

**B.Sc. DEGREE COURSE IN ADVANCED ZOOLOGY & BIOTECHNOLOGY  
SYLLABUS WITH EFFECT FROM 2020-2021**

**CORE-I: INVERTEBRATA**

**Instr. Hrs.: 6**

**Year I**

**Credits : 4**

**Semester: I**

**Learning Outcomes**

Students will be able to

- (i) Gain knowledge of Kingdom Animalia, classification and hierarchy of grouping.
- (ii) Interpret the changes in the animal organisation from unicellular to multicellular complex bodyplan.
- (iii) Understand the structural diversity among the various non-chordate phyla on the basis of the morphological features.
- (iv) Develop phylogenetic relation between different group of organisms.
- (v) Recognise the importance of animals with respect to their socio-economic status (beneficial, pests or pathogens).

**Unit I**

**15 Hours**

Introduction to animal kingdom- Classification of invertebrate phyla upto class level- taxonomic characteristics and nomenclature- grades of organisation based on cellularity (Diploblastic and triploblastic)- symmetry and coelom- protostomes & deuterostomes  
Phylum Protozoa- General characteristics and classification with examples- Type study- *Paramecium*- Protozoan and human diseases (common diseases caused by protozoans in man)- life cycle of *Plasmodium vivax*

**Unit II**

**18 Hours**

Phylum Porifera - Parazoans- General characteristics and classification with examples- Type study- *Scypha* (Sycon) Canal system in sponges  
Phylum Coelenterata- General characteristics and classification with examples- Type study- *Obelia geniculata* - Polymorphism – Coral and coral reefs

**Unit III****18 Hours**

Phylum Platyhelminthes-General characteristics and classification with examples- Type study- *Fasciola hepatica* ( Liver fluke )- Phylum Nematelminthes- General characteristics and Classification with examples- Helminth parasitic in man - *Wucheria bancrofti*-Parasitic adaptations in helminthes

Phylum Annelida-General characteristics and classification with examples- Type study- *Neanthes*

(*Neries*)- Types of nephridia in annelids - *Trochophore* larva and its significance

**Unit IV****21Hours**

Phylum Arthropoda-General characteristics and classification with examples-Type study- *Penaeus* (Prawn)- Crustacean larvae and their significance- *Peripatus* and its affinities- Economic importance of insects .

Phylum Mollusca- General characteristics and classification with examples- Type study- *Pila* (snail)- Foot in Mollusca -Torsion in Molluscs .

**Unit V****18 Hours**

Phylum Echinodermata-General characteristics and classification with examples- Type study- *Asterias* (starfish) -Water vascular system Echinoderm larva and its significance

Enteropneusta - General characters of *Balanoglossus* (acorn worms)

General Topics -Affinities and systematic position of *Pterobranchia*

**Suggested Readings**

- Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition
- Barnes, R. S. K.; Calow, P.; Olive, P. J. W.; Golding, D. W.; Spicer, J. I. (2002) The Invertebrates: a Synthesis, Blackwell Publishing.
- Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. and Nelson.
- Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students.Asia Publishing Home.
- Bushbaum, R. (1964) Animals without Backbones. University of Chicago Press.
- Kotpal, R.L., Invertebrates (Animal Diversity-I). 11<sup>th</sup> Edition (Second

Reprint); 2016-2017, Rastogi Publication.

- Majpuria, T.C. Invertebrate Zoology. Pradeep publication, Jalandar
- Ayyar E.K and T. N . Ananthakrishnan 1992. Manual of zoology Vol. I  
Invertebrate, Part I & II, S. Viswanathan Printers and publishers Pvt Ltd.,  
Madras

## CORE-II: CHORDATA

**Instr.Hrs.: 6**

**Year : I**

**Credits : 4**

**Semester: II**

### Learning Outcomes

Students will be able to

- (i) Understand the distinctive features of chordates and its classification,
- (ii) Understand the evolutionary status and affinities of prochordates
- (iii) Gain knowledge on the characteristics of jawless vertebrates and advancement of the type of animals in each vertebrate class
- (iv) Depict the adaptations of animal types to reveal their relation with their mode of life and environment

### Unit I

**15 Hours**

Prochordates- General characters and classification-Type study- *Amphioxus*

Affinities and systematic position of Urochordata and Cephalochordata

### Unit II

**18 Hours**

Agnatha- General characters, classification & affinities- Type study- *Petromyzon*

Gnathostomata- Pisces- General characters and classification-Type study- *Scoliodon sorrakowah*-

Accessory respiratory organs in fishes- Migration in fishes

### Unit III

**21 Hours**

Amphibia-General characters and classification-Type study- *Rana hexadactyla*-Parental

care in Amphibians-Adaptive features of Apoda (Gymnophiona), Urodela and Anura

Reptilia-General characters and classification-Type study- *Calotes versicolor*-

Identification of poisonous and non-poisonous snakes – Poison apparatus and biting

mechanism

**Unit IV**

**18 Hours**

Aves- General characters and classification-Type study-*Columba livia*-

Birds are glorified reptiles - Connecting link to *Archaeopteryx*-Flight adaptations and migration in birds

**Unit V**

**18**

**Hours**

Mammalia-General characters and classification-Type study-*Oryctolagus cuniculus*

(Rabbit) Egg laying mammals –Dentition in mammals- Adaptations of aquatic mammals

**Suggested Readings**

- Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.
- Kardong, K.V. (2006) Vertebrates: Comparative Anatomy, Function, Evolution (4th edition), McGraw- Hill.
- Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
- Jordan E. L. and P. S. Verma. (2002). Chordate Zoology. S. Chand and Co. New Delhi.
- Ekambaranath Iyer. (2000). A Manual of Zoology. Vol. II S. Viswanathan and Co.
- Dhama, P.S., Dhama, J.K., Chordate Zoology, Dinesh Publishers, Jalandhar, 1982.

**CORE-III: PRACTICAL- I (INVERTEBRATA AND CHORDATA)**

**Instr.Hrs.: 2 + 2**

**Year : I**

**Credits : 4**

**Semester: I / II**

**Learning Outcomes**

Students will be able to

- (i) Understand the anatomy and organ system of animals through dissections and mounting of easily available invertebrate and vertebrate animal.

- (ii) View the various specimens and study the characters of the organisms belonging to different taxa.

