

List of Ph.D. Course work subjects that can be offered under
Medical Biochemistry Group from 2026

Medical Biochemistry							
Group I		Group II		Group III		Group IV	
Subject Code	Name of the subject	Subject Code	Name of the subject	Subject Code	Name of the subject	Subject Code	Name of the subject
PHBC101	Clinical Biochemistry	PHBC201	General Metabolism & Nutrition	PHBC301	Microbiology-Genito Urinary System	PHBC401	Drug Discovery & Development Process
PHBC102	Reproductive Health &n Diseases	PHBC202	Phytochemicals & Nutraceuticals & Evaluation	PHBC302	Cancer Biology		

PHBC101: CLINICAL BIOCHEMISTRY

1. Clinical Enzymology and Biomarkers

Creatine kinase, Cardiac troponins, Lactate dehydrogenase, Alanine amino Transferase, Aspartate amino Transferase, Alkaline phosphatase, Prostate specific antigen, Glucose-6-phosphate dehydrogenase, Amylase, Lipase, Enolase.

2. Regulation of Blood Glucose and Diabetes Mellitus

Regulation of blood glucose, Reducing substances in urine, Hyperglycaemic hormones Glucagon, Diabetes mellitus, Acute metabolic complications

3. Liver Function Tests

Functions of liver, Clinical manifestations of liver dysfunction.

4. Renal Function Tests

Renal function tests, Abnormal constituents of urine, Markers of glomerular filtration rate, Markers of glomerular permeability, Tests for tubular function

5. Plasma Proteins

Electrophoresis, Albumin, Transport proteins, Acute phase proteins, Clotting factors, Abnormalities in coagulation

6. Acid-Base Balance and pH

Acids and bases, Buffers, Acid-base balance, Buffers of the body fluids
Respiratory regulation of pH, Renal regulation of pH, Cellular buffers, Disturbances in acid-base balance.

7. Electrolyte and Water Balance

Intake and output of water, Osmolality of extracellular fluid, Sodium Potassium, Chloride

8. Clinical Laboratory

Quality Control, Reference values, Pre-analytical variables, Specimen collection.

7. General Techniques for Separation, Purification and Quantitation

Serum Electrophoresis, Chromatography, Radioimmunoassay, ELISA, PCR, Colorimeter, Auto analyzer, Mass spectrometry.

8. Biochemistry of Cancer

PHBC102: REPRODUCTIVE HEALTH & DISEASES

Unit 1: Fundamentals of Female Reproductive Health

- Anatomy and physiology of the female reproductive system
- Hormonal regulation and menstrual cycle
- Gametogenesis, fertilization, and implantation
- Endocrinology of reproduction: Hypothalamic-pituitary-ovarian (HPO) axis
- Ovarian function, folliculogenesis, and oocyte maturation
- Uterine and endometrial function: Implantation and pregnancy maintenance
- Common reproductive disorders: PCOS, endometriosis, infertility

Unit 2: Immunology, Inflammation, and Reproductive Health

- Role of the immune system in reproduction
- Immune tolerance in pregnancy and implantation
- Cytokines and immune-modulating factors in fertility
- Autoimmune disorders and reproductive implications
- Inflammatory pathways in reproductive diseases (e.g., endometriosis, PCOS)
- TLR and P2Y12 signaling in immune regulation of implantation

Unit 3: Toll-Like Receptors (TLRs) and Reproductive Biology

- Overview of TLRs and their signaling pathways
- TLRs in ovarian function, endometrial receptivity, and implantation
- TLR-mediated inflammation and its impact on fertility
- Role of TLRs in pregnancy complications (miscarriage, preterm birth)

