

iMSc IN LIFE SCIENCES (2018-23)

# CURRICULUM BOOK

---



Department of Life Sciences  
School of Life Sciences  
Central University of Tamil Nadu

Revised in September 2018



## DEPARTMENT OF LIFE SCIENCES

### ABOUT

#### INAUGURAL YEAR

2012

#### PROGRAMMES OFFERED

Integrated MSc (iMSc) & Doctor of Philosophy (PhD)

#### VISION & MISSION

The vision of the department is *to help students understand the genesis, diversity, & functioning of living organisms in order to conserve, & coexist in concert with nature.*

The mission of DLS is to contribute to the *improvement of knowledge in life sciences through research, education & creative analysis, innovative teaching & learning for addressing problems affecting human health & global environmental issues.*

#### THRUST AREAS

Founded in 2012, the Department of Life Sciences (DLS) offers two programs, a 5-year-integrated MSc & PhD. DLS is supported by a team of faculty members who are committed themselves to the highest standards both in academics & research. DLS represents one of the most vibrant & visible departments of the Central University of Tamil Nadu (CUTN) in terms of competition for admission, faculty ratio, internationally-trained faculty members, high-impact publications & extra-mural research grants from various national & international funding agencies. The aim of DLS is to provide a strong platform for the various interdisciplinary/research oriented/advanced higher education in life sciences for translating the standards of personal & societal living. The teachers at DLS carry out research in parallel with teaching to ensure that students are aware of the latest advances within the life sciences field. DLS has excellent research infra-structure, & offers state-of-the-art pedagogical experience to its students, which explains the testimony of its success story as a vibrantly evolving & productive department.

The integrated master's program comprises of various subjects including plant sciences, animal sciences, biochemistry, biophysics, biotechnology, developmental biology, immunobiology, neurosciences, microbiology, molecular biology, genetics, cell biology, pharmacology, environmental sciences etc. Apart from these, it also offers novel computational approaches to develop newer biomarkers & identification of novel drug targets. Student-teacher interactive seminars in new biology, hands-on practical sessions, problem-based learning (PBL), tutorials, journal clubs, science café, & field visits for reputed research institutions & industries across the country represent some of the prospective agenda planned for the course with an aim to transform teaching & research into a more contemporary & vibrant phenomenon.

The department is actively involved in organizing various national & international workshops, *Science Café* seminars & documentary clubs, *Spring School Symposia* & conferences to provide a better learning platform for its student community. The students are given opportunities to interact with leading scientists/professors from various national & international institutions, industries & medical schools during their visit to the department. DLS students are also actively taking part in various summer internship programs offered by prestigious national institutions like IISc, IISERs, THSTI, NII & ICMR laboratories. The faculty members of DLS have earned several national & international distinctions & laurels in terms of fellowships, awards, recognitions & publications. The faculty members are actively engaged in research & outreach projects/programs at various funding agencies, & collaborate with global leaders of research & innovation. The research focus of DLS is multifaceted by research across various disciplines such as infection biology, neurobiology, immunology, cancer biology, vector biology, blood & vascular biology. Plant physiology gives special emphasis on a deeper understanding of the mechanisms of abiotic stress responses in plants. DLS, in a nutshell, inspires cutting-edge research/teaching & foster creativity in the next generation of scientists & academicians.

## ABOUT THE FACULTY

### E. M. Shankar PhD



Shankar's area of research is *Immunology & Medical Microbiology*. Before getting on board CUTN, he was an Associate Professor of Immunology at the *Department of Medical Microbiology, Faculty of Medicine, University of Malaya, Kuala Lumpur, Malaysia*. He underwent his post-doctoral training at the *Institutionen för Klinisk och Experimentell Medicin, Linköpings Universitet, Sweden* & has supervised 3 PhD & 9 master graduates by research. He serves on the editorial boards of several leading international biomedical journals, & owns over 108 PubMed-Indexed publications with a *h-index* of 26 & an *i10-index* of 51 from ~1867 citations.

### Jayalakshmi Krishnan PhD



Jayalakshmi's areas of research are Vector Sciences, Neuroimmunology & Molecular Neurosciences. She underwent post-doctoral training at the *Department of Molecular Sciences & Technology, Ajou University, South Korea*. Currently, she is guiding two PhD scholars. She has organized several national & international seminars/conferences at the Department of Life Sciences & has over 15 publications to her credit.

### Meganathan Kannan PhD



Kannan's focus is related to Hemostasis & Thrombosis. Before joining CUTN he was a Postdoctoral Fellow in *Cincinnati Children's Hospital Medical Center, USA*. Currently, he is also a Visiting Professor at the *Loyola University Medical Center, Chicago*. He has received various national & international awards, including an International Young Investigator cash prize award for the best publication. Presently, he has two research scholars under his supervision & has over 50 publications. Dr. Kannan has a *h-index* of 19 & an *i10-index* of 25.

## ABOUT THE FACULTY

### Indranil Chattopadhyay PhD



Indranil is working in the area of Cancer Biology. He underwent his postdoctoral training at the prestigious *Roswell Park Cancer Institute, New York, USA* & has received various fellowships including the INSA fellowship. Dr. Chattopadhyay is a member of the International Union Against Cancer (IUAC). Currently, he is supervising one PhD scholar who is working on Cancer Biology. Indranil has over 15 publications to his credit.

### Dinakar Challabathula PhD



Dinakar's area of interest is Plant Stress Physiology. He underwent his postdoctoral training from the *University of Bonn, Germany*. He is the member of Indian Society for Plant Physiology and Indian Science Congress Association. He is the Visiting Scientist at *Swedish University of Agricultural Sciences, Uppsala, Sweden*, & *IMBIO, Germany*. Currently, his team has 3 researchers under his direct supervision. Dinakar has over 15 publications to his credit, which includes a paper that he published in *Nature* in 2015.

### Latchoumyandane Calivarathan PhD



Latchoumyandane is an American Board Certified toxicologist. Before joining CUTN, he has been working as a Research Associate in the *Department of Cellular & Molecular Medicine, Cleveland Clinic, USA*. Latch is a member of several global societies including the Society of Toxicology & the Endocrine Society (USA). He has published over 30 research papers in peer-reviewed international journals & his publications have received >1600 Scopus citations with a h-index of 24.



## iMSc LIFE SCIENCES SYLLABUS 2018-23

SEMESTER	CODE	SUBJECT TITLE	CREDITS
01	LIF111	Botany: Biodiversity (Microbes, Algae, Fungi & Archegoniate) (CC-Botany)	03
	LIF112	Botany: Practicals-I (CC-Botany)	02
	LIF113	Zoology: Animal Diversity (CC-Zoology)	03
	LIF114	Zoology: Practicals-I (CC-Zoology)	02
	CHE111	General Chemistry (CC-Chemistry)	03
	CHE112	General Chemistry: Practicals (CC-Chemistry)	02
	ENG111	English Communications (AECC)	02
02	LIF101	Botany: Plant Ecology & Taxonomy (CC-Botany)	03
	LIF102	Botany: Practicals-II (CC-Botany)	02
	LIF103	Zoology: Comparative Anatomy & Developmental Biology of Vertebrates (CC-Zoology)	03
	LIF104	Zoology: Practicals-II (CC-Zoology)	02
	CHE101	Physical Chemistry (CC-Chemistry)	03
	CHE102	Physical Chemistry: Practicals (CC-Chemistry)	02
	LIF001	Environmental Sciences (AECC)	02
03	LIF211	Botany: Plant Anatomy & Embryology of Angiosperms (CC-Botany)	03
	LIF212	Botany: Practical-III (CC-Botany)	02
	LIF213	Zoology: Animal Physiology (CC-Zoology)	03
	LIF214	Zoology: Practicals-III (CC-Zoology)	02
	CHE211	Inorganic Chemistry (CC-Chemistry)	03
	CHE212	Inorganic Chemistry: Practicals (CC-Chemistry)	02
	LIF215	Economic Botany	03
	LIF216	Biofertilizers (SEC-1)	02
04	LIF201	Botany: Plant Physiology & Metabolism (CC-Botany)	03
	LIF202	Botany: Practicals-IV (CC-Botany)	02
	LIF203	Zoology: Genetics & Evolutionary Biology (CC-Zoology)	03
	LIF204	Zoology: Practicals-IV (CC-Zoology)	02
	CHE201	Organic Chemistry (CC-Chemistry)	03
	CHE202	Organic Chemistry: Practicals (CC-Chemistry)	02
	LIF205	Economic Zoology	03
LIF206	Medical Diagnostics (SEC-II)	02	
05	LIF311	Bioinformatics (DSE-Botany I)	03
	LIF312	Bioinformatics: Practicals (DSE-Botany I)	02
	LIF313	Animal Biotechnology (DSE-Zoology I)	03
	LIF314	Animal Biotechnology: Practicals (DSE-Zoology I)	02
	LIF315	Drug Discovery & Design (DSE-Chemistry I)	03
	LIF316	Drug Discovery & Design: Practicals (DSE-Chemistry I)	02
	LIF317	Basic Biochemistry	03
	LIF318	Basic Biochemistry: Practicals	02
	LIF319	Medicinal Botany (SEC-III)	02



## iMSc LIFE SCIENCES SYLLABUS 2018-23

06	LIF301	Analytical Techniques in Plant Sciences (DSE- Botany II)	03
	LIF302	Analytical Techniques in Plant Sciences: Practicals (DSE- Botany II)	02
	LIF303	Reproductive Biology (DSE-Zoology II)	03
	LIF304	Reproductive Biology: Practicals (DSE-Zoology II)	02
	LIF305	Biochemistry – Intermediary Metabolism (DSE-Chemistry II)	03
	LIF306	Biochemistry – Intermediary Metabolism: Practicals (DSE-Chemistry II)	02
	LIF307	Basic Microbiology	03
	LIF308	Basic Microbiology: Practicals	02
	LIF309	Aquatic Biology (SEC-IV)	02
<b>Total Credits</b>			<b>118</b>
<b>Tamil/Other Languages, Disaster Management</b>			<b>06</b>
<b>Total Credits for (Exit Option for a BSc Degree in) Life Sciences</b>			<b>124</b>
07	LIF411	Cell Biology	03
	LIF412	Immunobiology	03
	LIF413	Immunobiology: Practicals	02
	LIF414	Molecular Biology	03
	LIF415	Molecular Biology: Practicals	02
	LIF416	Endocrinology	03
	LIFE	<b>Elective 1</b>	03
08	LIF401	Infectious Diseases	03
	LIF402	Infectious Diseases: Practicals	02
	LIF403	Neurobiology	03
	LIF404	Plant Pathology & Crop Protection	03
	LIF405	Plant Pathology & Crop Protection: Practicals	02
	LIF406	Pharmacology	03
	LIFE	<b>Elective 2</b>	03
	LIFE	<b>Elective 3</b>	03
09	LIF511	Theoretical Pathology	03
	LIF512	Environmental Toxicology	03
	LIF513	Behavioral Ecology	03
	LIF514	Biosafety & Bioethics	02
	LIF515	Biostatistics & Intellectual Property Rights	03
	LIF516	Laboratory Animal Care & Maintenance & Research Methodology	03
	LIFE	<b>Elective 4</b>	03
10	LIF501	Life Sciences Project Dissertation	12
<b>Total Credits</b>			<b>72</b>
<b>Total Credits for iMSc Degree in Life Sciences (124 + 72)</b>			<b>196</b>



# SEMESTER 01

## LIF111: BOTANY

### Biodiversity

#### BOTANY THEORY - 3 Credits: (3 Theory Hrs/Week)

#### Learning Outcomes

On completion of this course, the student will be able to:

- understand the classification & distribution of microbes and primitive plant species.
- describe the structural details of different species of microorganisms & plants.

#### Unit 1      Microbes

Viruses: Discovery, General Structure, Replication, DNA Virus (T-phage), Lytic & Lysogenic Cycle (TMV). Economic Importance, Bacteria: Discovery, General Characteristics & Cell Structure, Vegetative, Asexual & Recombination (Conjugation, Transformation & Transduction), Economic Importance of Bacteria

#### Unit 2      Algae

General Characteristics: Ecology & Distribution, Range of Thallus Organization & Reproduction, Classification, Morphology & Life Cycles of *Nostoc*, *Chlamydomonas*, *Oedogonium*, *Vaucheria*, *Fucus*, *Polysiphonia*, Economic Importance

#### Unit 3      Fungi

Introduction: General Characteristics, Ecology & Significance, Range of Thallus Organization, Cell Wall Composition, Nutrition, Reproduction & Classification, True Fungi: General Characteristics, Ecology & Significance, Life Cycle of *Rhizopus* (Zygomycota) *Penicillium*, *Alternaria* (Ascomycota), *Puccinia*, *Agaricus* (Basidiomycota); Symbiotic Associations – Lichens: General Account, Reproduction & Significance, Mycorrhiza: Ectomycorrhiza & Endomycorrhiza & Significance

#### Unit 4      Archegoniates

Unifying Features of Archegoniates, Transition to Land Habit, Alternation of Generations

#### Unit 5      Bryophytes

General Characteristics: Adaptations to Land Habit, Classification, Range of Thallus Organization, Classification (up to family), Morphology, Anatomy & Reproduction of *Marchantia* & *Funaria* (Developmental details not to be included). Ecology & Economic Importance of Bryophytes with Special Mention on *Sphagnum*

#### Unit 6      Pteridophytes

General Characteristics: Classification, Early Land Plants (*Cooksonia* & *Rhynia*). Classification (up to family), Morphology, Anatomy & Reproduction of *Selaginella*, *Equisetum* & *Pteris* (Developmental details not to be included), Heterospory & Seed Habit, Stellar Evolution, Ecological & Economical Importance

#### Unit 7      Gymnosperms

General Characteristics, Classification. Classification (up to family), Morphology, Anatomy & Reproduction of *Cycas* & *Pinus* (Developmental details not to be included). Ecological & Economical Importance



# SEMESTER 01

## LIF112: BOTANY – Practicals-I

### Botany Practicals - 2 Credits: (3 Hrs/Week)

EMs/Models of Viruses: T-Phage & TMV, Line Drawing/Photograph of Lytic & Lysogenic Cycle

Types of Bacteria from Temporary/Permanent Slides/Photographs; EM bacterium; Binary Fission; Conjugation; Structure of Root Nodule

Gram Staining

Study of Vegetative & Reproductive Structures of *Nostoc*, *Chlamydomonas* (EM Images), *Oedogonium*, *Vaucheria*, *Fucus*\* & *Polysiphonia* through Temporary Preparations & Permanent Slides. (\**Fucus* - Specimen & Permanent Slides)

**Rhizopus & Penicillium:** Asexual Stage from Temporary Mounts & Sexual Structures through Permanent Slides

**Alternaria:** Specimens/Photographs & Tease Mounts

**Puccinia:** Herbarium Specimens of Black Stem Rust of Wheat & Infected Barberry Leaves; Section/Tease Mounts of Spores on Wheat & Permanent Slides of Both the Hosts

**Agaricus:** Specimens of Button Stage & Full Grown Mushroom; Sectioning of Gills of *Agaricus*

**Lichens:** Study of Growth Forms of Lichens (Crustose, Foliose & Fruticose)

**Mycorrhiza:** Ectomycorrhiza & Endomycorrhiza (Photographs)

**Marchantia:** Morphology of Thallus, w.m. Rhizoids & Scales, VS Thallus through Gemma Cup, WM Gemmae (all temporary slides), VS Antheridiophore, Archegoniophore, LS. Sporophyte (Permanent Slides)

**Funaria:** Morphology, WM Leaf, Rhizoids, Operculum, Peristome, Annulus, Spores (Temporary Slides); Permanent Slides Showing Antheridial & Archegonial Heads, LS Capsule & Protonema

**Selaginella:** Morphology, WM Leaf with Ligule, TS Stem, WM Strobilus, WM Microsporophyll & Megasporephyll (Temporary Slides), LS Strobilus (Permanent Slide)

**Equisetum:** Morphology, TS Internode, LS Strobilus, TS Strobilus, WM Sporangiphore, WM Spores (Wet & Dry) (Temporary Slides); TS Rhizome (Permanent Slide)

**Pteris:** Morphology, TS Rachis, VS Sporophyll, WM Sporangium, WM Spores (Temporary Slides), TS Rhizome, WM Prothallus with Sex Organs & Young Sporophyte (Permanent Slide)

**Cycas:** Morphology (Coralloid Roots, Bulbil, Leaf), TS Coralloid Root, TS Rachis, VS Leaflet, VS Microsporophyll, WM Spores (Temporary Slides), LS Ovule, TS Root (Permanent Slide)

**Pinus:** Morphology (Long & Dwarf Shoots, WM Dwarf Shoot, Male & Female), WM Dwarf Shoot, TS Needle, TS Stem, LS/TS Male Cone, WM Microsporophyll, WM Microspores (Temporary Slides), LS Female Cone, TLS & RLS Stem (Permanent Slide)



## SUGGESTED READING

- Alexopoulos CJ, Mims CW & Blackwell M.** (1996) *Introductory Mycology*. Wiley & Sons, Singapore.
- Bhatnagar SP & Moitra A.** (1996) *Gymnosperms*. New Age International (P) Ltd Publishers, New Delhi.
- Kumar HD.** (1999) *Introductory Phycology*. Affiliated East-West. Press Pvt. Ltd. Delhi.
- Parihar NS.** (1991) *An Introduction to Embryophyta. Vol. I. Bryophyta*. Central Book Depot, Allahabad.
- Raven PH, Johnson GB, Losos JB & Singer SR.** (2005) *Biology*. Tata McGraw Hill, Delhi, India.
- Sethi IK & Walia SK.** (2011) *Textbook of Fungi & Their Allies*. MacMillan Publishers Pvt. Ltd., Delhi.
- Tortora GJ, Funke BR & Case CL.** (2010) *Microbiology: An Introduction*. Pearson Benjamin, USA.
- Vashishta PC, Sinha AK & Kumar A.** (2010) *Pteridophyta*. S. Chand. Delhi, India.

# SEMESTER 01

## LIF113: ZOOLOGY

### Animal Diversity

**THEORY - 3 Credits: (3 Theory Hrs/Week)**

#### Learning Outcomes

On completion of this course, the student will be able to:

- understand the classification & distribution of animal species.
- describe the structural details of different species of animals.
- distinguish the anatomical and functional details of physiological systems in animal species.

#### Unit 1 Kingdom Protista

General Characters & Classification up to Classes; Locomotory Organelles & Locomotion in Protozoa

#### Unit 2 Phylum Porifera

General Characters & Classification up to Classes; Canal System in *Sycon*

#### Unit 3 Phylum Cnidaria

General Characters & Classification up to Classes; Polymorphism in Hydrozoa

#### Unit 4 Phylum Platyhelminthes

General Characters & Classification up to Classes; Life History of *Taenia solium*

#### Unit 5 Phylum Nematelminthes

General Characters & Classification up to Classes; Life History of *Ascaris lumbricoides* & its Parasitic Adaptations

#### Unit 6 Phylum Annelida

General Characters & Classification up to Classes; Metamerism in Annelida

#### Unit 7 Phylum Arthropoda

General Characters & Classification up to Classes; Vision in Arthropoda, Metamorphosis in Insects

#### Unit 8 Phylum Mollusca

General Characters & Classification up to Classes; Torsion in Gastropods

#### Unit 9 Phylum Echinodermata

General Characters & Classification up to Classes; Water-Vascular System in Asteroidea

**Unit 10    Protochordates**

General Features & Phylogeny of Protochordata

**Unit 11    Agnatha**

General Features of Agnatha & Classification of Cyclostomes up to Classes

**Unit 12    Pisces**

General Features & Classification up to Orders; Osmoregulation in Fishes

**Unit 13    Amphibia**

General Features & Classification up to Orders; Parental Care

**Unit 14    Reptiles**

General Features & Classification up to Orders; Poisonous & Non-Poisonous Snakes, Biting Mechanism in Snakes

**Unit 15    Aves**

General Features & Classification up to Orders; Flight Adaptations in Birds

**Unit 16    Mammalia**

Classification up to Orders; Origin of Mammals

*Note: Classification of Unit 1-9 to be followed from "Barnes, R.D. (1982). Invertebrate Zoology, V Edition"*

## SEMESTER 01

### LIF114: ZOOLOGY – Practicals-I

#### Zoology Practicals - 2 Credits: (3 Hrs/Week)

**Study of Specimens:** *Amoeba, Euglena, Plasmodium, Paramecium, Sycon, Hyalonema, & Euplectella, Obelia, Physalia, Aurelia, Tubipora, Metridium, Taenia solium, Male & female Ascaris lumbricoides, Aphrodite, Nereis, Pheretima, Hirudinaria, Palaemon, Cancer, Limulus, Palamnaeus, Scolopendra, Julus, Periplaneta, Apis, Chiton, Dentalium, Pila, Unio, Loligo, Sepia, Octopus, Pentaceros, Ophiura, Echinus, Cucumaria & Antedon, Balanoglossus, Herdmania, Branchiostoma, Petromyzon, Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis, Any Six Common Birds from Different Orders, Sorex, Bat, Funambulus, Loris*

**Study of Permanent Slides:** TS & LS of Sycon, Study of Life History Stages of *Taenia*, TS of Male & Female *Ascarids*

Key for Identification of Poisonous & Non-Poisonous Snakes

An "animal album" containing photographs, cut outs, with appropriate write up about the above mentioned taxa. Different taxa/ topics may be given to different sets of students for this purpose.

