

# Vidyasagar University

## Curriculum for B.Sc. (Honours) in Zoology [Choice Based Credit System]

### Semester-V

| Course         | Course Code | Name of the Subjects    | Course Type/<br>Nature           | Teaching Scheme in hour per week |   |   | Credit | Marks |
|----------------|-------------|-------------------------|----------------------------------|----------------------------------|---|---|--------|-------|
|                |             |                         |                                  | L                                | T | P |        |       |
| CC- 11         |             | C11T: Molecular Biology | Core Course-11                   | 4                                | 0 | 0 | 6      | 75    |
|                |             | - Lab                   |                                  | 0                                | 0 | 4 |        |       |
| CC- 12         |             | C12T: Genetics          | Core Course-12                   | 4                                | 0 | 0 | 6      | 75    |
|                |             | - Lab                   |                                  | 0                                | 0 | 4 |        |       |
| DSE-1          |             | TBD                     | Discipline Specific Elective - 1 | 4                                | 0 | 0 | 6      | 75    |
|                |             |                         |                                  | 0                                | 0 | 4 |        |       |
| DSE-2          |             | TBD                     | Discipline Specific Elective -2  | 4                                | 0 | 0 | 6      | 75    |
|                |             |                         |                                  | 0                                | 0 | 4 |        |       |
| Semester Total |             |                         |                                  |                                  |   |   | 24     | 300   |

**L**= Lecture, **T**= Tutorial, **P** = Practical, **CC** - Core Course, **TBD** - To be decided, **DSE**: Discipline Specific Elective.

## **Semester-V**

### **List of Core Course (CC)**

**CC-11: Molecular Biology**

**CC-12: Genetics**

### **Discipline Specific Electives (DSE)**

**DSE-1: Animal Behaviour and Chronobiology**

**Or**

**DSE-1: Fish and Fisheries**

**Or**

**DSE-1: Reproductive Biology**

**DSE-2: Animal Biotechnology**

**Or**

**DSE-2: Microbiology**

## Semester-V

### Core Courses (CC)

**CC-11: Molecular Biology**

**Credits 06**

**C11T: Molecular Biology**

**Credits 04**

#### **Course Contents:**

##### **Unit 1: Nucleic Acids**

Salient features of DNA and RNA. Watson and Crick Model of DNA

##### **Unit 2: DNA Replication**

Mechanism of DNA Replication in Prokaryotes, Semi-conservative, bidirectional and discontinuous Replication, RNA priming, Replication of telomeres

##### **Unit 3: Transcription**

Mechanism of Transcription in prokaryotes and eukaryotes, Transcription factors, Difference between prokaryotic and eukaryotic transcription.

##### **Unit 4: Translation**

Mechanism of protein synthesis in prokaryotes, Ribosome structure and assembly in prokaryotes, fidelity of protein synthesis, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation

##### **Unit 5: Post Transcriptional Modifications and Processing of Eukaryotic RNA**

Capping and Poly A tail formation in mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, Processing of tRNA

##### **Unit 6: Gene Regulation**

Regulation of Transcription in prokaryotes: *lac* operon and *trp* operon;  
Regulation of Transcription in eukaryotes: Activators, enhancers, silencer, repressors, miRNA mediated gene silencing, Genetic imprinting

##### **Unit 7: DNA Repair Mechanisms**

Types of DNA repair mechanisms, RecBCD model in prokaryotes, nucleotide and base excision repair, SOS repair

##### **Unit 8: Molecular Techniques**

PCR, Western and Southern blot, Northern Blot, Sanger DNA sequencing

#### **Suggested Readings:**

1. Molecular Cell Biology by Harvey Lodish. 7<sup>th</sup> Edition. W.H. Freeman.
2. Molecular Biology of the Gene by Watson. 7<sup>th</sup> Edition. Pearson.

3. iGenetics: A Molecular Approach by Peter. J. Russell. 3<sup>rd</sup> edition. Pearson Benjamin Cummings.