Unit 4: P2Y12 Receptors, SNPs & Vascularization in Reproduction

- **P2Y12 receptor signaling and function** in platelet activation, thrombosis, endometrial vascularization
- **Genetic Variations & Reproductive Implications:**
 - **T744C (rs6785930), C34T (rs2046934), G52T (rs6809699)** → affect platelet reactivity, clotting risk, and implantation success
 - **H2 haplotype** → increased platelet reactivity, higher cardiovascular risks
 - **H1 haplotype** → improved response to antiplatelet therapy
 - Impact on **implantation, pregnancy loss, preeclampsia**, ART success rates

Unit 5: Antiplatelet Therapy in Reproductive Health

- **Drugs:** Clopidogrel, Prasugrel, Ticagrelor, Aspirin
- **Role in pregnancy and infertility:**
 - Preventing placental thrombosis, improving uterine blood flow
 - Reducing preeclampsia risk, aiding implantation
 - **Risks:** bleeding complications, need for personalized dosing
- **Pharmacogenomics in ART** → Influence of P2Y12 SNPs on drug response

Unit 6: Clinical Relevance of TLR-Modulating Drugs

- **Fertility & Implantation:** TLR4 inhibitors (Eritoran, TAK-242) reduce cytokines, MPLA enhances IVF success
- **Pregnancy Complications:** Statins & TLR inhibitors reduce preeclampsia inflammation; TLR9 antagonists for autoimmune-related miscarriage
- **Endometriosis & PCOS:** Curcumin, Statins help suppress inflammation
- **Autoimmune Disorders & ART:** Chloroquine, IMO-8400 support women with SLE, RA in ART
- **Future Therapies:** Genetic screening, combination therapy (TLR modulators + antiplatelets), novel TLR inhibitors

Unit 7: Interplay Between TLRs, P2Y12, and Infertility

- Crosstalk between **immune and vascular pathways** in infertility
- **Genetic predisposition** to reproductive disorders via TLR and P2Y12 variants
- TLR-P2Y12 signaling in implantation failure and pregnancy loss
- **Therapeutic potential** of targeting TLRs and P2Y12 in reproductive medicine

Unit 8: Assisted Reproductive Technology (ART) – Advances

- **IVF & ICSI:** stimulation, fertilization, embryo selection (PGT)
- **IUI:** ovulation induction, sperm preparation
- **Oocyte/Embryo Cryopreservation:** fertility preservation options
- **Donor Egg, Sperm, Surrogacy:** ethical & genetic considerations
- **Mitochondrial Replacement Therapy (Three-Parent IVF)**
- **Stem Cell & Regenerative Medicine:** ovarian stem cells, uterine tissue engineering
- **AI in ART:** predictive models, embryo selection

Unit 9: Research Methodologies in Reproductive Health

- Study designs in reproductive immunology & vascular biology
- Genetic/molecular techniques for TLRs, P2Y12 SNPs
- Laboratory methods for immune & vascular analysis
- Bioinformatics & statistical approaches in reproductive genetics

Unit 10: Translational Research and Future Therapies

- **Emerging Trends in Reproductive Health Research**
- **Gene-Editing and CRISPR** for treating reproductive disorders
- **Targeting TLRs and P2Y12** for therapeutic intervention in infertility
- **Biomarkers and Genetic Screening** for reproductive disorders
- **Impact of P2Y12 SNPs** on fertility treatments and ART outcomes
- **Antiplatelet Therapy & Immune-Modulating Treatments** in reproductive medicine
- **Personalized Medicine** for infertility and reproductive health
- **Bioinformatics & Statistical Approaches** in reproductive genetics
- **Ethical Considerations & Policy Implications** in reproductive medicine

PHBC201: GENERAL METABOLISM AND NUTRITION

1. CARBOHYDRATE METABOLISM

Digestion and Absorption of carbohydrates, Glucose metabolism, Glycolysis, Metabolic fate of pyruvate, Citric Acid Cycle, Regulation of citric acid cycle, Gluconeogenesis, Glycogen metabolism, Glycogen storage diseases, Hexose monophosphate shunt pathway, Oxidative phase, Non-oxidative phase, Glucuronic acid pathway of glucose, Polyol pathway of glucose, Fructose metabolism, Galactose metabolism

2. METABOLISM OF LIPIDS

Digestion and Absorption of lipids, Oxidation of fatty acids, De novo synthesis of fatty acids, Synthesis of triacylglycerol, Fatty liver and lipotropic factors, Metabolism of ketone bodies, Ketosis, Biosynthesis of cholesterol, cholesterol derivatives, Metabolism of phospholipids, Metabolism of glycolipids, Metabolism of lipoproteins.

