPO_4$ precipitation, Short Gun, Electroporation, Lipofection, Microinjection, Agrobacterium mediated gene transfer. Somatic cell nuclear transfer- reproductive cloning and therapeutic cloning. Gene knockout and knockin technology. Applications of transgenic animals.
Stem cell culture : General and historical aspects, properties and types of stem cells, advantages and disadvantages, stem cell niche, application of stem cell technology in medicine.

Module IV. Biotechnology in Healthcare **4 hrs.**

Disease prevention – DNA vaccines. Disease diagnosis - Probes, Monoclonal antibodies, detection of genetic disorders. Disease treatment - Therapeutic proteins, hormones and growth factors. RNAi, Drug targeting, Gene therapy. Forensic medicine. Biosensors-different types, applications - medical and non medical. Introduction to Biochips and their application in modern sciences.

Module V. Biotechnology in Industry and Agriculture 5 hrs.

Metabolite production. Antibiotics, Organic acids, Amino acids, Vitamins, Upstream processing, downstreamprocessing.

Microbial enzymes and biotranformation- Microbial production of enzymes, fermentation, Enzyme engineeringandapplications. Food industry- Single cell protein, probiotics. Transgenic plants- Plants with resistance to Pests, plants with increased shelf life. Biofertilizers and microbial inoculants, biotechnology of nitrogen fixation, biocontrol agents, biopesticides, bioinsecticides, Terminator gene technology -concept and basics.

Module VI. Environmental Biotechnology 3 hrs.

Sewage treatment. Solid waste management. Biodegradation of xenobiotic compounds. Bioremediation and Biorestoration. Microbialleachingandmining. Biofuels. Transgenicsandenvironment.

Module VII. Intellectual Property Rights, Biosafety and Bioethics 4 hrs.

Introduction to Intellectual PropertyRights, Types of IP: Patents, Trademarks, Copyrights. Basics of Patents Types of patents; Indian Patent Act 1970; Recent Amendments, Protection of New GMOs. IPs of relevance to Biotechnology and few Case Studies (Rice, Neem, Curcumin). Introduction to History of GATT, WTO, WIPO and TRIPS.

Biosafety conceptsand issues. General guidelines for recombinant DNAresearch activity. Biosafety protocol 2000.

Bioethics: Principles of bioethics: autonomy, humanrights, beneficence, privacy, justice, equity*etc*. Ethics in postgenomic era-genetictestingandgenetic screening.

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Doyle, Alan and Griffith Bryan J. 1999. *Cell and Tissue Culture- Laboratory Procedures in Biotechnology*.WileyInternational,NY.

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Primrose, S.B., Twyman, R.M., and Old, R.W. 2001. *Principle of Gene Manipulation* (6th edn). Blackwell Science Ltd, London.

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Sobti, R. C. and Pachauri, Suparna S. 2009. *Essentials of Biotechnology*. Ane Books Pvt. Ltd. New Delhi.

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PZO3CRT04 IMMUNOLOGY

Total: 54 Hours. (3hrs./ week). **Credit-3**

Objectives:

- To provide an intensive and in-depth knowledge to the students in immunology
- To help the learner to understand the role of immunology in human health and well-being
- To familiarize the students the new developments in immunology

Module I. Overview of the Immune System **3 hrs.**

Types of Immunity- Innate and acquired, Passive and active. Pattern recognition receptors- scavenger receptors and Toll – like receptors. Humoral and cell-mediated immune responses. Haematopoiesis. B-cell and T-cell maturation and differentiation.

***Prerequisite*:** *Historical perspective and early theories of immunity, Components of immune system, cells, tissues and organs involved in immune system.*

Module II. Antigens and Antibodies **8 hrs.**

Antigen processing and presentation. Monoclonal antibodies and abzymes. Genetic model compatible with Ig structure. Multi- gene organization of Ig genes. Variable region gene arrangements. Generation of antibody diversity. Expression of Ig genes and regulation of Ig genes transcription. Antibody genes and antibody engineering.

***Prerequisite*:** *Antigen-structure and properties, Haptens, Adjuvants, Epitopes, Immunoglobulins- structure, classes and functions.*

Module III. Antigen –Antibody Interactions **2 hrs.**

Antigen-Antibody reactions. Biological consequences of antigen-antibody reaction.

