January 2018 Onwards

SYLLABUS & COURSES OFFERED

TO

Ph.D Students
Admitted in
University School of Biotechnology

Implemented from January 2018

GGS INDRAPRASTHA UNIVERSITY
SECTOR 16C, DWARKA
NEW DELHI - 110 078

Implemented from January 2018 session, by adding one tutorial to the scheme of August 2015.

Signature of Dean

(August 2017 Onwards)

SCHEME OF SYLLABUS
Offered to Ph.D Students

S. No.	Programme Code	Title
1.	BT-701	Latest Trends in Drug Research
2.	BT-702	Research Methodology
3.	BT-703	Advanced Microbial Biotechnology
4.	BT-705	Genes and Genomics
5.	BT-707	Protein Purifiction and Characterization
6.	BT-709	Advances in Plant Tissue Culture
7.	BT-711	Cancer Biology
8.	BT-713	Clinical Immunology
9.	BT-715	Molecular Aspects of Plant Abiotic Stress
10.	BT-717	Advanced Molecular Biology and Functional Genomics

Implemented from January 2018 session, by adding one tutorial to the scheme of August 2015.

Signature of Dean

SECOND SEMESTER EXAMINATION (Ph. D.)

L	T	Credits	Hours
3	1	4	40

BT-701 LATEST TRENDS IN DRUG RESEARCH

1. Drug discovery and development process: A brief overview. Phases of the drug discovery process and stages of drug discovery process before clinical trails. (4)

2. Drug discovery and utilization of imaging in drug research. Computerized Tomography, Positron Emission Tomography, and Single Photon Emission, Computed Tomography, Ultrasound, Optical Imaging. Benefits & limitation of MRI. In vivo MR Techniques in drug research. (4)

3. Imaging as biomarker for decision making in drug development. Biomarker lexicon, progression from validation to qualification. Imaging biomarker. Imaging in cardiovascular diseases, in neuroscience and multimodality challenge. (5)

4. Drug discovery based on functional genomics. EST database, proteomic methods in target identification, role of bioinformatics in target identification. Genomic based drug target validation. Gene disruption technique, antisense methods, ribozymes, antibodies &intrabodies, chemical ligands, for RNA targets. High-through put drug screening.(5)

5. Combinatorial chemistry. Parallel syntheses, (multipin, teabag, spot and other methods). Split-mix synthesis, mixed monomer and light-directed combinatorial synthesis. Deconvolution methods, Radio frequency encoding of capsules and string syntheses. (5)

6. Lead search, selection and optimization in silico (virtual) screening. Binding site, ligand structure, methods. Test compound selection, undesired chemical groups. Drug likeness, Rule of five (Lipinski's rule). Blood-brain barrier penetration. Application of QSAR methods. Validation of QSAR models, and selection and optimization for lead selection. (6)

7. Development of carbohydrate based therapeutics, Role of carbohydrates (N-Glycans, O- Glycans, Glylolipids & Proteo-glycans). Carbohydrate therapeutics-antithrombosis perspective. Anti-inflammatories, antibiotics, carbohydrate anti-cancer vaccine. Future potential for carbohydrates in drug discovery. (6)

8. Systemic antifungal agents. Azoles, Polyenes, Allylamines Nucleic acid inhibitors. Glucan synthesis inhibitors, mannoprotein binders, chitin synthase inhibitors. Drug under clinical trials & future prospects. (5)

Text/ References books:

- Molecular pathomechanism & drug research by Keri Gyorgy & Toth Istvan. 2003, Taylor & Francis.
- Pharmaceutical Chemistry by Christine M. Bladon. *John Wiley & Sons, Ltd.* (2002).
- Burger's Medicinal Chemistry and Drug Discovery (5^{th} edition) by Manfred E. Wolff. A *Wiley & Sons, Inc.* (2000).

Implemented from January 2018 session, by adding one tutoriaBto the scheme of August 2015.

