

SARDAR PATEL UNIVERSITY  
VALLABH VIDYANAGAR



Programme: MSC (CBCS)  
Syllabus with effective from: 2018-19

**BIOCHEMISTRY**  
**Semester IV**

**PS04CBIC21: Animal Biotechnology**

**Unit I:**

**Introduction to animal tissue culture** (Historical background, Advantages of tissue culture, limitations, major differences in vitro, types of tissue culture)

**Biology of cultured cells** (Brief description on cell adhesion, cell proliferation, energy metabolism and origin of cultured cells)

**General out-line of cell types** (epithelial tissue, connective tissue, muscular tissue and nervous tissue)

**Equipments and materials for animal cell culture technology** (Inverted microscope, Laminar flow-hood, humid CO<sub>2</sub> incubator, centrifuges, refrigerators and other miscellaneous equipments) **Aseptic Techniques** (Objectives of aseptic techniques, elements of aseptic environment, sterile handling)

**Sterilization** (Different types - dry heat (hot air oven), wet heat (autoclaving), various chemical agents used in sterilization, irradiation techniques (UV and Gamma Ray)

**Unit II**

**Defined media and supplements**( Physicochemical properties, Balanced salt solutions, serum, selection of medium and serum)

**Serum – Free Media** (Disadvantages of serum, advantages of Serum -free media, Preparation of serum free media, Animal protein free media)

**Primary culture** (Initiation of primary cell culture, isolation of tissue, types of primary culture, , mechanical and enzymatic disaggregation)

**Sub culture and cell lines** (Subculture and propagation, routine maintenance, subculture of monolayer and suspension cultures)

**Monitoring for contamination** – Visible microbial contamination, Mycoplasma, Viral contamination, Eradication of contamination.

**Unit III**

**Cell cloning and selection** (Feeder layer, suspension cloning, separation of clones)

**Cell separation** (Centrifugation, Antibody based techniques, FACS)

**Cell differentiation** (Stem cell plasticity, markers of differentiation, induction of differentiation, differentiation and malignancy)

**Transformation and immortalization** ( Immortalization with viral genes, Immortalization

of human fibroblasts, telomerase induced immortalization, Aberrant growth control, Tumorigenicity)

**Characterization** (Need for characterization, characterization based on cell morphology, DNA and RNA content, enzyme activity and antigenic markers)

#### **Unit IV**

**Culture of specialized cells**( Mammary epithelium, liver, epidermal keratinocytes, adipose tissue, muscle, glial cells, human astrocytes, lymphocytes, testis and ovary)

**Stem cells, germ cells and aminocytes**( Culture of embryonic stem cells, culture of aminocytes, applications of stem cells)

**Embryo technology** (Embryo sexing, embryo splitting)

Assisted reproductive techniques (IVF, ISCI, ZIFT, GIFT)

**Scale-up and automation** (Scale – up in suspension and monolayer culture)

**Three-Dimensional Cultures** (Histotypic and organotypic cultures, tissue equivalents)

#### **Basic Text and Reference Books:**

1. Freshney, R. I. (2015). *Culture of animal cells: a manual of basic technique and specialized applications*(6<sup>th</sup>Edn) John Wiley & Sons.
2. Masters, J. R. (2000). *Animal cell culture: a practical approach* (3<sup>rd</sup>Edn) Oxford University Press
3. Butler, M., 2004. *Animal cell culture and technology*. Taylor & Francis.
4. Clynes, M. (Ed.). (2012). *Animal cell culture techniques*. Springer Science & Business Media.
5. Davis, J. M. (Ed.). (2011). *Animal cell culture: essential methods*. John Wiley & Sons.

## **PS04CBIC22: Nutritional & Clinical Biochemistry**

### **Unit I**

Basic concept- composition of human body: Energy content of food. Measurements of energy expenditure. Energy requirements of man, woman and factor affecting energy requirements, Basal metabolic rate, factor affecting BMR.

Carbohydrates- Dietary requirements and sources of available and unavailable carbohydrates and action of dietary fibers.

Disorders of carbohydrate metabolism: Diabetes mellitus;.Metabolic syndrome, Glucose tolerance test; Glycogen storage diseases

### **Unit II**

Proteins: protein reserves of body. Nitrogen balance studies and factor affecting it. Protein quality and essential amino acids. Cereal proteins requirement at different stages of development

Disorder of AA metabolism-phenylalaninemia, homocystinuria and tyrosinemia.