***Prerequisite*:** *Types of antigen-antibody reactions - Cross-reaction, Precipitation, Agglutination.*

Module IV. The Complement System **5 hrs.**

Terminal sequence of complement activation (MAC). Classical, Alternate and Lectin Pathways. Complement activation, Regulation of complement system. Biological consequences of complement activation. Complement deficiencies.

Module V. Immune Effector Mechanisms **5 hrs.**

Inflammatory Cells. Types of Inflammation-acute and chronic. Chemokines. Role of cytokines in immune system. Properties and functions of Cytokines. Therapeutic uses of cytokines.

Module VI. Hypersensitivity **4 hrs.**

Allergy and hypersensitivity. Genetics of allergic response in humans.

***Prerequisite*:** *Types of Hypersensitivity*

Module. VII. Major Histocompatibility Complex **8 hrs.**

General organization and inheritance of MHC. MHC molecules and genes. Genomic map of H-2 Complex in the mouse. HLA Complex in humans. MHC-peptide interaction. Expression of MHC molecules on different cell types. Regulation of MHC expression. MHC and graft rejection. MHC and disease susceptibility. Biological significance of MHC. HLA typing

Module. VIII. Immunity in Health and Disease **15 hrs.**

Immune response during bacterial (tuberculosis), Parasitic (Malaria) and viral (HIV) infections. Congenital immunodeficiency diseases (SCID, WAS, CVI, Ataxia, CGD, LAD). Acquired Immunodeficiency Disease (AIDS). Autoimmunity. Organ- specific autoimmune diseases. Systemic auto-immune diseases. Animal

models for autoimmune disease. Evidences implicating $CD4^+$ T cell, MHC and TCR in autoimmunity. Induction of autoimmunity. Treatment of autoimmunediseases.
Transplantationimmunology. Immunologic basis of graft rejection. Clinical manifestation of graft rejection. Generaland specificimmunosuppressivetherapy. Clinical transplantation. Tumourimmunology. Vaccines, Whole organism vaccines, Purified macromolecules as Vaccines, Recombinant vector vaccines, Synthetic peptidevaccines, Multivalentsubunitvaccines.

Module IX.Immunological Techniques 4hrs.

Serological Reactions. Radio-allergosorbentTest(RAST).Immunoprecipitation. Immunofluorescence. Flow cytometryand fluorescence. Immunoelectron microscopy.

REFERENCES

Abbas, A.K., Lichtman, A.K and Pober , J.S. 1997. *Cellular and Molecular Immunology*. W.B. Saunders Co. New York

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PZO3CRP01 PRACTICAL 1: CELLAND MOLECULAR BIOLOGY, MICROBIOLOGYAND BIOTECHNOLOGY

72 Hours (4hrs./week) **Credit-2**

Cell and Molecular biology and Biotechnology

Squash preparation of grasshopper testis to study meiotic stages.

Squash preparationand identification of salivary gland chromosomes in *Drosophila* / *Chironomus* larva.

Determinationof mitotic index in the squash preparationof onion root tip.

Effect of drugs on celldivision(Colchicine or anyotherinhibitor)

Preparation of Microtomesection, spreadingandhistochemical staining of carbohydrates(PAS),Protein (Bromophenol blue), lipids (Sudan Black), DNA (Fuelgen stain).

Cell fractionationandDifferential Centrifugation to isolatemitochondria and nuclei

Isolationofgenomic DNAusing Agarose gel electrophoresis

Isolation of Plasmid DNA.

Microbiology

Sterilization, disinfection and safety in microbiological laboratory.

Preparation of culture media

(a) liquid media – nutrient broth, peptone water

(b) Solid media – Nutrient Agar, Mac Conkey' Agar.

(c) Semi solidagar

(d) Firm agar.

Culturing of microorganism –

(a) broth culture

(b) pure culture techniques- streak plate, pour plate culture, lawn culture, stab culture

(c) serial dilutionand standard plate count, calculation of Cfu/mlin water samples.

Isolationand preservation of bacterial culture.

Identification of microorganisms-

(a) Staining techniques- gram staining of mixed cultures, negative stainingand spore staining.