Signature of Dean

RESEARCH METHODOLOGY

L	T	Credits	Hours
3	1	4	40

BT-702

1. **Scientific Research:** Meaning and characteristics of scientific research; Validity in research; Phases or Stages in research; Various types of research: Quantitative, Qualitative, experimental, Exploratory, Empirical, Descriptive, Ex-post facto, Case studies. (4)

2. **Review of literature:** Purpose of the review, Sources of the review, Citing references, Ethical and IPR issues in research. (3)

3. **Data representation:** Collection of data, Tabulation, Organization and graphical representation of quantitative data- Line Graphs, Bar Graphs, Pie Charts, Histograms; Probability concept and theories. (4)

4. **Sampling:** Meaning and types of sampling- Probability and Non probability Sampling. Methods of drawing random samples, requisites of good sampling methods, Sample size, Sampling error. (4)

5. **Hypothesis testing:** Null hypothesis, Alternate hypothesis, Steps of hypothesis testing, Level of significance, Type I and Type II error. (3)

6. **Measures of Variability:** Range; Quartile Deviation; Standard Deviation; Average Deviation; and Coefficient of Variation; Measures of Relative position: Percentiles, Percentiles Ranks, Standard Scores, Stanine Scores, T- Scores; Normal Probability Distribution, properties of normal curve, applications of normal curve, Divergence from Normality : Skewness and Kurtosis. (5)

7. **Correlation and Regression:** Karl Pearson's correlation Coefficient(r), Spearman's rank order correlation coefficient (rho), Partial and Multiple Correlation, Scatter diagrams, Regression and Prediction, Regression equations, linear regression, multiple regression analysis, Cause and effect- Path analysis (5)

8. **Statistical inference:** Concept of Standard Error and it's uses; The Significance of Statistical Measures; Tests of Significance of Difference between two means Z-Test, T-test; Analysis of variance and analysis of covariance: Assumptions of Anova, One way Anova, Two way Anova, Post Hoc tests- Duncan's multiple range test, Tukey's test, Newmann-Keuls test; Non-parametric Tests: Chi-square test, Medium test, Mann Whitney U test, Kolmogorov- Smirnov two sample test; Multivariate analysis: Factor analysis, Cluster analysis and Discriminant analysis. (5)

9. **Experimental Designs:** Meaning and purpose of research design, Criteria of research design, Basic principles of experimental design, General layout and Anova of experimental designs: Completely Randomized Design, Randomized Block Design, Latin Square Design, Split Plot, Factorial designs. (4)

10. **Preparation of Thesis:** Introduction to scientific writing, Introduction to different softwares used for thesis preparation (3)

Recommended bibliography:-

- Kothari, C. R. (2004). Research methodology. New Age International, 2nd Edition.
- Singh, Y. K. (2009). Fundamental of research methodology and statistics. New Age International.
- Ott, R. L. and Longnecker, M. (2010). An introduction to statisrical method and data analysis. Brroks/Cole Cengage Learning, Canada.
- Laake, P., Bennestad, H. B. and Olson, B. R. (Eds) Research Methodology in the medical and biological sciences (2007) Elsevier/Academic Press.
- Betz, F. (2011) Managing Science, Methodology and Organization of Research. Springer

Implemented from January 2018 session, by adding one tutorial to the scheme of August 2015.

Signature of Dean

SECOND SEMESTER EXAMINATION (Ph. D.)

L	T	Credits	Hours
3	1	4	40

BT-703 ADVANCED MICROBIAL BIOTECHNOLOGY

1. Influence of *E. Coli* toxin on the mammalian central nervous system. Symptoms, CNS histopathology from autopsy. CNS pathology from MRI, animal models, CNS symptoms of animal models. CNS histopathology, Hematology & serum of animal models. Similarity between animal & human patients. (5)

2. Microbial fingerprinting using matrix-assisted laser desorption ionization time of flight- Mass spectrometry (MALDI – TOF - MS). Applications & challenge need to identify microorganism, using (MALDI – TOF). Application in case of bacteria, fungi, viruses & current application challenges, reproducibility, effect of culture conditions. (7)

3. Pathway for discovering microbial metabolism for functional genomics & biotechnology. Hypothesis, organization of existing metabolic functions. Approaches for new discoveries. Newly Discovered microbial metabolism. Significance of new discoveries in novel functional group metabolism. (6)

4. Gastrointestinal micro flora: Probiotics. Human gastrointestinal micro flora, probiotic history. Microorganisms used as probiotics. Selection criteria for probiotic bacteria. Lactose intolerance. Atopic disorders. Treatment & prevention of diarrhea, ulcerative colitis, & pouchitis, irritable bowel syndrome & *Helicobacter pylori* infection. (7)