3. AMINO ACID METABOLISM

Digestion of proteins Ammonia Metabolism, Urea cycle, One-carbon metabolism,

- **Simple, Hydroxy and Sulfur-containing Amino Acids**
Glycine, Serine, Alanine, Threonine, Methionine, Cysteine.
- **Acidic, Basic and Branched Chain Amino Acids**
Glutamine, Asparagine, Lysine, Arginine, Nitric Oxide, Valine, Leucine, Isoleucine.
- **Branched chain amino acids, Aromatic Amino Acids**
Phenylalanine, Tyrosine, Tryptophan and Amino Acidurias, Phenylketonuria, Alkaptonuria, Albinism, Hypertyrosinemias, and hydroxyproline, Aminoacidurias

4. VITAMINS AND MINERAL

Fat Soluble Vitamins- Vitamin A, Vitamin D, Vitamin E, Vitamin K.

Water Soluble Vitamins- Thiamine, Riboflavin, Niacin, Pyridoxine, Pantothenic Acid, Biotin, Folic Acid, Vitamin B12 and Ascorbic Acid, vitamins like compounds.

Mineral- Calcium, Phosphorus, Magnesium, Sulfur, Iron, Copper, Iodine, Zinc, Fluoride

5. ENERGY METABOLISM AND NUTRITION

Energy aspects of foods, BMR, Dietary fibers, Nutritional Importance of carbohydrates, Nutritional Importance of lipids, Importance of proteins, Protein-Energy Malnutrition, Obesity, Prescription of Diet

PHBC202 PHYTOCHEMICALS & NUTRACENTICS & EVALUATION

This course provides an advanced understanding of phytochemicals and nutraceuticals at the interface of pharmacognosy, food and nutritional sciences, and evidence-based therapeutics. Plant-derived phytochemicals and nutraceutical products form an important bridge between traditional medicine, food science and modern evidence-based therapeutics. Sound understanding of their chemistry, biological effects, product development and quality evaluation is essential for students who will engage in research, industry or clinical application of natural products. This course develops the conceptual and practical skills needed to characterize phytochemicals, design and appraise nutraceuticals, and apply appropriate evaluation and regulatory frameworks.

Specific learning objectives

1. Elucidating and rationalizing the scientific and public health justification for investigating phytochemicals and nutraceuticals, and discerning priority health conditions wherein plant and food based interventions possess established or emerging roles.
2. Systematically categorizing the principal groups of phytochemicals (e.g. alkaloids, glycosides, terpenoids, phenolics, flavonoids, tannins, steroids, saponins) and correlating their structural and physicochemical characteristics to recognized pharmacological and nutraceutical effects.
3. Identifying, classifying, and critically evaluating functional foods and nutraceuticals, integrating concepts from nutrition science, food science, and regulatory science to establish a robust scientific justification for asserted health benefits.
4. Formulating explicit aims and measurable, hypothesis-driven objectives for phytochemical or nutraceutical research and product development, ensuring consistency between intended health outcomes, selected phytochemical classes, and dosage form

