

# **Study Scheme & Syllabus of**

**PhD Course Work in Pharmaceutical Sciences**

**Batch 2019 Onward**



**By**

**Board of Study Pharmacy**

**Department of Academics**

**IK Gujral Punjab Technical University**

## Study Scheme

| Course Code  | Course Type                              | Course Name                                    | Load      |           |           | Marks      |            |            | Credits   |
|--------------|--|--|-----------|-----------|-----------|------------|------------|------------|-----------|
|              |  |  | L         | T         | P         | Internal   | External   | Total      |           |
| PHP-101      | Compulsory Course                        | Research Methodology                           | 3         | 1         | -         | 30         | 70         | 100        | 4         |
| PHP-201      | Core Theory<br>(Any One)                 | Pharmaceutics                                  | 3         | 1         | -         | 30         | 70         | 100        | 4         |
| PHP-202      |  | Pharmaceutical Chemistry                       | 3         | 1         | -         | 30         | 70         | 100        |           |
| PHP-203      |  | Pharmacology                                   | 3         | 1         | -         | 30         | 70         | 100        |           |
| PHP-204      |  | Pharmacognosy                                  | 3         | 1         | -         | 30         | 70         | 100        |           |
| PHP-301      | Interdisciplinary<br>Course<br>(Any One) | Modern Pharmaceutical Analytical Techniques    | 3         | 1         | -         | 30         | 70         | 100        | 4         |
| PHP-302      |  | Intellectual Property Rights                   | 3         | 1         | -         | 30         | 70         | 100        |           |
| PHP-303      |  | Pharmacology & Toxicological Screening Methods | 3         | 1         | -         | 30         | 70         | 100        |           |
| PHP-304      |  | Biochemical & Separation Techniques            | 3         | 1         | -         | 30         | 70         | 100        |           |
| PHP-305      |  | Bioprocess Technology                          | 3         | 1         | -         | 30         | 70         | 100        |           |
| PHP-306      |  | Recombinant Biotechnology                      | 3         | 1         | -         | 30         | 70         | 100        |           |
| PHP-307      |  | Plant Tissue Culture                           | 3         | 1         | -         | 30         | 70         | 100        |           |
| PHP-401      | Presentation                             | *Presentation                                  | -         | -         | 6         | 75         | -          | 75         | 3         |
| <b>Total</b> |  |  | <b>09</b> | <b>03</b> | <b>06</b> | <b>165</b> | <b>210</b> | <b>375</b> | <b>15</b> |

*\*Minimum three presentations related to proposed research area of the candidate*

*\*Non-University Exam*

| Course Code | Course Title         | Teaching Load |   |   | Marks |      | Exam (hrs) |      | Credits |
|-------------|----------------------|---------------|---|---|-------|------|------------|------|---------|
|             |                      | L             | T | P | Int.  | Ext. | Int.       | Ext. |         |
| PHP-101     | Research Methodology | 3             | 1 | - | 30    | 70   | 1.5        | 3    | 4       |

### **Overview of Research**

**10 Hrs**

Research and its type, identifying and defining research problems, introduction to different types of research designs. Essential constituents of literature review. Basic principles of experimental design, completely randomized, randomized block, Latin square, factorial

### **Methods of Data Collection**

**04 Hrs**

Primary and secondary data, methods of primary data collection, classification of secondary data

### **Sampling Methods**

**10 Hrs**

Probability sampling: simple random sample, systematic sampling, stratified sampling, cluster sampling and multistage sampling; Non-probability sampling: convenience sampling, judgement sampling, quota sampling; sampling distribution

### **Processing and Data Analysis**

**15 Hrs**

Statistical measures and their significance: central tendencies, measures of variability, skewness, kurtosis, correlation and regression; hypothesis testing: parametric test (z, t, F), Chi square, ANOVA and non-parametric test

### **Reliability and Validity**

**03 Hrs**

Test- retest reliability, alternative form reliability, internal-comparison reliability, and scorer reliability; content validity, criterion- related validity and construct validity