Disorders of purine and pyrimidine metabolism.

Protein energy malnutrition (PEM)-Marasmus and Kwashiorkor disease.

Starvation –protein metabolism in prolonged fasting, high proteins, low caloric weight reducing diets.

### **Unit III**

Lipids-major classes of dietary lipids. Properties and composition of plasma lipoproteins.

Essential fatty acid and their physiological function.

Clinical inter-relationship of lipids, lipoproteins and apolipoproteins.

Tests for apolipoproteins, HDL, LDL, cholesterol and Triglyceride disorder.

Obesity-factor leading to obesity –environmental and genetic. Role of leptin in regulation of body mass.

### **Unit IV**

Electrolytes and water balance

Food processing and loss of nutrients during processing and cooking.

Anti-nutrients-naturally occurring food born toxicants, Protease inhibitors, hepatotoxins allergens, toxins from mushroom, animal and sea foods

### **Reference Books:**

Harper's Illustrated Biochemistry by Murray, Granner and Rodwell 27<sup>th</sup> edition McGraw Hill

Food and nutrition by Swaminathan

Nutritional biochemistry and metabolism by Linton .

Biochemistry with clinical correlation: Devlin.

## **PS04EBIC23: Microbial Physiology**

### **Unit-I**

Bacterial Cell Structure and its type, Bacterial Cell surfaces, Bacterial Cell wall structure function and synthesis, Membrane transport in bacteria-simple, group translocation, ABC transporters, Protein export in bacteria-Type 1,2,3,4, Protein export pathways.

Bacterial capsules structure and importance.

Bacterial organs for locomotion: Flagella: structure, synthesis, function and mechanism of locomotion, Swarming motility, Motility in spirochetes, Gliding motility, Twitching.

Chemotaxis: Molecular mechanism and physiological significance.

Two component signal transduction in prokaryotes

### **Unit-II**

Bacterial differentiation: endospore formation, physiological and genetic aspects of sporulation, Sporulation inducing signals & events in sporulation

Bacterial cell division: molecular mechanisms involved in formation of Z-ring, Cell division machinery.

Yeast cell division: Growth and cell division coordination, Cell division events, molecular basis of cell cycle and control.

Microbial stress responses: Oxygen toxicity, pH, Heat shock, Osmotic pressure, Osmolarity regulation in *E.coli* (Omp system) Phosphate assimilation in *E.coli* (Pho system), Nitrogen fixation in *Klebsiella* & *Rhizobium* (Ntr system).

Metabolism in Autotrophs, Methylophiles and Photoautotrophs

### **Unit-III**

Bioluminescence: process, biochemistry, genetics and significance.

Mechanism of action of antibiotics and mechanisms of drug resistance.

Bacteriocins: Structure, Classification and physiological significance of it.

Microbial reserve compounds: Types, Synthesis and Applications

Siderophores; structure, function and significance

Bacterial biofilms formation steps, dispersion and control strategies

### **Unit-IV**

Quorum sensing process in gram positive and gram negative bacteria.

Microbial fuel cells: Energy generation principle and application.

Microbial production of Hydrogen.

Host Parasite interactions: Structures and functions involved in Host-parasite interactions, Bacterial damages to host upon infection. Structure and Mechanism of Endotoxin, Exotoxin and Exoenzymes formed by bacteria.

The prokaryotic “immune system”, CRISPR/Cas

**References:**

- Bacterial signalling, Kramar and Jung
- Microbial Physiology, Moat, Foster and Spector
- The Physiology and Biochemistry of prokaryotes, David White
- Bacterial physiology: A molecular approach, W. E. Sharoud

Topic related review articles

## **PS04EBIC24: Plant Biotechnology**

### **Unit-I**

Cell & tissue culture in plants; callus cultures; in-vitro morphogenesis organogenesis and embryogenesis; Artificial Seeds, Micro propagation (Clonal propagation); Haploidy; anther and ovule cultures, Embryo cultures; Protoplast isolation, culture and protoplast fusion and somatic hybridization, Cybrids, Somaclonal Variation; in-vitro mutation methods; Virus elimination, pathogen indexing; Cryopreservation.

### **Unit-II**

Production of secondary metabolites; Sources of plant secondary metabolites; criteria for cell selection, factors affecting the culture of cells; different bioreactors and their use in secondary metabolite production; biochemical pathways for the production of different secondary metabolites; and biotransformation.