## **I. DISSECTION**

### **A. COCKROACH/ PRAWN**

1. External characters
2. Digestive system
3. Nervous system

### **B. Any bony fish:**

4. External characters
5. Digestive system
6. Urinogenital system

## **II. MOUNTING**

Mouth parts of

1. Cockroach
2. Mosquito
3. Bedbug
4. Housefly
5. Shark: placoid-Carp-cycloid
6. Types of fins-Homocercal, Heterocercal, Diphyrcal

## **III. SPOTTERS**

### **A. Classify giving reasons up to order:**

1. *Paramecium*

2. *Scypha*
3. *Obelia*
4. *Taneaia solium*
5. *Ascaris*
6. *Neanthes*
7. *Penaeus*
8. *Asterias*
9. *Balanoglossus*
10. *Amphioxus*
11. *Scoliodon sorrakowah*
12. *Rana hexadactyla*
13. *Calotes versicolor*
14. *Columba livia*
15. *Oryctolagus cuniculus*

**B- Draw labeled sketches:**

16. *Obelia* medusa
17. *Nereis* T.S
18. Bipinnaria larva
19. *Amphioxus* T.S
20. Quill feather

**C. Comment on biological significance:**

21. *Entamoeba*
22. *Paramecium*-conjugation
23. *Plasmodium*
24. *Ascaris*
25. Heteronereis
26. *Peripatus*
27. Nauplius larva
28. *Sacculina* on crab
29. Sea anemone on hermit crab
30. *Vipera russelli*

31. Bat

**D- Relate structure and function:**

32. Sponge-spicules

33. Sponge-  
gemmule

34. *Taenia*-  
scolex

35. *Neanthes*-  
parapodium

36. *Panaeus*-petasma

37. Starfish-tubefoot

38. Snake-poison apparatus

39. Quill feather

**E. Osteology/palate in  
Birds/Dentition Osteology**

**FROG**

40. Skull and lower jaw

41. Vertebral column

42. Pectoral girdle

43. Pelvic girdle

44. Forelimb

45. Hindlimb

**Palate in Birds**

46. Pigeon-palate

47. Crow-palate

48. Duck-palate

**Dentition**

49. Rabbit-dentition

50. Dog-dentition

## CORE-IV: CELL AND MOLECULAR BIOLOGY

**Instr.Hrs.: 6**

**Year : II**

**Credits : 4**

**Semester: III**

### **Learning Outcomes**

Students will be able to

- (i) Know the history of cell biology and current methods used in the study of cell and molecular biology
- (ii) Get an overview of the structure of cell, its structural components and their functions
- (iii) Understand the chromatin structure, ultrastructure and macromolecular organisation of DNA & RNA
- (iv) Understand the molecular machinery involved in protein synthesis
- (v) Attain the concepts of apoptosis, cancer and stem cell

### **Unit I**

**18 Hours**

History of cell biology- Cell theory- Prokaryotic and eukaryotic cells- Cell fractionation- Homogenisation and centrifugation- Microtechniques –Fixation and Staining -Principle and working mechanism of Light, Phase contrast and Electron Microscope (SEM & TEM)-Ultrastructure of animal cell

### **Unit II**

**18 Hours**

Plasma membrane organisation-structure, composition, models and functions-Junctional complexes, membrane receptor modifications-microvilli, desmosomes and plasmodesmata-Cytoplasm-composition and functions

### **Unit III**

**18 Hours**

Cell organelles- Endoplasmic reticulum- types, structure and functions-Peroxisomes, Glyoxysomes and centrioles-Golgi complex- structure and functions- Ribosomes– structure and functions – Lysosomes - Centioles – Mitochondria - structure and functions

### **Unit IV**

**18 Hours**

Nucleus and Nucleolus - Structure and functions - Chromosomes –Structure - Heterochromatin and Euchromatin-Giant chromosomes (polytene and lampbrush) Cell cycle and stages- Cell divisions and their significance- Amitosis, Mitosis and Meiosis-



Ageing of Cells- Programmed cell death (Apoptosis)- Cancer cells- Characteristics- Stem cells

### **Unit V**

**18 Hours**

Central dogma of molecular biology-Molecular structure of DNA and RNA-Ribosomal RNA (rRNA),Transfer RNA (tRNA),Messenger RNA (mRNA)- Basic mechanism of Transcription and translation in prokaryotes

### **Suggested Readings**

- Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments (6 th edition) John Wiley & Sons. Inc.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006) Cell and Molecular Biology (8<sup>th</sup> edition) Lippincott Williams and Wilkins, Philadelphia.
- Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. (5<sup>th</sup> edition) ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
- Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Scott, M. P., Bretscher, A., Ploegh, H. and Matusdaira, P., (2007) Molecular Cell Biology. 6<sup>th</sup> edition, W.H.Freeman and Company, New York.

## **CORE-V: GENETICS AND EVOLUTION**

**Instr.Hrs.:** 6

**Year :** II

**Credits :** 4

**Semester:** IV

### **Learning Outcomes**

Students will be able to

- (i) Understand the principles of heredity, modification and extensions of Mendel's basic principles and role of genetics in biology
- (ii) Gain Knowledge in linkage & recombination (crossing over) and chromosomal mutations
- (iii) Understand 'DNA' as the basic genetic material and regulation of gene expression
- (iv) Interpret that process of evolution depends on genetic variation and know the major

events in

the evolution

(v) Perceive the microevolutionary concepts and principle of macroevolution

### **Unit I**

**18 Hours**

Mendel and his experiments (Monohybrid and dihybrid cross)-Laws of inheritance- Mendelian traits in Man- Complete, incomplete and codominance- Gene interaction- epistasis- Lethal and multiple alleles- Polygenes and polygenic inheritance-Sex determination- genic balance theory, chromosomal mechanism of sex determination- Sex-linked characters- sex limited genes- Cytoplasmic inheritance- CO<sub>2</sub> sensitivity in drosophila, Kappa particles in paramecium- Genetic maternal effect in shell coiling of *Limnaea*

### **Unit II**

**19 Hours**

Linkage- Morgan's experiment, complete & incomplete linkage- Crossing over- types, mechanisms- chromosome mapping- interference and coincidence- Non-disjunction & translocation of chromosomes- Chromosomal Aberrations- Structural & Numerical- Mutations- Types, mutagens, and molecular basis of mutation

### **Unit III**

**19 Hours**

DNA as the genetic material- experimental proof- DNA replication and repair mechanism- Fine structure of gene- Regulation of gene expression- operon concept (*Lac* operon)- Inborn errors of metabolism- Genetic counseling- Eugenics & Euthenics

### **Unit IV**

**17 Hours**

Theories of Evolution- Lamarckism, Neo Lamarckism, Darwinism, Neo-Darwinism, Modern synthetic- Morphological, physiological, biochemical, embryological and paleontological evidences- Geological time scale-Fossil & Fossilisation- Types, Living and Extinct fossils.