**C11P: Molecular Biology (Lab)****Credits 02****List of Practical**

1. Demonstration of polytene and lampbrush chromosome from photograph
2. Isolation and quantification of genomic DNA using spectrophotometer (A260 measurement)
3. Agarose gel electrophoresis for DNA

**CC-12: Genetics****Credits 06****C12T: Genetics****Credits 04****Course Contents:****Unit 1: Mendelian Genetics and its Extension**

Principles of inheritance, Incomplete dominance and co-dominance, Epistasis Multiple alleles, Lethal alleles, Pleiotropy, Sex-linked, sex- influenced and sex-limited inheritance, Polygenic Inheritance.

**Unit 2: Linkage, Crossing Over and Chromosomal Mapping**

Linkage and Crossing Over, molecular basis of crossing over, Measuring Recombination frequency and linkage intensity using three factor crosses, Interference and coincidence

**Unit 3: Mutations**

Types of gene mutations (Classification), Types of chromosomal aberrations (Classification with one suitable example of each), Non-disjunction and variation in chromosome number; Molecular basis of mutations in relation to UV light and chemical mutagens

**Unit 4: Sex Determination**

Mechanisms of sex determination in *Drosophila*

Sex determination in mammals

Dosage compensation in *Drosophila* & Human

**Unit 5: Extra-chromosomal Inheritance**

Criteria for extra chromosomal inheritance, Antibiotic resistance in *Chlamydomonas*, Kappa particle in *Paramoecium* Shell spiralling in snail

**Unit 6: Recombination in Bacteria and Viruses**

Conjugation, Transformation, Transduction, Complementation test in Bacteriophage

**Unit 7: Transposable Genetic Elements**

Transposons in bacteria, Ac-Ds elements in maize and P elements in *Drosophila*, LINE, SINE, Alu elements in humans

**Suggested Readings:**

1. Developmental biology by Scott. F. Gilbert, 9<sup>th</sup> edition.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc

3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings
4. Russell, P. J. (2009). Genetics- A Molecular Approach.III Edition. Benjamin Cummings  
Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B.

### **C12P: Genetics (Lab)**

**Credits 02**

#### **List of Practical**

1. Chi-square analyses
2. Linkage maps based on conjugation
3. Identification of chromosomal aberration in Drosophila and man from photograph
4. Pedigree analysis of some human inherited traits

### *Discipline Specific Electives (DSE)*

#### **DSE-1 : Animal Behaviour and Chronobiology**

**Credits 06**

#### **DSE1T : Animal Behaviour and Chronobiology**

**Credits 04**

#### **Course Contents:**

##### **Unit 1: Introduction to Animal Behaviour**

Origin and history of Ethology, Brief profiles of Karl Von Frish, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen Proximate and ultimate causes of behaviour, Methods and recording of a behaviour

##### **Unit 2: Patterns of Behaviour**

Stereotyped Behaviours (Orientation, Reflexes); Individual Behavioural patterns; Instinct vs. Learnt Behaviour; Associative learning, classical and operant conditioning, Habituation, Imprinting.

##### **Unit 3: Social and Sexual Behaviour**

Social Behaviour: Concept of Society; Communication and the senses

Altruism; Insects' society with Honey bee as example; Foraging in honey bee and advantages of the waggle dance.

Sexual Behaviour: Asymmetry of sex, Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Sexual conflict in parental care.

##### **Unit 4: Introduction to Chronobiology**

Historical developments in chronobiology; Biological oscillation: the concept of Average, amplitude, phase and period.

Adaptive significance of biological clocks

##### **Unit 5: Biological Rhythm**

Types and characteristics of biological rhythms: Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Concept of synchronization and masking; Photic and non-photic zeitgebers; Circannual rhythms; Photoperiod and regulation of seasonal reproduction of vertebrates; Role of melatonin.

#### **Suggested Readings:**

1. Animal Behaviour by Drickamar.
2. John Alcock, Animal Behaviour, Sinauer Associate Inc., USA.
3. Paul W. Sherman and John Alcock, Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts, USA.
4. Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros Patricia J. De Coursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
5. Insect Clocks D.S. Saunders, C.G.H. Steel, X., Afopoulou (ed.) R.D. Lewis. (3rdEd) 2002 Barenz and Noble Inc. New York, USA
6. Biological Rhythms: Vinod Kumar (2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

### **DSE1P: Animal Behaviour and Chronobiology (Lab)**

**Credits 02**

#### **List of Practical**

1. To study nests and nesting habits of the birds and social insects.
2. To study the behavioural responses of wood lice to dry and humid conditions.
3. To study geotaxis behaviour in earthworm.
4. To study the phototaxis behaviour in insect larvae.
5. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a short report.
6. Study and actogram construction of locomotor activity of suitable animal models.
7. Study of circadian functions in humans (daily eating, sleep and temperature patterns).