#### SUGGESTED READING

**Barnes RSK, et al.** (2002) *The Invertebrates: A New Synthesis*. Blackwell Science

**Hall BK & Hallgrímsson B.** (2008) *Strickberger's Evolution*. Jones & Bartlett Publishers Inc.

**Pough H.** *Vertebrate Life*. Pearson International.

**Ruppert & Barnes RD.** (2006) *Invertebrate Zoology*. Holt Saunders International Edition.

**Young JZ.** (2004) *The Life of Vertebrates*. Oxford University Press.



# SEMESTER 01

## CHE111: GENERAL CHEMISTRY

### THEORY - 3 Credits: (3 Theory Hrs/Week)

#### Unit 1 Atomic Structure

Review of: Bohr's Theory & its Limitations, Dual Behaviour of Matter & Radiation, De Broglie's Relation, Heisenberg Uncertainty Principle. Hydrogen Atom Spectra. Need of a New Approach to Atomic Structure. Introduction to Quantum Mechanics: Time Independent Schrodinger Equation & Meaning of Various Terms in it. Significance of  $\Psi$  &  $\Psi^2$ , Schrödinger Equation for Hydrogen Atom. Radial & Angular Parts of the Hydrogenic Wave Functions (Atomic Orbitals) & their Variations for 1s, 2s, 2p, 3s, 3p & 3d Orbitals (Only Graphical Representation). Radial & Angular Nodes & their Significance. Radial Distribution Functions & the Concept of the Most Probable Distance with Special Reference to 1s & 2s Atomic Orbitals. Discovery of Spin, Spin Quantum Number ( $S$ ) & Magnetic Spin Quantum Number ( $M_s$ ). Significance of Quantum Numbers, Orbital Angular Momentum & Quantum Numbers  $M_l$  &  $M_s$ . Shapes of S, P & D Atomic Orbitals, Nodal Planes. Rules for Filling Electrons in Various Orbitals, Electronic Configurations of the Atoms. Stability of Half-Filled & Completely Filled Orbitals, Concept of Exchange Energy. Relative Energies of Atomic Orbitals, Anomalous Electronic Configurations.

#### Unit 2 Chemical Bonding & Molecular Structure

Ionic Bonding: General Characteristics of Ionic Bonding. Energy Considerations in Ionic Bonding, Lattice Energy & Solvation Energy & their Importance in the Context of Stability & Solubility of Ionic Compounds. Statement of Born-Landé Equation for Calculation of Lattice Energy, Born-Haber Cycle & its Applications, Polarizing Power & Polarizability. Fajan's Rules, Ionic Character in Covalent Compounds, Bond Moment, Dipole Moment & Percentage Ionic Character.

#### Unit 3 Fundamentals of Organic Chemistry

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance & Hyperconjugation. Cleavage of Bonds: Homolysis & Heterolysis. Structure, Shape & Reactivity of Organic Molecules: Nucleophiles & Electrophiles. Reactive Intermediates: Carbocations, Carbanions & Free Radicals. Strength of Organic Acids & Bases: Comparative Study with Emphasis on Factors Affecting pK Values. Aromaticity: Benzenoids & Hückel's Rule.

#### Unit 4 Organic Stereochemistry

Conformations with Respect to Ethane, Butane & Cyclohexane. Interconversion of Wedge Formula, Newman, Sawhorse & Fischer Representations. Concept of Chirality (Up to Two Carbon Atoms). Configuration: Geometrical & Optical Isomerism; Enantiomerism, Diastereomerism & Meso Compounds). Threo & Erythro; D & L; Cis – Trans Nomenclature; CIP Rules: R / S (For up to 2 Chiral Carbon Atoms) & E / Z Nomenclature (For up to Two C=C Systems).

#### Unit 5 Chemical Energetics

Review of Thermodynamics & Laws of Thermodynamics. Important Principles & Definitions of Thermochemistry. Concept of Standard State & Standard Enthalpies of Formations, Integral & Differential Enthalpies of Solution & Dilution. Calculation of Bond Energy, Bond Dissociation Energy & Resonance Energy From Thermochemical Data. Variation of Enthalpy of a Reaction with Temperature – Kirchhoff's Equation. Statement of Third Law of Thermodynamics & Calculation of Absolute Entropies of Substances.

## **Unit 6    Ionic Equilibria**

Strong, Moderate & Weak Electrolytes, Degree of Ionization, Factors Affecting Degree of Ionization, Ionization Constant & Ionic Product of Water. Ionization of Weak Acids & Bases, pH Scale, Common Ion Effect. Salt Hydrolysis- Calculation of Hydrolysis Constant, Degree of Hydrolysis & pH for Different Salts. Buffer Solutions. Solubility & Solubility Product of Sparingly Soluble Salts – Applications of Solubility Product Principle.

## **Unit 7    Chemical Kinetics**

The Concept of Reaction Rates. Effect of Temperature, Pressure, Catalyst & Other Factors on Reaction Rates. Order & Molecularity of a Reaction. Derivation of Integrated Rate Equations for Zero, First & Second Order Reactions (Both for Equal & Unequal Concentrations of Reactants). Half-Life of a Reaction. General Methods for Determination of Order of a Reaction. Concept of Activation Energy & its Calculation from Arrhenius Equation. Theories of Reaction Rates: Collision Theory & Activated Complex Theory of Bimolecular Reactions. Comparison of the Two Theories (Qualitative Treatment Only).

## SEMESTER 02

### CHE112: GENERAL CHEMISTRY – Practicals

#### General Chemistry Practicals - 2 Credits: (3 Hrs/Week)

##### Thermochemistry:

1. Determination of Heat Capacity of Calorimeter for Different Volumes.
2. Determination of Enthalpy of Neutralization of HCl with NaOH.
3. Determination of Enthalpy of Ionization of CH<sub>3</sub>COOH.
4. Determination of Integral Enthalpy of Solution of Salts (KNO<sub>3</sub>, NH<sub>4</sub>Cl).
5. Determination of Enthalpy of Hydration of CuSO<sub>4</sub>.

##### Ionic Equilibria:

1. Measurement of pH of Different Solutions like Aerated Drinks, Fruit Juices, Shampoos & Soaps Using pH Meter.
2. Preparation of Buffer Solutions:
  - a) Sodium Acetate-Acetic Acid
  - b) Ammonium Chloride-Ammonium Hydroxide
3. Measurement of pH of Buffer Solutions & Comparison of the Values with Theoretical Values.

## SUGGESTED READING

- Alberty FA & Silby RJ.** *Physical Chemistry.* John Wiley.
- Atkins P & Paula J.** *The Elements of Physical Chemistry.* Oxford University Press
- Barrow GM.** *Physical Chemistry.* Tata McGraw Hill.
- Castellan GW** (2004). *Physical Chemistry.* Narosa Publishing House, New Delhi.
- Clayden J, Greeves N & Warren S** (2014). *Organic Chemistry.* Oxford University Press.
- Eliel EL** (2000). *Stereochemistry of Carbon Compounds.* Tata McGraw Hill Education.
- Finar IL** (2002). *Organic Chemistry.* Pearson Education.
- Graham Solomons TW, Fryhle CB, Snyder SA** (2016). *Organic Chemistry.* Wiley.
- James AM & Prichard FE** (1974). *Practical Physical Chemistry.*
- Kuhn H & Fosterling HD.** *Principles of Physical Chemistry.* John Wiley.
- Kumar S & Kumar N** (2012). *Physical Chemistry Practical.* New Central Book Agency.
- Laidler KJ** (2004). *Chemical Kinetics.* Pearson Education.
- McMurry JE** (2013). *Fundamentals of Organic Chemistry.* Cengage Learning India Edition.
- Moore WJ.** *Basic Physical Chemistry.* Orient Longman.
- Morrison RT, Boyd RN.** *Organic Chemistry.* Pearson Education.
- Puri BR, Sharma LR & Pathania MS.** Elements of Physical Chemistry, Vishal Pub. Co. Jalandhar
- Rajaram J & Kuriakose JC** (1986). *Thermodynamics.* Shoban Lal Nagin Chand & Co.
- Rastogi RP, Misra RR** (2003). *An Introduction to Chemical Thermodynamics.* Vikas Pub. Pvt. Ltd.
- Sharma KK & Sharma LK.** *A Textbook of Physical Chemistry.* Vikas publishing House
- Sykes P** (1988). *A Guidebook to Mechanism in Organic Chemistry.* Orient Longman, New Delhi.
- Vemulapalli GK** (1997). *Physical Chemistry.* Prentice-Hall of India Pvt. Ltd.
- Viswanathan B** (2005). *Practical Physical Chemistry.* Viva Pub.



## SEMESTER 02

### LIF101: BOTANY

#### Plant Ecology & Taxonomy

#### **THEORY - 3 Credits: (3 Theory Hrs/Week)**

#### **Learning Outcomes**

On completion of this course, the student will be able to:

- understand the ecological factors associated with evolution and adaptation of plant species.
- describe the different identification systems available to classify plant species.

#### **Unit 1 Introduction**

Introduction to Plant Ecology & Taxonomy

#### **Unit 2 Ecological Factors**

Soil: Origin, Formation, Composition, Soil Profile, Water: States of Water in the Environment, Precipitation Types, Light & Temperature: Variation Optimal & Limiting Factors, Shelford Law of Tolerance, Adaptation of hydrophytes & Xerophytes

#### **Unit 3 Plant Communities**

Characters; Ecotone & Edge Effect, Succession; Processes & Types

#### **Unit 4 Ecosystem**

Structure, Energy Flow Trophic Organisation, Food Chains & Food Webs, Ecological Pyramids Production & Productivity, Biogeochemical Cycling, Cycling of Carbon, Nitrogen & Phosphorous

#### **Unit 5 Phytogeography**

Principal Biogeographical Zones; Endemism

#### **Unit 6 Introduction to Plant Taxonomy**

Identification, Classification, Nomenclature

#### **Unit 7 Identification**

Functions of Herbarium, Important Herbaria & Botanical Gardens of the World & India, Documentation: Flora, Keys: Single Access & Multi-Access

#### **Unit 8 Taxonomic Evidences from Palynology, Cytology, Phytochemistry & Molecular Data**

Taxonomic Evidences from Palynology, Cytology, Phytochemistry & Molecular Data

## **Unit 9 Taxonomic Hierarchy**

Ranks, Categories & Taxonomic Groups

## **Unit 10 Botanical Nomenclature**

Principles & Rules (ICN); Ranks & Names; Binominal System, Typification, Author Citation, Valid Publication, Rejection of Names, Principle of Priority & its Limitations

## **Unit 11 Classification**

Types of Classification-Artificial, Natural & Phylogenetic. Bentham & Hooker (up to Series), Engler & Prantl (up to Series)

## **Unit 12 Biometrics, Numerical Taxonomy & Cladistics**

Characters; Variations; OTUs, Character Weighting & Coding; Cluster Analysis; Phenograms, Cladograms (Definitions & Differences)

## SEMESTER 02

### LIF102: BOTANY – Practicals-II

#### Botany Practicals - 2 Credits: (3 Hrs/Week)

Study of Instruments Used to Measure Microclimatic Variables: Soil Thermometer, Maximum & Minimum Thermometer, Anemometer, Psychrometer/Hygrometer, Rain Gauge & Lux Meter

Determination of pH, & Analysis of Two Soil Samples for Carbonates, Chlorides, Nitrates, Sulphates, Organic Matter & Base Deficiency by Rapid Field Test

Comparison of Bulk Density, Porosity & Rate of Infiltration of Water in Soil of Three Habitats

(A) Study of Morphological Adaptations of Hydrophytes & Xerophytes (Four Each)

(B) Study of Biotic Interactions of the Following: Stem Parasite (Cuscuta), Root Parasite (Orobanchae), Epiphytes, Predation (Insectivorous Plants)

Determination of Minimal Quadrat Size for the Study of Herbaceous Vegetation in CUTN by Species Area Curve Method (Species to be Listed)

Quantitative Analysis of Herbaceous Vegetation in the CUTN for Frequency & Comparison with Raunkiaer's Frequency Distribution Law

Study of Vegetative & Floral Characters of the Following Families (Description, VS Flower, Section of Ovary, Floral Diagram/S, Floral Formula/E & Systematic Position According to Bentham & Hooker's System of Classification):

Brassicaceae -*Brassica*, *Alyssum*/*Iberis*;

Asteraceae -*Sonchus*/*Launaea*, *Vernonia*/*Ageratum*, *Eclipta*/*Tridax*;

Solanaceae -*Solanum nigrum*, *Withania*;

Lamiaceae -*Salvia*, *Ocimum*;

Liliaceae -*Asphodelus*/*Lilium*/*Allium*

Mounting of a Properly Dried & Pressed Specimen of any Wild Plant with Herbarium Label (To be Submitted in the Record Book)

#### SUGGESTED READING

**Kormondy EJ.** (1996) *Concepts of Ecology*. Prentice Hall, USA.

**Sharma PD.** (2010) *Ecology & Environment*. Rastogi Publications, Meerut, India.

**Simpson MG.** (2006) *Plant Systematics*. Elsevier Academic Press, San Diego, CA, USA.

**Singh G.** (2012) *Plant Systematics: Theory & Practice*. Oxford & IBH Pvt. Ltd., New Delhi.



## SEMESTER 02

### LIF103: ZOOLOGY

#### Comparative Anatomy & Developmental Biology of Vertebrates

#### **THEORY - 3 Credits: (3 Theory Hrs/Week)**

#### **Learning Outcomes**

On completion of this course, the student will be able to:

- understand the comparative anatomy of body systems in vertebrate animal species
- describe the mechanisms of embryonic development in vertebrate animal species.

#### **Unit 1 Integumentary System**

Derivatives of Integument with Reference to Glands & Digital Tips

#### **Unit 2 Skeletal System**

Evolution of Visceral Arches

#### **Unit 3 Digestive System**

Brief Account of Alimentary Canal & Digestive Glands

#### **Unit 4 Respiratory System**

Brief Account of Gills, Lungs, Air Sacs & Swim Bladder

#### **Unit 5 Circulatory System**

Evolution of Heart & Aortic Arches

#### **Unit 6 Urogenital System**

Succession of Kidney, Evolution of Urinogenital Ducts

#### **Unit 7 Nervous System**

Comparative Account of Brain

#### **Unit 8 Sense Organs**

Types of Receptors

### **Unit 9 Early Embryonic Development**

Gametogenesis: Spermatogenesis & Oogenesis w.r.t. Mammals, Vitellogenesis in Birds; Fertilization: External (Amphibians), Internal (Mammals), Blocks to Polyspermy; Early Development of Frog & Humans (Structure of Mature Egg & its Membranes, Patterns of Cleavage, Fate Map, up to Formation of Gastrula); Types of Morphogenetic Movements; Fate of Germ Layers; Neurulation in Frog Embryo

### **Unit 10 Late Embryonic Development**

Implantation of Embryo in Humans, Formation of Human Placenta & Functions, Other Types of Placenta on the Basis of Histology; Metamorphic Events in Frog Life Cycle & its Hormonal Regulation.

### **Unit 11 Control of Development**

Fundamental Processes in Development (Brief Idea) – Gene Activation, Determination, Induction, Differentiation, Morphogenesis, Intercellular Communication, Cell movements & Cell Death

## SEMESTER 02

### LIF104: ZOOLOGY – Practicals-II

#### Zoology Practicals - 2 Credits: (3 Hrs/Week)

Osteology: a) Disarticulated Skeleton of Fowl & Rabbit; b) Carapace & Plastron of Turtle/Tortoise; c) Mammalian Skulls: One Herbivorous & One Carnivorous Animal

Frog - Study of Developmental Stages - Whole Mounts & Sections through Permanent Slides – Cleavage Stages, Blastula, Gastrula, Neurula, Tail Bud Stage, Tadpole External & Internal Gill Stages

Study of the Different Types of Placenta- Histological Sections through Permanent Slides or Photomicrographs

Study of Placental Development in Humans by Ultrasound Scans

Examination of Gametes - Frog/Rat - Sperm & Ova through Permanent Slides or Photomicrographs

#### SUGGESTED READING

**Balinsky BI.** (2008) *An Introduction to Embryology*. International Thomson Computer Press.

**Bruce MC.** (1996) *Patten's Foundations of Embryology*. McGraw Hill.

**Gilbert SF.** (2006) *Developmental Biology*. Sinauer Associates, Sunderland, Massachusetts, USA.

**Hilderbr& M & Gaslow GE.** (1998) *Analysis of Vertebrate Structure*. John Wiley & Sons.

**Kardong KV.** (2005) *Vertebrates' Comparative Anatomy. Function & Evolution*. McGraw-Hill Higher Education.

**Kent GC & Carr RK.** (2000) *Comparative Anatomy of the Vertebrates*. The McGraw-Hill Companies.

**Walter HE & Sayles LP.** (1949) *Biology of Vertebrates*. Khosla Publishing House.



## SEMESTER 02

### CHE211: PHYSICAL CHEMISTRY

#### THEORY - 3 Credits: (3 Theory Hrs/Week)

##### Unit 1 Chemical Equilibrium

Free Energy Change in a Chemical Reaction. Thermodynamic Derivation of the Law of Chemical Equilibrium. Distinction between  $\Delta G$  &  $\Delta G_0$ , Le Chatelier's Principle. Relationships between  $K_p$ ,  $K_c$  &  $K_x$  for Reactions involving Ideal Gases.

##### Unit 2 Solutions

Thermodynamics of Ideal Solutions: Ideal Solutions & Raoult's Law, Deviations from Raoult's Law – Non-Ideal Solutions. Vapour Pressure-Composition & Temperature Composition Curves of Ideal & Non-Ideal Solutions. Distillation of Solutions. Lever Rule. Azeotropes. Partial Miscibility of Liquids: Critical Solution Temperature; Effect of Impurity on Partial Miscibility of Liquids. Immiscibility of Liquids- Principle of Steam Distillation. Nernst Distribution Law & its Applications, Solvent Extraction.

##### Unit 3 Phase Equilibrium

Phases, Components & Degrees of Freedom of a System, Criteria of Phase Equilibrium. Gibbs Phase Rule & its Thermodynamic Derivation. Derivation of Clausius – Clapeyron Equation & its Importance in Phase Equilibria. Phase Diagrams of One-Component Systems (Water & Sulphur) & Two Component Systems Involving Eutectics, Congruent & Incongruent Melting Points (lead-silver,  $\text{FeCl}_3\text{-H}_2\text{O}$  & Na-K only).

##### Unit 4 Electrochemistry

Reversible & Irreversible Cells. Concept of EMF of A Cell. Measurement of EMF of a Cell. Nernst Equation & its Importance. Types of Electrodes. Standard Electrode Potential. Electrochemical Series. Thermodynamics of a Reversible Cell, Calculation of Thermodynamic Properties:  $\Delta G$ ,  $\Delta H$  &  $\Delta S$  from EMF Data. Calculation of Equilibrium Constant from EMF Data. Concentration Cells with Transference & Without Transference. Liquid Junction Potential & Salt Bridge. pH Determination Using Hydrogen Electrode & Quinhydrone Electrode. Potentiometric Titrations -Qualitative Treatment (Acid-Base & Oxidation-Reduction Only). Irreversible Electrode Processes – Overvoltage. Corrosion of Metals – Forms of Corrosion, Corrosion Monitoring & Prevention Methods.

##### Unit 5 Conductance

Conductivity, Equivalent & Molar Conductivity & their Variation with Dilution for Weak & Strong Electrolytes. Kohlrausch Law of Independent Migration of Ions. Transference Number & its Experimental Determination using Hittorf & Moving Boundary Methods. Ionic Mobility. Applications of Conductance Measurements: Determination of Degree of Ionization of Weak Electrolyte, Solubility & Solubility Products of Sparingly Soluble Salts, Ionic Product of Water, Hydrolysis Constant of a Salt. Conductometric Titrations (Only Acid-Base).



## SEMESTER 02

### CHE212: PHYSICAL CHEMISTRY – Practicals

#### Physical Chemistry Practicals - 2 Credits: (3 Hrs/Week)

**Distribution:**

1. Study the Partition of Solute in Two Immiscible Liquids
2. Study of the Equilibrium of the Following Reactions by the Distribution Method:  
 $I_2(aq) + I^-(aq) \rightarrow I_3^-(aq)$

**Phase Equilibria:**

1. Construction of the Phase Diagram of a Binary System (Simple Eutectic) Using Cooling Curves.
2. Determination of the Critical Solution Temperature & Composition of the Phenol Water System & Study of the Effect of Impurities on it.