Antibioticsensitivity(differentnatural fluids)

(a) Oxidase test

(b) Catalase test

(c) Oxidation/fermentation (O/F) test

Stainingandenumeration of microorganisms:

(a) using haemocytometer

(b) nephelometry/ Turbidimetry

Environmental sample analysis.

a) Coliform count in water

b) Isolationand enumeration of soil bacteria

c) Identification of symbiotic bacterioids fromroot nodules of leguminousplants

Bacteriologicalanalysis of milk- methylenebluereductasetest.

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PZO3CRP02 PRACTICAL 2: ANIMAL PHYSIOLOGYAND IMMUNOLOGY

72 Hours (4hrs/week) **Credit -2**

Animal Physiology

Rate of salivary amylase activity on starch (colorimetry)

Effect of different pH on salivary amylase activity (colorimetry)

Influence of temperature on salivary amylase activity – Calculation of Q 10

Effect of drugs on the heartbeat of cockroach (Result with graphical representation corresponding to different concentrationand timeintervals expected)

Oxygen consumption in fish (normal and stressed).Graphical representation andinterpretation.

Kymograph: workingprincipleandapplications.

Virtual Practicals in Physiology

(Use of PhysioEX 9.0 : *Laboratory Simulations in Physiology* by P.Zao.,T.Stabler., L.A.Smith and E .Griff. 2011.is suggested) for muscle and nerve physiology practical for class room training and for practical examination in orderto replace Frog as per UGC guidelines).

Any four of the following:

(1) Muscle Twitchand the Latent Period

(2) The effect of stimulus Voltage on Skeletal Muscle Contraction

(3) Tetanus

(4) Fatigue

(5) Receptor Potential

(6) TheAction Potential Threshold

(7) Importance of Voltage –Gated Na+ Channels

Differential count of Human WBC

Haematocrit and ESR of Human blood

Feeding activity of paramecium

Observation on the effect of decreasing PO_2 ofwater on therespiratoryrate of a fishand determination of the lacticacid content of the muscle

Effect ofdifferent concentration of NaCl solution (0.1%-2%) on the diameter of RBCs(preferably human) anddetermination of the concentration, which is isotonic to theblood froma plot of diameter of RBC against concentration of NaCl

Immunology

Separation of lymphocytes from whole blood.

Separation of T and B lymphocytes

Blood Typing in Man.

WIDAL Test.

Western Blotting –Demonstration

ELISA -Demonstration

Rocket Immuno electrophoresis- Demonstration

Note:

Virtual Practical developed by the Ministry of Human Resources,Govt.of Indiaand available in the web site:**www.vlab.ac.in** canbeavailed fordemonstration.

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SEMESTER IV

ELECTIVE COURSE : MEDICAL MICROBIOLOGY

PZO4CRT01 GENERAL MICROBIOLOGY & PARASITOLOGY

PZO4CRT02 BACTERIOLOGY, VIROLOGY & MYCOLOGY

PZO4CRT03 CLINICAL MICROBIOLOGY

PZO4CRP01 PRACTICAL–I. GENERALMICROBIOLOGY & PARASITOLOGY

PZO4CRP02 PRACTICAL-II . CLINICAL MICROBIOLOGY

ELECTIVE COURSE: MEDICAL MICROBIOLOGY

Objectives:

To introduce the diversity of microbial world

To learn various patyhogens, parasites and related diseases of man

To familiarise with various tools and techniques in the study of microbes and to manage a microbial laboratory

To provide skills and competency in the field of clinical microbiology

PZO4CRT01 GENERAL MICROBIOLOGY AND PARASITOLOGY

90 Hours(5hrs/week) Credit-4

Module 1. Historical Introduction to Microbiology 3 hrs.

History, scope, relevance and future of microbiology.

Module II . Nomenclature and Identification of Bacteria 12 hrs.

Identification and nomenclature of bacteria - common biochemical tests for the identification. Serological identification. Classification of bacteria and salient features according to Bergey's manual of determinative Bacteriology. Microbial diversity in different ecosystems (halophiles, mesophiles, thermophiles, acidophiles, alkalophiles, barophiles and other extremophiles). Identification and classification using molecular techniques.

Module III. Sterilization and Control of Microbial Growth 20 hrs.