5. Application of Raman micro spectroscopy on identification of microbial species. Using single cell, Raman tweezers to measure & manipulate single microbial cells. Surface enhanced Raman scattering. Single cell Raman spectroscopy & measuring microbial metabolic potential. Raman spectra data analysis. (7)

6. Nanotechnology in the detection of microorganisms. Carbohydrate biofuntional polymeric nano materials. Nano materials for vaccine development. Florescence based detection of microorganisms. Metallic nano materials, elemental metal nano materials, metal–oxide nano materials. Magnetic nano materials for the detection of microorganisms. Metallic nano materials, elemental metal nano materials, metal oxide nano materials. Magnetic nano materials for the detection of microorganisms. (8)

Text/ References books:

1. Advances in Applied Microbiology. Vo. 71, 2010. Vol. 61, 2007.
2. Annual Reviews in Microbiology, 2010 and others volumes.
3. Critical Reviews in Biotechnology.

Implemented from January 2018 session, by adding one tutoriaЬto the scheme of August 2015.

Signature of Dean

SECOND SEMESTER EXAMINATION (Ph. D.)

L	T	Credits	Hours
3	1	4	40

BT-705 GENES AND GENOMICS

1. DNA Sequencing: Principles and techniques of DNA sequencing; Automated DNA sequencing, Next Generation Sequencing, Single molecule sequencing, Shot gun sequencing. (6)

2. Analysis of Sequence Data: Contig assembly, ORF, Exon – Intron boundaries; Other features of nucleic acid sequencing; Protein motifs & domains; DNA Sequence Databanks; Sequence alignment and comparisons. (6)

3. Analysis of DNA Sequence Variation: Nature of genetic variation; Methods to study variation - Hybridization and PCR based methods, SNPs; Genome – wide comparisons. (6)

4. Comparative Genomics: Comparative account of representative microbial, animal, plant and human genome projects, Synteny in model genomes, Genome evolution. (6)

5. Analysis of Gene Expression: Methods of analyzing gene expression; whole genome expression; differential gene expression comparing transcriptomes – subtractive hybridization, deferential display, SAGE, RNA-seq, Micro arrays. (8)

6. Metagenomics, epigenetics, gene silencing, genome editing. (4)

7. Genome assisted crop and live stock improvement, Genomics and human health care. (4)

Text/ Reference Books:

1. Handbook of comparative Genomics: Principles and Methodology by Cecilia Saccone, Graziano Pesole. Wiley-LISS Publication, 2003.
2. Comparative Genomics by Melody S. Clark. Kluwer Academic Publishers, 2001.
3. Essentials of Genomics & Bioinformatics by C. W. Sensen Wiley, 2003.
4. Discovering Genomics, Proteomics & Bioinformatics by A.M. Camopbell, C.S. H. Press, 2003.
5. Genetics: From Genes to Genomes by Hartwell, L. et al. 2010 McGraw Hill
6. Analysis of Genes and Genomes by Greece, R. J. (2008) Wiley
7. Genomes by T. A. Brown 2009 Oxford/Wiley Liss
8. Various research and review journals like Nature Biotechnology, Current Opinion Series, Trends Series and Annual Reviews, etc.

Implemented from January 2018 session, by adding one tutorial to the scheme of August 2015.

Signature of Dean

SECOND SEMESTER EXAMINATION (Ph. D.)

L	T	Credits	Hours
3	1	4	40

BT-707 PROTEIN PURIFICATION AND CHARACTERIZATION: A PRACTICAL APPROACH

1. General methods for handling proteins and enzymes: Setting up a laboratory, Buffers, Measurements of enzyme activity, Quantitation of protein, Concentration of proteins and removal of salts, Maintaining protein stability. (4)

2. Preparation of crude extract and sub-cellular fractionation: Raw material, Cell disintegration and extraction of protein, Optimization and clarification of the extract, Procedures for particulate-associated enzymes. (4)

3. Concentration of proteins and removal of solutes: Chromatography, Electrophoresis Dialysis, Ultra filtration, Lyophilization, Precipitation, Crystallization. (4)