**Potentiometry:** Perform the following potentiometric titrations:

1. Strong Acid Vs Strong Base
2. Weak Acid Vs Strong Base

**Conductance:** Conductometric titrations:

1. Strong Acid Vs Strong Base
2. Weak Acid Vs Strong Base

#### SUGGESTED READING

- Alberty FA & Silby RJ.** *Physical Chemistry*. John Wiley.
- Atkins P & Paula J.** *The Elements of Physical Chemistry*. Oxford University Press.
- Barrow GM** (2007). *Physical Chemistry*. Tata McGraw-Hill.
- Castellan GW** (2004). *Physical Chemistry*. Narosa.
- Garland GW, Nibler JW & Shoemaker DP** (2009). *Experiments in Physical Chemistry*. McGraw Hill.
- James AM & Prichard FE** (1974). *Practical Physical Chemistry*.
- Kapoor KL.** *A Textbook of Physical Chemistry*. Volume 1, Macmillan India Ltd.
- Kotz JC, Treichel PM & Townsend JR** (2009). *General Chemistry*. Cengage Learning. New Delhi.
- Kuhn H & Fosterling HD.** *Principles of Physical Chemistry*. John Wiley.
- Mahan BH** (1998). *University Chemistry*. Narosa.
- McQuarrie DA & Simon JD.** *Physical Chemistry – A Molecular Approach*. Viva Books Pvt. Ltd.
- Moore WJ.** *Basic Physical Chemistry*. Orient Longman.
- Petrucci RH** (1985). *General Chemistry*. Macmillan Publishing, New York.
- Puri BR, Sharma LR & Pathania MS.** *Elements of Physical Chemistry*. Vishal Publishers, Jalandhar.
- Rajaram J & Kuriakose JC** (1986). *Thermodynamics*. Shoban Lal Nagin Chand & Co.
- Rastogi RP & Misra RR** (2003). *An Introduction to Chemical Thermodynamics*. Vikas.
- Yadav JB** (2001). *Advanced Practical Physical Chemistry*. Goel Publishing House.

## SEMESTER 03

### LIF211: BOTANY

#### Plant Anatomy & Embryology

#### **THEORY - 3 Credits: (3 Theory Hrs/Week)**

#### **Learning Outcomes**

On completion of this course, the student will be able to:

- understand the anatomical and internal vascular transport structural details in plants
- discuss the developmental mechanisms operational in plant systems.

#### **Unit 1 Meristematic & Permanent Tissues**

Root & Shoot Apical Meristems; Simple & Complex Tissues

#### **Unit 2 Organs**

Structure of Dicot & Monocot Root, Stem & Leaf

#### **Unit 3 Secondary Growth**

Vascular Cambium – Structure & Function, Seasonal Activity. Secondary Growth in Root & Stem, Wood (Heartwood & Sapwood)

#### **Unit 4 Adaptive & Protective Systems**

Epidermis, Cuticle, Stomata; General Account of Adaptations in Xerophytes & Hydrophytes

#### **Unit 5 Structural Organization of Flower**

Structure of Anther & Pollen; Structure & Types of Ovules; Types of Embryo Sacs, Organization & Ultrastructure of Mature Embryo Sac

#### **Unit 6 Pollination & Fertilization**

Pollination Mechanisms & Adaptations; Double Fertilization; Seed-Structure Appendages & Dispersal Mechanisms

#### **Unit 7 Embryo & Endosperm**

Endosperm Types, Structure & Functions; Dicot & Monocot Embryo; Embryo-Endosperm Relationship

#### **Unit 8 Apomixis & Polyembryony**

Definition, Types & Practical Applications

## SEMESTER 03

### LIF212: BOTANY – Practicals-III

#### Botany Practicals - 2 Credits: (3 Hrs/Week)

Study of Meristems through Permanent Slides & Photographs.

Tissues (Parenchyma, Collenchyma & Sclerenchyma); Macerated Xylary Elements, Phloem (Permanent Slides, Photographs)

Stem: Monocot: *Zea mays*; Dicot: Helianthus; Secondary: Helianthus (Only Permanent Slides).

Root: Monocot: *Zea mays*; Dicot: Helianthus; Secondary: Helianthus (Only Permanent Slides).

Leaf: Dicot & Monocot Leaf (Only Permanent Slides).

Adaptive Anatomy: Xerophyte (Nerium Leaf); Hydrophyte (Hydrilla Stem).

Structure of Anther (Young & Mature), Tapetum (Amoeboid & Secretory) (Permanent Slides).

Types of Ovules: Anatropous, Orthotropous, Circinotropous, Amphitropous/Campylotropous.

Female Gametophyte: Polygonum (Monosporic) Type of Embryo Sac Development (Permanent Slides/Photographs).

Ultrastructure of Mature Egg Apparatus Cells through Electron Micrographs.

Pollination Types & Seed Dispersal Mechanisms (Including Appendages, Aril, Caruncle) (Photographs & Specimens).

Dissection of Embryo/Endosperm from Developing Seeds.

Calculation of Percentage of Germinated Pollen in a Given Medium.

#### SUGGESTED READING

**Bhojwani SS & Bhatnagar SP.** (2011) *Embryology of Angiosperms*. Vikas Publication House, New Delhi.

**Mauseth JD.** (1988) *Plant Anatomy*. The Benjamin/Cummings Publishers, USA.

# SEMESTER 03

## LIF213: ZOOLOGY

### Animal Physiology

#### **THEORY - 3 Credits: (3 Theory Hrs/Week)**

#### **Learning Outcomes**

On completion of this course, the student will be able to:

- understand the functional physiological mechanisms of different tissue & organ systems in mammals.
- describe the importance of tissues & organ systems for functional existence in animals.

#### **Unit 1 Membrane Physiology: Nerve & Muscle**

Structure of a Neuron, Resting Membrane Potential, Graded Potential, Origin of Action Potential & its Propagation in Myelinated & Non-Myelinated Nerve Fibres, Ultra-Structure of Skeletal Muscle, Molecular & Chemical Basis of Muscle Contraction

#### **Unit 2 Gastrointestinal Physiology**

Physiology of Digestion in the Alimentary Canal; Absorption of Carbohydrates, Proteins, Lipids

#### **Unit 3 Respiratory Physiology**

Pulmonary Ventilation, Respiratory Volumes & Capacities, Transport of Oxygen & Carbon Dioxide in Blood

#### **Unit 4 Excretory System: Kidneys & Acid-Base Balance**

Structure of Nephron, Mechanism of Urine Formation, Counter-Current Mechanism, Regulation of Acid-Base Balance, Normal pH of Body Fluids – Buffer Systems in Blood, Functions of Respiratory System & Kidneys for Maintenance of Acid-Base Balance, Disorders of Acid-Base Balance

#### **Unit 5 Cardiovascular Physiology**

Composition of Blood, Hemostasis, Structure of Heart, Origin & Conduction of the Cardiac Impulse, Cardiac Cycle

#### **Unit 6 Blood & Vascular Physiology**

Blood - Composition & Chemical Properties, Haematocrit, Changes/Abnormalities, Sedimentation Rate & Abnormalities, Erythrocytes – Structure, Size, Function, Normal Count, Polyglobulia, its Causes & Consequences. Anaemia & Consequences, Haemoglobin – Composition, Types, Main Derivatives, Haemostasis, Haemocoagulation – Extrinsic & Intrinsic Pathways, Haemocoagulation Factors, Vitamin K – Functions, Haemocoagulation Tests. Thrombocytes, Activity in Haemostasis - Haemopoiesis, Erythropoietin, Stimuli for its Synthesis & Secretion

## **Unit 7    Reproduction & Endocrine Glands**

Physiology of Male Reproduction: Hormonal Control of Spermatogenesis; Physiology of Female Reproduction: Hormonal Control of Menstrual Cycle, Structure & Function of Pituitary, Thyroid, Parathyroid, Pancreas & Adrenal

## **Unit 8    Physiology of Senses**

Structure & Function of Sensory Receptors, Adequate Stimulus, Sensory Pathways, Cortical Centres, Somatovisceral Sensory System. Tactile & Thermoceptive Sensitivity: Receptors – Structure & Function, Sensory Pathway, Cortical Centres. Pain – Receptors, Stimuli, Types of Pain, Mechanisms of Hypoalgesia, Vision: Refraction System – Structure, Function. Accommodation, Receptors for Vision, Adequate Stimulus, Colour Vision & its Disorders, Central & Peripheral Vision, Binocular Vision & 3D Perception, Sense of Hearing – External, Middle Inner Ear – Structure & Function. The Organ of Corti, Sound & its Intensity, Relations between Threshold Intensity & Frequency of Sound Waves, Audiometry. Auditory Pathway, Cortical Centre, Sense of Balance – Organs of Static & Dynamic Balance & Functions, Vestibular Pathway, Nystagmus

## SEMESTER 03

### LIF214: ZOOLOGY – Practicals-III

#### Zoology Practicals - 2 Credits: (3 Hrs/week)

Phlebotomy

Physiological Measurement of Blood Pressure (Sphygmomanometry), Body Temperature (Stethoscopy), ECG, EEG, EMG (using Automated Biopac Physiological Measurement System)

Study of Permanent Slides of Spinal Cord, Duodenum, Liver, Lung, Kidney, Bone, Cartilage

Preparation of Hemin & Hemochromogen Crystals

Study of Permanent Histological Sections of Mammalian Pituitary, Thyroid, Pancreas, Adrenal Gland

#### SUGGESTED READING

**Berg JM, Tymoczko JL & Stryer L.** (2006) *Biochemistry*. WH Freeman & Co.

**Guyton AC & Hall JE.** (2011) *Textbook of Medical Physiology*. Harcourt Asia Pvt. Ltd/WB Saunders, USA.

**Murray RK, Granner DK, Mayes PA & Rodwell VW.** (2009) *Harper's Illustrated Biochemistry*. Lange Medical Books/McGraw Hill.

**Nelson DL, Cox MM & Lehninger AL.** (2009) *Principles of Biochemistry*. WH Freeman & Co.

**Tortora GJ & Derrickson BH.** (2009) *Principles of Anatomy & Physiology*. John Wiley & Sons, Inc.

**Widmaier EP, Raff H & Strang KT.** (2008) *Vander's Human Physiology*. McGraw Hill.



## SEMESTER 03

### CHE211: INORGANIC CHEMISTRY

#### **THEORY - 3 Credits: (3 Theory Hrs/Week)**

##### **Unit 1 Covalent Bonding**

VB Approach: Shapes of Some Inorganic Molecules & Ions on the Basis of VSEPR & Hybridization with Suitable Examples of Linear, Trigonal Planar, Square Planar, Tetrahedral, Trigonal Bipyramidal & Octahedral Arrangements. Concept of Resonance & Resonating Structures in Various Inorganic & Organic Compounds. MO Approach: Rules for the LCAO Method, Bonding & Antibonding Mos & their Characteristics for S-S, S-P & P-P Combinations of Atomic Orbitals, Nonbonding Combination of Orbitals, MO Treatment of Homonuclear Diatomic Molecules of 1<sup>st</sup> & 2<sup>nd</sup> Periods (Including Idea of S-P Mixing) & Heteronuclear Diatomic Molecules Such as HF, CO, NO & NO<sup>+</sup>. Polyatomic Molecules BeH<sub>2</sub>, BH<sub>3</sub> & NH<sub>3</sub> - Walsh Diagram. Comparison of VB And MO Approaches.

##### **Unit 2 Transition Elements (3d Series)**

General Group Trends with Special Reference to Electronic Configuration, Variable Valency, Colour, Magnetic & Catalytic Properties, Ability to Form Complexes & Stability of Various Oxidation States (Latimer Diagrams) for Mn, Fe & Cu.

##### **Unit 3 Lanthanoids & Actinoids**

Electronic Configurations, Oxidation States, Colour, Magnetic Properties, Lanthanide Contraction, Separation of Lanthanides (Ion Exchange Method Only).

##### **Unit 4 Coordination Chemistry-I**

Ligands, IUPAC Nomenclature – Coordination Number, Geometries & Isomerism. Theories of Coordination Compounds - Werner's Theory.

##### **Unit 5 Valence Bond Theory (VBT)**

Inner & Outer Orbital Complexes of Cr, Fe, Co, Ni & Cu (Coordination Numbers 4 & 6). Structural & Stereoisomerism in Complexes with Coordination Numbers 4 & 6. Drawbacks of VBT.

##### **Unit 6 Crystal Field Theory**

Crystal Field Effect, Octahedral Symmetry. Crystal Field Stabilization Energy (CFSE), Crystal Field Effects for Weak & Strong Fields. Tetrahedral Symmetry. Factors Affecting the Magnitude of 10Dq. Spectrochemical Series. Comparison of CFSE for Oh & Td Complexes, Spectral & Magnetic Properties, Application of CFT, Tetragonal Distortion of Octahedral Geometry. Jahn-Teller Distortion, Square Planar Coordination.



## SEMESTER 03

### CHE212: INORGANIC CHEMISTRY – Practicals

#### Inorganic Chemistry Practicals - 2 Credits: (3 Hrs/week)

##### Volumetric Analysis:

1. Estimation of Sodium Carbonate & Sodium Hydrogen Carbonate Present in a Mixture.
2. Estimation of Oxalic Acid by Titrating it with  $\text{KMnO}_4$ .
3. Estimation of Water of Crystallization in Mohr's Salt by Titrating with  $\text{KMnO}_4$ .
4. Estimation of Fe (II) Ions by Titrating it with  $\text{K}_2\text{Cr}_2\text{O}_7$  using Internal Indicator.
5. Estimation of Cu (II) Ions Iodometrically using  $\text{Na}_2\text{S}_2\text{O}_3$ .
6. Estimation of (i)  $\text{Mg}^{2+}$  or (ii)  $\text{Zn}^{2+}$  by Complexometric Titrations using EDTA.
7. Estimation of Total Hardness of a Given Sample of Water by Complexometric Titration.

##### Qualitative Analysis:

Semi-micro Qualitative Analysis using  $\text{H}_2\text{S}$  of Mixtures - Not More than Four Ionic Species (Two Anions & Two Cations & Excluding Insoluble Salts) of the Following:

Cations :  $\text{NH}_4^+$ ,  $\text{Pb}_2^+$ ,  $\text{Ag}^+$ ,  $\text{Bi}_3^+$ ,  $\text{Cu}_2^+$ ,  $\text{Cd}_2^+$ ,  $\text{Sn}_2^+$ ,  $\text{Fe}_3^+$ ,  $\text{Al}_3^+$ ,  $\text{CO}_2^+$ ,  $\text{Cr}_3^+$ ,  $\text{Ni}_2^+$ ,  $\text{Mn}_2^+$ ,  $\text{Zn}_2^+$ ,  $\text{Ba}_2^+$ ,  $\text{Sr}_2^+$ ,  $\text{Ca}_2^+$ ,  $\text{K}^+$

Anions :  $\text{CO}_3^{2-}$ ,  $\text{S}_2^{2-}$ ,  $\text{SO}_3^{2-}$ ,  $\text{S}_2\text{O}_3^{2-}$ ,  $\text{NO}_3^-$ ,  $\text{CH}_3\text{COO}^-$ ,  $\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{I}^-$ ,  $\text{NO}_3^-$ ,  $\text{SO}_4^{2-}$ ,  $\text{PO}_4^{3-}$ ,  $\text{BO}_3^{3-}$ ,  $\text{C}_2\text{O}_4^{2-}$ ,  $\text{F}^-$  (Spot tests should be carried out wherever feasible)

#### SUGGESTED READING

- Cotton FA & Wilkinson G. Basic Inorganic Chemistry. Wiley.  
Department of Chemistry. In house Manual. CUTN, Thiruvapur.  
Douglas BE, et al. (2010) *Concepts & Models in Inorganic Chemistry*. John Wiley & Sons.  
Ghoshal, et al. (2011) *An Advanced Course in Practical Chemistry*. New Central Book Agency.  
Hein M, et al. (2011) *Foundations of College Chemistry in the Laboratory*. Wiley & Sons.  
Huheey JE, et al. (2006) *Inorganic Chemistry: Principles of Structure & Reactivity*. Pearson Education.  
Jeffery GH, et al. (1989) *Quantitative Chemical Analysis*. Longman Scientific & Technical.  
Lee JD. (1991) *Concise Inorganic Chemistry*. ELBS.  
Mahan BH. (1998) *University Chemistry*. Narosa.  
Mendham J. (2009) *Vogel's Quantitative Chemical Analysis*. Pearson.  
Mendham J, et al. (2000) *Vogel's Prescribed Book of Qualitative Chemical Analysis*. Prentice Hall.  
Petrucci RH. (1985) *General Chemistry*. Macmillan Publishing, New York.  
Rao CNR. (2001) *Understanding Chemistry*. University Press Ltd.  
Sarkar RP. (2011) *General & Inorganic Chemistry Part- I*. New Central Book Agency.  
Shriver D & Atkins PW. (2009). *Inorganic Chemistry*. W. H. freeman Company.  
Svehla G. (2012) *Vogel's Qualitative Inorganic Analysis*. Pearson Education.  
Woollins JD. (2012) *Inorganic Experiments*. Wiley-VCH Verlag GmbH Co.  
Wulfsberg G. (2014) *Inorganic Chemistry*. Viva Books.

## SEMESTER 03

### LIF215: ECONOMIC BOTANY

#### THEORY - 3 Credits: (3 Theory Hrs/Week)

#### Learning Outcomes

On completion of this course, the student will be able to:

- effectively demonstrate knowledge of the value of plants in our everyday lives.
- demonstrate the ability to identify & describe the impact of economic botany on the environment & society.

#### Unit 1 Origin of Cultivated Plants

Concept of Centres of Origin, Their Importance with Reference to Vavilov's Work

#### Unit 2 Cereals

Wheat, Corn, Rice - Origin, Morphology, Uses; Pseudocereals

#### Unit 3 Legumes

General Account with Special Reference to Gram & Soybean

#### Unit 4 Spices

General Account with Special Reference to Clove & Black Pepper (Botanical Name, Family, Part Used, Morphology & Uses)

#### Unit 5 Beverages

Tea, Coffee (Morphology, Processing, Uses)

#### Unit 6 Oils & Fats

General Description with Special Reference to Groundnut

#### Unit 7 Fibre Yielding Plants

General Account with Special Reference to Cotton (Botanical Name, Family, Part Used, Morphology & Uses)

#### SUGGESTED READING

- Kingsolver B.** (2007) *Animal, Vegetable, Miracle: A Year of Food Life*. HarperCollins, New York, NY, USA.
- Kochhar SL.** (2011) *Economic Botany in the Tropics*. MacMillan Publishers India Ltd., New Delhi.
- Schery RW.** (1972) *Plants for Man*. Prentice-Hall, Englewood Cliffs, NJ, USA.
- Simpson BB & Ogorzaly MC.** (2001) *Economic Botany: Plants in Our World*. McGraw-Hill.

## SEMESTER 03

### LIF215: BIOFERTILIZERS

#### SEC-1

#### THEORY - 2 Credits: (2 Theory Hrs/Week)

#### Learning Outcomes

On completion of this course, the student will be able to:

- understand the classification, importance & usefulness of biofertilizers used in organic farming.
- describe the basis of organic farming for human welfare.

#### Unit 1 Microbes as Biofertilizers

*Rhizobium* – Isolation, Identification, Mass Multiplication, Carrier-Based Inoculants, Actinorrhizal Symbiosis

#### Unit 2 *Azospirillum* & *Azotobacter*

*Azospirillum*: Isolation & Mass Multiplication – Carrier Based Inoculant, Associative Effect of Different Microorganisms. *Azotobacter*: Classification, Characteristics – Crop Response to *Azotobacter* Inoculum, Maintenance & Mass Multiplication

#### Unit 3 Cyanobacteria, *Azolla* & *Anabaena*

Cyanobacteria (Blue Green Algae), *Azolla* & *Anabaena* Association, Nitrogen Fixation, Factors Affecting Growth, Blue Green Algae & *Azolla* in Rice Cultivation

#### Unit 4 Mycorrhizae

Mycorrhizal Association, Types of Mycorrhizal Association, Taxonomy, Occurrence & Distribution, Phosphorus Nutrition, Growth & Yield – Colonization of VAM – Isolation & Inoculum Production of VAM, & its Influence on Growth & Yield of Crop Plants

#### Unit 5 Organic Farming

Organic Farming – Green Manuring & Organic Fertilizers, Recycling of Biodegradable Municipal, Agricultural & Industrial Wastes – Biocompost Making Methods, Types & Method of Vermicomposting – Field Application

#### SUGGESTED READING

- Dubey RC. (2005) *A Text Book of Biotechnology*. S. Chand & Co, New Delhi.
- John Jothi Prakash E. (2004) *Outlines of Plant Biotechnology*. Emkay Publications, New Delhi.
- Kumaresan V. (2005). *Biotechnology*. Saras Publications, New Delhi.
- Sathe TV. (2004) *Vermiculture & Organic Farming*. Daya publishers, India.
- Subha Rao NS. (2000). *Soil Microbiology*. Oxford & IBH Publishers, New Delhi.
- Vayas SC, Vayas S & Modi HA. (1998) *Bio-fertilizers & Organic Farming*. Akta Prakashan, Nadiad

# SEMESTER 04

## LIF201: BOTANY

### Plant Physiology & Metabolism

#### THEORY - 3 Credits: (3 Theory Hrs/Week)

#### Learning Outcomes

On completion of this course, the student will be able to:

- understand the association of plant with the immediate external environment and the factors contributing to existence of plant species.
- describe physiological mechanisms operational in plants for healthy survival & existence.
- understand how plants respond to different external & internal physiochemical factors.