### **Essentials of Report Writing**

**05 Hrs**

### **Suggested Readings/Recommended Books (Latest Editions)**

1. Geoffrey R. Norman, David L. Streiner, Biostatistics: The Bare Essentials, PMPH USA
2. Beth Dawson, Robert G. Trapp, Basic & Clinical Biostatistics, McGraw-Hill
3. Marcello Pagano, Kimberlee Gauvreau, Principles of Biostatistics, CRC Press
4. Antonella Bacchieri, Giovanni Della Cioppa, Fundamentals of Clinical Research, Springer
5. Katsumi Kobayashi, K. Sadasivan Pillai, A Handbook of Applied Statistics in Pharmacology, CRC Press

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|             |               | L             | T | P | Int.  | Ext. | Int.       | Ext. |         |
| PHP-201     | Pharmaceutics | 3             | 1 | - | 30    | 70   | 1.5        | 3    | 4       |

#### **Pre-formulation Studies**

**07 Hrs**

Introduction, pre-formulation testing criteria, regulatory requirements, testing systems, solid-state characterization, transport across biological membranes

#### **Polymers**

**05 Hrs**

Polymer classification, physiochemical properties and polymer solutions, biodegradable and non-biodegradable polymers, application of polymers in controlled release of drugs, transport of small molecules in polymers, ionic polymers as drug carriers, polymer drug interactions

#### **Controlled Drug Delivery**

**07 Hrs**

Introduction, basic concept, rationale of SR/CR drug delivery, physicochemical and biological factors influencing design and performance of CR products, therapeutic status of CDDS, targeting through nano-particles, monoclonal antibodies, vitreous body, colon targeting, lung targeting

#### **Pharmaceutical Process Validation**

**08 Hrs**

Basic concept, regulatory basis of validation, benefits of validation, types of process validation related to prospective retrospective and concurrent process validation, re-validation of validation process and scale-up and post approval changes (SUPAC), analytical Validation

#### **Optimization**

**05 Hrs**

Introduction to statistical methods and factorial design, quality by design

#### **Bioequivalence Studies**

**07 Hrs**

Basic pharmacokinetic concepts, *in vitro* and *in vivo* methods in establishment of bioequivalence

#### **Pharmaceutical Packaging**

**08 Hrs**

Introduction, quality control, paper and board-based packaging materials and their use in pack security systems, sterile products, closures and closure systems, sterile product and the role of rubber components, blister strip, child resistant, sachet packaging, present and future trends

#### **Suggested Reading/Reference Books (Latest Edition)**

1. J.R. Robinson & V.H.L. Lee (Eds), Controlled Drug Delivery, Fundament and applications, Vol. 29&Vol. 31, Marcel Dekker, N.Y.
2. Y.W. Chien (Ed.), Transdermal Controlled Systemic Medications, Marcel Dekker, N.Y.
3. N.K. Jain, Controlled and novel drug delivery, CBs, New Delhi.

4. N.K. Jain, Advances in Controlled and novel drug delivery, CBS, New Delhi.
5. J.I. Wells, Pharmaceutical Preformulation: The Physicochemical Properties of Drug Substances, Ellis Horwood, Chichester (UK)
6. S.P.Vyas and R.K.Khar, Controlled Drug Delivery, concept and advances
7. J.G. Wagner, Pharmacokinetics for the Pharmaceutical Scientist, Technomic, Pa
8. L. Shargel, and A. Yu, Applied Biopharmaceutics and Pharmacokinetics, Appleton and Large, Norwalk, CT.
9. M. Gibaldi and D. Perrier, Pharmacokinetics, J. Swarbrick, ed., Marcel Dekker, N.Y.