### **Unit V**

**17 Hours**

Speciation and isolating mechanism -Genetic drift-Adaptive radiation-Hardy Weinberg equilibrium- Convergent, Divergent and Parallel evolution- Coevolution- Evolution of Horse and Humans (Biological & Cultural)

### **Suggested Readings**

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Edition. Wiley India
- Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings
- Benjamin A. Pierce (2012). Genetics A conceptual Approach. IV edition. W.H. Freeman and Company
- John C. Herron and Scott Freeman (2015). Evolutionary analysis. V Edition. Pearson Education
- Dadson E.O. (1960). Evolution: Process and Product. Reinhold Pub.
- Dobzhansky T. (1964). Genetics and the origin of species Oxford and IBH Pub. New Delhi

**CORE-VI: PRACTICAL-II (CELL BIOLOGY, GENETICS AND EVOLUTION)**

**Instr.Hrs.: 2 + 2**

**Year : II**

**Credits : 4**

**Semester: III / IV**

**Learning**

**Outcomes Students**

**will be able to**

- (i) Focus the microscope and usage of ocular & stage micrometer, camera lucida
- (ii) Prepare and observe the chromosome arrangement during cell division
- (iii) gain knowledge in the various types of cells and tissues by viewing through prepared slides
- (iv) Know the various syndromes through karyotype
- (vi) do and view the polytene chromosome in chironomous larva
- (vii) Understand the significance of living fossils and know the contributions of famous evolutionists

## CELL BIOLOGY

1. Micrometry-use of microscopes-microscopes-light microscope,camera lucida, stage and ocular micrometer.
2. Blood smear preparation-differential count of WBC
3. Counting of RBC and WBC using haemocytometer (Demonstration) .
4. Mounting of buccal epithelium and observing living cells using vital staining
5. Mitosis in onion root tip squash
6. Meiosis in grasshopper testis squash (Demonstration)
7. Study of prepared slides of histology.
 

a. Columnar epithelium	b. Ciliated epithelium	c. Glandular epithelium
d. Connective tissue	e. Cartilage T.S	f. Bone T.S
g. Cardiac tissue	h. Striated muscle	i. Non-striated muscle
j. Nervous tissue	k.ovary T.S	l. T.S of testis

## GENETICS

1. Observation of common mutants of drosophila
2. Identification of human blood groups
3. Study on normal karyotype –male and female, Down syndrome, Turner and Klinefelter syndrome.
4. Chironomous-salivary gland chromosomes-squash preparation.

## EVOLUTION

1. Living Fossils- Features
2. Feet and Beak of Birds
3. Identify and mention the contributions- Charles Darwin , Lamarck, Sewall Wright

## CORE-VII: ANIMAL PHYSIOLOGY AND BIOCHEMISTRY

**Instr.Hrs.:** 4

**Year** III

**Credits** : 4

**Semester:** V

**Students will be able to**

- Understand the basic principles of animal Physiology.
- Interpret and compare the physiology of various organs and organ systems.
- Gain knowledge in the basic structure of carbohydrates, fats and proteins
- Understand the role of biomolecules in metabolism and learn the metabolic pathway

**UNIT I**

**12 Hours**

Nutrition – Nutrients – Carbohydrates, proteins, fats, minerals, and vitamins. Digestive enzymes and their role in digestion – absorption and assimilation.

Respiration - Respiratory organs - Respiratory Pigments and functions - Transport of gases-Respiratory quotient-BMR.

Circulation - Types- Properties and Function of Blood – Coagulation of blood-Types of heart – Cardiac Cycle - Regulation of heart Beat - ECG-Myocardial infarction , stroke – Blood Pressure.

**UNIT II**

**12 Hours**

Excretion- Excretory organs – kinds of excretory products – Mechanism of urine formation in mammals- hormonal regulation of excretion- Kidney failure and dialysis.

Osmo-ionic regulation- Osmo-ionic regulation in aquatic and terrestrial animals.Bioluminescence

Thermoregulation-Temperature regulation in poikilotherms and homeotherms – physiology of hibernation - aestivation.

**UNIT III**

**10 Hours**

Neuromuscular Co-ordination – Neuron – Structure, types of neurons-Nerve impulse – Synaptic transmission – Neurotransmitters.

Muscles –Structure and Types of muscles –Physiological properties of muscle contraction- Biochemical events of muscle contraction.

**UNIT IV****12 Hours**

Endocrine glands- structure, secretions and functions of endocrine glands of vertebrates – Pituitary, Thyroid, Parathyroid, Adrenal, Thymus, Islets of Langerhans, Ovary and testis. Receptors – Chemoreceptors - Photoreceptor – mammalian eye – visual pigments – physiology of vision phonoreceptors – mammalian Ear- Organ of Corti – working mechanism- - equilibrium receptors.

**UNIT - V****14 Hours**

Biochemistry-Definition and scope -biological importance, classification and structure of Carbohydrate, Proteins and Lipids. Metabolism-metabolic pathways with reference to carbohydrates

,proteins & lipids .

Glycogenesis – Glycogenolysis – Gluconeogenesis – Glycolysis–Kreb’s Cycle Oxidative phosphorylation – Cori cycle. Electron transport system-Deamination–Transamination–Beta oxidation of fatty acids.

Enzymes – properties and classification – mechanism of enzyme action – Enzyme kinetics.