#### Unit 1 Plant-Water Relationship

Importance of Water, Water Potential & its Components; Transpiration & its Significance; Factors Affecting Transpiration; Root Pressure & Guttation

#### Unit 2 Mineral Nutrition

Essential Elements, Macro & Micronutrients; Criteria of Essentiality of Elements; Role of Essential Elements; Transport of Ions Across Cell Membrane, Active & Passive Transport, Carriers, Channels & Pumps

#### Unit 3 Translocation in Phloem

Composition of Phloem Sap, Girdling Experiment; Pressure Flow Model; Phloem Loading & Unloading

#### Unit 4 Photosynthesis

Photosynthetic Pigments (Chl A, B, Xanthophylls, Carotene); Photosystem I & II, Reaction Center, Antenna Molecules; Electron Transport & Mechanism of ATP Synthesis; C<sub>3</sub>, C<sub>4</sub> & CAM Pathways of Carbon Fixation; Photorespiration

#### Unit 5 Enzymes

Structure & Properties; Mechanism of Enzyme Catalysis & Enzyme Inhibition

#### Unit 6 Nitrogen Metabolism

Biological Nitrogen Fixation; Nitrate & Ammonia Assimilation

#### Unit 7 Plant Growth Regulators

Discovery & Physiological Roles of Auxins, Gibberellins, Cytokinins, ABA, Ethylene

#### Unit 8 Plant Response to Light & Temperature

Photoperiodism (SDP, LDP, Day Neutral Plants); Phytochrome (Discovery & Structure), Red & Far Red Light Responses on Photomorphogenesis; Vernalization

## SEMESTER 04

### LIF202: BOTANY – Practicals-IV

#### Botany Practicals - 2 Credits: (3 Hrs/week)

Determination of Osmotic Potential of Plant Cell Sap by Plasmolytic Method

To Study the Effect of Two Environmental Factors (Light & Wind) on Transpiration by Excised Twig

Calculation of Stomatal Index & Stomatal Frequency of a Mesophyte & a Xerophyte

Demonstration of Hill Reaction

Demonstrate the Activity of Catalase & Study the Effect of pH & Enzyme Concentration

To Study the Effect of Light Intensity & Bicarbonate Concentration on O<sub>2</sub> Evolution in Photosynthesis

Comparison of the Rate of Respiration in any Two Parts of a Plant

Separation of Amino Acids by Paper Chromatography

Demonstration Experiments (any Four): Bolting/Effect of Auxins on Rooting/Suction Due to Transpiration/RQ/Respiration in Roots

#### SUGGESTED READING

- Bajracharya D.** (1999) *Experiments in Plant Physiology - A Laboratory Manual*. Narosa Publishing, New Delhi.
- Hopkins WG & Huner NP.** (2009) *Introduction to Plant Physiology*. John Wiley & Sons, USA.
- Taiz L & Zeiger E.** (2010) *Plant Physiology*. Sinauer Associates Inc, USA.

# SEMESTER 04

## LIF203: ZOOLOGY

### Genetics & Evolutionary Biology

#### THEORY - 3 Credits: (3 Theory Hrs/Week)

#### Learning Outcomes

On completion of this course, the student will be able to:

- understand the principles of genetic mechanisms of inheritance in animal species.
- understand the evolution of animal species on earth & discuss the concepts and principles of evolutionary biology.

#### Unit 1 Mendelian Principles & Extensions of Mendelian Principles

Principles of Mendelian Inheritance, Dominance & Recessive, Segregation, Independent Assortment, Epistasis, Allele, Multiple Alleles, Pseudo Allele, Lethal Alleles, Complementation Tests, Codominance, Incomplete Dominance, Gene Interactions, Pleiotropy, Genomic Imprinting, Penetrance & Expressivity, Phenocopy, Autosomal & Sex Linked Inheritance, Extra-Chromosomal Inheritance

#### Unit 2 Linkage, Crossing Over & Chromosomal Mapping

Linkage & Crossing Over, Recombination Frequency as a Measure of Linkage Intensity, Two Factor & Three Factor Crosses, Interference & Coincidence, Somatic Cell Genetics - An Alternative Approach to Gene Mapping, Sex Linkage, Pedigree Analysis

#### Unit 3 Sex Determination

Dosage Compensation, Chromosomal Basis of Sex- Determination in Animals & Plants, Dosage Compensation of X-Linked Genes, Lampbrush Chromosome & their Function, Polytene Chromosome & Gene Expression

#### Unit 4 Mutations

Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy & Polyploidy; Gene Mutations: Induced Versus Spontaneous Mutations, Back Versus Suppressor Mutations, Change in Chromosome Number, Somatic Vs Germinal Mutation, Types, Causes & Detection Of Mutation

#### Unit 5 Introduction to Evolutionary Theories & Evidences of Evolution

Major Events in History of Life, Mass Extinction (Causes, Names of Five Major Extinctions, K-T Extinction in Detail), Lamarckism, Darwinism, Neo-Darwinism, Macro-Evolutionary Principles (Example: Darwin's Finches), Role of Extinction in Evolution, Types of Fossils, Incompleteness of Fossil Record, Dating of Fossils, Phylogeny of Horse

#### Unit 6 Processes of Evolutionary Change & Biological Speciation

Organic Variations; Isolating Mechanisms; Natural Selection (E.g. Industrial Melanism); Types of Natural Selection (Directional, Stabilizing, Disruptive), Artificial Selection, Biological Species Concept (Advantages & Limitations); Modes of Speciation (Allopatric, Sympatric)

**Unit 7****Population & Evolutionary Genetics**

Hardy Weinberg Principal for Calculating Recessive Gene Frequency, Calculating Frequency of Sex –Linked Alleles, Calculation of Allele Frequencies, Evolutionary Change by Mutation, Gene Flow, Genetic Drift, Natural Selection & Non-Random Mating, Molecular Clocks, Origin of New Genes & Proteins; Gene Duplication & Divergence. Gene Families: Multigene Families – Classical Gene Families, Families with Large Conserved Domains, Families with Small Conserved Domains, Gene Superfamilies, Gene Families in Clusters, Pseudogenes, Repetitive DNA & Transposable Elements, Origin of Gene Families Organization of Genes Coding for rRNA, mRNA, Small Nuclear RNA

## SEMESTER 04

### LIF204: ZOOLOGY – Practicals-IV

#### Zoology Practicals - 2 Credits: (3 Hrs/Week)

Study of Mendelian Inheritance & Gene Interactions (Non Mendelian Inheritance) Using Suitable Examples. Verify the Results Using Chi-Square Test

Study of Linkage, Recombination, Gene Mapping Using the Data

Study of Human Karyotypes (Normal & Abnormal)

Study of Fossil Evidences from Plaster Cast Models & Pictures

Study of Homology & Analogy from Suitable Specimens/Pictures

Charts:

A) Phylogeny of Horse with Diagrams/Cut Outs of Limbs & Teeth of Horse Ancestors

B) Darwin's Finches With Diagrams/Cut Outs of Beaks of Different Species

Visit to Natural History Museum & Submission of Report

#### SUGGESTED READING

**Barton NH, et al.** (2007) *Evolution*. Cold Spring, Harbour Laboratory Press.

**Campbell NA & Reece JB.** (2011) *Biology*. Pearson, Benjamin-Cummings.

**Futuyma DJ.** (1997) *Evolutionary Biology*. Sinauer Associates

**Gardner EJ, Simmons MJ & Snustad DP.** (2008) *Principles of Genetics*. Wiley India.

**Griffiths AJF, et al.** *Introduction to Genetic Analysis*. WH Freeman & Co.

**Hall BK & Hallgrimsson B.** (2008) *Evolution*. Jones & Bartlett Publishers

**Klug WS, Cummings MR & Spencer CA.** (2012) *Concepts of Genetics*. Benjamin Cummings.

**Ridley M.** (2004) *Evolution*. Blackwell Publishing.

**Russell PJ.** (2009) *Genetics- A Molecular Approach*. Benjamin Cummings, USA.

**Snustad DP & Simmons MJ.** (2009) *Principles of Genetics*. John Wiley & Sons Inc.



## SEMESTER 04

### CHE201: ORGANIC CHEMISTRY

#### THEORY - 3 Credits: (3 Theory Hrs/Week)

##### Unit 1 Aromatic Hydrocarbons

Preparation (Case Benzene) from Phenol, by Decarboxylation, from Acetylene, from Benzene Sulphonic Acid. Reactions: (Case Benzene): Electrophilic Substitution: Nitration, Halogenation & Sulphonation. Friedel-Craft's Reaction (Alkylation & Acylation) (Up to 4 Carbons on Benzene). Side Chain Oxidation of Alkyl Benzenes (Up to 4 Carbons on Benzene)

##### Unit 2 Alkyl, Aryl Halides & Aryalkyl Halides (Up to 5 Carbons)

Types of Nucleophilic Substitution (SN1, SN2 & SNi) Reactions. Preparation: From Alkenes & Alcohols. Reactions: Hydrolysis, Nitrite & Nitro Formation, Nitrile & Isonitrile Formation. Williamson's Ether Synthesis: Elimination Vs Substitution. Aryl Halides Preparation: (Chloro, Bromo & Iodo-Benzene Case): From Phenol, Sandmeyer & Gattermann Reactions. Reactions (Chlorobenzene): Aromatic Nucleophilic Substitution (Replacement By -OH Group) & Effect of Nitro Substituent. Benzyne Mechanism: KNH<sub>2</sub>/NH<sub>3</sub> (or NaNH<sub>2</sub>/NH<sub>3</sub>). Reactivity & Relative Strength of C-Halogen Bond in Alkyl, Allyl, Benzyl, Vinyl & Aryl Halides

##### Unit 3 Alcohols, Phenols & Ethers (Up to 5 Carbons)

Alcohols: Preparation of 10, 20 & 30 Alcohols: Using Grignard Reagent, Ester Hydrolysis, Reduction of Aldehydes, Ketones, Carboxylic Acid & Esters. Reactions: With Sodium, HX (Lucas Test), Esterification, Oxidation (With PCC, Alk. KmnO<sub>4</sub>, Acidic Dichromate, Conc. HNO<sub>3</sub>). Oppeneauer Oxidation Diols: (Up to 6 Carbons) Oxidation of Diols

##### Unit 4 Phenols

Phenols: Preparation: Cumene Hydroperoxide Method, from Diazonium Salts. Reactions: Electrophilic Substitution: Nitration, Halogenation & Sulphonation. Reimer Tiemann Reaction, Gattermann-Koch Reaction, Houben-Hoesch Condensation, Schotten - Baumann Reaction. Ethers (Aliphatic & Aromatic): Cleavage of Ethers with HI

##### Unit 5 Aldehydes & Ketones (Aliphatic & Aromatic)

(Formaldehyde, Acetaldehyde, Acetone & Benzaldehyde) Preparation: from Acid Chlorides & from Nitriles. Reactions - Reaction with HCN, ROH, NaHSO<sub>3</sub>, NH<sub>2</sub>-G Derivatives. Iodoform Test. Aldol Condensation, Cannizzaro's Reaction, Wittig Reaction, Benzoin Condensation. Clemensen Reduction & Wolff Kishner Reduction. Meerwein-Ponndorf Verley Reduction

##### Unit 6 Carboxylic Acids & Their Derivatives

Carboxylic Acids (Aliphatic & Aromatic): Preparation: Acidic & Alkaline Hydrolysis of Esters. Reactions: Hell - Vohlard - Zelinsky Reaction. Carboxylic Acid Derivatives (Aliphatic): (Up to 5 carbons) Preparation: Acid Chlorides, Anhydrides, Esters & Amides from Acids & their Interconversion. Reactions: Comparative Study of Nucleophilicity of Acyl Derivatives. Reformatsky Reaction, Perkin Condensation.

### **Unit 7 Amines & Diazonium Salts Amines (Aliphatic & Aromatic) (Up to 5 Carbons)**

Preparation: from Alkyl Halides, Gabriel's Phthalimide Synthesis, Hofmann Bromamide Reaction. Reactions: Hofmann Vs Saytzeff Elimination, Carbylamine Test, Hinsberg Test, with  $\text{HNO}_2$ , Schotten – Baumann Reaction. Electrophilic Substitution (Case Aniline): Nitration, Bromination, Sulphonation. Diazonium Salts: Preparation: From Aromatic Amines. Reactions: Conversion to Benzene, Phenol, Dyes.

### **Unit 8 Amino Acids, Peptides & Proteins**

Preparation of Amino Acids: Strecker Synthesis using Gabriel's Phthalimide Synthesis. Zwitterion, Isoelectric Point & Electrophoresis. Reactions of Amino Acids: Ester of  $-\text{COOH}$  Group, Acetylation of  $-\text{NH}_2$  Group, Complexation with  $\text{Cu}_2^+$  Ions, Ninhydrin Test. Overview of Primary, Secondary, Tertiary & Quaternary Structure of Proteins. Determination of Primary Structure of Peptides by Degradation Edmann Degradation (N-Terminal) & C-Terminal (Thiohydantoin & with Carboxypeptidase Enzyme). Synthesis of Simple Peptides (Up to Dipeptides) by N-Protection (T-Butyloxycarbonyl & Phthaloyl) & Carbon Activating Groups & Merrifield Solid-Phase Synthesis.

### **Unit 9 Carbohydrates**

Classification & General Properties, Glucose & Fructose (Open Chain & Cyclic Structure), Determination of Configuration of Monosaccharides, Absolute Configuration of Glucose & Fructose, Mutarotation, Ascending & Descending in Monosaccharides. Structure of Disaccharides (Sucrose, Cellobiose, Maltose, Lactose) & Polysaccharides (Starch & Cellulose) Excluding their Structure Elucidation.

## SEMESTER 04

### CHE202: ORGANIC CHEMISTRY – Practicals

#### Organic Chemistry Practicals - 2 Credits: (3 Hrs/Week)

##### 1. Organic Qualitative Analysis:

Systematic Qualitative Analysis of Organic Compounds possessing Monofunctional Groups (-COOH, Phenolic, Aldehydic, Ketonic, Amide, Nitro, Amines) & Preparation of One Derivative.

##### 2. Preparations & Characterizations:

Separation of Amino Acids/Organic Compounds by Chromatography (Paper/TLC).

- A. Titration Curve of Glycine.
- B. Action of Salivary Amylase on Starch & Effect of Temperature
- C. Differentiation between a Reducing & a Non-Reducing Sugar.

#### SUGGESTED READING

- Ahluwalia VK & Aggarwal R.** *Comprehensive Practical Organic Chemistry*. Universities Press.
- Barrow GM** (2007) *Physical Chemistry*. Tata McGraw-Hill.
- Berg JM, Tymoczko JL & Stryer L** (2002) *Biochemistry*. WH Freeman.
- Castella GW** (2004) *Physical Chemistry*. Narosa.
- Finar IL** (2002) *Organic Chemistry Vol I*. Pearson Education.
- Finar IL** (2002) *Organic Chemistry Vol II*. Pearson Education.
- Kotz JC, et al.** (2009) *General Chemistry*. Cengage Learning, New Delhi.
- Mahan BH** (1998) *University Chemistry*. Narosa.
- Mann FG & Saunders BC** (1960) *Practical Organic Chemistry*. Orient-Longman.
- Morrison RT & Boyd RN** (2010) *Organic Chemistry*. Pearson Education.
- Nelson DL & Cox MM** (2017) *Lehninger's Principles of Biochemistry*. WH Freeman.
- Petrucci RH** (1985) *General Chemistry*. Macmillan Publishing, New York.
- Vogel AI, et al.** (1996) *Textbook of Practical Organic Chemistry*. Prentice-Hall.

## SEMESTER 04

### LIF205: ECONOMIC ZOOLOGY

#### THEORY - 2 Credits: (2 Theory Hrs/Week)

#### Learning Outcomes

On completion of this course, the student will be able to:

- understand the principles and economic importance of sericulture & apiculture.

#### Unit 1 Sericulture

Definition, History & Present Status, Silk Route, Types of Silkworms, Distribution & Races, Exotic & Indigenous Races, Mulberry & Non-Mulberry Sericulture

#### Unit 2 Biology & Rearing of Silk Worm

Life Cycle of *Bombyx mori*, Structure of Silk Gland & Secretion of Silk, Selection of Mulberry Variety & Establishment of Mulberry Garden, Rearing House & Rearing Appliances; Disinfectants: Formalin, Bleaching Powder, RKO, Silkworm Rearing Technology: Early Age & Late Age Rearing; Types of Mountages, Spinning, Harvesting & Storage of Cocoons

#### Unit 3 Pests & Diseases of Silk Worm

Pests of Silkworm: Uzi Fly, Dermestid Beetles & Vertebrates; Pathogenesis of Silkworm Diseases: Protozoan, Viral, Fungal & Bacterial; Control & Prevention of Pests & Diseases

#### Unit 4 Entrepreneurship in Sericulture

Prospectus of Sericulture in India: Sericulture Industry in Different States, Employment, Potential in Mulberry & Non-Mulberry Sericulture.

#### Unit 4 Apiculture: Biology & Rearing of Bees

History, Classification & Biology of Honey Bees Social Organization of Bee Colony, Artificial Bee Rearing (Apiary), Beehives – Newton & Langstroth; Bee Pasturage, Selection of Bee Species for Apiculture; Bee Keeping Equipment; Methods of Extraction of Honey (Indigenous & Modern)

#### Unit 4 Bee Enemies & Diseases, Economy & Entrepreneurship in Apiculture

Bee Diseases & Enemies, Control & Preventive Measures; Bee Economy: Products of Apiculture Industry & its Uses (Honey, Bees Wax, Propolis), Pollen etc.; Entrepreneurship in Apiculture: Bee Keeping Industry – Recent Efforts, Modern Methods in Employing Artificial Beehives for Cross Pollination in Horticultural Gardens

## SUGGESTED READING

**Bisht DS.** *Apiculture*. ICAR Publications.

**Chun W & Da-Chung C.** (1988) *Silkworm Rearing*. FAO, Rome.

**Krishnaswamy S.** (1986) *Improved Method of Rearing Young Age Silkworm*. CSB, Bangalore.

**Narasimhanna MN.** (1988) *Manual of Silkworm Egg Production*. CSB, Bangalore.

**Prost PJ.** (1962) *Apiculture*. Oxford & IBH, New Delhi.

**Sengupta K.** (1989) *A Guide for Bivoltine Sericulture*. CSR & TI, Mysore.

**Singh S.** *Beekeeping in India*. Indian Council of Agricultural Research, New Delhi.

# SEMESTER 04

## LIF206: MEDICAL DIAGNOSTICS

### SEC-2

#### THEORY - 2 Credits: (2 Theory Hrs/Week)

#### Learning Outcomes

On completion of this course, the student will be able to:

- understand the types, working principle & importance of diagnostic tests against communicable & non-communicable diseases in humans.

#### Unit 1 Introduction to Medical Diagnostics & its Importance

Introduction to Medical Diagnostics & the Significance of Diagnosis in Human Diseases

#### Unit 2 Diagnostics Methods Used for Analysis of Blood

Blood Composition, Preparation of Blood Smear & Differential Leucocyte Count (DLC) Using Leishman's Stain, Platelet Count Using Haemocytometer, Erythrocyte Sedimentary Rate (ESR), Packed Cell Volume

#### Unit 3 Diagnostic Methods Used for Urine Analysis

Urine Analysis: Physical Characteristics; Abnormal Constituents

#### Unit 4 Non-infectious Diseases

Causes, Types, Symptoms, Complications, Diagnosis & Prevention of Diabetes (Type I & Type II), Hypertension (Primary & Secondary), Testing of Blood Glucose Using Glucometer/Kit

#### Unit 5 Infectious Diseases

Causes, Types, Symptoms, Diagnosis & Prevention of Tuberculosis & Hepatitis

#### Unit 6 Tumors

Types (Benign/Malignant), Detection & Metastasis; Medical Imaging: X-Ray of Bone Fracture, PET, MRI & CT Scan (Using Photographs)

#### SUGGESTED READING

- Cheesbrough M.** (1976) *A Laboratory Manual for Rural Tropical Hospitals - A Basis for Training Courses*, UK.
- Godkar PB & Godkar DP.** (2005) *Textbook of Medical Laboratory Technology*. Bhalani Publishing House.
- Guyton AC & Hall JE.** (2010) *Textbook of Medical Physiology*. Saunders, USA.
- Park K.** (2007) *Preventive & Social Medicine*. BB. Publishers.
- Prakash G.** (2012) *Lab Manual on Blood Analysis & Medical Diagnostics*. S. Chand & Co. Ltd.
- Robbins & Cortan.** (2004) *Pathologic Basis of Disease*. Saunders, USA.