**Or**

### **DSE-1: Fish and Fisheries**

**Credits 06**

### **DSE1T: Fish and Fisheries**

**Credits 04**

#### **Course Contents:**

#### **Unit 1: Introduction and Classification**

General description of fish

Feeding habit, habitat and manner of reproduction

Classification of fish (up to Subclasses)

#### **Unit 2: Morphology and Physiology**

Types of fins and their modifications; Locomotion in fish; Hydrodynamics; Types of Scales, Use of scales in Classification and determination of age of fish; Gills and gas exchange; Swim Bladder: Types and role in Respiration, buoyancy; Osmoregulation in Elasmobranchs; Reproductive strategies (special reference to Indian fish); Electric organ, Bioluminescence

#### **Unit 3: Fisheries**

Inland Fisheries; Marine Fisheries; Environmental factors influencing the seasonal variations in fish catches in the Arabian Sea and the Bay of Bengal; Fishing crafts and Gears; Depletion of fisheries resources; Application of remote sensing and GIS in fisheries; Fisheries law and regulations

#### **Unit 4: Aquaculture**

Sustainable Aquaculture; Extensive, semi-intensive and intensive culture of fish; Pen and cage culture; Polyculture; Composite fish culture; Brood stock management; Induced breeding of fish; Management of finfish hatcheries; Preparation and maintenance of fish aquarium; Preparation of compound diets for fish; Role of water quality in aquaculture; Fish diseases: Bacterial, viral and parasitic; Preservation and processing of harvested fish, Fishery by-products

### Unit 5: Fish in research

Transgenic fish

Zebrafish as a model organism in research

### Suggested Readings:

1. Q Bone and R Moore, Biology of Fishes, Talyor and Francis Group, CRC Press, U.K.
2. D. H. Evans and J. D. Claiborne, The Physiology of Fishes, Taylor and Francis Group, CRC Press, UK von der Emde, R.J. Mogdans and B.G. Kapoor. The Senses of Fish: Adaptations for the Reception of Natural Stimuli Springer, Netherlands
3. C.B.L. Srivastava, Fish Biology, Narendra Publishing House J.R. Norman, A history of Fishes, Hill and Wang Publishers
4. Khanna and H.R. Singh, A text book of Fish Biology and Fisheries, Narendra Publishing House.

**Note: Classification to be followed from: Romar A. S. (1959)**

### DSE1P: Fish and Fisheries (Lab)

**Credits 02**

#### List of Practical

1. Morphometric and meristic characters of fishes
2. Study of *Petromyzon*, *Myxine*, *Pristis*, *Chimaera*, *Exocoetus*, *Hippocampus*, *Gambusia*, *Labeo*, *Heteropneustes*, *Anabas*
3. Study of different types of scales (through permanent slides/ photographs).
4. Study of crafts and gears used in Fisheries
5. Water quality criteria for Aquaculture: Assessment of pH, conductivity, Total solids, Total dissolved solids
6. Study of air breathing organs in *Channa*, *Heteropneustes*, *Anabas* and *Clarias*
7. Project Report on a visit to any fish farm/ pisciculture unit/Zebrafish rearing Lab.

**Or**

### DSE-1: Reproductive Biology

**Credits 06**

### DSE1T: Reproductive Biology

**Credits 04**

### Course Contents:

#### Unit 1: Reproductive Endocrinology

Mechanism of action of steroids and glycoprotein hormones. hypothalamo – hypophyseal – gonadal axis, regulation of gonadotrophin secretion in human (male and female) Reproductive system:

Development and differentiation of gonads, genital ducts and external genitalia

#### Unit 2: Functional anatomy of male reproduction

Histoarchitecture of testis in human; Spermatogenesis; Kinetics and hormonal regulation; Androgen synthesis and metabolism; Accessory glands functions