### **Unit-III**

Principles and methods of genetic engineering, and its applications in Agriculture. Methods for genetic transformation and transgenic plants production through *Agrobacterium tumefaciens* and *A. rhizogenes*; Gene transfer methods in plants; PEG mediated, microinjection, particle bombardment, electroporation, Molecular markers and their importance in plant breeding, Marker Assisted Selection (MAS).

### **Unit-IV**

Molecular plant pathology: Mechanisms of disease resistance in plants against pathogens; Signalling pathways and molecular events during pathogen – plant interaction. Biotechnology and intellectual property rights (IPR); Plant genetic resources GATT & TRIPS; Patent for higher plant genes and DNA sequence.

#### **Basic Text and Reference books:**

- Plant biotechnology - J Hammond, et. al., Springer Verlag.
- Plant cell and tissue culture for production of food ingredients – T J Fu, G Singh, et. al.
- Biotechnology in crop improvement – H S Chawla.
- Practical application of plant molecular biology – R J Henry, Chapman & Hall.
- Elements of biotechnology – P K Gupta.
- An introduction to plant tissue culture – M K Razdan.
- Plant propagation by tissue culture: The technology (Vols. 1 & 2) – Edwin George.
- Handbook of plant cell culture (Vols. 1 to 4) – Evans et. al., Macmillan.
- Plant tissue and cell culture – H E Street, Blackwell Scientific.
- Cell culture and somatic cell genetics of plants (Vols. 1 to 3) – A K Vasil, A. Press.
- Plant cell culture technology – M M Yeoman.

- Plant tissue culture and its biotechnological applications – W Bary, et. al., Springer Verlag.
- Principles of plant biotechnology: An introduction to genetic engineering in plants – S H Mantel, et. al. Advances in biochemical engineering / Biotechnology – Anderson, et. al.
- Applied and fundamental aspects of plant cell tissue and organ culture edited by Reinert& Bajaj Y P S, Springer Verlag.
- Plant cell and tissue culture - S Narayanswamy, Tata Mc Graw Hill Co.

## **PS04EBIC25: IPR and Biosafety**

### **UNIT-I**

**Biotechnology and society:** Biotechnology and social responsibility, public acceptance issues in biotechnology, issues of access, ownership, monopoly, traditional knowledge, biodiversity, benefit sharing, environmental sustainability, public vs private funding. Social and ethical issues in biotechnology. Principles of bioethics. Ethical conflicts in biotechnology- interference with nature, unequal distribution of risk and benefits of biotechnology, bioethics vs business ethics.

### **UNIT-II**

**Bio- safety:** Definition of bio-safety, Biotechnology and bio-safety concerns at the level of individuals, institutions, society, region, country and world.

Bio-safety in laboratory institution: laboratory associated infection and other hazards, assessment of biological hazards and level of biosafety.

Bio safety regulation: handling of recombinant DNA products and process in industry and in institutions.

### **UNIT-III**

**IPR I:** Introduction to IPR: Forms of IPR and Intellectual property protection. Concept of property with respect to intellectual creativity, Tangible and Intangible property.

WTO: agency controlling trade among nations, WTO with reference to biotechnological affairs, TRIPs. WIPO, EPO.

### **UNIT-IV**

**IPR II:** Concept related to patents novelty, non-obviousness, utility, anticipation, prior art etc. Type of patents. Indian patent act and foreign patents.

Patentability, Patent application, Revocation of patent, Infringement and Litigation with case studies on patent, Commercialization and Licensing.

### **References:**

1. Fleming, D.A., Hunt, D.L., (2000). Biotechnology and Safety Assessment (3rd Ed) Academic press. ISBN-1555811804, 9781555811808.
2. Thomas, J.A., Fuch, R.L. (1999). Biotechnology and safety assessment (3rd Ed). CRC press, Washington. ISBN: 1560327219, 9781560327219
3. Law and Strategy of biotechnological patents by Sibley. Butterworth publication.(2007) ISBN: 075069440, 9780750694445.
4. Intellectual property rights- Ganguli-Tat McGrawhill. (2001) ISBN-10: 0074638602,
5. Intellectual Property Right- Wattal- Oxford Publication House.(1997) ISBN:0195905024.
6. Biotechnology - A comprehensive treatise (Vol. 12). Legal economic and ethical dimensions VCH. (2<sup>nd</sup> ed) ISBN-10 3527304320.