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|             |                          | L             | T | P | Int.  | Ext. | Int.       | Ext. |         |
| PHP-202     | Pharmaceutical Chemistry | 3             | 1 | - | 30    | 70   | 1.5        | 3    | 4       |

### Stereochemistry

10 Hrs

Optical isomerism: chirality and molecular symmetry; stereochemical designation of chiral centre(s) (*R* & *S*); chiral axis; resolution of racemic mixture-techniques including chiral chromatography, geometric Isomerism: *cis*, *trans*; *E*, *Z*, conformational analysis: boat-chair conformations; staggered, gauche, eclipsed conformations

### Fundamentals of Medicinal Chemistry

05 Hrs

Basics of drug action: covalent, ionic, ion-dipole, hydrogen bonding, van der Waals interactions, bio-isosterism, drug receptor interaction, constitution of cell membrane

### Drug Design

12 Hrs

Analogue synthesis versus rational drug design, discovery of lead compounds, pharmacophore identification, structure modifications of lead compound (prototype), physicochemical alterations, pro-drug approach, quantitative structure activity relationship, computer aided drug design, molecular modelling, combinatorial chemistry and high throughput screening

### Natural Products

14 Hrs

Drugs of natural origin: from plants, micro-organisms, animal source, marine products, biosynthesis of natural products, approaches of structure elucidation: degradation and synthetic approaches; spectral analysis (UV, IR, NMR, Mass), hyphenated techniques: GC-MS, LC-MS, chemical modifications of natural products; opioid analgesics, anti-neoplastic agents, anti-malarials

### Techniques of Quantitative Estimation of Drugs for Determination of Purity

06 Hrs

### Suggested Reading/Reference Books (Latest Edition)

1. Ernest EI and Samuel H. Stereochemistry of Organic Compounds. John Wiley and Sons, New York.
2. Lehr RE and Marchand AP. Orbital Symmetry: A Problem Solving Approach. Academic Press, New York.
3. March J. Advanced Organic Chemistry: Reactions, Mechanisms and Structures. John Wiley and Sons, New York.
4. Lehr RE and Marchand AP. Orbital Symmetry: A problem solving approach. Academic Press, New York.
5. Mitscher LA and Baker WR. Wiley and Sons
6. A Search for Novel Chemotherapy Against Tuberculosis Amongst Natural Products. Pure and Applied Chemistry (1998), Vol. 70, No.2, pp 365-371.
7. Wermuth CG. The Practice of Medicinal Chemistry. Academic Press, Jordon Hill, Oxford.

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|             |              | L             | T | P | Int.  | Ext. | Int.       | Ext. |         |
| PHP-203     | Pharmacology | 3             | 1 | - | 30    | 70   | 1.5        | 3    | 4       |

**Molecular Aspects of Drug Action** **07 Hrs**

Receptor occupancy, types of drug targets, main families of receptors and ion channels, signal transduction mechanisms coupling receptors to cellular function

**Cellular Mechanisms of Drug Action** **08 Hrs**

Short-term regulation of cellular function (excitation, contraction and secretion), slower mechanisms of cell response (cell proliferation, apoptosis) and their pathophysiological significance

**Inflammation and Immune Reactions** **04 Hrs**

Acute inflammatory reaction, mediators of inflammation and immune response, therapies based on manipulation of immune response

**Antioxidants** **02 Hrs**

Reactive oxygen intermediates, antioxidants and their therapeutic implications

**Toxicity Studies** **06 Hrs**

Acute, sub-acute, sub-chronic, chronic toxicity

**Advances in Transgenic Animals** **02 Hrs**

**Regulatory Guidelines** **06 Hrs**

Guidelines for maintenance and experimentation using laboratory animals (CPCSEA, OECD, ICH, ICMR, Schedule Y)

**In-vitro Experimentation Techniques** **06 Hrs**

Animal cell lines and their uses, radioligand binding assay, patch clamp, ELISA

**Molecular Techniques** **06 Hrs**

PCR, blotting, immunostaining, cloning, RIA

**Suggested Reading/Reference Books (Latest Edition)**

1. BG Katzung AJ Trevor, Basic and Clinical Pharmacology, Mc Graw-Hill.
2. HP Rang, MM Dale, JM Ritter, RJ Flower, G Henderson, Rang & Dale's Pharmacology, Elsevier.
3. PN Bennett, MJ Brown and P Sharma, Clinical Pharmacology, Churchill Livingstone Elsevier.
4. KD Tripathi, Essentials of Medical Pharmacology, Jay Pee Medical.