Control of microorganisms by physical methods: heat, filtration and radiation; Sterilization equipments: Hot air oven and Pasteurization, Tyndallization.

Autoclaves- principles, precautions and applications; Filtration- types and methods

Sterilization by radiation.

Chemical methods: phenolics, alcohols, halogens, heavy metals, quartenary ammonium compounds, aldehydes and sterilizing gases; Disinfectants and their mechanisms of action.

Evaluation of antimicrobial agent effectiveness. Antibiotics- types, mechanism of action. Determination of MIC and MBC

Antibiotic sensitivity tests, antibiogram.

Antimicrobial agents (bacterial, viral and fungal).

Module IV. Microbial Growth and Cultivation of Bacteria 10 hrs.

Growth and nutritional requirements of bacteria. Autotrophs, heterotrophs - enrichment culture - growth curve - Kinetics of Growth - Mathematical expression of exponential growth phase; Measurement of growth and growth yields - Culture media, culture methods; Batch Culture - Synchronous growth - Techniques of pure culture.

Module V. Study of Morphology of Bacteria 20 hrs.

Microscopy, different types of microscopy.

Morphology and arrangement of bacteria, ultrastucture of bacteria. Cellular components of bacteria - sporulation and its mechanics.

Staining: Principle and Methods. Simple Staining and Differential staining, Common differential staining - Gram staining, Acid –fast staining (Ziehl-Neilson Method), Staining of Specific Structures, Spore staining (Schaeffer-Fulton Method), Capsule staining, staining of volutin granules, Negative staining.

Examination of bacterial motility.

Epidemiology of bacterial infections, Guidelines for the collection, Transport, Processing analysis, isolation of bacterial pathogens and reporting of cultures from specimens for bacterial infections.

Module VI. Microbiology of Water, Milk and Food Substances 5hrs.

Microbialcontamination of water-types, sources, threats. Microbialcontamination of milk. Foodpoisoning. Major food borne diseases. Methods of detection of mirobial contamination of food, water and milk. Microbial standardsofdrinkingwater.

Module VII. Parasites and Vectors 20 hrs.

Study of Parasites- parasitism,types, origin and theories.

Structure and life cycle ofthe following parasites and pathogenesis of diseases caused: Also study their laboratorydiagnosis, treatmentand prevention, antiparasiticagentsand susceptibility test(of each).

Protozoan parasites-*Entamoeba histolytica, Plasmodium* sp., *Lieshmania, Trypanosoma, Trichomonas, Giardia.*

Taenia; Trematodes: *Schistosoma; Paragonimus*;

Helminthes – *Ascaris lumbricoides,* Hook Worm, Pin worm, Filarial Parasites.

Arthropod vectors of medical importance: defenition, types, importance. Major vector borne diseases and their pathogens.

A brief study of the following insects, the major diseases they transmit, epidemiology of such diseases, controland preventivemeasures:

Mosquito, Sand fly, House fly, Tse-Tse fly, Fleas, Louse, Bed bug, Ticks, Mites

REFERENCES

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PZO4CRT02 BACTERIOLOGY, VIROLOGY AND MYCOLOGY

90 Hours (5hrs/week) **Credits- 4**

Module I. Pathogenesis **5 hrs.**

Mechanism of pathogenesis- bacterial and viral.
Prophylaxis of communicable diseases.
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Module II. Pathogenic Bacteria **25 hrs.**

Study of important properties, pathogenicity and laboratory identification of: *Staphylococci, Streptococci, Pneumococcus, Corynebacterium diphtheriae, Bacillus anthracis, Clostridium Neisseria, E.coli, Proteus, Klebsiella, Shigella* and *Salmonella*. *Vibrio, Pseudomonas, Haemophilus, Brucella.*
Study of important properties, pathogenicity and laboratory identification of: *Mycobacterium, Treponema, Leptospira, Yersinia, Bordetella, Mycoplasma,* Actinomycetes, Rickettsiae and Chlamydiae Abrief study of bacteria *viz. Borrelia, Listeria, Campylobacter, Helicobacter* and *Legionella.*

Module III. Bacterial Infections of Human Body **15 hrs.**

Bacterial infections of respiratory tract, Bacterial infections of gastro intestinal tract and food poisoning, Bacterial urinary tract infections, Bacterial infections of genital tract and reproductive organs, Bacterial infections of central nervous system, Skin and soft tissue infections, Bone and joint infections, Eye ear and sinus infections, Cardiovascular infections, Tissue samples for culture, Anaerobic infections, Zoonotic infections.
Infections associated with immunodeficiency and immune suppression, Pyrexia of unknown origin.