7. Encyclopedia of Bioethics 5 vol set, (2003) ISBN-10: 0028657748.
8. Thomas, J.A., Fuch, R.L. (2002). Biotechnology and safety Assessment (3<sup>rd</sup> Ed) Academic press.
9. B.D. Singh. Biotechnology expanding horizons.
10. H.K.Das. Text book of biotechnology 3<sup>rd</sup> edition.

## **PS04EBIC26: Pharmacognosy**

### **Unit-I**

Plants as sources of drugs, pharmaceuticals and pharmaceutical aids.

Ethnomedicobotany: Basic approaches to study traditional knowledge on herbal medicine;

Scope and potential applications.

### **Unit –II**

Collection methods of ethnomedicobotanical data: Field methods and scrutiny of Herbarium specimens and folklore; verification of data; collection of materials for voucher specimen and for phytochemical screening; application of ethnomedicobotany.

Creating indigenous knowledge base of traditional medicines of plant origin.

### **Unit-III**

Pharmacognosy of drugs derived from alkaloids, glycosides, volatile oils, lipids, gums, resins, tannins and saponins. Drugs of botanical origin: Structure, physical properties and chemistry of secondary metabolites: phenols, phenolic glycosides, saponins, steroids, alkaloids.

### **Unit-IV**

Vitamins and hormones and natural antibiotics.

Biosynthesis of important secondary metabolites such as Glycosides, alkaloids, terpenes and phenols in plants.

Methods for screening natural sources for bioactive principles.

### **References Books:**

Dennis, D. T., D. H. Turpin, D. D. Lefebvre and D. B. Layzell : Plant Metabolism. Addison Wesley Longman Ltd. England.

Doby, G. : Plant Biochemistry. Inter Science Publishers, New York

Dey, P. M. and J. B. Harborne: Plant Biochemistry. Academic Press, London.

Lehninger, A. L., D. L. Nelson and M. M. Cox 2000: Principles of Biochemistry. CBS Publishers and Distributors, New Delhi.

Sadasivam, S. and A. Manickam : Biochemical Methods. 2<sup>nd</sup> edition. New Age International (P) Ltd. New Delh.

Voet, D., J. G. Voet and C. W. Pratt : Fundamentals of Biochemistry. John Wiley & sons, Inc. New York.

Zubay, G. : Biochemistry. Vol. 1 – 3. Wm. C. Brown Publishers, Oxford, England

Chadwick, D.J. & Marsh, J.: Bioactive compounds from plants

Wiley Chichester, CIBA Foundation Symposium 185: Ethnobotany and the search for new drugs

J.B. Harborne: Phytochemical methods

J.C. Willis: Pharmacognosy

C.K. Kokate: Pharmacognosy

Trease, G.E and Evans, W.C.: Pharmacognosy

## PS04EBIC27: Endocrinology

### UNIT I

#### **General Principles of Endocrine Physiology :**

- endocrine, paracrine, and autocrine; Definition of hormone, target cell, and receptor.
- mechanisms of action of peptides, steroids, and thyroid hormones; hormone actions exerted via plasma membrane receptors with those mediated via intracellular receptors.
- the role of hormone-binding proteins.
- the feedback control mechanisms of hormone secretion.
- the effects of secretion, degradation, and excretion on plasma hormone concentrations - the basis of hormone measurements and their interpretation.

#### **The Hypothalamus and Posterior Pituitary Gland :**

- The physiologic and anatomic relationships between the hypothalamus and the anterior and the posterior pituitary.
- The appropriate hypothalamic releasing and inhibitory factors controlling the secretion of each of the anterior pituitary hormones.
- Differences between the routes of transport of hypothalamic neuropeptides to the posterior and anterior pituitary.
- The mechanisms that control the release of oxytocin and ADH (arginine vasopressin, AVP); the cellular mechanisms of oxytocin and AVP action.

### UNIT II

#### **Thyroid Gland:**

- The steps and control factors of thyroid hormone biosynthesis, storage, and release; the distribution of iodine and the metabolic pathway involved in thyroid hormone synthesis.
- Explain the importance of thyroid hormone binding in blood for free and total thyroid hormone levels.
- The significance of the conversion of tetraiodothyronine ( $T_4$ ) to triiodothyronine ( $T_3$ ) and reverse  $T_3$  ( $rT_3$ ) in extrathyroidal tissues.
- Cellular effects of thyroid hormones; their effects on development and metabolism; the causes and consequences of excess and deficiency of thyroid hormones.