4. Separation of proteins by precipitation: Salting in and salting out, Organic solvent precipitation, Precipitation with organic polymers and other materials, Precipitation by selective denaturation. (4)

5. Separation of proteins by adsorption: Ion-exchange chromatography, Affinity chromatography, Dye ligand chromatography, Immunoadsorbants, Batch adsorption. (6)

6. Separation of proteins in solution: Gel filtration, Electrophoretic methods, Liquid phase partitioning, Ultrafilteration. (5)

7. Characterization of purified protein: Determination of purity, Determination of size, MW and subunit structure, Amino acid analysis, Limited N- terminal sequence analysis. Peptide mapping, Analysis of protein modifications and non-protein cofactors, Protein crystallization. (5)

8. Immunological procedures: Preparation of polyclonal and monoclonal antibodies, Protein blotting and immunodetection, Immunoassays. (3)

9. Radio –labeling of proteins (2)

10. Purified proteins to gene cloning (3)

Text/ References books:

- Methods in Enzymology: Guide to Protein purification, Edited by Richards R Burgess and Murray P Deutscher. Elsevier (2009)
- Purifying Proteins for Proteomics: A laboratory manual, Edited by Richard J. Simpson (Cold Spring harbor Laboratory Press(2004)
- Protein Analysis and Purification: Benchtop Techniques by Ian M. Rosenberg (Birkh Ã¤user Boston (2004)
- Protein Purification (THE BASICS) by Philip L. R. Bonner Taylor & Francis (2007)
- Research Papers and review articles

Implemented from January 2018 session, by adding one tutorial to the scheme of August 2015.

Signature of Dean

SECOND SEMESTER EXAMINATION (Ph. D.)

L	T	Credits	Hours
3	1	4	40

BT-709 ADVANCES IN PLANT TISSUE CULTURE

1. Events in the refinement of plant tissue culture as a major biotechnological tool: tracing evolution of medium proposition, aseptic procedures, choice of sterilizing agents, nature of regeneration protocols etc. (3)

2. Introduction to variety of explants and their potential: orthodox/recalcitrant nature of explants, best explants choice, selection criterion based on purely academic interest /commercial exploitation for improvement and modification purposes. (5)

3. Understanding the requirements of In vitro culture technique: need and application of specific media (liquid/semisolid), basic composition and other supplements to be added and specific equipments/accessories (for single cell/tissue/organ culture) necessary for achieving specific targets. (5)

4. Regeneration protocol optimization: with a focus on achieving different objectives such as clonal propagation/micropropagation/ cryopreservation/ multiplication for saving from extinction etc. (5)

5. Protocol development for exploiting somaclonal/ tissue culture induced variations: Screening, selecting the desirable variants, characterizing their nature (heritable or otherwise) and optimizing their regeneration protocols for stable production of abiotic and biotic stress tolerant plants. (5)

6. Creating novel combinations in vitro: Using aseptic procedures to create inter/ intra specific or generic hybrids or combinations not possible in nature through somatic hybridization/ parasexual hybridization, in vitro pollination and fertilization, production of haploids/ homozygous diploids, gynogenic haploids, triploids etc. (6)

7. Production of transgenic plants: Development of protocol for transforming explants from existing genotypes and their multiplication for further evaluation and characterization for academic as well as commercial purposes. (5)

8. Production of desirable compounds in vitro: Protocol development and optimization for enhanced yields of compounds such as secondary metabolites etc for flavouring, perfumery or pharmaceutical interest or molecular pharming, commercialization and automation potential. (6)

Text/ References books:

- Bhojwani, SS. (2005). Plant Tissue Culture: Theory And Practice, 5th Revised Edition, Elsevier.
- Bhojwani, SS. (2003). Agrobiotechnology and Plant Tissue Culture. Oxford University Press.
- Slater, S, Scott, NW & Fowler, MR. (2008). Plant Biotechnology: the genetic manipulation of plants, second edition, Oxford.
- Dodds, JH & Roberts, LW. (1995). Experiments in plant tissue culture. Cambridge University press, Cambridge.
- Bhojwani, SS. (2003). Agrobiotechnology And Plant Tissue Culture. Oxford University Press.

Implemented from January 2018 session, by adding one tutorial to the scheme of August 2015.