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|             |               | L             | T | P | Int.  | Ext. | Int.       | Ext. |         |
| PHP-204     | Pharmacognosy | 3             | 1 | - | 30    | 70   | 1.5        | 3    | 4       |

### **Organoleptic Evaluation of Plant Drugs**

**08 Hrs**

Gross morphology, detection of foreign matter, quantitative microscopy: vein islet number, vein termination number, stomatal number, stomatal index, palisade ratio, micrometry: measurement of fibers, trichomes, starch grains, calcium oxalate crystals, lycopodium spore analysis, fluorescence analysis, determination of moisture content, ash values, extractive values, swelling index, refractive index, optical rotation

### **Primary and Secondary Plant Metabolites**

**05 Hrs**

Classification of secondary metabolites (e.g. alkaloids, glycosides, terpenoids, saponins, flavonoids, coumarins, phenolics, etc.), biogenetic theories

### **Extraction Techniques**

**04 Hrs**

Maceration, percolation, sonication, soxhlet assisted extraction, ultrasound assisted extraction, super critical fluid extraction, microwave assisted extraction, enzyme assisted extraction

### **Isolation of Plant Constituents**

**10 Hrs**

Column Chromatography (adsorbents, elutropic series of solvents), paper chromatography, TLC, HPLC, HPTLC, GLC, preparative chromatography

### **Phytoconstituent Characterization**

**10 Hrs**

Basic concepts of spectroscopy (UV, IR, NMR and Mass), interpretation of spectral data

### **Cultivation of Medicinal Plants and Harvesting**

**01 Hrs**

### **WHO Guidelines for Assessment of Crude Drugs**

**02 Hrs**

Evaluation of identity, purity, quality of crude drugs, determination of pesticide residue, determination of microorganisms, aflotoxins, determination of arsenic and heavy metals (Hg, Pb, Cd)

### **Herbal Drug Standardization**

**06 Hrs**

Phytochemical reference standards (PRS), botanical reference standards (BRS), TLC fingerprint profile along with PRS, quantitative estimation of biomarker by HPTLC or GC, GC-MS, LC-MS

### **Nutraceuticals**

**01 Hrs**

### **Suggested Reading/Reference Books (Latest Edition)**

1. W.C.Evans, Trease and Evans Pharmacognosy, 15th edition, W.B. Saunders & Co., London.
2. Egon Stahl, Thin Layer chromatography -A laboratory handbook, Springer-Verlag, Berlin.
3. M.J. Cupp, Toxicology and Clinical Pharmacology of Herbal Products, Humana Press New-Jersey.



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|             |   | L             | T | P | Int.  | Ext. | Int.       | Ext. |         |
| PHP-301     | Modern Pharmaceutical Analytical Techniques | 3             | 1 | - | 30    | 70   | 1.5        | 3    | 4       |

#### **UV-Visible Spectroscopy**

**05 Hrs**

Introduction, theory, laws, instrumentation associated with UV-Visible spectroscopy, choice of solvents and solvent effect and applications of UV-Visible spectroscopy

#### **IR Spectroscopy**

**05 Hrs**

Theory, modes of molecular vibrations, sample handling, instrumentation of dispersive and fourier - transform IR Spectrometer, factors affecting vibrational frequencies and applications of IR spectroscopy

#### **Spectrofluorimetry**

**04 Hrs**

Theory of fluorescence, factors affecting fluorescence, quenchers, instrumentation and applications of fluorescence spectrophotometer