# SEMESTER 05

## LIF311: BIOINFORMATICS

### DSE

#### **THEORY - 3 Credits: (3 Theory Hrs/Week)**

#### **Learning Outcomes**

On completion of this course, the student will be able to:

- understand the basic principles & concepts of biology, computer science & mathematics.
- use existing software effectively to extract information from large databases & to use this information in computer modeling.
- enhance problem-solving skills, including the ability to develop new algorithms & analysis methods
- understand the intersection of life & information sciences, the core of shared concepts, language & skills the ability to speak the language of structure-function relationships, information theory, gene expression, & database queries.

#### **Unit 1 Introduction to Bioinformatics**

Introduction, Branches of Bioinformatics, Aim, Scope & Research Areas of Bioinformatics.

#### **Unit 2 Databases in Bioinformatics**

Introduction, Biological Databases, Classification Format of Biological Databases, Biological Database Retrieval System

#### **Unit 3 Biological Sequence Databases**

National Center for Biotechnology Information (NCBI): Tools & Databases of NCBI, Database Retrieval Tool, Sequence Submission to NCBI, Basic Local Alignment Search Tool (BLAST), Nucleotide Database, Protein Database, Gene Expression Database. EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, Sequence Retrieval, Sequence Submission to EMBL, Sequence Analysis Tools. DNA Data Bank of Japan (DDBJ): Introduction, Resources at DDBJ, Data Submission At DDBJ. Protein Information Resource (PIR): About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR. Swiss-Prot: Introduction & Salient Features

#### **Unit 4 Sequence Alignments**

Introduction, Concept of Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM)

#### **Unit 5 Molecular Phylogeny**

Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction

#### **Unit 6 Applications of Bioinformatics**

Structural Bioinformatics in Drug Discovery, Quantitative Structure-Activity Relationship (QSAR) Techniques in Drug Design, Microbial Genome Applications, Crop Improvement

## SEMESTER 05

### LIF312: BIOINFORMATICS – Practicals

#### **Bioinformatics Practicals - 2 Credits: (3 Hrs/week)**

Nucleic Acid & Protein Databases

Sequence Retrieval from Databases

Sequence Alignment

Sequence Homology & Gene Annotation

Construction of Phylogenetic Tree

#### SUGGESTED READING

- Campbell AM & Heyer LJ.** (2006) *Discovering Genomics, Proteomics & Bioinformatics*. Benjamin Cummings.  
**Ghosh Z & Bibek M.** (2008) *Bioinformatics: Principles & Applications*. Oxford University Press.  
**Pevsner J.** (2009) *Bioinformatics & Functional Genomics*. Wiley-Blackwell Publishing.





## SEMESTER 05

### LIF313: ANIMAL BIOTECHNOLOGY

**THEORY - 3 Credits: (3 Theory Hrs/Week)**

#### Learning Outcomes

On completion of this course, the student will be able to:

- understand the applications of biotechnology and advances in the different areas like medical, microbial, environmental, bioremediation, agricultural, plant, animal & forensics.
- describe the steps involved in the production of biopharmaceuticals in microbial, plant & mammalian systems.
- explain the general principles of generating transgenic plants, animals & microbes.

#### Unit 1 Introduction

Concept & Scope of Biotechnology

#### Unit 2 Molecular Techniques in Gene Manipulation

Cloning Vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, M13, BAC, YAC, MAC & Expression Vectors (Characteristics), Restriction Enzymes: Nomenclature, Detailed Study of Type II. Transformation Techniques: Calcium Chloride Method & Electroporation. Construction of Genomic & cDNA Libraries & Screening by Colony & Plaque Hybridization, Southern, Northern & Western Blotting; DNA Sequencing: Sanger Method, Polymerase Chain Reaction, DNA Fingerprinting & DNA Micro Array

#### Unit 3 Genetically Modified Organisms

Production of Cloned & Transgenic Animals: Nuclear Transplantation, Retroviral Method, DNA Microinjection, Applications of Transgenic Animals: Production of Pharmaceuticals, Production of Donor Organs, Knockout Mice. Production of Transgenic Plants: *Agrobacterium*-Mediated Transformation. Applications of Transgenic Plants: Insect & Herbicide Resistant Plants

#### Unit 4 Culture Techniques & Applications

Animal Cell Culture, Expressing Cloned Genes in Mammalian Cells, Molecular Diagnosis of Genetic Diseases (Cystic Fibrosis, Sickle Cell Anemia), Recombinant DNA in Medicines: Recombinant Insulin & Human Growth Hormone, Gene Therapy

## SEMESTER 05

### LIF314: ANIMAL BIOTECHNOLOGY – Practicals

#### Animal Biotechnology Practicals - 2 Credits: (3 Hrs/Week)

Genomic DNA Isolation from *E. coli*.

Plasmid DNA Isolation (pUC 18/19) from *E. coli*.

Restriction Digestion of Plasmid DNA.

Construction of Circular & Linear Restriction Map from the Data Provided.

Calculation of Transformation Efficiency from the Data Provided.

To Study the Following Techniques Through Photographs:

Southern Blotting

Northern Blotting

Western Blotting

DNA Sequencing (Sanger's Method)

PCR

DNA Fingerprinting

Project Report on Animal Cell Culture

#### SUGGESTED READING

**Beauchamp TI & Childress JF.** (2008) *Principles of Biomedical Ethics*. Oxford University Press.

**Brown TA.** (1998) *Molecular Biology Labfax II: Gene Cloning & DNA Analysis*. Academic Press, California.

**Glick BR & Pasternak JJ.** (2009) *Molecular Biotechnology - Principles & Applications of Recombinant DNA*. ASM Press, Washington.

**Griffiths AJF, et al.** (2009) *An Introduction to Genetic Analysis*. Freeman & Co. NY, USA.

**Snustad DP & Simmons MJ.** (2009) *Principles of Genetics*. John Wiley & Sons Inc.

**Watson JD, Myers RM, Caudy A & Witkowski JK.** (2007) *Recombinant DNA Genes & Genomes- A Short Course*. Freeman & Co. NY, USA.

# SEMESTER 05

## LIF315: DRUG DISCOVERY & DESIGN

**THEORY - 3 Credits: (3 Theory Hrs/Week) (Lectures: 45)**

### Learning Outcomes

On completion of this course, the student will be able to:

- understand the theoretical & practical importance of molecular pharmacology, drug design & discovery.
- use the knowledge gained for commercial projects related to drug discovery & developments.

#### Unit 1 Introduction to Drug Designing

Introduction, Drug-Like Properties & Drugable Targets

#### Unit 2 *In Silico* Pharmacology

*In silico* Pharmacology, Docking, Molecular Simulation, Medium Throughput, High Throughput & Ultrahigh Throughput Assay Platforms, *In vitro* & *In vivo* Pharmacological Assays

#### Unit 4 Molecular Dynamics

Target Identification, Target Validation, Lead; Identification & Lead Identification. Economics of Drug Discovery, Structure-Related Drug-Like Criteria of Global Approved Drugs

#### Unit 5 Drug Prediction

Anti-Microbials, Anti-Obesity, Anti-Inflammatory, Anti-Viral Anti-Cancer, Anti-Angina, Anti-Atherosclerotic, Anti-Hypersensitive Anti-Alzheimer's & Parkinson's, Anti-Depressive, Anti-Epileptic Drug Discovery

#### Unit 5 Pharmacokinetics & Pharmacodynamics

Pharmacokinetics & Pharmacodynamics, Mode of Drug Administration, Drug-Drug Interactions, Drug-Food Interactions

#### Unit 5 Drug Metabolism

Drug Metabolism, Toxicological Studies, Drug Safety, Modern Pharmaceutical & Analytical Techniques, Small Molecule Discovery in Academia, Intellectual Property Rights

## SEMESTER 05

### LIF316: DRUG DISCOVERY & DESIGN – Practicals

#### Drug Discovery & Design Practicals - 2 Credits: (3 Hrs/Week)

##### Basic Pharmacological Principles:

*In vitro* Biochemical Assays to Demonstrate Agonists, Antagonists, Non-Competitive/Competitive Inhibitors, Receptor-Ligand Interaction, Single-Point Assays, Bracketing Assays, Three-Point Assays

##### Cell-Based Assays:

Freshly Isolated & Cultured Cells, Cultured Cells, Cell Counting, Platelets, Inhibition of Aggregation by Nitric Oxide Donors, Neutrophils, Measurement of NADPH Cytochrome c Reductase, Measurement of Intracellular  $[Ca_2^+]$ , Electrophysiology of Primary & Neuronal Cell Lines, Whole-Cell Screening for GPCR Ligands, Cell Fusion Assay, Flow-Cytometry-Based Cell Receptor Assay, Direct Small-Molecule Kinase Activation, Embryonic Stem Cell-Derived Hepatocytes & Adult Liver Cells for CYP<sub>450</sub> Toxicity Evaluation, *In vitro* Blood-Brain Barrier Assay, Anti-Angiogenic Assay (Matrigel), Cell Immigration & Uptake Assays, Cell Wounding Assay, Three-Dimensional Primary Cell Cultures for Drug Development.

#### SUGGESTED READING

**Goodman & Gilman.** *The Pharmacological Basis of Therapeutics*. Mc Graw Hill Ed.

**Kalueff AV, et al.** (2009) *Experimental Animal Models in Neurobehavioral Research*. Nova Science Publishers.

**Kreitzer G, et al.** *Cell Biology Assays: Essential Methods*. Elsevier.

**Salmon DM.** *Practical Pharmacology for the Pharmaceutical Sciences*. Wiley & Sons.

# SEMESTER 05

## LIF317: BASIC BIOCHEMISTRY

### THEORY - 3 Credits: (3 Theory Hrs/Week)

#### Learning Outcomes

On completion of this course, the student will be able to:

- demonstrate an understanding of fundamental biochemical principles, such as the structure/function of biomolecules, metabolic pathways, and the regulation of biological/biochemical processes.
- gain proficiency in basic laboratory techniques in both chemistry & biology, and be able to apply the scientific method to the processes of experimentation and hypothesis testing.

#### Unit 1 Carbohydrates

Overview of Biomolecules, Definition, Physical & Chemical Properties, Structure & Importance; Classifications- Monosaccharides- Aldoses & Ketoses, Disaccharides & Polysaccharides; Different Types of Polysaccharides (Homo, Hetero & Mucopolysaccharides). Derivatives of Sugars. Glycoproteins-Structure & Function

#### Unit 2 Amino Acids & Proteins

Overview, Definition, Classification & Properties of Amino Acids; Proteins: Non-Protein Amino Acids, Peptide Bond, Structure, Classification Based on the Function, Solubility & Nutritional Value; Proteoglycans, Protein Glycosylations & its Significance-Blood Grouping, Structure & Functions of Hemoglobin

#### Unit 3 Lipids

Classification & Properties of Lipids; Lipoproteins-Chylomicrons, HDL, LDL & VLDL. Sphingophospholipids, Cholesterol, Steroids, Bile Acids & Bile Salts; Lipid Bilayers. Glycolipids, Lipopolysaccharides

#### Unit 4 Enzymes

Nomenclature, Classifications, Factors Affecting Enzymes, Enzyme Kinetics, Significance of  $V_{max}$  &  $K_m$ , Enzyme Inhibition - Competitive, Non-Competitive & Uncompetitive, Enzyme Regulation-Product Inhibition, Feedback Control, Covalent Modification & Allosteric Regulation. Vitamins- Classification, General Sources, Functions, Deficiency Symptoms & Structural Aspects of Vitamins

#### Unit 5 Nucleic Acids

Nucleosides & Nucleotides- Composition & Structure, DNA- Types, Primary & Secondary Structure, Denaturation & Renaturation; RNA- Types, Structure & Functions of tRNA, rRNA & mRNA. Nucleoproteins, Chromatin. Direction of DNA Synthesis, Overview of DNA & RNA Synthesis

## SEMESTER 05

### LIF318: BASIC BIOCHEMISTRY – Practicals

#### Practicals - 2 Credits: (3 Hrs/Week)

Qualitative Analysis of Carbohydrates

Color Reactions of Amino Acids

Estimation of Protein by Lowry's Method

Estimation of DNA by Diphenylamine Method

Estimation of RNA by Orcinol Method

Separation of Cells by Centrifugation

Blood Cells Counting

Measurement of Hemoglobin Content in Blood

Blood Grouping & ESR

#### SUGGESTED READING

**Conn E & PK Stump.** (1989) *Outlines of Biochemistry*. Willey Eastern Ltd, New Delhi.

**Nelson DL & Cox MM.** (2012) *Lehninger Principles of Biochemistry*. WH Freeman, USA.

**Plummer M & Plummer DT.** (1988) *Practical Biochemistry*. Tata McGraw Hill.

**Sawhney SK & Singh R.** (2014) *Introductory Practical Biochemistry*. Narosa Publishers, India.

**Stryer L.** (2002) *Biochemistry*. WH Freeman & Company. New York, USA.

**Varley H.** (1962) *Practical Biochemistry*. John Wiley & Sons.

**Varley H.** (1954) *Practical Clinical Biochemistry*. New York, Interscience Publishers.

**Voet D & Voet G.** (2010) *Biochemistry*. John Wiley & Sons, UK.

**Zubay G.** (1989) *Biochemistry*. Maxwell Macmillan International, USA.

# SEMESTER 05

## LIF319: MEDICINAL BOTANY

### SEC-3

#### THEORY - 2 Credits: (2 Theory Hrs/Week)

#### Learning Outcomes

On completion of this course, the student will be able to:

- identify the features that make plants valuable to humans & discuss the human history of plant uses.
- discuss how plants & plant science affected the development of medicine, culture & society.
- examine the major medicinal plants to include their features, history & effectiveness.
- identify uses of plants in the future.

#### Unit 1 Introduction to Medical Botany

History, Scope & Importance of Medicinal Plants - Indigenous Medicinal Sciences

#### Unit 2 Indigenous Herbs & Traditional System of Medicine

Definition & Scope – Ayurveda: History, Origin, Panchamahabhutas, Saptadhatu & Tridosha Concepts, Rasayana, Plants Used in Ayurvedic Treatments, Siddha: Origin of Siddha Medicinal Systems, Basis of Siddha System, Plants Used in Siddha Medicine. Unani: History, Concept: *Umoor-E-Tabiya*, Tumors Treatments/Therapy, Polyherbal Formulations

#### Unit 3 Conservation of Endangered & Endemic Medicinal Plants

Definition: Endemic & Endangered Medicinal Plants, Red List Criteria; *in situ* Conservation: Biosphere Reserves, Sacred Groves, National Parks; *Ex situ* Conservation: Botanic Gardens, Ethanomedicinal Plant Gardens. Propagation of Medicinal Plants: Objectives of the Nursery, its Classification, Important Components of a Nursery, Sowing, Prickling, Use of Green House for Nursery Production, Propagation through Cuttings, Layering, Grafting & Budding

#### Unit 4 Ethnobotany & Folk Medicines

Definition; Ethnobotany in India: Methods to Study ethnobotany; Applications of Ethnobotany: Applications of Ethnobotany: National Interacts, Palaeo-Ethnobotany. Folk Medicines of Ethnobotany, Ethnomedicine, Ethnoecology, Ethnic Communities of India. Application of Natural Products to Certain Diseases – Jaundice, Cardiac, Infertility, Diabetes, Blood Pressure & Skin Diseases

#### SUGGESTED READING

- Purohit & Vyas.** (2008) *Medicinal Plant Cultivation: A Scientific Approach*. Agrobios, India.  
**Trivedi PC.** (2006) *Medicinal Plants: Ethnobotanical Approach*. Agrobios, India.

# SEMESTER 06

## LIF301: ANALYTICAL TECHNIQUES IN PLANT SCIENCES

### THEORY - 3 Credits: (3 Theory Hrs/Week)

#### Learning Outcomes

On completion of this course, the student will be able to:

- develop technical skills in a wide range of plant science methods.
- understand the latest technological developments & ways whereby they can be used in plant biology.
- apply his/her knowledge to practical problems in plant biology.

#### Unit 1 Imaging & Related Techniques

Principles of Microscopy; Light Microscopy; Fluorescence Microscopy; Confocal Microscopy; Use of Fluorochromes: (A) Flow Cytometry (FACS); (B) Applications of Fluorescence Microscopy: Chromosome Banding, FISH, Chromosome Painting; Transmission & Scanning Electron Microscopy – Sample Preparation for Electron Microscopy, Cryofixation, Negative Staining, Shadow Casting, Freeze Fracture, Freeze Etching

#### Unit 2 Cell Fractionation

Centrifugation: Differential & Density Gradient Centrifugation, Sucrose Density Gradient, CsCl<sub>2</sub> Gradient, Analytical Centrifugation, Ultracentrifugation, Marker Enzymes

#### Unit 3 Radioisotopes

Use in Biological Research, Auto-Radiography, Pulse Chase Experiment

#### Unit 4 Spectrophotometry

Principle & its Application in Biological Research

#### Unit 5 Chromatography

Principle; Paper Chromatography; Column Chromatography, TLC, GLC, HPLC, Ion-Exchange Chromatography; Molecular Sieve Chromatography; Affinity Chromatography

#### Unit 6 Characterization of Proteins & Nucleic Acids

Mass Spectrometry; X-Ray Diffraction; X-Ray Crystallography; Characterization of Proteins & Nucleic Acids; Electrophoresis: AGE, PAGE, SDS-PAGE



## SEMESTER 06

### LIF302: ANALYTICAL TECHNIQUES IN PLANT SCIENCES – Practicals

#### Analytical Techniques in Plant Sciences Practical

#### 2 Credits: (3 Hrs/Week)

Study of Blotting Techniques: Southern, Northern & Western, DNA Fingerprinting, DNA Sequencing, PCR through Photographs.

Demonstration of ELISA.

To Separate Nitrogenous Bases by Paper Chromatography.

To Separate Sugars by Thin Layer Chromatography.

Isolation of Chloroplasts by Differential Centrifugation.

To Separate Chloroplast Pigments by Column Chromatography.

To Separate Proteins Using PAGE.

To Separate DNA (Marker) Using AGE.

Study of Different Microscopic Techniques Using Photographs/Micrographs (Freeze Fracture, Freeze Etching, Negative Staining, Positive Staining, Fluorescence & FISH).

Preparation of Permanent Slides (Double Staining).

#### SUGGESTED READING

**Ausubel F, et al.** (1995) *Short Protocols in Molecular Biology*. John Wiley & Sons.

**Plummer DT.** (1996) *An Introduction to Practical Biochemistry*. Tata McGraw-Hill. New Delhi.

**Ruzin SE.** (1999) *Plant Microtechnique & Microscopy*. Oxford University Press, New York, USA.

# SEMESTER 06

## LIF303: REPRODUCTIVE BIOLOGY

### THEORY - 3 Credits: (3 Theory Hrs/Week)

#### Learning Outcomes

On completion of this course, the student will be able to:

- explain the difference between peptide & steroid hormones & understand the mechanisms by which these hormones regulate reproductive function in their target tissues
- explain how the integrated function of the hypothalamus, pituitary gland & gonads (testis/ovary) are critical for normal male & female reproduction
- describe how spermatogenesis in the testis & oogenesis in the ovary are regulated during normal fertility as well as understand the various causes of infertility.
- understand how sperm fertilize the egg, how the zygote implants in the uterus & how early embryo development progresses.
- understand which factors determine the sex & phenotypic differentiation of the fetus, & apply his/her understanding of reproductive function & hormonal regulation to the various methods for male & female contraception.
- apply his/her understanding of reproductive function and fertilization to methods for assisted reproductive technologies to circumvent infertility.

#### Unit 1 Reproductive Endocrinology

Gonadal Hormones & Mechanism of Hormone Action, Steroids, Glycoprotein Hormones & Prostaglandins, Hypothalamo – Hypophyseal – Gonadal Axis, Regulation of Gonadotrophin Secretion in Male & Female; Reproductive System: Development & Differentiation of Gonads, Genital Ducts, External Genitalia, Mechanism of Sex Differentiation

#### Unit 2 Functional Anatomy of Male Reproduction

Outline & Histological of Male Reproductive System in Rat & Human; Testis: Cellular Functions, Germ Cell, System Cell Renewal; Spermatogenesis: Kinetics & Hormonal Regulation; Androgen Synthesis & Metabolism; Epididymal Function & Sperm Maturation; Accessory Glands Functions; Sperm Transportation in Male Tract

#### Unit 3 Functional Anatomy of Female Reproduction

Outline & Histological of Female Reproductive System in Rat & Human; Ovary: Folliculogenesis, Ovulation, Corpus Luteum Formation & Regression; Steroidogenesis & Secretion of Ovarian Hormones; Reproductive Cycles (Rat & Human) & their Regulation, Changes in the Female Tract; Ovum Transport in the Fallopian Tubes; Sperm Transport in the Female Tract, Fertilization; Hormonal Control of Implantation; Hormonal Regulation of Gestation, Pregnancy Diagnosis, Foeto-Maternal Relationship; Mechanism of Parturition & Its Hormonal Regulation; Lactation & its Regulation

#### Unit 4 Reproductive Health

Infertility in Male & Female: Causes, Diagnosis & Management; Assisted Reproductive Technology: Sex Selection, Sperm Banks, Frozen Embryos, *in vitro* Fertilization, ET, EFT, IUT, ZIFT, GIFT, ICSI, PROST; Modern Contraceptive Technologies; Demographic Terminology Used in Family Planning

## SEMESTER 06

### LIF304: REPRODUCTIVE BIOLOGY – Practicals

#### Reproductive Biology Practicals - 2 Credits: (3 Hrs/Week)

Study of Animal House: Set Up & Maintenance of Animal House, Breeding Techniques, Care of Normal & Experimental Animals.