### **Unit 3: Functional anatomy of female reproduction**

Histoarchitecture of ovary in human; Oogenesis; Kinetics and hormonal regulation; Steroidogenesis and secretion of ovarian hormones; Reproductive cycles (human) and their regulation, fertilization; Hormonal control of implantation; Hormonal regulation of gestation, pregnancy diagnosis, foeto – maternal relationship; Mechanism of parturition and its hormonal regulation; Lactation and its Regulation

### **Unit 4: Reproductive Health**

Infertility in male and female: causes, diagnosis and management Assisted Reproductive Technology: sex selection, sperm banks, frozen embryos, in vitro fertilization Modern contraceptive technologies

### **Suggested Readings:**

1. Ross & Pawlina. Histology: A text and Atlas. 6th edition.
2. Guyton & Hall. Medical Physiology. 11th edition.
3. Knobil, E. et al. (eds). The Physiology of Reproduction. Raven Press Ltd.
4. Hatcher, R.A. et al. The Essentials of Contraceptive Technology. Population Information Programme.

### **DSE1P: Reproductive Biology (Lab)**

**Credits 02**

### **List of Practicals:**

1. Study of animal house: set up and maintenance of animal house, breeding techniques, care of normal and experimental animals.
2. Examination of vaginal smear rats from live animals.
3. Tissue fixation, embedding in paraffin, microtomy and slide preparation of any endocrine gland
4. Examination of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems; Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina.
5. Sperm count and sperm motility in rat

### **DSE-2: Animal Biotechnology**

**Credits 06**

### **DSE2T: Animal Biotechnology**

**Credits 04**

### **Course Contents:**

#### **Unit 1: Introduction**

Organization of prokaryotic and eukaryotic genome, Concept of genomics

#### **Unit 2: Molecular Techniques in Gene manipulation**

Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, M13, BAC, YAC, MAC and Expression vectors (characteristics). Restriction enzymes: Nomenclature, detailed



study of Type II. Transformation techniques: Calcium chloride method and electroporation. Construction of genomic and cDNA libraries and screening by colony and plaque hybridization Southern, Northern and Western blotting  
DNA sequencing: Sanger method  
Polymerase Chain Reaction, DNA Finger Printing and DNA micro array

### **Unit 3: Genetically Modified Organisms**

Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection. Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knock out mice

### **Unit 4: Culture Techniques and Applications**

Animal cell culture, expressing cloned genes in mammalian cells, Molecular diagnosis of genetic diseases (Cystic fibrosis, Sickle cell anemia)

### **Suggested Readings:**

1. Brown, T.A. (1998). Molecular Biology Labfax II: Gene Cloning and DNA Analysis. II Edition, Academic Press, California, USA.
2. Glick, B.R. and Pasternak, J.J. (2009). Molecular Biotechnology - Principles and Applications of Recombinant DNA. IV Edition, ASM press, Washington, USA.
3. Weaver. Molecular Biology of Gene. 5th edition.
4. Primrose & Twyman. Principles of Gene Manipulation and Genomics. 7th edition.

### **DSE2P: Animal Biotechnology (Lab)**

**Credits 02**

#### **List of Practical**

1. Genomic DNA isolation from E. coli
2. Plasmid DNA isolation (pUC 18/19) from E. coli
3. Restriction digestion of plasmid DNA.
4. Construction of circular and linear restriction map from the data provided.
5. Calculation of transformation efficiency from the data provided.
6. To study following techniques through photographs
  - a. Southern Blotting
  - b. Northern Blotting
  - c. Western Blotting
  - d. DNA Sequencing (Sanger's Method)
  - e. PCR
  - f. DNA fingerprinting
7. Project report on animal cell culture

**Or**

### **DSE-2: Microbiology**

**Credits 06**

### **DSE2T: Microbiology**

**Credits 04**

### **Course Contents:**

#### **Unit 1: Introduction to Microbiology**

Historical perspective of Microbiology, Prokaryotic pathogens, Eukaryotic pathogens

### **Unit 2: Bacterial taxonomy**

Principles and modern approaches of bacterial taxonomy. Basic idea about Hackel and Whittaker's kingdom concept and domain concept of Carl Woese