#### **NMR Spectroscopy**

**10 Hrs**

Quantum numbers and their role in NMR; principle, instrumentation, solvent requirement in NMR, relaxation process, NMR signals in various compounds, chemical shift, factors influencing chemical shift, spin-spin coupling, coupling constant, nuclear magnetic double resonance, brief outline of principles of FT-NMR and <sup>13</sup>C NMR, applications of NMR spectroscopy

#### **Mass Spectroscopy**

**10 Hrs**

Principle, theory, instrumentation of mass spectroscopy, different types of ionization like electron impact, chemical, field, FAB and MALDI, APCI, ESI, APPI analyzers of quadrupole, time of flight, mass fragmentation and its rules, meta stable ions, isotopic peaks, applications of mass spectroscopy

#### **Chromatography**

**08 Hrs**

Principle, apparatus, instrumentation, chromatographic parameters, factors affecting resolution and applications of: paper chromatography, thin layer chromatography, ion exchange chromatography, column chromatography, gas chromatography, high performance liquid chromatography, affinity chromatography

#### **X ray Crystallography**

**05 Hrs**

Production of X rays, different X ray methods, Bragg's law, rotating crystal technique, X ray powder technique, types of crystals, applications of X-ray diffraction

#### **Suggested Reading/Reference Books (Latest Edition)**

1. Robert M Silverstein, Spectrometric Identification of Organic Compounds, John Wiley & Sons.
2. Douglas A Skoog, F. James Holler, Timothy A. Nieman, Principles of Instrumental Analysis Eastern press, Bangalore.

3. Willards Instrumental methods of analysis, CBS Publishers.
4. Beckett and Stenlake, Practical Pharmaceutical Chemistry, CBS Publishers, New Delhi.
5. William Kemp, Organic Spectroscopy, ELBS.
6. P D Sethi, Quantitative Analysis of Drugs in Pharmaceutical formulation, CBS Publishers, New Delhi.
7. J W Munson, Pharmaceutical Analysis- Modern Methods, Marcel Dekker Series.

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|             |                              | L             | T | P | Int.  | Ext. | Int.       | Ext. |         |
| PHP-302     | Intellectual Property Rights | 3             | 1 | - | 30    | 70   | 1.5        | 3    | 4       |

Definition, need for patenting, types of patents, conditions to be satisfied by an invention to be patentable, introduction to patent search. **10 Hrs**

Parts of patents, filling of patents, the essential elements of patent, guidelines for preparation of laboratory note book, non-obviousness in patent **10 Hrs**

Role of GATT, TRIPS, and WIPO **05 Hrs**

Brief introduction to trademark protection and WHO Patents, IPR's and its types, major bodies regulating Indian pharmaceutical sector **07 Hrs**

Brief introduction to CDSCO, WHO, USFDA, EMEA, TGA, MHRA, MCC, ANVISA **08 Hrs**

Regulatory requirements for contract research organization, regulations for biosimilar **07 Hrs**

#### **Suggested Reading/Reference Books (Latest Edition)**

1. Ira R. Berry and Robert A. Nash, Pharmaceutical Process Validation, CRC Press
2. Willing S.H. Marcel and Dekker, GMP for pharmaceuticals, Marcel Dekker Inc
3. Parikshit Bansal, IPR Handbook for Pharma Students and Researchers, BSP Books Private Limited
4. Josef Drexler, Nari Lee, Pharmaceutical Innovation, Competition and Patent Law: A Trilateral Perspective, Edward Elgar
5. Rashmi Aggarwal and Rajinder Kaur, Patent Law and Intellectual Property in the Medical Field, IGI Global
6. Arthur Miller and Michael Davis, Intellectual Property, Patents, Trademarks, and Copyright in a Nutshell (Nutshells), West Academic Publishing

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|-------------|--|---------------|---|---|-------|------|------------|------|---------|
|             |  | L             | T | P | Int.  | Ext. | Int.       | Ext. |         |
| PHP-303     | Pharmacology & Toxicological Screening Methods | 3             | 1 | - | 30    | 70   | 1.5        | 3    | 4       |