**Suggested Readings**

- Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Harcourt Asia PTE Ltd. /W.B. Saunders Company.
- William S. Hoar, 1976. General and comparative physiology, prentice Hall of India PvtLtd.
- Sambasivaiah, Kamalakara rao and Augustine chellappa 1990. A Text book of Animal physiology and ecology, S. Chand & co., Ltd.
- Verma, P.S., Tyagi, B.S. and Agarwal, V.K., (2002). Animal Physiology. S. Chand and Co. Ltd.
- Nelson, D.L. & Cox, M.M. (2017) Lehninger principles of Biochemistry (7<sup>th</sup> edition), W.H. Freeman and Co., New York.
- Berg, J.M.; Tymoczko, J.L. and Stryer, L. (2012) biochemistry (7<sup>th</sup> edition) Freeman.
- Zubay, G. (2017) Biochemistry (4<sup>th</sup> edition) McGraw-Hill.
- Jain, J.L. (2001) Fundamentals of Biochemistry, Chandra & CO. Pvt.Ltd. New Delhi.

- Ambika, S. (1990) Fundamentals of biochemistry for Medical students.

### **CORE-VIII: DEVELOPMENTAL BIOLOGY**

**Instr.Hrs.: 4**

**Year III**

**Credits : 4**

**Semester: V**

#### **Learning Outcomes**

Students will be able to

- (i) Explain and contrast the processes of spermatogenesis, oogenesis and fertilization.
- (ii) Understand various cleavage patterns in animals.
- (iii) Knowledge of the sequential changes from cellular grade of organization to organ grade of organization.
- (iv) Demonstrate experiments on reproductive biology.
- (v) Gain information about human reproduction, sexually transmitted diseases control measures.
- (vi) Critically assess relevant scientific literature in Human Reproductive Biology and present their argument in oral and written work.

#### **UNIT I**

**12 Hours**

Origin of germ cells -Gametogenesis -Spermatogenesis –Oogenesis- Structure of Sperm and Egg Fertilization: Pre and Post fertilization events - Mechanism and Physiology of Fertilization and significance.

#### **UNIT II**

**12 Hours**

Cleavage – Types of cleavage patterns - Fate map- Gastrulation- Morphogenetic movements. Cleavage and gastrulation in Amphioxus, Frog and Chick.

#### **UNIT III**

**12 Hours**

Organogenesis -Derivatives of primary germ layers. Development of Brain, Eye and heart in Frog. Induction- Organizer concept. Extra embryonic membranes. Placenta in Mammals.

**UNIT IV****12 Hours**

Parthenogenesis- Artificial Parthenogenesis-Nuclear Transplantation in Acetabularia - Regeneration studies in Amphibians. Hormonal control of Amphibian metamorphosis.

**UNIT V****12 Hours**

Human reproduction: Puberty, Menstrual cycles, – Menopause – Pregnancy and related problems – Parturition – Lactation. Sexual dysfunctions, sexually transmitted diseases; Cancers of the reproductive system; Adenomyosis: gland-like growth into myometrium; Birth Control; endometriosis, fibroids, Endometritis: chronic infection of uterus, congenital uterine anomalies; Ovarian cysts, pelvic varicosities.

**SUGGESTED READINGS**

- Balinsky, B. I., 1981, Introduction to Embryology, Saunders, Philadelphia.
- Berrill, N. J., 1979, Developmental Biology, Tata McGraw Hill Publ. Comp. Ltd., New Delhi.
- Berry, A. K., 1986, An Introduction to Embryology, Emkay Pub., Delhi.
- Gary C.S.; Steven B.B.; Philip R.B. and Philippa H.F. (2014) Larsen's Human Embryology (5th edition) Elsevier.
- Gilbert, S.F. (2016) Developmental Biology (11th edition) Sinauer McEwen, R. S., 1957, Vertebrate Body, Henry Holt & Comp., New York.
- Patten, B. M. & Carlson, B. M., 1980, Foundations of Embryology, Tata McGraw Hill Publ. Comp. Ltd., New Delhi.
- Subramaniam, T., 2002, Developmental Biology, Narosa Publ. House, Chennai.
- Thomas W.S. (2014) Langman's Medical Embryology (13th edition) Lippincott, Williams & Wilkins, Baltimore.
- Verma, P. S., V. K. Agarwal & B. S. Tyagi, 1995, Chordate Embryology, S.Chand & Co., New Delhi



## CORE-IX: GENETIC ENGINEERING AND BIOTECHNOLOGY

**Instr.Hrs.: 4**

**Year III**

**Credits : 4**

**Semester: V**

### Learning Outcomes

Students will be able to

- (i) Learn the techniques used in Genetic Engineering.
- (ii) Understand the basic concepts in Biotechnology.
- (iii) Acquire knowledge regarding the applications of Biotechnology in various fields.

### Unit I

**12 Hours**

Biotechnology-Definition and scope - Achievements of Biotechnology - Biotechnology in India- rDNA technology- Enzymes in rDNA technology –Cloning vectors- properties of vectors-Types- plasmid (pBR 322,pBR 327, pUC8), phage, cosmid, phagemids, yeast - Gene transfer-direct and indirect methods.

### Unit II

**12 Hours**

Tools and techniques for selecting viable recombinant – Identification of clone from gene libraries – nucleic acid hybridization – PCR – types – applications - blotting types – applications – DNA finger printing – RAPD – SNPS – FISH – DNA sequencing – Sanger method – Maxam Gilbert method – Human genome project.

### Unit III

**12 Hours**

Application of Genetic Engineering – In medicine – Insulin and Hepatitis vaccine production – gene therapy – food and alcoholic beverages – production of single cell protein – Algae –spirulia –fungi – saccharomyces – Biofertilizer – Rhizobium – phosphate biofertilizer – Bio pesticides (*Bacillus thuringiensis*).

### Unit IV

**12 Hours**

Biotechnology and Environmental management – Bioremediation – types of bioremediation – sewage and waste treatment – pollution monitoring – Biomass from waste.

**Unit V****12 Hours**

Intellectual property rights and protection – GMOs – IPR – PGR – GATT and trade related intellectual property rights (TRIPS) – biosafety- patenting of biological material – copy right – bioethics.

**SUGGESTED READINGS**

- R.M. Old, S.B. Primrose (2001). Principles of gene manipulation (Wiley- Blackwell).
- White Bruce A. (1997). PCR cloning protocols: from molecular cloning to genetic engineering (Humana Press).
- Sandy B. Primrose, Richard Twyman (2006). Principles of gene manipulation and genomics (Wiley Blackwell).
- Dubey, R.C. 1995, A Text Book of Biotechnology, S.Chand & Co. Ltd., Ram Nagar, New Delhi - 110 055.
- Sathyanarayane, U. (2006) Biotechnology Books and Allied (p) Ltd, India.