#### **Parathyroid Gland and $Ca^{2+}$ and $PO_4$ Regulation**

- The origin, target organs and cell types, and physiologic effects of parathyroid hormone.
- The functions of osteoblasts and osteoclasts in bone remodeling and the factors that regulate their activities.
- The regulation of parathyroid hormone secretion and the role of the calcium-sensing receptor.
- The sources of vitamin D and the biosynthetic pathway involved in modifying it to its biologically active form and cellular mechanisms of action of vitamin D.
- The negative feedback relationship between parathyroid hormone and the biologically active form of vitamin D.
- The causes and consequences of excess or deficiency of parathyroid hormone and of vitamin D.

- The regulation of calcitonin release and the cell of origin and target organs for calcitonin action.

### **UNIT III**

#### **Adrenal Gland :**

- The functional anatomy and zones of the adrenal glands and the principal hormones secreted from each zone.
- The regulation of synthesis and release of the adrenal steroid hormones (glucocorticoids, mineralocorticoids, and androgens) and the consequences of abnormalities in their biosynthetic pathways.
- The cellular mechanism of action of adrenal cortical hormones and their major physiologic actions, particularly during injury and stress.
- The regulation of mineralocorticoid secretion and relate this to the regulation of sodium and potassium excretion.
- The causes and consequences of oversecretion and undersecretion of glucocorticoids, mineralocorticoids, and adrenal androgens.
- The chemical nature of catecholamines and their biosynthesis and metabolic fate.
- The biologic consequences of sympatho-adrenal medulla activation and identify the target organs or tissues for catecholamine effects along with the receptor types that mediate their actions.
- The interactions of adrenal medullary and cortical hormones in response to stress.
- Diseases caused by oversecretion of adrenal catecholamines.

#### **Endocrine Pancreas :**

- The principal hormones secreted from the endocrine pancreas, their cells of origin, and their chemical nature.
- Understand the nutrient, neural, and hormonal mechanisms that regulate pancreatic hormone release.
- Insulin and glucagon action and their major physiologic effects;; The disease states caused by oversecretion, undersecretion, or decreased sensitivity to insulin.

### **UNIT IV**

#### **Reproductive Endocrinology:**

##### **Male Reproductive System:**

- The physiologic functions of the principal components of the male reproductive system.
- The endocrine regulation of testicular function by gonadotropin-releasing hormone, follicle-stimulating hormone, luteinizing hormone, testosterone, and inhibin.
- The cell of origin for testosterone, its biosynthesis, mechanism of transport within the blood, metabolism, and clearance. List other physiologically produced androgens.
- List of the target organs or cell types, the cellular mechanisms of action, and the physiologic effects of testosterone.
- Spermatogenesis and the role of different cell types in this process; the neural, vascular, and endocrine factors involved in the erection and ejaculation response.

- The causes and consequences of androgen oversecretion and undersecretion in prepubertal and postpubescent adult males.

### **Female Reproductive System:**

- Oogenesis, its relationship to follicular maturation, and the roles of pituitary and ovarian factors in their regulation.
- Gonadotropin control of ovarian function.
- The target organs and principal physiologic actions of estrogen and progesterone and how they interact with each other.
- The cellular mechanisms of action for estrogen and progesterone.
- The menstrual cycle.
- The pathways of sperm and egg transport required for fertilization and for movement of the embryo to the uterus.
- The principal endocrine functions of the placenta, particularly in rescue of the corpus luteum and maintenance of pregnancy, and the fetal adrenal-placental interactions involved in estrogen production.
- The roles of oxytocin, relaxin, and prostaglandins in the initiation and maintenance of parturition.
- The hormonal regulation of mammary gland development during puberty, pregnancy, and lactation, and explain the mechanisms
- Control of milk production and secretion.
- The physiologic basis for the effects of steroid hormone contraceptive methods.
- The age-related changes in the female reproductive system, including the mechanisms responsible for these changes, throughout life from fetal development to senescence.

### **Basic Text and Reference Books:**

1. Molina P.A. (2013). *Endocrine Physiology* (4<sup>th</sup>Edn). Mcgraw Hill Lange
2. Bolander, F(2004) **Molecular Endocrinology** Third Edition. Academic press. SanDiego.
3. Holt, E.H. and Peery, H., (2010) **Basic medical endocrinology**. Academic Press.
4. Gard, P. R. (2002). *Human endocrinology*. CRC Press.