5. Describing, comparing, and selecting suitable techniques for extraction, isolation, and characterization of plant-derived phytochemicals, with particular reference to chromatographic and spectroscopic methodologies utilized for qualitative profiling, quantitative assessment, and standardization.
6. Outlining and applying essential quality control and evaluation parameters for herbal drugs and nutraceutical products, encompassing organoleptic, microscopic, physico chemical, phyto chemical, and microbiological standards, in accordance with pharmacopoeia and WHO recommendations.
7. Interpreting and critically engaging with national regulatory requisites and guidelines for nutraceuticals, functional foods, and herbal products (e.g. FSSAI regulations, pharmacopoeia monographs), and discussing their ramifications for product development, labeling, permissible assertions, and safety documentation.
8. Planning the foundational design of a phytochemical or nutraceutical based product, including selection of active constituents, dosage form, and excipients, preliminary stability considerations, and identification of key challenges in development, scale-up, and commercialization.
9. Executing and interpreting fundamental quantitative data analyses pertaining to phytochemical content, product quality, and simple evaluation studies, utilizing spreadsheets or equivalent analytical software for data entry, management, and descriptive statistics.
10. Demonstrating scientific writing proficiency by preparing a concise, structured protocol or concept note for a phytochemical or nutraceutical evaluation study, incorporating background, rationale, objectives, methodology, and appropriately formatted references.

Course contents

1. Introduction to phytochemicals and nutraceuticals

Concept and extent of pharmacognosy, phytochemistry, functional alimentary products and nutraceuticals; overview of the function of bioactive botanical constituents and food-derived products in the deterrence and management of principal chronic ailments.

2. Classification and chemistry of phytochemicals

Primary versus secondary metabolites; meticulous examination of principal categories of phytoconstituents (alkaloids, glycosides, terpenoids, phenolics, flavonoids, tannins, steroids, saponins and other pertinent groups); fundamental structural characteristics, presence in alimentary and medicinal plants, and significance to health.

3. Functional foods and nutraceutical categories

Definitions and categorization of functional foods, nutraceuticals, dietary supplements and cosmeceuticals; illustrative instances of cereal, fruit, vegetable, dairy, meat, marine and herb derived functional foods and nutraceuticals and their documented or asserted advantages.

4. Bioactive components and health effects

Polyphenols, carotenoids, phytosterols, omega-3 fatty acids, probiotics, prebiotics, synbiotics and dietary fibers: origins, mechanisms of action, and contemporary evidence for roles in cardiovascular, metabolic, gastrointestinal and immune health.

5. Extraction and characterization of phytochemicals

Criteria for selection and authentication of botanical material; conventional and modern extraction methodologies; principles and applications of chromatographic (TLC, HPTLC, HPLC, GC) and spectroscopic techniques in qualitative and quantitative phytochemical analysis.

6. Quality control of herbal drugs and nutraceuticals

Identity, purity and quality attributes: macroscopic and microscopic examination, physicochemical constants, preliminary and advanced phytochemical profiling, microbiological thresholds; utilization of pharmacopoeia monographs and pertinent standards for assessment of herbal and nutraceutical products.

7. Product development and formulation aspects

Principles of devising herbal and nutraceutical products, encompassing selection of active ingredients, dosage forms and excipients; overview of formulation technologies for fortification, protection and distribution of bioactives (e.g. encapsulation, matrix systems); introductory considerations in stability and shelf-life estimation.

8. Regulatory and ethical considerations

Overview of national regulatory frameworks for nutraceuticals and functional foods (e.g. FSSAI regulations and related notifications) and relevant international perspectives; fundamental requirements for labeling, health and nutrition claims, safety assessment, post-marketing surveillance and ethical conduct in product development and evaluation.

9. Evaluation studies and basic data analysis

Outline of simple in vitro, product-quality and consumer-focused evaluations suitable for early-stage phytochemical and nutraceutical inquiry; essential elements of small-scale study design; organization, summarization and fundamental statistical analysis of evaluation data utilizing spreadsheet tools.

10. Scientific communication in phytochemicals and nutraceuticals

Structure and content of succinct protocols, project concepts and technical reports in the domain; fundamentals of scientific composition, referencing styles and critical utilization of primary literature to substantiate the rationale, methodology and interpretation in phytochemical and nutraceutical inquiry.