**CORE-X: BIOSTATISTICS AND COMPUTER APPLICATIONS****Instr.Hrs.: 4****Year III****Credits : 4****Semester: V****Learning Outcomes**

Student will be able to

- (i) Understand key concepts and statistical methods used in biology
- (ii) Compute and interpret basic statistical parameters
- (iii) Gain knowledge in population statistics
- (iv) Get an insight into the basic computer applications and operation of various application softwares
- (v) Access the internet for scholarly resources for the advancement of knowledge

**Unit I** **12 Hours**

Biostatistics- Definition and scope- Collection of data- Census and sampling methods- Variable and attribute-classification and tabulation of data-Diagrams and graphs- Bar, Pie, Histogram and Line graph- Concept of statistical population and sample characteristics of frequency distribution.

**Unit II** **13 Hours**

Measures of central tendency: Arithmetic Mean, Median, Mode; Measures of dispersion: Range, Quartile deviation, Mean deviation and Standard deviation (Computation for Arithmetic Mean, mean deviation and standard deviation for discrete and continuous data)

**Unit III** **13 Hours**

Correlation-Types of correlation, Calculation of Karl Pearson's correlation coefficient- Regression- Regression Equations- Hypothesis Testing- Null hypothesis- Level of significance- Chi-Square test and student's *t* -test.

**Unit IV** **12 Hours**

Vital statistics-population growth and estimation –population forecast- Crude and Specific vital statistics rate- Natality rate- fertility rate- mortality rate (computation not required)

**Unit V** **10 Hours**

Definition of computer – Basic components of computer- Input and output devices- Windows operating system and application software -MS word- MS Excel- MS Power point -Computer network- Introduction- types (LAN, MAN, WAN)- Social networks- Uses of Internet

**Suggested Readings**

- Daniel, W.W. (2012) Biostatistics: A Foundation for Analysis in Health Sciences (10<sup>th</sup> edition) John Wiley.
- Zar, J.H. (2013) Biostatistical Analysis (5<sup>th</sup> edition) Pearson.
- Milton, J.S. and Tsokos, J.O. (1992) Statistical Methods in the Biological and Health Sciences (2<sup>nd</sup> edition) McGraw Hill.
- Gurumani, N. 2005. Biostatistics, 2<sup>nd</sup> edition, MJP Publishers India.
- User manual and online user manual of respective softwares for the most updated content

**CORE-XI: ENVIRONMENTAL BIOLOGY****Instr.Hrs.: 4****Year III****Credits : 4****Semester: VI****Learning Outcomes**

Students will be able to

- (i) Understand the interactions between species and their environment
- (ii) Know the evolutionary and functional basis of animal ecology
- (iii) Engage them in field based research activities, with the theoretical aspects

**Unit-I****12 Hours**

Scope- Concept- Branches in Ecology- Autoecology and Synecology- Micro and Macro environment- Types of media and substratum. Biosphere- Hydrosphere, Lithosphere, Stratosphere Abiotic factors-Water, Soil, Light and Temperature  
Biotic factors- Animal relationships- Symbiosis, Commensalism, Mutualism, Antagonism, Predation, Parasitism and Competition.

**Unit-II****12 Hours**

Biogeochemical cycles- Nitrogen, Carbon, Phosphorous and Oxygen cycles- Introduction to the laws of limiting factors-Leibig's law of minimum- Shelford's law of tolerance.  
Ecosystem- Pond ecosystem- Energy flow in ecosystem, Pyramid of number, biomass and energy. Food chain- grazing and detritus, Food web and trophic levels.  
Terrestrial Ecology- Biomes- Characters- tundra, grassland, forest and desert biomes.

**Unit-III****12 Hours**

Fresh Water Habitat- Physico chemical nature of fresh water- Biotic communities- lentic(lakes and ponds) and lotic (river) environment- Stratification of ponds and lakes.  
Marine Habitat - Characteristics- salinity, temperature, pressure, zonation and stratification- Biotic communities of pelagic, benthic, intertidal (rocky shore, sandy shore and muddy shore) and littoral zones- Coral reefs.  
Estuarine Habitat – Characteristics- Biotic communities and their adaptations.

**Unit- IV****14 Hours**

Population Ecology- Definition and characteristics: Density, Natality, Mortality, Migration, Emigration and Immigration, Population fluctuation- Age pyramid, growth and growth curve.

Community Ecology- Types of communities, characteristics of community, stratification, Ecotone and Edge effect, Ecological niche, Ecological Succession.

Environmental Pollution- Air pollution- sources of pollution, Acid rains, ozone, prevention and control of air pollution. Water pollution- sources of pollution and pollutants, prevention and control of water pollution. Land pollution- Solid waste pollution, radioactive pollution, noise pollution, pollution control through law. Green chemistry- Designing of green synthesis- Basic principles of Green Chemistry.

**Unit- V****10 Hours**

Natural resources- Renewable and non-renewable, Concepts of threatened species- red data book- IUCN, WWF protected areas, biosphere reserves, wild life sanctuaries and National Parks- forests in India- desertification- deforestation- carbon dating- Importance of mangroves in coastal ecosystem- Conservation and management.

**Suggested Readings**

- Colinviaux, P. A. (1993) Ecology (2<sup>nd</sup> edition) Wiley, John and Sons, Inc.
- Krebs, C. J. (2001) Ecology (6<sup>th</sup> edition) Benjamin Cummings.
- Odum, E.P., (2008) Fundamentals of Ecology. Indian Edition. Brooks/Cole.
- Stiling, P. D. (2012) Ecology Companion Site: Global Insights and Investigations. McGraw Hill Education.

## CORE-XII: MICROBIOLOGY AND IMMUNOLOGY

**Instr.Hrs.: 4**

**Year III**

**Credits : 4**

**Semester: VI**

### **Learning outcomes**

Students will be able to

- (i) Classify the microorganisms and identify the structure with emphasis on the culture methods.
- (ii) Understand the impact of microbes in soil, food and medicinal industries.
- (iii) Aware of disease causing microbes.
- (iv) Know the structure and functions of immune organs and cells.
- (v) Understand the mechanism of immune reactions.