Examination of Vaginal Smear Rats from Live Animals.

Surgical Techniques: Principles of Surgery in Endocrinology. Ovariectomy, Hysterectomy, Castration & Vasectomy in Rats.

Examination of Histological Sections from Photomicrographs/ Permanent Slides of Rat/Human: Testis, Epididymis & Accessory Glands of Male Reproductive Systems; Sections of Ovary, Fallopian Tube, Uterus (Proliferative & Secretory Stages), Cervix & Vagina.

Human Vaginal Exfoliate Cytology.

Sperm Count & Sperm Motility in Rat

Study of Modern Contraceptive Devices

#### SUGGESTED READING

**Austin CR & Short RV.** (1982) *Reproduction in Mammals*. Cambridge University Press, UK.

**Degroot LJ & Jameson JL.** (2005) *Endocrinology*. WB Saunders & Company.

**Hatcher RA, et al.** (1998) *The Essentials of Contraceptive Technology*. Population Information Programme.

**Jones R & Lopez KH.** (2013) *Human Reproductive Biology*. Academic Press.

**Knobil E, et al.** (1994) *The Physiology of Reproduction*. Raven Press Ltd.

## SEMESTER 06

### LIF305: BIOCHEMISTRY – INTERMEDIARY METABOLISM

#### THEORY - 3 Credits: (3 Theory Hrs/Week)

#### Learning Outcomes

On completion of this course, the student will be able to:

- demonstrate an understanding of fundamental biochemical principles, such as the structure/function of biomolecules, metabolic pathways & the regulation of biological/biochemical processes.
- gain proficiency in basic laboratory techniques in both chemistry & biology & be able to apply the scientific method to the processes of experimentation & hypothesis testing.

#### Unit 1 Metabolism

Basic Concepts- Anabolism & Catabolism, Role of ATP in Metabolism, High Energy Compounds & Intermediates, Common Types of Reactions Involved in Metabolism

#### Unit 2 Carbohydrate Metabolism

Glycolysis- Aerobic & Anaerobic, Regulation of Glycolysis, TCA Cycle & its Regulation; Glycogen Metabolism- Glycogenesis & Glycogenolysis, Glycogen Storage Diseases; Gluconeogenesis, Pentose Phosphate Pathway (HMP Shunt) & Glyoxylate Cycle

#### Unit 3 Protein Metabolism

Catabolism of Amino Acid Nitrogen- Transamination, Deamination, Ammonia Formation & the Urea Cycle. Catabolism of Carbon Skeletons of Amino Acids. Conversion of Amino Acids to Special Products. Disorders of Amino Acid Metabolism

#### Unit 4 Metabolism of Lipids

Fatty Acid Oxidation, Biosynthesis of Fatty Acids, Elongation & Unsaturation of Fatty Acids, Comparison of Fatty Acid Oxidation with Synthesis; Triacyl Glycerol Biosynthesis, Cholesterol Biosynthesis & its Regulation, Ketone Bodies

#### Unit 5 Nucleic Acid Metabolism

Purine- Biosynthesis, Regulation & Degradation; Pyrimidine- Biosynthesis, Regulation & Degradation; Formation of Uric Acid; Gout; Disorders Associated with Nucleic Acid Metabolism

## SEMESTER 06

### LIF306: BIOCHEMISTRY – INTERMEDIARY METABOLISM – Practicals

#### Practicals - 2 Credits: (3 Hrs/Week)

Estimation of Ascorbic Acid.

Quantitative Estimations in Blood (such as Glucose, Cholesterol, Calcium).

Estimation of Creatinine by Jaffe's Method.

Isolation of Proteins from Clinical Samples.

Determination of Enzyme Activity.

Estimation of Aminotransaminases (ALT/AST).

Estimation of Serum Alkaline Phosphatase.

Effect of pH on Enzyme Activity.

Chromatography.

Electrophoresis.

#### SUGGESTED READING

- Conn E & PK Stump.** (1989) *Outlines of Biochemistry*. Willey Eastern Ltd, New Delhi.  
**Nelson DL & Cox MM.** (2012) *Lehninger Principles of Biochemistry*. WH Freeman, USA.  
**Plummer M & Plummer DT.** (1988) *Practical Biochemistry*. Tata McGraw Hill.  
**Sawhney SK & Singh R.** (2014) *Introductory Practical Biochemistry*. Narosa Publishers  
**Stryer L.** (2002) *Biochemistry*. WH Freeman & Company, New York, USA.  
**Varley H.** (1962) *Practical Biochemistry*. John Wiley & Sons, UK.  
**Varley H.** (1954) *Practical Clinical Biochemistry*. Interscience Publishers, New York, USA.  
**Voet D & Voet G.** (2010) *Biochemistry*. John Wiley & Sons, UK.  
**Zubay G.** (1989) *Biochemistry*. Maxwell Macmillan International, USA.



## SEMESTER 06

### LIF307: BASIC MICROBIOLOGY

#### THEORY - 3 Credits: (3 Theory Hrs/Week)

#### Learning Outcomes

On completion of this course, the student will be able to:

- describe/explain the history of microbiology, the types of microbes, & processes used by microorganisms for their replication, survival & interaction with their environment, hosts, & host populations.
- demonstrate practical skills in the use of tools, technologies & methods common to microbiology & apply the scientific method & hypothesis testing in the design & execution of experiments.

#### Unit 1 Introduction to Microbiology

Brief History of Microbiology, Microbes & Human Welfare – Recycling Vital Elements, Sewage Treatment, Bioremediation, Insect-Pest Control by Microbes, Normal Microbiota, Biofilms, Units of Measurements of Microorganisms, Microscopy, Principles in Magnification, Resolution, Preparation of Specimens for Microscopy, Simple Stains, Differential Staining, Special Staining, Microbial Classification – Phylogenetic Relationships, Scientific Nomenclature, Taxonomic Hierarchy, Methods of Classifying & Identifying Microorganisms – Morphological Characteristics, Differential Staining, Biochemical Tests, Serology, Phage Typing, Fatty Acid Profiles, DNA Base Composition, DNA Fingerprinting, NAATs, NA Hybridization

#### Unit 2 Microbial Anatomy

Prokaryotic & Eukaryotic Cell, Biology of Bacteria – Cell Structure, Size, Shape, Arrangement Cell Membrane, Cell Wall, Cytoplasmic Inclusions, Mesosomes, Flagella & Motility, Slime, Glycocalyx, Capsule, Pili, Chemotaxis, Endospore, Archea – Diversity – Chlamydiae & Mycoplasmas – Virus (bacteriophages) Structure, Life cycle (Lytic & Lysogenic). Prions, Virioids, Biology of Fungi, Cell Structure, Physiology & Classification – Biology of Yeast – Reproduction. Biology of Algae, Protozoa, Helminths

#### Unit 3 Microbial Growth & Metabolism

Microbial Nutrition & Growth Requirements, Macro-nutrients, Micro-nutrients, Growth Factors, Sources of Nutrients, Culture Media, Pure Culture (Streak/Spread/Pour plates, Stab/Slant cultures), Preservation of Pure Cultures, Bacterial Growth, Nutritional Classification: Phototrophs, Chemotrophs, Autotrophs, Heterotrophs, Photoautotrophs, Photoheterotrophs, Chemoautotrophs, Chemoheterotrophs – Nutritional Patterns of Pathogens, Saprophytes, Auxotrophs, Enzymes, Energy Production, Carbohydrate, Protein, Lipid Metabolism, Metabolic Diversity, Metal-tolerance, Radio-resistance

#### Unit 4 Control of Microorganisms

Control of Microbes – Sterilisation, Disinfection, Antiseptic, Tyndalization, Pasteurization: Physical – Dry Heat, Moist Heat, UV, Ionizing Radiation, Filtration, HEPA Filter, Chemical Methods, QC of Microbial Control, Antimicrobial Drugs: Classes & Modes of Action, Measurement of Antibiotic Sensitivity, Antimicrobial Resistance – Mechanisms in Mycobacteria & Nosocomial Pathogens

#### Unit 5 Environmental Microbiology

Microbial Diversity & Habitats, Soil Microbiology & Biogeochemical Cycles – Carbon Cycle, Nitrogen Cycle, Sulfur Cycle, Phosphorus Cycle, Degradation of Synthetic Chemicals in Soil & Water, Aquatic Microorganisms, Role of Microorganisms in Water Quality, Water Treatment & Sewage Treatment

## **Unit 6    Applied & Industrial Microbiology**

Food Microbiology – Foods & Disease, Industrial Food Canning, Aseptic Packaging, Radiation & Industrial Food Preservation, High Pressure Food Preservation, Role of Microorganisms in Food Production; Industrial Microbiology – Fermentation Technology, Industrial Products, Alternative Energy Sources Using Microorganisms, Biofuels

## SEMESTER 06

### LIF308: BASIC MICROBIOLOGY – Practicals

#### Basic Microbiology Practicals - 2 Credits: (3 Hrs/Week)

Direct Microscopic Observations of Bacterial Shape – Cocci, Rods, Chains, Fungal Spores, Mycelium, Yeast Budding.

Staining Methods: Simple, Negative, Acid Fast, Gram Staining, Spore, Capsule, Metachromatic Granular Staining, Lactophenol Cotton Blue Staining - Fungal Slide Culture.

Measurement of Size of Microbes – Micrometry, Bacterial Motility by Hanging Drop Method, Enumeration of Bacterial/Yeast Cells-Viable Count (Plate Count) Total Count (Haemocytometer).

Preparation of Media: Broth & Agar Media, Basal, Selective & Differential Culture Media, Plates, Slants, Pure Culture Techniques: Streak/Spread/Pour Plate Methods, Bacterial & Fungal Cultivations.

Bacterial DNA – Bacterial Protein Extractions & Estimations.

PCR – RFLP & RAPD, Phylogenetic Analysis.

#### SUGGESTED READING

**Holt JS, et al.** (1994) *Bergey's Manual of Determinative Bacteriology*. Williams & Wilkins, Baltimore, USA.

**Madigan MT, et al.** (2017) *Biology of Microorganisms*. Pearson Publishers, USA.

**Mara D & Horan N.** (2013) *The Handbook of Water & Waste-Water Microbiology*. Academic CRC Press.

**Nester EW, Roberts CV & Nester MT.** (2015) *Microbiology - A Human Perspective*. McGraw-Hill Education

**Schaechter M & Leaderberg J** (2009). *The Desk Encyclopedia of Microbiology*. Elsevier Academic Press.

**Tortora, Funke & Case.** (2013) *Microbiology: An Introduction*. Pearson Publishers, USA.

**Webster J.** (2007). *Introduction to Fungi*. Cambridge University Press, Cambridge, UK.

**Woolverton CJ, et al.** (2016) *Microbiology*. McGraw-Hill Education.



## SEMESTER 06

### LIF309: AQUATIC BIOLOGY

#### SEC-4

#### THEORY - 2 Credits: (2 Theory Hrs/Week)

#### Learning Outcomes

On completion of this course, the student will be able to:

- demonstrate familiarity with & critically apply current theories, subject content, professional methodologies, ethical frameworks & research procedures relevant to marine & aquatic biology.
- undertake studies relating to aquatic biology in both laboratory & field contexts.
- demonstrate skill at identifying organisms found in aquatic environments.
- understand the dynamics of aquatic ecosystems & their potential responses to changes.
- apply conservation & management principles for conservation & sustainable use of aquatic resources.

#### Unit 1 Aquatic Biomes

Brief Introduction of the Aquatic Biomes: Freshwater Ecosystem (Lakes, Wetlands, Streams & Rivers), Estuaries, Intertidal Zones, Oceanic Pelagic Zone, Marine Benthic Zone & Coral Reefs

#### Unit 2 Freshwater Biology

Lakes: Origin & Classification, Lake as an Ecosystem, Lake Morphometry, Physico–Chemical Characteristics: Light, Temperature, Thermal Stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates & Nitrates, Turbidity; Dissolved Gases (Oxygen, Carbon Dioxide). Nutrient Cycles in Lakes-Nitrogen, Sulphur & Phosphorous. Streams: Different Stages of Stream Development, Physico-Chemical Environment, Adaptation of Hill-Stream Fishes

#### Unit 3 Marine Biology

Salinity & Density of Sea Water, Continental Shelf, Adaptations of Deep Sea Organisms, Coral Reefs, Sea Weeds

#### Unit 4 Management of Aquatic Resources

Causes of Pollution: Agricultural, Industrial, Sewage, Thermal & Oil Spills, Eutrophication, Management & Conservation (Legislations), Sewage Treatment Water Quality Assessment- BOD & COD

#### SUGGESTED READING

- Anathakrishnan TN.** (1989) *Bioresources Ecology*. Oxford & IBH Publishers, New Delhi.
- Goldman C.** (1994) *Limnology*. McGraw-Hill Education.
- Odum EP & Barrett GW.** (2005) *Fundamentals of Ecology*. Pearson Publishers, USA
- Pawlowski L.** (1982) *Physicochemical Methods for Water & Wastewater Treatment*. Elsevier, USA.
- Wetzel RG.** (2001) *Limnology: Lake & River Ecosystems*. Elsevier, USA.

# SEMESTER 07

## LIF411: CELL BIOLOGY

### THEORY - 3 Credits: (3 Theory Hrs/Week)

#### Learning Outcomes

On completion of this course, the student will be able to:

- understand the structures & purposes of basic components of prokaryotic & eukaryotic cells, especially macromolecules, membranes & organelles.
- understand how these cellular components are used to generate & utilize energy in cells.
- understand the cellular components underlying mitotic cell division.
- apply his/her knowledge of cell biology to selected examples of changes or losses in cell function.

#### Unit 1 Membrane Transport

Membrane Transport of Small Molecules, Membrane Transport of Macromolecules & Particles, Exocytosis & Endocytosis, Structure & Function of Cell Wall, Structure of ATP-Powered Pumps & their Role in Intracellular Ionic Environment, Non-Gated Ion Channels, Structure & Function of Symporters & Antiporters, Movement of Water (Structure & Function of Aquaporines), Transepithelial Transport, Structure & Function of Voltage-Gated Ion Channels Macromolecular Transport Across the Nuclear Envelop.

#### Unit 2 Structural Organization & Functions of Cell Organelles

Translocation of Secretory Proteins Across the ER Membrane, Insertion of Proteins into the ER Membrane, Protein Modifications, Folding & Quality Control in the ER, Export of Bacterial Proteins, Sorting of Proteins to Mitochondria & Chloroplasts, Sorting of Peroxisomal Proteins. Mitochondria & Chloroplast, Ribosome & Vacuoles

#### Unit 3 Cytoskeleton

Nature of Cytoskeleton, Intermediate Filaments, Microtubules, Actin Filaments, Cilia & Centrioles, Organization of the Cytoskeleton. Cell Growth & Division, Cell Division - Mitosis & Meiosis, Cell Cycle - Phases of Cell Cycle & Regulation of Cell Growth & Cell Cycle, Checkpoints in Cell Cycle Regulation. Cell Junctions & Extracellular Matrix, Cell Motility, Microtubules, Structure & Composition, Microtubular Associated Proteins - Role in Intracellular Motility, Cell-Cell Adhesion & Communication, Cell Matrix Adhesion, Collagen, Fibrous Protein of the Matrix, Non-Collagen Component of the Extracellular Matrix. Differentiation of Cell Membrane - Microvilli, Epithelia, Bell & Spot Desmosomes, Cell-Cell Interaction, Cell Junctions

#### Unit 4 Cell-to-Cell Signaling

Cell Aging & Death - Necrosis & Apoptosis - Mitochondrial & Death Receptor Pathway. Autophagy, Cell Signalling - Signalling Molecules & their Receptors, Functions of Cell Surface Receptors, Pathways of Intracellular Signal Transduction, G Protein-Coupled Receptors, Receptors Tyrosine Kinases, Role of Ras & Raf in Oncogenesis, MAP Kinase Pathways, Introduction to Gene Therapy

#### Unit 5 Methods in Cell Biology

Methods for Disrupting Tissues & Cells, Organ & Tissue Slice Techniques, Isolation of Clones, Tissue Culture Techniques (Animal & Plant), Cell Fixation - Fluid Fixatives, Freezing & Section Drying, Fixation for Electron Microscopy - Buffered Osmium Solutions, Fixation of Organic & Inorganic Substances, Staining Techniques Acid & Basic, Fluorescent & Radioactive Dyes, Staining of Lipids, Steroids, Nucleic Acids, Proteins &

Enzymatic Reaction Products. Histopathological Studies – Organ-Specific Morphohistological Examination, Identification of Morphological Changes Related to Pathology

## SUGGESTED READING

- Alberts B & Alexander J, et al.** (2014) *Molecular Biology of the Cell*. Garland Science, USA.
- Carp G & Puritt NL.** (2013) *Cell & Molecular Biology - Concepts & Experiment*. John Wiley & Sons, USA.
- Cooper GM & Hausman RE.** (2015) *The Cell: A Molecular Approach*. Oxford University Press, UK.
- Lodish H, et al.** (2007) *Molecular Cell Biology*. WH Freeman, New York, USA.



## SEMESTER 07

### LIF412: IMMUNOBIOLOGY

#### THEORY - 3 Credits: (3 Theory Hrs/Week)

#### Learning Outcomes

On completion of this course, the student will be able to:

- identify the cellular & molecular basis of immune responsiveness.
- describe the roles of the immune system in both maintaining health & contributing to disease.
- describe immunological response & how it is triggered & regulated.
- transfer knowledge of immunology into clinical decision-making through case studies presented in class.

#### Unit 1 Introduction to Immunobiology & Innate Immunity

Principles of Innate & Adaptive Immunity, Effector Mechanisms – The First-Lines of Defense, Complement System, Pattern Recognition, Induced Innate Responses to Infection

#### Unit 2 Recognition of Antigen

Antigen Recognition by B-Cell & T-Cell Receptors, Structure of Antibody Molecule, The Interaction of Antibody Molecule with Specific Antigen, Antigen Recognition by T Cells, Generation of Lymphocyte Antigen Receptors, Primary Ig Rearrangement, T-Cell Receptor Gene Rearrangement, Structural Variation in Ig Constant Regions, Secondary Diversification of Antibody Repertoire, Antigen Presentation to T Lymphocytes, Generation of T-Cell Receptor Ligands, the MHC & its Functions

#### Unit 3 Development of Mature Lymphocyte Receptor Repertoires

Signaling via Immune-System Receptors, General Principles of Signal Transduction & Propagation, Antigen Receptor Signaling & Lymphocyte Activation, Other Receptors & Signaling Pathways: Cytokine & Cytokine Receptors, Apoptosis Receptors, Development of B Lymphocytes & T Lymphocytes, Positive & Negative Selection, Survival & Maturation of Lymphocytes in Lymphoid Tissues

#### Unit 4 Adaptive Immune Responses

T Cell-Mediated Immunity, Entry of Naïve T Cells & APCs Into Peripheral Lymphoid Organs, Priming of Naïve T Cells by DCs, General Properties of Effector T Cells & their Cytokines, T Cell-Mediated Cytotoxicity, Macrophage Activation by Th1 Cells, Th2 Cells, Th17 Cells & Tregs. Humoral Immune Response: B Cell Activation by Helper T Cells, Distribution & Functions of Ig Classes, Destruction of Antibody-Coated Pathogens via Fc Receptors, Dynamics of Adaptive Immunity, the Mucosal Immune System & Organization, Mucosal Responses to Infection & Regulation

#### Unit 5 Applied Immunology

Failures of Host Defense Mechanisms: Evasion & Subversion of Immune Defenses, Immunodeficiency Diseases, Allergy & Other Hypersensitivity Disorders & Mechanisms, Autoimmunity & Transplantation: the Making & Breaking of Self-Tolerance, Autoimmune Diseases & Mechanisms, Genetic & Environmental Basis of Autoimmunity, Responses to Alloantigens, Transplant Rejection, Manipulation of Immune Responses, Treatment of Adverse Responses, Anti-Tumor Responses & Vaccination. Immunodiagnosics: Serological Reactions: Immunoprecipitation, Flocculation, Agglutination, ELISA, RIA, Complement Fixation, Western Blotting, Flow Cytometry, Cytokine Arrays

## SEMESTER 07

### LIF413: IMMUNOBIOLOGY – Practicals

#### Immunobiology Practicals - 2 Credits: (3 Hrs/Week)

Extraction of Human PBMCs by Ficoll-Hypaque Overlay Method.

Quantification of Immune Cells in PBMCs by Haemocytometer.