#### **Laboratory Animals**

**07 Hrs**

Common lab animals: description, handling and applications of different species and strains of animals; transgenic animals: production, maintenance and applications; anaesthesia and euthanasia of experimental animals; maintenance and breeding of laboratory animals; CPCSEA guidelines to conduct experiments on animals; good laboratory practice

#### **Preclinical Screening of New Substances for the Pharmacological Activity**

**22 Hrs**

General principles of preclinical screening; CNS pharmacology: behavioural and muscle coordination, CNS stimulants and depressants, anxiolytics, anti-psychotics, anti epileptics and nootropics; drugs for neurodegenerative diseases like parkinsonism, alzheimers and multiple sclerosis; drugs acting on autonomic nervous system; respiratory pharmacology: anti-asthmatics, drugs for COPD and anti-allergic; reproductive pharmacology: aphrodisiacs and anti-fertility agents; analgesics, anti-inflammatory and antipyretic agents; gastrointestinal drugs: anti ulcer, anti-emetic, anti-diarrheal and laxatives; cardiovascular pharmacology: anti-hypertensives, anti-arrhythmics, anti-anginal, anti-atherosclerotic agents and diuretics; drugs for metabolic disorders like anti-diabetic, anti-hyperlipidemic, and agents; anti cancer agents; immunosuppressants and immunomodulators

#### **Limitations of Animal Experimentation and Alternate animal Experiments**

**04 Hrs**

#### **Extrapolation of in vitro Data to Preclinical and Preclinical to Humans**

**02 Hrs**

#### **Regulatory Guidelines for Conducting Toxicity Studies**

**12 Hrs**

OECD, ICH, EPA, Schedule Y, OECD principles of Good laboratory practice (GLP)

#### **Suggested Reading/Reference Books (Latest Edition)**

1. J.H. Burn D.J. Finney and I.G. Goodwin, Biological standardization, Oxford University Press, New York
2. Robert A. Turner, Screening methods in Pharmacology, Academic Press
3. Laurence and Bachrach, Evaluation of Drugs Activities: Pharmacometrics, Academic Press
4. Arnold Schwartz, Methods in Pharmacology , Springer
5. M. N. Ghosh, Fundamentals of experimental Pharmacology, Hilton Company
6. L. J. McLeod, Pharmacological experiment on intact preparations, Churchill Livingstone
7. Vogel H.G., Drug discovery and Evaluation by, Springer
8. Hand book on GLP, Quality practices for regulated non-clinical research and development (<http://www.who.int/tdr/publications/documents/glp-handbook.pdf>)

9. Schedule Y Guideline: drugs and cosmetics (second amendment) rules, 2005, ministry of health and family welfare (department of health) New Delhi
10. Rick N.G., Drugs from discovery to approval by, Wiley-Blackwell.
11. Shayne C. Gad, Animal Models in Toxicology, CRC Press
12. OECD test guidelines.
13. Karen E. Stine, Thomas M. Brown, Principles of toxicology by, CRC Press
14. Guidance for Industry M3(R2) Nonclinical Safety Studies for the Conduct of Human Clinical Trials and Marketing Authorization for Pharmaceuticals (<http://www.fda.gov/downloads/drugs/guidancecomplianceregulatoryinformation/guidances/ucm073246.pdf>)

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|             |                                     | L             | T | P | Int.  | Ext. | Int.       | Ext. |         |
| PHP-304     | Biochemical & Separation Techniques | 3             | 1 | - | 30    | 70   | 1.5        | 3    | 4       |

**Chromatography** **12Hrs**  
Introduction, Principles, Types- paper, two dimensional, HPLC, Ion exchange chromatography, Uses, Advantages and Limitations

**Spectroscopy** **12 Hrs**  
UV/Visible spectroscopy, spectrophotofluorimeter, scope, basic principle and uses in biotechnology of different types of spectrometry (NMR, Magnetic resonance spectroscopy)