Module IV. Virology **20 hrs.**

Study of properties of viruses *viz*., Alpha virus, Pox, Herpes Virus, Adeno, Orthomyxo virus, Paramyxo virus and Papova. Pathogenesis and laboratory diagnosis of diseases caused by these viruses.
Sudy of properties of. viruses *viz.* Polio, Influenza, Rabies, and Rubella viruses, Hepatitis viruses, HIV and AIDS.
Pathogenesis of these viral diseases
Oncogenic viruses, Slow viruses and Prion diseases
Immunology of viral infections

Module V. Control of Viruses and Emerging Viruses **5 hrs.**

Control of viral infections through vaccines, interferons and chemotherapeutic agents.
Structure, genomic organization, pathogenesis and control of Human immunodeficiency virus.
Emerging viruses

Module VI. Bacteriophages **10 hrs.**

Structure and life cycle patterns of T-even phages; one step growth
curve and burst size; Bacteriophage typing; Structure of Cyanophages, Mycophages.
General principles of phage-bacterium interaction and growth cycle studies of RNA and DNA phages. The biochemistry of phages infected bacterium. Phage genetics.

Module VII. Mycology **10 hrs.**

Introduction, Classification of fungi, General techniques used in mycology. Cultivation of fungi, Staining of fungi.
Mycosis in man- Classification, pathogenesis and clinical findings in various superficial, cutaneous and systemic fungal infections. Oppurtunistic mycoses;
Immuno compromised situation and mycological infections; emerging diseases.
Antifungal agents (specific to disease to included in course) and their susceptibility test.

REFERENCES

Ananthanarayan and Jayaram Panicker. 2002. *Text Book of Microbiology*. Orient Longman.

Belsche, R.B., 1991. *Text Book of Human Virology* (2nd edn.). Mosby, St.Louis.

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Grady F.O, H.P. Lambert, R.G. Finch, G. Greenwood.1997. *Antibiotic and Chemotherapy; Anti-infective Agents and their Use in Therapy* (7th edn).Churchil Livingstone, NY.

Kwon-Chung, K.J and J.E. Bennet.1992.*Medical Mycology*. Lea &Febiger,Philadelphia,

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Mims C.A. and D.O. White,1994.*Viral Pathogenesis and Immunology*. Oxford Blackwell.

Monica Cheesbrough 1991. *Medical Laboratory Manual for Tropical Countries*. Vol.2.ELBS

Panicker, CKJ.1998. *Text book of Medical Parasitology*, Jaypee, New Delhi.

Szaniszlo,P.J. (edn) 1985.*Fungal Dimorphism; with Emphasis on Fungi Pathogenic for Humans*. Plenum, NY.

Topley W.W.C. and G. Wilson. 2002. *Principles of Bacteriology, Virology and Immunity. Systematic Bacteriology*: (8th edn.). BWW Publishers.

White, D.C. and F.J. Fenner.2004. *Medical Virology.* (4rd edn.) Academic Press, New York.

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PZO4CRT03 CLINICAL MICROBIOLOGY

90 Hours (5hrs./week) **Credit-4**

Module I. Introduction **5hrs.**

History of development of Medical Microbiology, Contributions made by eminent scientists. Safety in Clinical Microbiology laboratory. Good laboratory practices. Microbiological safety cabinets-Types. WHO safe code of practice for a clinical microbiology laboratory.

Module II. Epidemiology **15hrs.**

Factors predisposing to microbial pathogenicity Infections. Sources of infections. Mode of transmission of infections, nosocomial infections, opportunistic infections, Normal microflora of human body. Identification of pathogens- cultural, biochemical, serological and molecular methods.