Signature of Dean

SECOND SEMESTER EXAMINATION (Ph. D.)

L	T	Credits	Hours
3	1	4	40

BT-711 CANCER BIOLOGY

1. Characteristics of Human Cancer: Definition and description of cancer, Significant events in cancer research, Hallmarks of malignant disease, Classification of human cancers. (5)

2. The Epidemiology of Human Cancer: Trends of cancer incidence and mortality- worldwide and Indian scenario, Role of risk factors in development of cancer- intrinsic and extrinsic factors. (3)

3. Causes of cancer: Introduction to mutagens and carcinogens, Tumor viruses and the discovery of oncogenes, Mechanism of tumor initiation promotion and progression. (5)

4. The Biochemistry and Cell Biology of Cancer: Growth characteristics of malignant cells- immortality, loss of anchorage dependence, decreased dependence on growth factors, loss of cell cycle control and resistance to apoptosis, Invasion and metastasis. (5)

5. Molecular Genetics of Cancer: Oncogenes, Tumor suppressor genes, DNA methylation, telomeres and telomerase, Molecular genetic alterations in cancer cells. (5)

6. Tumor immunology: Tumor evasion of immune system, the role of immune surveillance, tumor antigens, cytokine therapy, NK cell and dendritic cell therapy, cancer vaccines (5)

7. Cancer Diagnosis and treatment: Present methods and techniques for cancer detection and therapy, molecular diagnosis, Tumor markers, blood based markers for early detection and screening of cancer. (6)

8. Applications of new technologies in diagnostics and treatment advances in cancer: Biomarker discovery using mass spectrometry based proteomics, Gene expression microarrays, noncoding RNAs, use of RNAi techniques and stem cells. (6)

Text/ References books:

- **The Biology of Cancer, by Robert A. Weinberg, 2014, Garland Science, ISBN 978-0-8153-4220**
- **Ruddon - Cancer Biology by** Raymond W. **4th Edition** Oxford University Press
- Recent articles from **Nature Reviews Cancer**

Implemented from January 2018 session, by adding one tutoriaÐto the scheme of August 2015.

Signature of Dean

SECOND SEMESTER EXAMINATION (Ph. D.)

L	T	Credits	Hours
3	1	4	40

BT-713 CLINICAL IMMUNOLOGY

1. Understanding of Basic Immunology: Structure and function of the immune system, Infection and immunity, Immune regulation and Tolerance. (4)
2. Hypersensitivity Reactions – Types 1, II, III, IV, IgE-mediated (type-I), Ab-mediated cytotoxic (type-II), Immune complex mediated (type-III), Delayed type hypersensitivity (type-IV). (4)
3. Autoimmune Diseases- Factors influencing the development of autoimmunity, The spectrum of autoimmunity, Organ non -specific diseases, Systemic lupus erythematosus, Rheumatoid arthritis, Sjogren's syndrome, Scleroderma, Organ-specific Autoimmune Diseases, Endocrine gland disorders, autoimmune thyroiditis, Pancreas – IDDM, Gastrointestinal disorders – pernicious anemia. (5)
4. Immune Deficiency Disorders- Accessory Cell Dysfunction, Primary Immune Deficiency Disorders, Humoral immune deficiency - Bruton's gammaglobulins ,Selective IgA deficiency, Cellular immune deficiency, DiGeorge Syndrome, Combined humoral and cellular immune deficiency SCID, Wiskott-Aldrich syndrome, Secondary Immune Deficiency Disorders . (6)
5. Immunoproliferative Disorders- Monoclonal gammopathy, Multiple myeloma, Waldenstrom's macroglobulinemia, monoclonal disorders, Polyclonal gammopathy. (5)
6. The immune response in infectious diseases- Spirochetal infections: Syphilis and Lyme disease, Streptococcal infections, Epstein – Barr virus, Tuberculosis, Leprosy, HIV infection, Etiologic agents, Stages of the disease, Direct detection, Serologic disease, Treatment and prevention. (5)
7. Tumour and Transplant Immunology- Predisposing genes, role of oncogenes, tumour markers, cancer treatment. Types of grafts, graft acceptance and rejection, tissue typing, immunosuppression. (5)
8. Immunodiagnostics: Theory and Diagnostic Procedures, Precipitation & Immunoelectrophoresis, Agglutination, Labeled immunoassays, Flow Cytometry, Lymphocyte subset analysis, Nephlometry, Lymphocyte phenotyping in HIV infection and leukemia and other diagnostic procedures. (6)