### **Unit- I**

**12 Hours**

History and Scope of Microbiology – Whittaker’s classification of microorganisms – Ultra structure – salient features and classification of microbes (Bacteria, Virus, Actinomycetes and Fungi). Bacterial growth and nutritional requirements – culture techniques and types of culture media – media preparation – sterilization techniques – preservation – staining (Gram's staining).

### **Unit- II**

**12 Hours**

Medical microbiology- study of common bacterial and viral diseases in man: Causative organisms, mode of transmission, pathogenicity, symptoms and preventive measures- Bacterial diseases - Typhoid, Tuberculosis, Leprosy, Syphilis. Viral diseases- Influenza, Poxviruses (Chicken pox) Hepatitis- B, AIDS.

### **Unit- III**

**12 Hours**

Food microbiology - Microbial food spoilage, food poisoning, physico-chemical methods in food preservation. Dairy microbiology- Pasteurization, fermented milk products (Curd and Cheese). Industrial microbiology- Basic design of fermentor, industrial fermentation of ethanol, penicillin and enzymes. Environmental Microbiology - Role of microorganisms in the productivity of ecosystem- Biology of Nitrogen fixation and

nitrogen fixers.

#### **Unit- IV**

**12 Hours**

Scope of Immunology - Types of Immunity- innate and acquired- Organs involved in immunity – structure and functions- Cells involved in immune response - origin and differentiation- significance- Immune response- Humoral and Cell mediated immune response- Mechanism- Primary and secondary immune response.

#### **Unit- V**

**12 Hours**

Immunoglobulins - Structure, types, distribution and biological functions- Complements - Classical and Alternative pathways- Hypersensitivity -Types with examples- Autoimmune Diseases - Concept and types- Organ transplantation- types of graft, mechanism of allograft rejection- MHC- Classes- Vaccines- types, vaccination schedule- Immunological Techniques in Clinical Diagnosis- Antigen - antibody reactions – agglutination- precipitation and immunodiffusion.

#### **Suggested Readings**

- Pelczar, M.J., Reid, R.D. and Chan, E.C.S. (1996), Microbiology, V Ed., Tata McGraw Hill Publishing Company Ltd., New Delhi.
- Ananthanayaranan and Jayaram Paniker, C.K. (2000), Text Book of Microbiology, VI Ed., Orient Longman Ltd., Madras.
- Dubey, A Text Book of Microbiology, S. Chand & Co.
- David Freifelder (1998), Microbial Genetics, Narosa Publishing House, New Delhi.
- Powar, C.B. and Dignawala, H.F. (1982), General Microbiology Volume I & II, Himalaya Publishing House, Bombay.
- Kuby, J. (2007) Immunology (Sixth edition)
- Roitt, I. (1987) Essential Immunology. P.G. Publishing PVT. Ltd., New Delhi.

**CORE-XIII: ANIMAL BIOTECHNOLOGY AND  
BIOINFORMATICS**

**Instr.Hrs.: 4**

**Year III**

**Credits : 4**

**Semester: VI**

**Learning Outcomes**

Students will be able to

- (i) Learn the maintenance of laboratory equipments/ tools, safety hazards and precautions.
- (ii) Understand the technique of cell culture.
- (iii) Describe the utilization of biotechnology in animal breeding
- (iii) Acquire information about stem cell and its applications
- (iv) know the scope and applications of bioinformatics
- (v) understand the characteristics and categories of database
- (vi) work with some important data analysis tools

**UNIT I**

**12 Hours**

History and Scope of Animal tissue culture- Design & layout of ATC laboratory- Requirements for Animal cell culture- Types of media, ingredients of media-Foetal Bovine Serum- Metabolic profiling of Animal cell culture.

**Unit II**

**12 Hours**

Basic Techniques of mammalian cell culture- Disaggregation of animal tissue-Primary culture & secondary culture- Evolution of cell line & continuous cell line, characterization of cell lines- Monolayer, suspension culture-Organ culture, Embryo culture- Maintenance of cell culture- Common cell culture contaminants.

**UNIT III**

**12 Hours**

Embryo Technology and Animal Breeding- *In vitro* fertilization, Embryo transfer, ICSI, Embryo splitting, Fertility control & regulation, test tube babies-Cell cloning methods- Production of transgenic animals & molecular pharming, animal cloning techniques-Cell culture based vaccines- Ethical values in animal biotechnology.



**UNIT IV****12 Hours**

Stem cells – potency definitions; embryonic and adult stem cells; applications of stem cells – cell based therapies and regenerative medicine.

**Unit V****12 Hours**

Overview of Bioinformatics- Definition, Scope, Development and Major tasks- Databases- Characteristics- Categories of databases-Nucleotide sequence database- EMBL, GenBank and DDBJ- Protein sequence database- SWISS-PROT, UniProt- Structure database- PDB, SCOP- Introduction to sequence analysis tool- Sequence alignment-BLAST- Applications of bioinformatics.

**Suggested Readings**

- Glick, B.R. and Pasternak, J.J. (2009). Molecular Biotechnology - Principles and applications of Recombinant DNA. IV Edition, ASM press, Washington, USA.
- Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA- Genes and Genomes- A Short Course. III Edition, Freeman and Co.,N.Y.,USA.
- R.C. Dubey., A Text Book of Biotechnology. S. Chand & Co Ltd, New Delhi.
- Sudha Gangal, Animal Tissue culture. Second edition. University Press (India) Pvt Ltd. Hyderabad.
- M. Ranga, 2006. Animal Biotechnology, Studam publishers
- R.Sasidhara, 2006. Animal Biotechnology, MJP Publishers.
- U.Satyanarayana, 2008. Biotechnology, Books and Allied (p)Ltd.
- R. Lanza, J. Gearhart et al (Eds), Essential of Stem Cell Biology. (2009), Elsevier Academic press.
- R. Lanza and I. Klimanskaya, Essential Stem Cells Methods. (2009), Academic Press.
- Mount, D.W. (2006) Bioinformatics (2<sup>nd</sup> edition) CBS.
- Attwood, T.K., Parry, D.J. (2006) Introduction to Bioinformatics. Smith Pearson Education Ltd. London

**ELECTIVE: APPLIED ZOOLOGY****Instr.Hrs.: 5****Year : III****Credits : 5****Semester: V / VI****Learning outcomes**

Students will be able to

- (i) Design and maintain ornamental fishes.
- (ii) Understand silkworms rearing and their products.
- (iii) Understand the Bee keeping equipments and apiary management.
- (iv) Understand dairy animals management, the breeds and diseases of cows, goats, pigs and learn
- (v) know about dairy animals, products and their values

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**Unit I****12 Hours**

Ornamental fish farming: Design and construction of glass aquarium and selection of fishes, accessories (aerators, light, filters) maintenance of water quality. Identification & biology of common ornamental fishes - fighting fish, Gold fish, Koicarp), Gourami, Angel fish and Red tailed black shark. Breeding of common ornamental fishes - balanced diets for aquarium fishes: Disease management and Economics. Economics of ornamental fish culture.