PHBC301: MICROBIOLOGY OF THE GENITOURINARY SYSTEM

Course Description

This course examines the microbiology of the genitourinary (GU) system, focusing on the normal microbiota, pathogenic microorganisms, and their roles in health and disease. Students will explore the mechanisms of infection, host immune responses, diagnostic techniques, and treatment strategies for GU-related microbial conditions, with an emphasis on clinical relevance and emerging research.

Learning Objectives

By the end of this course, students will be able to:

1. Describe the microbial of the genitourinary system and its protective roles.
2. Identify key pathogens associated with GU infections and their mechanisms of virulence.
3. Evaluate diagnostic methods and laboratory techniques for identifying GU pathogens.
4. Analyze treatment approaches, including antimicrobial therapies and resistance challenges.
5. Discuss current research trends and clinical implications in GU microbiology.

Course Outline

Module 1: Introduction to the Genitourinary System and Its Microbiota

- Anatomy and physiology of the genitourinary system
- Overview of the GU microbiome: urethra, bladder, kidneys, and reproductive organs
- Role of normal flora in maintaining GU health
- Factors influencing microbial colonization (pH, hormones, hygiene)

Module 2 : Bacterial Pathogens of the Urinary Tract

- Common pathogens: *Escherichia coli*, *Klebsiella pneumoniae*, *Proteus mirabilis*
- Pathogenesis of urinary tract infections (UTIs): Adhesion, biofilm formation
- Upper vs. lower UTIs: Cystitis, pyelonephritis

Module 3 : Antimicrobial Resistance in GU Infections

- Multidrug-resistant pathogens: MRSA, ESBL-producing bacteria

- Alternative therapies: Phage therapy, probiotics

Module 4 : Analytical Methods in GU Microbiology

- Specimen collection: Urine, swabs, and tissue samples
- Culture techniques and microscopy for GU pathogens
- Molecular diagnostics: PCR, 16S rRNA sequencing.

Module 5: General Diagnostic Microbiology in Clinical Practice

- Urinalysis and culture interpretation
- Rapid diagnostic tests vs. traditional methods
- Differentiating contamination from infection

Module 6: Emerging Trends and Research

- The role of the bladder microbiome in health and disease
- Metagenomics and next-generation sequencing in GU microbiology
- Novel therapeutics: Vaccines, microbiome-based interventions.

Recommended Resources

- **Textbooks:**
 - Medical Microbiology by Murray, Rosenthal, and Pfaller
 - Mandell, Douglas, and Bennett's Principles and Practice of Infectious Diseases
- **Journals:**
 - Journal of Clinical Microbiology
 - Infection and Immunity
- **Online Resources:**

WHO resources on antimicrobial resistance (www.who.int)

PHBC302 CANCER BIOLOGY

Fundamentals of Cancer Biology

- Definition and scope of cancer biology
- Hallmarks of cancer (Hanahan & Weinberg model)
- Tumor classification and epidemiology
- Global and Indian cancer burden

Molecular Basis of Cancer

- Oncogenes and proto-oncogenes
- Tumor suppressor genes (p53, RB)
- DNA damage and repair mechanisms
- Epigenetic modifications in cancer
- Signal transduction pathways (MAPK, PI3K/AKT, Wnt)

Cell Cycle and Apoptosis

- Cell cycle regulation and checkpoints
- Role of cyclins and CDKs
- Mechanisms of apoptosis and autophagy
- Dysregulation in cancer progression

Tumor Microenvironment

- Stromal cells and cancer-associated fibroblasts
- Angiogenesis and hypoxia
- Immune cells in tumor progression
- Cancer-immune system interactions

Cancer Genetics and Genomics

- Somatic vs germline mutations
- Next Generation Sequencing (NGS)
- Whole genome and exome sequencing
- Biomarkers and precision oncology

Metastasis and Invasion

- Epithelial–mesenchymal transition (EMT)
- Mechanisms of invasion and migration
- Circulating tumor cells (CTCs)
- Organ-specific metastasis