Immunostaining of T cells, Acquisition by Flow Cytometry & Data Analysis (FlowJo).

Serology: WIDAL for Enteric Fever & VDRL for Syphilis.

Serology: Immunoelectrophoresis.

Serology: ELISA & Immunoblotting.

#### SUGGESTED READING

**Abbas AK, Lichtman AH & Pillai S.** (2014) *Cellular & Molecular Immunology*. Elsevier, USA.

**Delves PJ, Martin SJ, Burton DR & Roitt IM.** (2016) *Essential Immunology*. Wiley-Blackwell, UK.

**Janeway CA, Travers P, Walport M & Shlomchik MJ.** (2016) *Janeway Immunobiology*. Garland Science.

**Paul WE.** (2012) *Fundamental Immunology*. Lippincott Williams & Wilkins, USA.

# SEMESTER 07

## LIF414: MOLECULAR BIOLOGY

### THEORY - 3 Credits: (3 Theory Hrs/Week)

#### Learning Outcomes

On completion of this course, the student will be able to:

- understand the chemical & molecular processes that occur in & between cells.
- describe & explain processes & their meaning for the characteristics of living organisms.
- gain insights into the most significant molecular & cell-based methods to expand his/her understanding of biology.

#### Unit 1 Introduction to Molecular Biology

Discovery of DNA- Evidence for DNA as the Genetic Material; Central Dogma of Molecular Biology; DNA Replication- Types of Replication, Evidence for Semiconservative Replication - Meselson & Stahl Experiment. Enzymes & Necessary Proteins Involved in DNA Replication

#### Unit 2 DNA Replication

Replication in Prokaryotes- Replication Bubble, Bidirectional Replication, Replicon, DNA Polymerases, Lagging & Leading Strand Synthesis, Okazaki Fragments, Mechanism of Replication, Action of SSB, Primase, DNA Gyrase. The Fidelity of DNA Replication, Overview Mechanism of Eukaryotic Replication. Telomeres, Telomerase & End Replication. Inhibitors of Replication

#### Unit 3 Transcription & RNA Processing

Definitions of Coding Strand, Template Strand, Sense Strand & Antisense Strand, Promotor, Transcription in Prokaryotes- RNA Polymerases, Mechanism of Transcription- Initiation, Elongation & Termination (Rho-Dependent & Independent Termination), Housekeeping Genes. Transcription in Eukaryotes- Mechanism, Posttranscriptional Processing & its Significance- Capping, Tailing, Splicing, Processing of rRNA & tRNA. RNA Editing

#### Unit 4 Protein Biosynthesis

Genetic Code, Wobble Mechanism & its Significance, Types of RNA Molecules, Structure of tRNA, Composition of Prokaryotic & Eukaryotic Ribosomes, Protein Biosynthesis in Prokaryotes & Eukaryotes- Activation of Amino Acids, Initiation, Chain Elongation, Translocation & Termination. Translational Machinery- Mechanism of Initiation- Elongation & Termination

#### Unit 5 Post-Translational Modifications

Regulation of Protein Synthesis, Post-Translational Modifications in Prokaryotes & Eukaryotes, Inhibitors of Protein Synthesis. Protein Modifications, Folding & Export of Proteins; Gene Mutations & DNA Repair

## SEMESTER 07

### LIF415: MOLECULAR BIOLOGY – Practicals

#### Molecular Biology Practicals - 2 Credits: (3 Hrs/Week)

Isolation of Genomic DNA from Human Blood

Quantification of DNA Using Spectrophotometer

Primer Designing

Polymerase Chain Reaction

Restriction Digestion

Purification of DNA

Polyacrylamide Gel Electrophoresis & Silver Staining of Protein

Isolation of Genomic DNA from Dicot & Monocot Plants

Isolation of RNA from Leaves

Western Blot Analysis of Expressed Plant Proteins

#### SUGGESTED READING

**Alberts B, et al.** (2002) *Molecular Biology of the Cell*. Garland Science, New York, USA.

**Freifelder D.** (2004) *Molecular Biology*. Narosa Publishing House, India.

**Graur D & Li W-H.** (1991) *Fundamentals of Molecular Evolution*. Sunderland Publishers.

**Karp G.** (2013) *Cell & Molecular Biology*. John Wiley & Sons Inc., UK.

**Krebs JE, Goldstein ES & Kilpatrick ST.** (2018) *Genes XII*. Oxford University Press, Cell Press, London.

# SEMESTER 07

## LIF416: ENDOCRINOLOGY

### THEORY - 3 Credits: (3 Theory Hrs/Week)

#### Learning Outcomes

On completion of this course, the student will be able to:

- discuss the definition & describe the different classes & chemical structures of hormones.
- identify the glands, tissues & cells that secrete hormones, precursors & associated compounds.
- describe the synthesis & modes of secretion of hormones.
- explain how hormone secretion is regulated, including the principles of feedback mechanisms.

#### Unit 1 Introduction to Endocrinology

Scope of Endocrinology, Endocrine Glands, Hormones & Hormone Action, Classification Based on Chemical Structure, Hormone Secretion & Functions of Hypothalamus & Pituitary Gland, Pineal Gland – Circadian Rhythm

#### Unit 2 Thyroid Hormones

Structure of Thyroid Gland – Biosynthesis of Thyroid Hormones, Biological Functions of Thyroid Hormones, Regulation of Thyroid Secretion, Hormones of Parathyroid Glands & their Biological Action

#### Unit 3 Adrenal Hormones

Adrenal Cortex – Glucocorticoids, Mineralocorticoids & their Biological Function, Renin Angiotensin System; Adrenal Medulla – Catecholamines – Synthesis & Biological Action

#### Unit 4 Pancreatic & Gastric Hormones

Pancreatic (Islets of Langerhans) Hormones – Insulin, Glucagon – Biosynthesis, Regulation, Biological Action, Gastrointestinal Hormones

#### Unit 5 Reproductive Hormones

Male Reproductive System; Structure of Testes, Biosynthesis of Testosterone, Regulation & Functions. Female Reproduction System; Structure of Ovary, Biosynthesis of Estrogen, Feed Back Regulation & Functions Female Reproductive Cycle – Estrous, Menstrual; Placental Hormones – Parturition – Lactation

### SUGGESTED READING

- Hadley ME.** (1992) *Endocrinology*. Prentice Hall, New Delhi, India.
- Lohar PS.** (2005) *Endocrinology - Hormones & Human Health*. MPJ Publishers, India.
- Norman AW & Litwack G.** (1987) *Hormones*. Academic Press.
- Turner CD & Bagnarr JT.** (1994) *General Endocrinology*. WB Saunder Company, USA.
- Wilson JD & Foster DW.** (1992) *William's Textbook of Endocrinology*. WB Saunders Company, USA.





## SEMESTER 08

### LIF401: INFECTIOUS DISEASES

#### THEORY - 3 Credits: (3 Theory Hrs/Week)

#### Learning Outcomes

On completion of this course, the student will be able to:

- describe transmission, risk factors, symptoms, pathology, treatment, & control & prevention measures for common viral, bacterial, fungal, & parasitic infectious diseases of public health importance.
- understand the various challenges & opportunities in preventing & controlling infectious diseases in diverse population settings (e.g., healthcare settings, mother-child relationships, resource-poor locations, food protection & emergency situations).
- research, analyze, & organize published infectious disease information for the purpose of utilizing & communicating scientific information for the reduction of infectious disease risks among diverse populations.

#### Unit 1 Introduction to Infectious Diseases

Host-Pathogen Interactions, Molecular Mechanisms of Microbial Pathogenesis, Immunization Principles & Vaccine Use, Health Advice for International Travel, Microbial Bioterrorism

#### Unit 2 Bacterial Infections

Staphylococcal, Streptococcal Infections, Diphtheria, Listeriosis, Tetanus, Botulism, Gas Gangrene, Pseudomembranous Colitis, Meningococcal & Gonococcal Infections, *Campylobacteriosis*, *Helicobacter pylori*, *Pseudomonas*, *Salmonella*, *Shigella*, Cholera, Brucellosis, Anaerobic Infections, Tuberculosis, Leprosy, Syphilis, Leptospirosis, *Mycoplasma* & *Chlamydia*

#### Unit 3 Viral Infections

Poxviruses, Herpes, Parvovirus, HPV, Influenza, Retroviruses, Viral Gastroenteritis, Viral Hepatitis, Enteroviruses, Reoviruses, MMR, Rubella, Mumps, Rabies, Ebola & Marburg, Prion Diseases

#### Unit 4 Parasitic & Fungal Infections

Amebiasis & Free-Living Amebae, *Toxoplasma*, Intestinal Protozoa & *Trichomoniasis*, *Trichinella*, Tissue & Intestinal Nematodes, *Schistosomiasis* & Trematodes, Cestodes, Dermatophytoses, Histoplasmosis, Blastomycosis, Cryptococcosis, Candidiasis, Pneumocystosis, Aspergillosis, Mucormycosis, Miscellaneous Mycoses

#### Unit 5 Vectors & Vector-Borne Infections

Dipterans as Vectors – Mosquitoes, Sand fly, Houseflies; Mosquito-Borne: Malaria, Dengue, Chikungunya, Viral Encephalitis, Filariasis; Control of Mosquitoes; Sand Fly-Borne: Visceral Leishmaniasis, Cutaneous Leishmaniasis, Control of Sand Fly; Fleas as Vectors; Flea-Borne Diseases: Plague, Typhus Fever; Control of Fleas. Human Louse as Vectors; Louse-Borne: Typhus fever; Tick-Borne: Borrelioses, Rickettsial, Bartonellosis, Bugs as Vectors; Blood Bugs; Chagas Disease, Control & Prevention

## SEMESTER 08

### LIF402: INFECTIOUS DISEASES – Practicals

#### Infectious Diseases Practicals - 2 Credits: (3 Hrs/Week)

Blood Culture & Automation in ID Diagnosis: BACTEC System.

Investigation of Urine, Wound, Tissue & Genital Samples.

Examination of Respiratory & Gastrointestinal Samples.

Basics in Diagnosis of Human Mycoses.

Laboratory Investigations of Viral Infections.

#### SUGGESTED READING

**Anaissie EJ, McGinnis MR & Pfaller MA.** (2009) *Clinical Mycology*. Elsevier, USA.

**Bauman RW.** (2009) *Microbiology: Diseases by Body System*. Benjamin Cummings, USA.

**Brooks GF, et al.** (2007) *Jawetz, Melnick & Adelberg's Medical Microbiology*. McGraw-Hill Professional.

**Greenwood D, Slack R, Peutherer J & Barer M.** (2007) *Medical Microbiology*. Churchill Livingstone.

**Harvey RA, Champe PC & Fisher BD.** (2007) *Lippincott's Illustrated Reviews: Microbiology*. Lippincott Williams & Wilkins, New Delhi/New York.

**Kasper DL & Fauci AS.** (2010) *Harrison's Infectious Diseases*. McGraw-Hill, USA.

**Murray PR, Pfaller MA, Tenover FC, & Tenover RH.** (2007) *Clinical Microbiology*, ASM Press, USA.

**Nester EW, Anderson DG & Nester MT.** (2006) *Microbiology: A Human Perspective*. McGraw Hill.

**Ryan KJ.** (2018) *Sherris Medical Microbiology: An Introduction to Infectious Diseases*. McGraw Hill.

**Wilks D, Farrington M & Rubenstein D.** (2010) *Infectious Diseases Manual*. Blackwell Science.

# SEMESTER 08

## LIF403: NEUROBIOLOGY

### THEORY - 3 Credits: (3 Theory Hrs/Week)

#### Learning Outcomes

On completion of this course, the student will be able to:

- demonstrate a broad foundation in the concepts & methodologies of the interdisciplinary field of neuroscience at the cellular, molecular, cognitive, systems, & behavioral levels.
- demonstrate research skills including the ability to design experiments, & collect, analyze, & interpret data through research projects, lab work, internships, & coursework.
- demonstrate critical thinking skills by analyzing & evaluating neuroscience primary literature.

#### Unit 1 Introduction to the Nervous System

Divisions of Nervous System, Anatomy of Brain & Spinal Cord, Structure & Types of Neurons, Types of Glial Cells & their Functions

#### Unit 2 Cerebral Circulation

Blood Brain Barrier Formation & Function, Cerebrospinal Fluid Secretion & Function, Blood Flow to Brain, Formation of Synapse, Synaptic Transmission, Electrical & Chemical Transmission, Membrane Potentials (Resting & Action Potentials)

#### Unit 3 Neurotransmitters

Synthesis, Storage & Function of Acetylcholine, GABA, Glutamate, Serotonin, Dopamine, Norepinephrine, Epinephrine in Brain

#### Unit 4 Cognitive Neuroscience

Types of Memory, Limbic System, Structure of Hippocampus & Associated Structures, Mechanisms of Long Term Potentiation & Memory Formation

#### Unit 5 Diseases of the Nervous System

Neuronal Dysfunction & Mechanisms Underlying Alzheimer's Disease, Multiple Sclerosis, Parkinson Disease, Epilepsy, Amyotrophic Lateral Sclerosis

### SUGGESTED READING

- Guyton AC & Hall JE.** (2010) *Textbook of Medical Physiology*. Saunders, USA.
- Krebs C, Weinberg J & Akesson E.** (2012) *Neuroscience*. Lippincott Williams & Wilkins, USA.
- Robbins & Cortan.** (2004) *Pathologic Basis of Disease*. Saunders, USA.
- Sherwood L.** (2016) *Human Physiology - From Cells to Systems*. Pearson India.
- Squire L, et al.** (2012) *Fundamental Neurosciences*. Academic Press, USA.

# SEMESTER 08

## LIF404: PLANT PATHOLOGY & CROP PROTECTION

**THEORY - 3 Credits: (3 Theory Hrs/Week)**

### Learning Outcomes

On completion of this course, the student will be able to:

- discuss how plants are affected by microbes, pests & weeds in crops & natural environments.
- discuss the concepts of plant pathology to the physiology of plants & microorganisms in the various types of association, including symbiosis & pathogenicity.
- discuss the main categories of microorganisms infecting plants (symbionts & pathogens) & methods for their diagnosis & control.
- explain the concepts of epidemiology & how these can be applied in selecting strategies for controlling plant diseases, pests & weeds (including economic aspects)

#### Unit 1 Plant-Microbe Interaction

Soil Environment- Microorganisms, Soil Structure, Profile, Physico-Chemical Conditions, Microbial Composition, Microorganisms in Organic Decomposition. Plant Growth Promoting Microorganisms. Molecular Plant Microbe-Interactions. Invasion of Plant Tissue: Mechanisms of Plant Growth Promotion.

#### Unit 2 Diseases of Plants & Mechanisms

Major Plant Disease Symptoms Caused by Fungi, Bacteria & Viruses. Development & Stages of Disease Development, Pathogen Dissemination, Relationship between Disease Cycles & Epidemics, Pathogenicity Genes, Genes Controlling: Degradation of Cuticle & Cell Wall, Production of Secondary Metabolites-Fungal Toxins; Resistance (R) Genes of Plants, Plant Diseases – Principles, Symptoms & Control: Fungal – General Characteristics of Diseases: Myxomycetes, Chytridiomycetes, Zygomycetes, Ascomycetes, Basidiomycetes & Deuteromycetes, Bacterial – Blight of Rice, Citrus Canker, Xanthomonas. Viral & Mycoplasmal – Bud Necrosis of Groundnut, Citrus Mosaic, Little Leaf of Brinjal, Tomato Leaf Curl

#### Unit 3 Crop Protection: Principles of Plant Disease Control

Protection - Diseases of Field, Vegetable, Orchard & Plantation Crops & their Control; Causes & Classification of Plant Diseases; Principles of Biological Control Of Diseases. Methods to Exclude Pathogens from Host-Quarantines & Inspections, Crop Certification, Evasion or Avoidance of Pathogen, Use of Pathogen-Free Propagating Material, Pathogen-Free Seeds & Vegetative Propagating Materials. Plant Immunization; Direct Protection; Integrated Control, Biopesticides – *Bacillus thuringiensis*, *B. sphaericus*, *B. popilliae*, *Pseudomonas syringae*. Biocontrol- Microbial Control - *Trichoderma*. Biological Control – Use of Baculovirus, NPV Virus, Protozoa & Fungi in Biological Control. Endophytic Fungi - Symbiotic & Opportunistic Associations, Co-Evolution & Loss of Reproductive Structures, Secondary Metabolite Production

#### Unit 4 Crop Protection: Integrated Pest Management & Recycling of Agricultural Wastes

Use of Endophytic Fungi as Biocontrol Agents Against Plant Diseases, Insect Herbivores, Resistance Mechanisms Against Attack by Plant Pathogens. Molecular Detection of Pathogens. Integrated Pest Management-Concepts & Components; Host Plant Resistance-Biological Control of Insect Pests; Recycling of Agricultural Wastes - Microbiology of Biogas, Bioethanol & Value Added Products, Vermicomposting

## SEMESTER 08

# LIF405: PLANT PATHOLOGY & CROP PROTECTION – Practicals

### Plant Pathology & Crop Protection - Practicals - 2 Credits: (3 Hrs/Week)

Methods of Isolation & Identification of Pathogenic Fungi from Infected Plants by Traditional Methods.

Isolation & Identification of Endophytic Fungi from Plants.

Observation & Identification of Mycorrhiza.

Isolation & Identification of Fungi from Seeds.

Study of Soil Fungi from Varied Geographical Origins.

Isolation of Antibacterial/ Antimycotic Compounds from Fungi.

Staining & Observation of Plant Pathogenic Fungi.

## SUGGESTED READING

**Agrios GN.** (2005) *Plant Pathology*. Academic Press.

**Dirk J, Elas V, Trevors JT & Wellington EMH.** (2006) *Modern Soil Microbiology*. CRC Press, USA.

**Schumann GL.** (2006) *Essential Plant Pathology*. APS Press.

**Sharma PD.** (2006) *Plant Pathology*. Rastogi Publishers, India.

**Tilak KVBR, Pal KK & Dey R.** (2009) *Microbes for Sustainable Agriculture*. IK International Publishing, India.



## SEMESTER 08

### LIF406: PHARMACOLOGY

#### THEORY - 3 Credits: (3 Theory Hrs/Week)

#### Learning Outcomes

On completion of this course, the student will be able to:

- identify a range of drugs used in medicine & discuss their mechanisms of action & report the clinical applications, side effects & toxicities of drugs used in medicine.
- explain the mechanisms of action & pathology of ethanol & drugs of abuse.

#### Unit 1 Principles of Pharmacology

Introduction to Pharmacology – Pharmacokinetics – Pharmacodynamics – Drug Development & Safety

#### Unit 2 Autonomic & Neuromuscular Pharmacology

Introduction to Autonomic & Neuromuscular Pharmacology – Acetylcholine Receptor Agonists – Acetylcholine Receptor Antagonists – Adrenoceptor Antagonists

#### Unit 3 Cardiovascular, Renal & Hematologic Pharmacology

Antihypertensive Drugs – Antianginal drugs – Drugs for Heart failure – Diuretics – Antiarrhythmic Drugs – Drugs for Hyperlipidemia – Anticoagulant, Antiplatelet & Fibrinolytic Drugs – Hematopoietic Drugs

#### Unit 4 Central Nervous System Pharmacology

Introduction to Central Nervous System Pharmacology – Sedative-Hypnotic & Anxiolytic Drugs – Antiepileptic Drugs – Local & General Anesthetics – Psychotherapeutic Drugs – Opioid Analgesics & Antagonists – Drugs for Neurodegenerative Diseases – Drugs of Abuse

#### Unit 5 Pharmacology of the Respiratory & Other Systems

Autocoid Drugs – Drugs for Respiratory Tract Disorders – Drugs for Gastrointestinal Tract Disorders – Drugs for Headache Disorders – Drugs for Pain, Inflammation & Arthritic Disorders

#### Unit 6 Endocrine Pharmacology

Hypothalamic & Pituitary Drugs – Thyroid Drugs – Adrenal Steroids & Related Drugs – Drugs affecting Fertility & Reproduction – Drugs for Diabetes Mellitus – Drugs Affecting Calcium & Bone

#### Unit 7 Antibiotics & Chemotherapy

Principles of Antimicrobial Chemotherapy – Inhibitors of Bacterial Cell Wall Synthesis – Inhibitors of Bacterial Protein Synthesis – Quinolones, Antifolate Drugs & Other Antimicrobial Agents – Antimycobacterial Drugs – Antifungal Drugs – Antiviral Drugs – Antiparasitic Drugs – Antineoplastic & Immunomodulating Drugs – Photodynamic Therapy

#### SUGGESTED READING

**Brenner G & Stevens C.** (2010) *Pharmacology*. Saunders, USA.

**Golan DE.** (2016) *Principles of Pharmacology: The Pathophysiologic Basis of Drug Therapy*. Wolters Kluwer, USA.

**Whalen K.** (2014) *Lippincott Illustrated Reviews: Pharmacology*. Wolters Kluwer, USA.



## SEMESTER 09

### LIF511: THEORETICAL PATHOLOGY

#### THEORY - 3 Credits: (3 Theory Hrs/Week)

#### Learning Outcomes

On completion of this course, the student will be able to:

- understand the structural and functional changes caused by disease in tissues and organs as a basis for clinical manifestations and principles of pathobiology, diagnosis and treatment of human diseases.