### **Unit 3: Morphology of Bacteria and Virus**

Cell wall (Structure of peptidoglycan), Cell envelope (Cell membrane, Differences between gram-positive and gram-negative species, External capsule and glycocalyx, Plasmids and episomes. Nuclear material, Bacterial Chromosome (Fundamental differences with eukaryotic chromosome). Reserve materials (carbon and phosphate reserve, cyanophycin), Cytoplasmic inclusions (Chlorosome, magnetosome, carboxysome, gas vesicles, ribosome). Structural organization of viruses, Prions and viroids

### **Unit 4: Normal flora**

Distribution of normal flora in the body: Skin, eye, mouth, intestinal tract, urino-genital tract, Beneficial functions of normal flora. Harmful effects of normal flora

### **Unit 5: Pathogenicity of Microorganisms**

Bacterial pathogenesis: Entry to the host, Adherence to host cells, Invasiveness, Bacterial toxins Exotoxins, Endotoxins, Antigenic switching. Viral Pathogenesis: Cellular level (Cell death, Transformation, Cell fusion, Cytopathic effect). Initial infections: Routes of entry and dissemination to secondary sites, Typical secondary sites of localization, Virus shedding and mode of transmission; Factors involved in termination of acute infection

### **Unit 6: Infection of pathogens to human populations**

Communicable, Non-communicable, Endemic, Epidemic, Pandemic and Sporadic

### **Unit 7: Diagnostic Microbiology and Bacteria culture**

Koch's postulates, Sensitivity and specificity of test results, Principles and applications: Simple staining, Gram-staining, Acid-fast staining, Collection of specimens, Growth requirements and Growth factors, Oxygen requirement. Culture Media: Simple media, Complex media, Selective media and Enriched media

### **Unit 8: Genetic recombination in bacteria**

Transformation, Conjugation- F<sup>+</sup>, F<sup>-</sup>, Hfr & F' strain, Transduction, Generalised & specialized types.

### **Unit 9: Microbial Diseases**

Name of pathogen, symptoms, pathogenesis, mode of action & preventive measures of following diseases: Bacterial (Polio, Typhoid, Staphylococcal Food Poisoning), Viral (Dengue, AIDS)

### **Suggested Readings:**

1. Alexander, M. (1977). Introduction to Soil Microbiology. John Wiley and Sons, New York.
2. Atlas, R. M. and Bartha, R. (1997). Microbial Ecology: Fundamentals and Applications, 4<sup>th</sup> ed.
3. Benjamin/ Cummings. Black, J. G. (2011). Microbiology: Principles and Explorations. 8<sup>th</sup> ed. John Wiley and Sons, New York.
4. Campbell, R. (1983). Microbial Ecology. 2nd ed. Oxford, Blackwell.

5. Pinehuk, G. (2003). Schaum's outline Series: Theory and Problems of Immunology.
6. McGrawHill.
7. Prescott, L. M., Harley, J. P. and Klein, D. A. (2011). Microbiology, 8th ed. McGrawHill, New York.
8. Schlegel, H. G. (1993). General Microbiology. 7th ed. Cambridge University Press.
9. Slonczewski, J.L. and Foster, J.W. (2009). Microbiology- An Evolving Science. Norton.
10. Stanier, R. Y., Adelberg, E. A. and Ingraham, J. L. (1986). General Microbiology. 5th ed. Macmillan.
11. Talaro, K. and Talaro, A. (1999). Foundations in Microbiology. 3rd ed. Dubuque, McGraw Hill.
12. Tortora, G. J., Funke, B. R., and Case. C. L. (2008). Microbiology. An Introduction. 9th ed. Benjamin/Cummings Publishing. Menlo Park Calif.
13. Voyleys, B. A. (2002). The biology of viruses, 2nd ed. McGraw-Hill.

## **DSE2P: Microbiology (Lab)**

**Credits 02**

### **List of Practical:**

1. Simple staining and Gram's staining of bacteria.
2. Preparation of liquid media (broth) and solid media for routine cultivation of bacteria.
3. Preparation of slant and stab.
4. Pure culture techniques: Spread plate, Pour plate and Streak plate
5. Biochemical test for characterization:  
Catalase, Nitrate-reduction, Indole production, Methyl Red and Voges-Proskauer Test.
6. Microbiological examination of milk (Methylene blue reductase test).
7. Sugar fermentation test.