**Radioisotopy** **05 Hrs**  
Use of radioisotope, detection and measurement of radioactivity, specific activity, applications in biological system, autoradiography

**Microscopy** **06 Hrs**  
Brief introduction, types of microscopes and role in microbiology, structure and function of microscopes (compound microscope, dissecting microscope, phase contrast microscope, scanning electron microscopy)

**Filtration** **02 Hrs**  
Theory and application

**Centrifugation** **02 Hrs**  
Theory and application

**Electrophoresis** **02 Hrs**  
Different methods for proteins and nucleic acids

**Molecular Diagnostic Techniques** **06 Hrs**  
PCR, southern, northern, western blotting, microarray

**Suggested Reading/Reference Books (Latest Edition)**

1. Keith Wilson and John Walker, Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press
2. P.C. van der Vliet and S. Pillai, Laboratory Techniques in Biochemistry and Molecular Biology, Elsevier

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|             |                       | L             | T | P | Int.  | Ext. | Int.       | Ext. |         |
| PHP-305     | Bioprocess Technology | 3             | 1 | - | 30    | 70   | 1.5        | 3    | 4       |

**Microbial Growth Kinetics**

**10Hrs**

Batch culture, continuous culture, fed-batch culture, biomass productivity, metabolite productivity, kinetics of microbial growth

**Enzymes**

**07 Hrs**

Classification, uses, methods for immobilization

**Fermentation**

**10 Hrs**

Raw materials used as media for industrial fermentations, development of inocula for industrial fermentations, isolation and preservation of industrially important microorganisms

**Design of a Fermenter**

**10 Hrs**

Aseptic operation and containment, construction materials, temperature control, aeration and agitation, sterilization of the fermenter, air supply and exhaust gas from a fermenter

**Recovery and Purification of Fermentation Products**

**10 Hrs**

Centrifugation, cell disruption, chromatography, ultra filtration, drying

**Suggested Reading/Reference Books (Latest Edition)**

1. Stanbury, Whitaker & Hall, Principles of fermentation technology, Butterworth Heinemann
2. Shuler M. L. and Kargi F, Bioprocess Engineering, Pearson
3. Pelczar, Chan & Krieg, Microbiology, McGraw-Hill Inc., US
4. Prescott, Harley & Klein, Microbiology, McGraw Hill Education
5. Nduka Okafor, Modern Industrial Microbiology & Biotechnology , CRC Press

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|             |                           | L             | T | P | Int.  | Ext. | Int.       | Ext. |         |
| PHP-306     | Recombinant Biotechnology | 3             | 1 | - | 30    | 70   | 1.5        | 3    | 4       |

### **Tools of Genetic Engineering**

**10Hrs**

Cloning vehicles, modifying enzymes, DNA ligase, DNA polymerase, polynucleotide kinase, T4 DNA ligase, nick translation system, terminal deoxynucleotidyl transferase, reverse transcriptase, restriction endonucleases Type I & II. etc.

### **Cloning Vectors**

**04 Hrs**

Plasmids, lambda phage, phagemids, cosmids, artificial chromosomes, yeast vectors, shuttle vectors, virus based vectors

### **Methods of Gene Transfer**

**05 Hrs**

Transformation, transduction, particle gun, electroporation, liposome mediated, microinjection, *Agrobacterium* mediated gene transfer

### **Preparation and Application of Molecular Probes**

**06 Hrs**

DNA probes, RNA probes, radioactive labelling, non radioactive labelling, use of molecular probes, DNA fingerprinting

### **Analysis and Expression of Cloned Gene In Host Cells**

**10 Hrs**

Expression vectors, restriction enzyme analysis, southern blotting, northern blotting, western blotting, *in-situ* hybridization, colony and plaque hybridization, factors affecting expression of cloned genes, reporter genes, fusion proteins

### **Gene Libraries**

**04 Hrs**

cDNA synthesis, genomic DNA libraries, amplification of gene libraries, identifying the products of cDNA clones