Text/ References books:

- Stevens, Christine Doresteyn. Clinical Immunology & Serology: A Laboratory Perspective. 3rd ed. F.A. Davis Co. Philadelphia, 2009
- Abdul K. Abbas, Andrew H, Lichtman and Shiv Pillai. Cellular and Molecular Immunology. 6th ed.
- Helen Chapel, Mansel Haeney, Siraj Misbah, Neil Snowden. Essentials of Clinical Immunology. 5th ed. Wiley Blackwell. 2006
- Robert R. Rich, Thomas A. Fleischer, William T. Shearer et al. Clinical Immunology Principles and Practice. 4th ed. Mosby Elsevier

Implemented from January 2018 session, by adding one tutorial to the scheme of August 2015.

Signature of Dean

SECOND SEMESTER EXAMINATION (Ph. D.)

L	T	Credits	Hours
3	1	4	40

BT-715 MOLECULAR ASPECT OF PLANT ABIOTIC STRESS

1. Plant Stress: Abiotic and biotic stresses, Effect of abiotic stress on plant productivity and growth, Response at morphological and physiological level. (3)

2. Salinity stress: Genetic diversity for salt tolerance, Mechanisms of salt stress, Sensors, Ion Homeostasis, Na+/H+ antiporter, Na+ - ATPase, Na+ influx and efflux, Na+ compartmentalization, K+/Na+ balance, Salinity responsive genes and proteins, Recent advances in engineering of salt-tolerant crops. (3)

3. Drought stress: Plant response to dehydration stress, Leaf water potential, Mechanisms of dehydration tolerance, **Calmodulin,** Antioxidant, Late-embryogenesis-abundant (LEA) proteins, drought-responsive genes and proteins, Secondary messenger, Recent advances in engineering drought tolerance plants. (5)

4. High temperature stress: Plant response to heat stress, Mechanisms of high temperature tolerance, Responses of C3 and C4 plants, Heat shock protein, Heat shock transcription factors, High temperature responsive genes and proteins Recent advances in engineering heat tolerance plants. (4)

5. Low temperature stress: Cold stress signaling, DREB1/CBFs transcription factor, Transcriptional regulation-ICE1–CBF transcriptional cascade, Negative regulators of the CBF regulon, CBF-independent regulons, Cold responsive genes and proteins, Recent advances in engineering cold tolerance plants. (4)

6. Stress signaling pathway: Ca2+ signaling, MAPK signaling, **Phospholipid signaling,** ABA-dependent and ABA-Independent pathway, Salt Overly Sensitive (SOS) Pathway, **Heat shock signal transduction pathway.** (7)

7. Heavy metal stress: Metalloenzymes, Metal Transporters, Role of Phytochelatins, Molecular mechanisms heavy metal uptake and tolerance. (3)

8. Secondary Messenger and Hormones: Ca2+ as secondary messenger, inositol phosphates, Reactive oxygen species, Abscisic acid (ABA), Jasmonic Acid (JA), Ethylene and Polyamines and their role in plant abiotic stress tolerance. (7)

9. Osmolytes and Osmoprotectants: Carbohydrates - Sucrose, Mannitol, Trehalose, Arabinitol, Mannitol, Pinnitol/ononitol, Sorbitol, Nitrogen compound - Proline, Glycine betaine, Choline, Putrescine, Organic acid - Oxalate and Malate. (4)

Text/ References books:

- Abiotic Stress Adaptation in Plants: Physiological, Molecular And Genomic Foundation. Pareek, A.; Sopory, S.K.; Bohnert, H.J.; Govindjee (Eds.) 1st Edition., 2010, XXVII, 526 p., Hardcover ISBN: 978-90-481-3111-2
- Physiology and Molecular Biology of Stress Tolerance in Plants. Madhava Rao, K.V.; Raghavendra, A.S.; Janardhan Reddy, K. (Eds.) 2006 ISBN: 1-4020-4224-8
- Biochemistry & Molecular Biology of Plants. B.B. Buchanan, W. Gruissem and R.L. Jones (Eds), 2000 American Society of Plant Physiologists, Rockville, Maryland. ISBN:0-943088-39-9
- Levitt, J. Responses of Plants to Environmental Stress, 2nd Edition, Volume 1: Chilling, Freezing, and High Temperature Stresses. 1980. Publisher: Academic Press.
- Major review articles on abiotic stresses from scientific journals including articles from Annual Review of Plant Biology, Plant Physiology, Crop Science, Environmental and Experimental Botany, Plant and Soil, and Plant, Cell, and the Environment.