Module III. Laboratory Procedures for Microbiology **30hrs.**

Collection, transport, processing and microbiological examination of Blood, Sputum, stool, urine, Cerebrospinal fluid, genital specimens, throat and mouth specimens, nasopharyngeal swabs and aspirates, ear discharges, eye specimens, pus from wounds, abcesses, burns and sinuses, and effusions.

Module IV. Diagnosis of Viral Diseases **10hrs** .

Laboratory Diagnosis of Viral diseases
Specimens for viral diagnosis, Viral isolation and growth, Cell culture for viral detection
Detection of viral proteins, Detection of viral genetic material, Viral serology

Module V. Diagnosis of Fungal Diseases **10hrs.**

Laboratory diagnosis of fungal diseases.
Diagnostic procedures, Superficial, Cutaneous and Systemic mycosis.

Module VI. Laboratory Studies of Parasites **15hrs.**

Laboratory methods for diagnosis of parasitic infections.
Identification of animal parasites, Collection of specimens for the detection of parasites
Intestinal protozoans, Blood protozoans, intestinal helminthes, blood helminthes

Module VII. Handling of Laboratory Animals **5hrs.**

Care and management of laboratory animals. Legal requirements for animal experiments. General aspects of organization of animal experiments- Preparation of animals, common experimental procedures, Humane methods of killing animals. Handling of common laboratory animals: Rabbit, guinea-pig, mouse and rat.

REFERENCES

Baron E.J, L.R. Peterson and S.M. Finegold. 1994. *Bailey and Scott's Diagnostic Microbiology.* ASM, Washington, DC

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P.R.Murray, E.J.Baron, M, Patrick R. M, K.S. Rosenthal, G.S. Koayashi and M.A. Ptaller, 1997. *Medical Microbiology.*

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PZ04CRP01 PRACTICAL I - GENERAL MICROBIOLOGY, PARASITOLOGYAND MYCOLOGY

90 hours(5 hrs./week) **Credit -2**

Preparation of stains and various staining methods
Simple Staining, gram's staining,Acid fast staining,Albert's staining
Sterilization-variousTechniques:Autoclave,Hotairoven; Laminar flowchamber
Disposalof contaminated materials and Laboratory refuse.
Preparation ofAntibiotic disc
Antibioticsensitivitytest-KirbyBauertestandTubedilutionMethod
Estimation ofMIC
Test for Beta Lactamase.
Testing of disinfectants
Bacteriological test for water, air and food.
Examination of faces for:
Amoeba and cyst
Eggs,larva and adult helminthes
Examination of blood for plasmodiumand Filariasis.
Collection of Specimen for Fungi
Preparation of special medium.
Inoculation, Incubation and Identification of Fungi-*Candida albicans.*
Slide culture Techniques.

PZO4CRP02 PRACTICAL 2 - BACTERIOLOGY, VIROLOGYAND CLINICAL MICROBIOLOGY

90 hours(5 hrs./week) **Credit -2**

Study of Morphological, cultural and Biochemical reactions of following organisms.
Staphylococcus aureus, Streptococcus Species, E.coli, Klebsiella, Proteus, Salmonella Schigella, Pseudomonas.
Slide agglutination
Anaerobic culture methods; Mcintosh Method
Slide Identification
Neisseria gonoerrhoea, Mycobacterium, Tuberculosis, Mycobacterium leprae, Clostridium botulinum, C.tetani.
Viral Haemagglutination
Heamagglutination Inhibition test
Precipitation of serum and preservation for shortand long term.
Widaltest.
Immonodiffusion.
Various antigen-antibody reactions
Agglutination,Precipitation,Complement fixation,PassiveHaemagglutination-latexagglutinationtest (RA,ASO,CRPAND TRUSTANTIGEN)
ELISA

Field Study Report: (Three to four days)
1. Visit to Institutions engaged in microbiology/virology research (*e.g.,* Vector Control Research Institute, Cherthala/ Virology Institute,Alapuzha/ Sree Chithra Institute, Thiruvananthapuram) ; 2. hospital with Pathology laboratory (e,g., Government Medical College Hospital), 3. Visit a polluted area and document microbial diveristy. Report the study conducted and submit a 10 page write up/ print out giving the dates, daywise itinerary, methodology, results and references. Include photgraphs of the activity.

Group and individual assignments shallbe preferred.

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