### **Isolation, Sequencing and Synthesis of Gene**

**04 Hrs**

Different methods of gene isolation, techniques of DNA sequencing, artificial DNA synthesis

### **Applications of r-DNA Technology**

**04 Hrs**

Gene cloning in medicine (Insulin, Blood clotting factor VIII), high level expression of proteins in different host systems (*E. coli*, yeast, Insect, mammalian cells), limitation and advantages and novel technologies generation of transgenic animals, applications of PCR (DNA finger printing)

### **Suggested Reading/Reference Books (Latest Edition)**

1. R.W. Old and S.B. Primrose, Principles of Gene Manipulation, Blackwell Scientific Publication
2. B. Lewin Genes VIII, Benjamin Cummings; United States
3. E. L. Winnecker, From Genes to Clones, Vch Pub
4. T.A. Brown, Gene Cloning, Wiley
5. Glick B., Pasternak J., Molecular Biotechnology: Principles and Applications of Recombinant DNA, ASM Press



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| PHP-307     | Plant Tissue Culture | 3             | 1 | - | 30    | 70   | 1.5        | 3    | 4       |

#### **Introduction to Cell and Tissue Culture**

**06 Hrs**

Conventional plant breeding, tissue culture as technique to produce novel plants and hybrids, tissue culture media (composition and preparation), initiation and maintenance of callus and suspension cultures, single cell clones

#### **Organogenesis: Somatic Embryogenesis**

**06 Hrs**

Transfer and establishment of whole plants in soil, shoot tip culture, rapid clonal propagation, embryo culture and embryo rescue

#### **Protoplast**

**08 Hrs**

Isolation, culture and fusion, selection of hybrid cell and regeneration of hybrid plants, symmetric and asymmetric hybrids, cybrids, cryopreservation, slow growth and DNA banking for germplasm conservation

#### **Plant Transformation Technology**

**06 Hrs**

Basis of tumor formation, hairy root, features of TI and RI plasmids, mechanism of DNA transfer, role of virulence genes, use of TI and RI as vectors, binary vectors, genetic markers, use of reporter genes, reporter gene with intron, methods of nuclear transformation, viral vectors and their application, multiple gene transfer, vectorless or direct DNA transfer (particle bombardment, electroporation, microinjection), transformation of monocots, transgene stability and gene silencing

#### **Application of Plant Transformation for Productivity and Performance**

**07 Hrs**

Herbicide resistance (phosphinothricin, glyphosphate, sulfonyl urea, atrazine), insect resistance (Bt genes, non-Bt like protease inhibitors, alpha amylase inhibitor), virus resistance (coat protein mediated, nucleocapsid gene), disease resistance (chitinase, 1-3 beta glucanase, RIP, antifungal proteins, thionins, PR proteins), nematode resistance, abiotic stress, post harvest losses, use of ACC synthase (polygalactouranase, ACC oxidase), male sterile lines, bar and barnase systems, carbohydrate composition and storage, ADP glucose pyrophosphatase, biosafety and ethical issues associated with transgenic plants

#### **Chloroplast Transformation**

**04 Hrs**

Advantages, vectors, success with tobacco and potato

#### **Metabolic Engineering and Industrial Products**

**06 Hrs**

Plant secondary metabolites, role of bioreactors for scaling up, biotransformation, biodegradable plastics, polyhydroxybutyrate

#### **Molecular Pharming in Plants**

**04 Hrs**

Production of therapeutic proteins, edible vaccines antibodies, purification strategies

**Suggested Reading/Reference Books (Latest Edition)**

1. H.S Chawla, Biotechnology in Crop Improvement, CRC Press
2. J. Hammond , R. McGravey and V. Yusibov, Plant Biotechnology, Springer
3. P.K Gupta, Elements of Biotechnology, Rastogi Publications
4. R.J Henry, Practical application of Plant Molecular Biology, CRC Press