Implemented from January 2018 session, by adding one tutorial to the scheme of August 2015.

Signature of Dean

SECOND SEMESTER EXAMINATION (Ph. D.)

L	T	Credits	Hours
3	1	4	40

BT 717: Advanced Molecular Biology and Functional Genomics

1. **Molecules of Life** -- Occurrence, structure, classification and functions of nucleic acids. Historical and General Aspects -- Basic discoveries on genetic material; genotype to phenotype. (6)

2. **Genome Replication and Maintenance** -- Basic principles of perpetuation and maintenance of genomic integrity; DNA polymerases and accessory proteins; Control of replication of chromosomes and extra-chromosomal elements, Transposable elements. (6)

3. **Regulation of Transcription and Translation** -- Discovery of RNA; Operon concept; Promoters and other control elements; RNA polymerases and accessory factors; Transcriptional controls; Controls at transcription termination; Control of gene expression in bacteriophages. Structure of ribosome and comparative studies in eukaryotes; tRNA; Genetic code; Translational and post-translational control; Codon bias. (6)

4. **Control of Gene Expression** -- Introns and exons - size, distribution and evolution; RNA splicing; Catalytic RNA; Alternative splicing; RNA stability; Small RNAs and RNA interference Transcriptional and post-transcriptional control of gene expression (6)

5. **Principles, Tools and Techniques of Recombinant DNA Technology** -- Gene cloning, Restriction enzymes and nucleic acid modifying enzymes; Vectors - plasmids, phages, cosmids, shuttle vectors, artificial chromosomes, plant viruses and other advanced vectors; cDNA and genomic libraries - construction, screening methods and applications; PCR and its applications; DNA sequencing methods; Techniques for studying gene expression and inter-biomolecular interactions. (6)

6. **Phylogenetic Analysis** -- Basic concept of phylogenetic analysis, rooted/uprooted trees, approaches for phylogenetic tree construction (UPGMA, Neighbour joining, Maximum parsimony, Maximum likelihood). (6)

7. **Introduction to Epigenetic Gene Regulatory Mechanisms**…. Posttranslational modifications on histone proteins, Histone code, Factors affecting chromatin remodeling and gene activation/silencing, DNA methylation, Components of DNA methylation machinery, Inheritance of epigenetic traits. (4)

References

1. ***Epigenetics,*** *Second Edition (2015) Edited by C. David Allis, The Rockefeller University; Marie-Laure Caparros, London; Thomas Jenuwein, Max-Planck Institute of Immunobiology and Epigenetics; Danny Reinberg, Howard Hughes Medical Institute, New York University School of Medicine-Smilow Research Center; Associate Editor Monika Lachlan, Max-Planck Institute of Immunobiology and Epigenetics*

2. ***Lewin, B****. 2008. Genes IX. Jones and Bartlett Publishers, Inc., USA.*

3. ***Lodish, H., Berk, A., Zipursky, S.L., Matsudaria, P., Baltimore, D. and Darnell, J.*** *(Eds.) 2000. Molecular Cell Biology. W.H. Freeman & Co., USA.*

4. ***Baxevanis, A.D. and Ouellette, B.F.F.*** *2005. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Third Edition. John Wiley and Son Inc., USA.*

5. ***Watson, J.W., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R.*** *2004. Molecular Biology of Gene. Pearson Education, USA.*

6. ***Brown, T.A.*** *2007. Genomes 3. Third Edition. Garland Science Publishing, USA.*

7. ***Genome Science: A Practical and Conceptual Introduction to Molecular Genetic Analysis in Eukaryotes (2014). Cold Spring Harbor Laboratory Press***

Implemented from January 2018 session, by adding one tutorial to the scheme of August 2015.

Signature of Dean