**Unit II****12 Hours**

Apiculture: Species of honey bees in India. Life history of Apis. Methods of Bee keeping. Bee products and their uses. Natural enemies and their control. Morphology and Biology of honey bees; social behavior of honey bees. Bee keeping and ancillary industries. Newton's Bee hive Extraction of honey. Medicinal value of honey; bee products. Importance of bee colonies in crop pollination. Lac culture: Lac insect and its life cycle. Cultivation of lac insect, host plants, processing and uses of lac. Sericulture: Types of silk; Silkworms and their host plants; Mulberry silkworm culture; Life history of silkworm; Natural enemies and their control.

**Unit III****12 Hours**

Vermiculture: Biology of *Eisenia foetida*. Rearing of earthworms, Equipments , devices used in vermiculture, Vermicompost Technology. Methods and products, Vermiwash Collection, Composition and use.

**Unit IV****12 Hours**

Dairy Farming: Breeds and types of cattle breeds; housing of dairy animals, dairy products; nutritive value of milk; Lactometer. Goat Farming - Breeds of Indian goats and sheep; Exotic breeds of goats and sheep; Nutrition requirements; Housing and management of lambs and kids; Common diseases and vaccination. Pig farming - Types of breeds of pigs; housing and maintenance of pigs, nutritional requirements; care during weaning; common diseases and their management.

**Unit V****12 Hours**

Poultry farming - Poultry houses; Management of chicks, growers, and layers; Management of broilers and layers; Nutritional requirement for different stages of layers and broilers; common poultry diseases

**SUGGESTED READINGS**

- Banerjee, G.C. 2010. Text book of animal husbandry, Oxford & IBH Publishing company Pvt. Ltd, New Delhi, India 2. Arumugam, N., Jeyasurya, Nair, N
- Jabde, P.V. (2005) Text Book of Applied Zoology: Vermiculture, Apiculture, Sericulture, Lac culture.
- Mani, M.S. (2006). Insects, NBT, India.
- Shukla, G.S. and Upadhyaya, V.B. (1999-2000). Economic Zoology (Rastogi Publishers).
- Somani, L.L. 2008. Vermicomposting and vermiwash. Agrotech Publishing Academy, Udaipur.
- Talashilkar and Dosani, 2005. Earthworm in Agriculture. Agrobios (India), Jodhpur

## ELECTIVE: ECONOMIC ENTOMOLOGY AND PEST MANAGEMENT

**Instr.Hrs.:** 5

**Year :** III

**Credits :** 5

**Semester:** V / VI

### Learning Outcomes

Students will be able to

- (i) Know the morphology of some of the major insect pests
- (ii) Understand the significance of economically beneficial insects
- (iii) Learn the various methods of pests control
- (iv) Attain the concept of formulation of insecticides, precaution to be taken during handling and its impact on the ecosystem.

### Unit I

**15 Hours**

Brief account of morphology, classification (Major orders) and development (Metamorphosis) of insects.

### Unit II

**15 Hours**

Beneficial and harmful insects. Economic importance of honeybees, silkworm and lac insect – parasitic and predatory insects. Damages to plants, animals and man by insects. Brief account of any three pests of

1. Rice, Choram and Pulses 2. Sugarcane 3. Cotton 4. Groundnut, Gingely and Coconut 5. brinjal, Tomato and Lady's finger 6. Cardomam, Chilies, tea and Coffee 7. Mango and Citrus.

### Unit III

**15 Hours**

Insect pests of stored grains – Insect vectors of plants, animals and man – Other insects affecting the health of man domestic animals.

### Unit IV

**15 Hours**

Insect pest control methods (Physical, mechanical, biological and chemical) – Classification of pesticides and their modes of action.

### Unit V

**15 Hours**

Plant protection appliances used – basic principles of insecticide formulations and their application in pest control. Pesticides and environmental pollution – precautions in handling

pesticides.

### **Suggested Readings**

- David, B.V. and T. Kumarasamy, 1984. Elements of Economic Entomology, Popular Book Depot, Madras, 536 pp.
- Nayar, K.K., T.N. Ananthkrishnan and B.V. David. 1992. General and Applied Entomology. Tata McGraw Hill Publishing Co., Ltd., New Delhi – 110 051.
- David, B.V., 1992. Pest Management and Pesticides Indian Scenario, Namratha Publications, Madras.
- Metcalf, C.L. and W.P. Flint, 1973. Desctructive and Useful Insects. 4<sup>th</sup> Ed., Tata McGraw Hill Publishing Co. Ltd., New Delhi – 110 051, 1087 pp.
- Roya D.N. and A.W.A. Brown (Eds), 1981. Entomology Medical and Veterinary (3<sup>rd</sup> Ed.) The Bangalore Printing and Publishing Company, Bangalore –18.
- Ramakrishna Iyer, T.V., Economic Entomology, Government Publications. Madras.

## **ELECTIVE: MEDICAL LABORATORY TECHNIQUES AND BIOINSTRUMENTATION**

**Instr.Hrs.: 5**

**Year : III**

**Credits : 5**

**Semester: V / VI**

### **Learning outcomes**

Students will be able to

- (i) Learn the maintenance laboratory equipments/ tools, safety hazards and precautions.
- (ii) understand collection of specimens and preparation of reports
- (iii) understand the importance sterilization.
- (iv) learn analysis of various samples and gain knowledge about pathology of infectious diseases.
- (v) learn the principles of bioinstruments.

### **Unit I**

**12 Hours**

Introduction – Scope of the subject. Collection of specimens, records and preparation of

reports. Cleaning, maintenance and care of glasswares.

**Unit II** **12 Hours**

Sterilization – Physical and Chemical methods. Disposal of specimens and infected materials, safety precautions and first aid treatment for superficial wounds, burns, chemical poisoning, contamination of infected microbiological specimens and electric shock.