#### Unit 1 The Nature & Investigation of Diseases

Characteristic Features of Diseases, Etiology, Pathogenesis, Manifestations, Outcome, Classification & Epidemiology of Diseases, Investigations, Types of Pathology Labs, Role & Evaluation of Lab Tests, Reference Ranges, Quality of Test Results & Clinical Auditing

#### Unit 2 Disorders of the Cardiovascular & Respiratory Systems

Cardiac Structure & Functions – The Electrocardiogram, Valvular Heart Disease, Coronary Heart Disease, Myocardial Infarction, Factors Associated with CVD Risk, Heart Failure, Acute Pulmonary Edema, Aneurysms, Disease of the Veins. Respiratory Disorders: Pneumothorax, Atelectasis, Pneumonia, Tuberculosis, Chronic Obstructive Pulmonary Disease, Bronchial Asthma, Respiratory Distress Syndrome,

#### Unit 3 Disorders of the Urinary & Gastrointestinal Systems

Disorders of the Urinary System: Glomerulonephritis, Nephrotic Syndrome, Diabetic Nephropathy, Calculi, Renal Tubular Injury, Renal Cysts, Renal Failure, Gastric Disorders: Diseases of Esophagus, Gastritis, Acute Gastroenteritis, Peptic Ulcer, Inflammatory Disorders of the Intestine, Intestinal Obstruction

#### Unit 4 Disorders of Nervous & Musculoskeletal Systems

Flaccid & Spastic Paralyzes, Stroke, Transient Ischemic Attack, Vascular Dementia, Cerebral Aneurysm, Alzheimer Disease, Multiple Sclerosis, Huntington Disease, Degenerative Diseases. Common Musculoskeletal Disorders: Arthritis, Fracture, Osteomyelitis, Myositis, Muscular Atrophy & Dystrophy, Myasthenia Gravis

#### Unit 5 Cancer & Neoplastic Diseases

Tumors: Classification, Etiologic Factors in Neoplastic Diseases, Diagnosis & Treatment of Tumors, Leukemia, Multiple Myeloma, Examination of the Breasts, Benign Cystic Changes in the Breast, Fibroadenoma, Carcinoma of the Breast, Sarcoma of the Breast, Pulmonary Fibrosis, Lung Carcinoma, Tumors of the Urinary Tract, Tumors of the Nervous System, Survival in Neoplastic Diseases

#### SUGGESTED READING

- Ahmed A, Dawson M, Smith C, Wood E. (2007) *Biology of Disease*. Taylor & Francis, NY, USA.  
Crowley LV. (2010) *An Introduction to Human Disease*. Jones & Bartlett, UK.  
Johnson LR. (2001) *Gastrointestinal Physiology*. Mosby, St Louis, USA.  
Stolley PD & Lasky T. (1998) *Investigating Disease Patterns*. Scientific American Library, NY  
Wallis G. (1999) *The Genetic Basis of Human Disease*. The Biochemical Society, London.



## SEMESTER 09

# LIF512: ENVIRONMENTAL TOXICOLOGY

### THEORY - 3 Credits: (3 Theory Hrs/Week)

#### Learning Outcomes

On completion of this course, the student will be able to:

- utilize scientific literature & databases to identify information needed to understand & effectively communicate aspects of toxicology.
- Demonstrate an understanding of legal, regulatory, & ethical considerations relating to toxicology within the broader societal context.

#### Unit 1 Introduction to Toxicology

Definitions in Environmental Toxicology, Examples of Anthropogenic Poisons & Natural Poisons, Definitions of "Toxic Effects" – Acute Vs Systemic; Quantification of Toxicity – LD<sub>50</sub>, Threshold Limit Values, Carcinogens, Mutagens & Teratogens, Risk Management & Acceptable Daily Intakes (ADI), Routes of Absorption, Fates of Absorbed Toxins

#### Unit 2 Toxicology of Organic Substances

Hydrocarbons - Alkanes, Alkenes & Alkynes (Incl. Petroleum Products), Aromatic Hydrocarbons - Simple Aromatic Compounds & Polycyclic Aromatic Hydrocarbons, Nitrogen Containing Compounds – Simple Amines (Incl. Naturally-Occurring Toxins such as Alkaloids) & Aromatic Amines, Halogenated Hydrocarbons - Pesticides & Herbicides, Oxygenated Hydrocarbons (Alcohols, Carbonyl Compounds & Acids)

#### Unit 3 Toxicology of Inorganic Substances

Toxicology of Heavy Metals (Mercury, Cadmium, Tin, Lead etc), Toxic Episodes, Relevant Chemistry, Bioaccumulation, Key Issues for the Environmental Toxicology of Heavy Metals

#### Unit 4 Atmospheric Chemistry & Pollution

Structure & Composition of the Atmosphere, Acid Rain, Radiation & the Atmosphere. Ozone Layer. Ozone Balance, Ozone Holes, Photochemical Smog, Nitrogen Oxides & Photochemical Smog. Oxidation of Hydrocarbons

#### Unit 5 Environmental Laws & Policies

The National Green Tribunal Act, 2010, The Air (Prevention & Control Of Pollution) Act, 1981, The Water (Prevention & Control Of Pollution) Act, 1974, The Environment Protection Act, 1986, The Hazardous Waste Management Regulations etc.

## SUGGESTED READING

- Klaassen C.** (2013) *Casarett & Doull's Toxicology: The Basic Science of Poisons*. McGraw Hill Education.
- Laws EA.** (2013) *Environmental Toxicology - Selected Entries from the Encyclopedia of Sustainability Science & Technology*. Springer.
- Moon TW & Mommsen TP.** (2005) *Environmental Toxicology*. Elsevier.
- Wright D & Welbourn P.** (2002) *Environmental Toxicology*. Cambridge University Press, UK.





## SEMESTER 09

### LIF513: BEHAVIORAL ECOLOGY

#### THEORY - 3 Credits: (3 Theory Hrs/Week)

#### Learning Outcomes

On completion of this course, the student will be able to:

- account for and critically evaluate theories and models for sexual selection, foraging, mating and life history strategies, sociality, predation, speciation, personality and communication.

#### Unit 1 Natural Selection, Ecology & Behaviour - Testing Hypotheses

Watching & Wondering, Natural Selection, Genes & Behaviour, Selfish Individuals or Group Advantage, Climate Change & Breeding Times, Ecology & Evolution. Breeding Behaviour of Gulls in Relation to Predation Risk, Social Organization of Weaver Birds & African Ungulates, Limitations of Early Comparative Studies

#### Unit 2 Economic Decisions & Predators Versus Prey: Evolutionary Arms Races

Economics of Carrying a Load, Economics of Prey Choice, Sampling & Information, Risk of Starvation, Environmental Variability, Body Reserves & Food Storing, Food Storing Birds, Evolution of Cognition, Feeding & Danger, Red Queen Evolution, Predators Vs Cryptic Prey, Enhancing Camouflage, Aposematism, Mimicry, Trade-Offs in Prey Defences, Cuckoos Versus Hosts

#### Unit 3 Competing for Resources & Living in Groups

The Hawk–Dove Game, Ideal Free Distribution, Despotic Distribution, Ideal Free Distribution with Unequal Competitors, Economics of Resource Defence, Producers & Scroungers, Alternative Mating, ESS Thinking, Animal Personalities. Grouping, Group Living: Shoaling in Guppies, Size & Skew, Decision Making

#### Unit 4 Sexual Selection, Parental Care & Family Conflicts

Males & Females, Parental Investment & Sexual Competition, Why Do Females Invest More in Offspring Care Than Do Males? Sexual Selection, Sex Differences in Competition, Sperm Competition, Mate Choice & Extra-Pair Matings, Sexual Conflict, Parental Care, Sibling Rivalry, Parent–Offspring Conflict, Brood Parasites

#### Unit 5 Mating Systems & Sex Allocation

Mating Systems with No Male Parental Care, Mating Systems with Male Parental Care, A Hierarchical Approach to Mating System Diversity, Fisher's Theory of Equal Investment, Sex Allocation when Relatives Interact, Sex Allocation in Variable Environments, Selfish Sex Ratio Distorters

#### Unit 6 Social Behaviours: Altruism to Spite

Kin Selection & Inclusive Fitness, Hamilton's Rule, How Do Individuals Recognize Kin? Kin Selection Doesn't Need Kin Discrimination, Selfish Restraint & Kin Selection, Spite. Cooperation, Kin Selection, Hidden Benefits, by-Product Benefit, Reciprocity, Enforcement

## Unit 7 Altruism & Conflict in the Social Insects

Social Insects, The Life Cycle & Natural History of a Social Insect, Economics of Eusociality, Pathway to Eusociality, Haplodiploidy Hypothesis, Monogamy Hypothesis, Ecological Benefits of Cooperation, Conflict within Insect Societies, Conflict Over the Sex Ratio, Worker Policing, Superorganisms, Comparison of Vertebrates with Insects. Communication & Signals, Problem of Signal Reliability, Indices, Handicaps, Common Interest, Human Language, Dishonest Signals

### SUGGESTED READING

**Danchin É, Giraldeau L-A, Cézilly F.** (2008) Behavioural Ecology: An Evolutionary Perspective on Behaviour. Oxford University Press, UK.

**Nicholas B. Davies NB & Krebs JR.** (2012) An Introduction to Behavioural Ecology. Wiley, UK.

**Dawkins R.** (1989) The Selfish Gene, Oxford University Press, Oxford.

**Sober E.** (1984) The Nature of Selection. Evolutionary Theory in Philosophical Focus. MIT Press, Harvard.

**Endler JA.** (1986) Natural Selection in the Wild. Princeton University Press, Princeton.



## SEMESTER 09

### LIF514: BIOSAFETY & BIOETHICS

#### THEORY - 3 Credits: (3 Theory Hrs/Week)

#### Learning Outcomes

On completion of this course, the student will be able to:

- define biosafety & bioethics in the context of biological sciences.
- demonstrate good laboratory practices & describe the SOPs & assign biosafety levels.
- justify the design of confinement facilities at different biosafety levels.
- discuss the social & ethical issues related to plant & animal biotechnology.

#### Unit 1 Biosafety & Good Laboratory Practices

Good Laboratory Practices, Lab Documentation, Maintenance of Lab Files, Chemical Safety, Fire Safety, Electrical Safety, Exposure Control Plan, Employee Education & Orientation, Disposal of Hazardous Waste, Standard Precautions, Engineering Controls: Lab Environment, Biosafety Cabinet, Personal Protective Equipment, Post-Exposure Control, Post-Exposure Control, Classification of Biologic Agents Based on Hazard, Mailing Bio-Hazardous Material

#### Unit 2 Genetically Modified Organisms

Legal, Socioeconomic, Public Elucidation of Process of Biotechnology in Generating New Forms of Life. Biosafety in General, Food & Feed Products Containing GMOs, Risk Assessment/Analysis, Risk Management, Ethical Aspects of GMOs, Policy on the Storage of GMOs, Gene Technology Act, Precautionary Principle, Potential Environmental Risks & Benefits, Potential Socio-Economical Risks & Benefits. Recombinant DNA Safety Guidelines & Regulations

#### Unit 3 Introduction to Biomedical Ethics

Ethical Theories, Contemporary Approaches to Medical Ethics, Physician-Patient Relationship, Confidentiality, Truth Telling, Autonomy, Paternalism & Informed Consent, Abortion, Medical Experimentation, Justice & Health Care System, the Nature of Bioethics, Genetic Modification/Research on Plants & Animals, Therapeutic Cloning, Human Cloning, Stem Cell Research

#### Unit 4 Laws in Biological Research

Federal Laws & the Roles of: The Food & Drug Administration, The Centers for Disease Control & Prevention, The United States Department of Agriculture, The Environmental Protection Agency, State & Local Agencies

#### SUGGESTED READING

- Ahuja VK & Nexis L. (2013) *Law Relating to Intellectual Property Rights*. LexisNexis Publishers.
- Centers for Disease Control & Prevention. (2009) *Biosafety in Microbiological & Biomedical Laboratories*. National Institutes of Health.
- Fleming DO & Hunt DL. (2007) *Biological Safety: Principles & Practices*. ASM Press.
- Sateesh MK (2010) *Bioethics & Biosafety*. IK International Publishing.
- Sibley D. (1994) *Law & Strategy of Biotechnological Patents*. Elsevier.



## SEMESTER 09

### LIF515: BIOSTATISTICS & INTELLECTUAL PROPERTY RIGHTS

#### THEORY - 3 Credits: (3 Theory Hrs/Week)

#### Learning Outcomes

On completion of this course, the student will be able to:

- select from, use & interpret results of, descriptive statistical methods;
- demonstrate an understanding of the central concepts of modern statistical theory & their probabilistic foundation;
- select from, use, & interpret results of, the principal methods of statistical inference & design;
- communicate the results of statistical analyses accurately & effectively;
- make appropriate use of statistical software;
- read & learn new statistical procedures independently;
- discuss the relevance of intellectual property rights to modern biotechnological innovations.

#### Unit 1 Introduction to Biostatistics

Sampling, Qualitative & Quantitative Data, Cross-Sectional & Time Series Data, Discrete & Continuous Data, Nominal, Ordinal, Ratio & Interval Scales; Data Presentation: Frequency Distribution & Cumulative Frequency Distribution, Measures of Variability Z-Score & Standard Normal Distribution, Graphical Presentation of Data, Bar, Pie Diagrams, Histograms & Frequency Curve

#### Unit 2 Basics of Biostatistics Data Analysis

T-Statistic (One Sample), Independent & Dependent (Paired) Samples T-Test, One-Way ANOVA, Simple Linear Regression Analysis, Chi-Square & Other Non-Parametric Tests, Introduction to Multivariate Analysis

#### Unit 3 Software for Data Analysis\*

Introduction to the Software, Required Data Format, Tables, Descriptive Measures, Graphs & Charts, Presentation of Tables/Charts

#### Unit 4 Intellectual Property Rights: Concepts & Policies

Introduction to IPR: IPR, Forms of IPR & Intellectual Property Protection. Concept of Property With Respect to Intellectual Creativity, Tangible & Intangible Property. WTO: Agency Controlling Trade Among Nations, WTO with Reference to Biotechnological Affairs, TRIPs. WIPO, EPO

#### Unit 5 Patents

Concept Related to Patents Novelty, Non-Obviousness, Utility, Anticipation, Prior Art etc. Type of Patents. Indian Patent Act & Foreign Patents. Patentability, Patent Application, Revocation of Patent, Infringement & Litigation with Case Studies on Patent, Commercialization & Licensing

*\*Note: Students must be taught on the basics of data analysis using SPSS & GraphPad or other relevant online tools.*

## SUGGESTED READING

- Ahuja VK & Nexis L.** (2013) *Law Relating to Intellectual Property Rights*. LexisNexis Publishers.
- Gupta SC & Kapoor VK.** (2014) *Fundamentals of Mathematical Statistics*. S Chand & Sons, India.
- Gupta SP.** (2009) *Statistical Methods*. S Chand & Sons, India.
- Lesk AM.** (2014) *Introduction to Bioinformatics*. Oxford University Press.
- Najarian K, et al.** (2009) *Systems Biology & Bioinformatics: A Computational Approach*. CRC Press.
- Sibley D.** (1994) *Law & Strategy of Biotechnological Patents*. Elsevier.
- Walliman N.** (2011) *Research Methods – The Basics*. Routledge, Abingdon, UK.

## SEMESTER 09

# LIF516: LABORATORY ANIMAL CARE & MAINTENANCE & RESEARCH METHODOLOGY

**THEORY - 3 Credits: (3 Theory Hrs/Week)**

### Learning Outcomes

On completion of this course, the student will be able to:

- obtain basic knowledge about lab animal care which will make it possible for him/her to participate in research contributing to the humane use of lab animals ensuring high standards of animal welfare and quality in the performing, evaluating & reporting of lab animal experiments.

#### Unit 1 Introduction to Laboratory Animal Care

Common Laboratory Animals Employed in Research, Ethics in Animal Experimentations, Management and Handling of Laboratory Mouse, Rats, Guinea Pigs, Hamsters, Rabbits, Sheep, Dogs & Cats

#### Unit 2 Essential Feeding Requirements

Food & Essential Nutrient Requirements for Various Species of Laboratory Animals, Feeding Schedule of Laboratory Animals, Feeding & Watering Devices, Sterilization & Disinfection Methods, Blood Collection, Handling & Sexing, Anaesthesia, Euthanasia in Experimental Animals, Disease Management, Infectious Diseases of Lab Animals & their Management, Understanding Tumor Immunology Using Nude Mouse

#### Unit 3 Legal Factors & Animal Facility

Ethical & Legal Provisions in Use of Lab Animals, Role of CPCSEA & IAEC in Conducting Experiments on Animals. Animal House – Hazards & Safety Precautions, Budget Requirement for Lab Animal Facility, Animal House for Research Institutions, Hematological & Biochemical Data of Commonly used Lab Animals

#### Unit 4 Research Methodology

Research Basics, Research Theory, Structuring the Research Project, Finding & Reviewing the Literature, Nature of Data, Collecting & Analysing Secondary Data, Collecting Primary Data, Quantitative Data Analysis, Qualitative Data Analysis

#### Unit 5 Research Dissemination

Proposal Writing & Writing up of Research: Research Papers/Manuscripts, Types of Research Papers, Publishers, Procedures in Publishing, Plagiarism & Detection, Research Irregularities/Manipulations, Infringements, Software in Publishing; Formatting & Bibliography, NCBI, Medline & Databases. Data Dissemination: Conference, Delivering Talks, Do's & Don'ts, Importance of Research dissemination

### SUGGESTED READING

- Desai PV & Saravanan P.** (2012) *Handbook on Laboratory Animals*. Jaypee Publishers.
- Knisely K.** (2017) *A Student Handbook for Writing in Biology*. WH Freeman & Co. USA.
- Walliman N.** (2011) *Research Methods – The Basics*. Routledge, Abingdon, UK.
- Zeiger M.** (2011) *Essentials of Writing Biomedical Research Papers*. McGraw Hill.

## SEMESTER 10

### LIF501: LIFE SCIENCES PROJECT DISSERTATION

#### Life Sciences Project Dissertation - 12 Credits

#### Learning Outcomes

On completion of this course, the student will be able to:

- identify an appropriate original topic for investigation within PLANT/ANIMAL biology & demonstrate a detailed understanding of a coherent new body of knowledge relating to that topic
- undertake appropriate research to attain a detailed understanding of the theories & concepts relevant to their particular research topic.
- critically evaluate information from a range of sources & place their own study in the context of other work in the theme.
- collect appropriate data, present & analyse those data appropriately & arrive conclusions from the data
- sustain a degree of involvement in one major piece of work from initiation to completion, accepting accountability for determining its outcome.
- work independently & manage time effectively to meet deadlines & produce a piece of work demonstrating high standards of presentation.



## Equipment/Instruments Available at DLS-CUTN

Autoclaves (Vertical)  
 Bacteriological Incubators  
 Bacteriology Culture  
 BD BACTEC Blood Culture System  
 BD FACScanto II Immunocytometry System  
 Bioinformatics & Computational Biology Facility  
 Biopac Physiological Measurement System  
 Bioplex-Luminex Multiplex Array (BioRad)  
 Biosafety Cabinets  
 Binocular Microscope  
 Cell Culture Facility  
 Centrifuge (REMI)  
 Centrifuge (MICRO)  
 Clean Rooms (MarkAir)  
 Cold Room (MarkAir)  
 Cooling Centrifuge (REMI)  
 CO<sub>2</sub> Incubators (Eppendorf)  
 Deep Freezer (-20°C)  
 Dissection Microscopes  
 Droplet Digital PCR System (BioRad)  
 Flame Photometer  
 Fluorescence Microscope (Nikon)  
 Fumehoods  
 Gel Documentation with Chemi-Doc Imaging System  
 Glucometers  
 Horizontal & Vertical Electrophoresis Systems (BioRad)  
 Icematic Ice Flaker  
 INCUBATOR Galaxy model  
 Laminar flow (Horizontal)  
 Master Cycler Nexus Gradient PCR  
 Micropipettes & Multichannel Pipettes (Eppendorf)  
 Microplate Reader (Bio-Rad)  
 Mosquito Larvae Culture Facility  
 Phase Contrast Microscope (Nikon)  
 pH Meters  
 Photosynthesis Unit with Fluorescence & Oxygen System  
 Plant Growth Chamber  
 Platelet Aggregometer UV-VIS Spectrophotometer  
 Refrigerated Centrifuges  
 Sphygmomanometers  
 Stethoscopes  
 Transilluminators  
 Trinocular Inverted Microscope  
 Trinocular Stereo Zoom (Parallel Optics Zoom) System with Epifluorescence  
 Vacuum Pump  
 Ultra Deep (-80°C) Freezers (Upright Model)  
 Ultrapurification System