**Unit III** **12 Hours**

Urine: Analysis of urine samples, chemical parameters routinely required to be analysed. Pregnancy test. Analysis of stools, semen, cerebrospinal fluid for chemical investigation.

**Unit IV** **12 Hours**

Pathology: Organisms causing infectious diseases. Viruses – Measles, Poliomyelitis, Hepatitis, HIV- Bacteria – Tuberculosis, Whooping cough – Tetanus – Diphtheria, Cholera. Protozoans – Amoebic dysentery, Malaria, Leishmaniasis- Helminths – Filariasis, Cysticercosis.

**Unit V** **12 Hours**

Principles use and maintenance of laboratory instruments like Autoclave, hot air oven, Incubators, Water- bath, Refrigerator, Centrifuge, Calorimeter, pH meter, Haemoglobinometer, Haemocytometer, Microtomes, balances.

**SUGGESTED READINGS**

- SOOD RAMNIK, 1985. Medical Laboratory Technology. Japee brothers, New Delhi, 384
- BAKER F.J. and SILVERTON R.E. Introduction to Medical Laboratory Technology.

**CORE-XIV: PRACTICAL – III**  
**(ANIMAL PHYSIOLOGY, BIOCHEMISTRY,**  
**DEVELOPMENTAL BIOLOGY, BIostatISTICS AND**  
**COMPUTER APPLICATIONS)**

**Instr.Hrs.: 4 + 4**

**Year III**

**Credits : 4**

**Semester: V / VI**

**Learning Outcomes**

Students will be able to

- (i) Understand the physiological process of respiration through simple experiment
- (ii) Gain knowledge in the qualitative analysis of sugars
- (iii) Learn the various developmental stages, and types of placenta
- (iii) Statistically analyse the real biological data
- (iv) Draw graph in MS- Excel

**ANIMAL PHYSIOLOGY**

1. Use of Kymograph unit, BP apparatus, Respirometer.
2. Survey of Digestive enzymes in cockroach.
3. Estimation of Oxygen consumption in a fish with reference to body weight.
4. Detection of nitrogenous waste products in fish tank water, frog tank water, bird excreta and mammalian urine.

**BIOCHEMISTRY**

1. Qualitative identification of functional groups present in given carbohydrates solutions- (Glucose, Fructose, Sucrose, Lactose, Starch)
2. Quantitative estimation of Protein (Biuret Method) (Demonstration)
3. Separation of amino acids using circular paper chromatography (Demonstration)

**DEVELOPMENTAL BIOLOGY**

Study of the following prepared slides, museum specimens and materials.

1. Slides of mammalian sperm and ovum

2. Sections of testis and ovary showing the maturation stages of gametes.
3. Study of egg type- Frog' s egg
4. Slides of cleavage stages, blastula, gastrula and neurula of frog
5. Slides of different stages of chick embryo 18 hours (primitive streak stage], 24 hours, 48 hours, 72 hours and 96 hours
6. Placenta of sheep , pig and man

### **BIOSTATISTICS**

1. Determine the height and weight of pupils in a class (number of observations not less than 30) and prepare the
  - (a) Frequency distribution table
  - (b) Calculate the arithmetic mean
  - (c) Correlate the height- weight relationship

### **COMPUTER APPLICATIONS**

1. Graphical representation of the data on height and weight of pupils in MS Excel.2. Spotters- Mouse, Key board, Monitor, Printer.

### **CORE-XV: PRACTICAL - IV**

**(ENVIRONMENTAL BIOLOGY, MICROBIOLOGY, IMMUNOLOGY,  
BIOTECHNOLOGY AND BIOINFORMATICS)**

**Instr.Hrs.: 4 + 4**

**Year: III**

**Credits : 4**

**Semester: V / VI**

### **Learning Outcomes**

Students will be able to

- (i) Analyse the various analyse the important ecological parameters in different types of water samples and can interpret the significance of these parameters.
- (ii) Know the adaptations of the organisms with respect to their environment.



- (iii) Acquire knowledge in media preparations and important microbiological techniques.
- (iv) Know the techniques available to study antigen- antibody reactions.
- (v) Gain Knowledge of PCR technique and important biotechniques.
- (vi) Retrieve the sequence from database and do the pairwise alignment of data.

## **ENVIRONMENTAL BIOLOGY**

1. Estimation of O<sub>2</sub>, salinity, PH, Free CO<sub>2</sub>, carbonates and bicarbonates, calcium in water sample
2. Use of rain guage, Maximum and minimum thermometer, hygrometer, anemometer and barometer.
3. Plankton study- freshwater and marine plankton
4. Adaptation of aquatic and terrestrial animals based on a study of museum specimens- rocky, sandy, muddy shore animals, flying and burrowing animals
5. Study of natural ecosystem and field report of the visit.

## **MICROBIOLOGY**

1. Media preparation- Broth, Agar, Slants, Plating
2. Spotters – *Staphylococcus aureus*, *E. coli*, *Rhizopus*, *Aspergillus flavus*, *Aspergillus niger*, *Pencillium*, *Candida albicans*
3. Instruments – Autoclave, Culture plate, Inoculation plate
4. Staining – Simple and differential staining
5. Antibiotic sensitivity test- Classification and collection of antibiotics, based on origin, mode of action and application
6. Observation of bacterial motility- Hanging drop method
7. Isolation of bacteria by pure culture- streak plate- pour plate method
8. Examination of milk- methyl blue – reduction test

## **IMMUNOLOGY**

1. Immunoelectrophoresis- Antigen- antibody reaction- agglutination- precipitation ring test (Demonstration ) by antisera.

**BIOTECHNOLOGY**

1. Demonstration of PCR techniques
2. Study of the techniques through Photograph- Southern Blotting, Northern Blotting, Western Blotting, DNA sequencing (Sanger's Method)
3. Instrumentation- components and application of instruments- Centrifuge- Electrophoresis – Spectrophotometer.
4. Visit to Sewage treatment plant and a biotech laboratory- Report to be submitted.

**BIOINFORMATICS**

1. Sequence (nucleotide and protein) retrieval from database (NCBI)
2. Pairwise alignment of sequence and interpretation of data
3. Translate a nucleotide sequence and select the correct reading frame of the polypeptide from the output sequences.

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