Cancer Stem Cells

- Concept and identification
- Role in tumor initiation and relapse
- Therapeutic resistance

Cancer Immunology & Immunotherapy

- Tumor antigens and immune surveillance
- Immune evasion mechanisms
- Immune checkpoint inhibitors (PD-1, CTLA-4)
- CAR-T cell therapy and cancer vaccines

Cancer Metabolism

- Warburg effect
- Metabolic reprogramming
- Role of mitochondria in cancer

Cancer Diagnostics

- Histopathology and cytology
- Molecular diagnostics (PCR, RT-PCR)
- Imaging (CT, MRI, PET)
- Liquid biopsy

Cancer Therapeutics

- Chemotherapy and targeted therapy
- Hormonal therapy
- Radiotherapy
- Precision medicine and personalized therapy

Drug Resistance in Cancer

- Mechanisms of resistance
- Tumor heterogeneity
- Strategies to overcome resistance

Translational Cancer Research

- Bench-to-bedside approach
- Clinical trials (Phase I-IV)
- Biomarker-driven therapy
- Regulatory and ethical aspects

Experimental Techniques in Cancer Biology

- Cell culture and 3D models
- Flow cytometry (FACS)
- Western blotting, ELISA
- CRISPR/Cas9 gene editing
- Animal models in cancer research

Bioinformatics and Systems Biology in Cancer

- Cancer databases (TCGA, COSMIC)
- Omics data integration
- AI in cancer diagnosis

Emerging Areas in Cancer Research

- Nanotechnology in cancer therapy
- Organoids and personalized medicine
- Microbiome and cancer
- Epitranscriptomics

PHBC401: DRUG DISCOVERY AND DEVELOPMENT PROCESS

Course Description

This course explores the multidisciplinary process of drug discovery and development, from initial target identification to regulatory approval and market entry. Students will learn about the scientific, regulatory, and commercial aspects of bringing a new therapeutic agent to patients, including key methodologies, challenges, and emerging trends in the pharmaceutical industry.

Learning Objectives

By the end of this course, students will be able to:

1. Understand the stages of the drug discovery and development pipeline.
2. Describe the scientific principles and technologies used in identifying and validating drug targets.
3. Explain the processes of lead compound identification, optimization, and preclinical testing.
4. Analyze the clinical trial phases and their role in ensuring drug safety and efficacy.
5. Evaluate the regulatory requirements and ethical considerations in drug development.
6. Identify current challenges and innovations shaping the future of drug discovery

Course Outline

Module 1: Introduction to Drug Discovery and Development

- History and evolution of drug discovery
- Regulatory bodies (FDA, EMA, ICH) and their roles
- Ethical considerations in drug development
- Nuremberg Code, Helsinki Declaration, Belmont Report

Module 2: Target Identification and Validation

- Biological targets in drug discovery
- Role of genomics, proteomics, and bioinformatics

- Target validation techniques
- Biomarker identification

Module 3: Lead Identification and Lead Optimization

- Principles of high-throughput screening (HTS)
- Chemical libraries and compound diversity
- Hit identification and confirmation
- Structure-activity relationship (SAR) studies
- Medicinal chemistry: Improving potency, selectivity, and pharmacokinetics
- ADME (Absorption, Distribution, Metabolism, Excretion) profiling

Module 4: Preclinical Development

- In vitro and in vivo testing: Efficacy and safety
- Animal models in drug development
- Toxicity studies (Acute, chronic, reproductive, genotoxic).
- Pharmacokinetics and pharmacodynamics (PK/PD)
- Good Laboratory Practices (GLP) and preclinical data requirements

Module 5: Regulatory Framework and Investigational New Drug (IND)

Application and Clinical Trials

- Role of regulatory agencies (FDA, EMA, etc.)
- Preparing an IND application
- Ethical considerations in preclinical research
- Intellectual property and patents in drug development
- Clinical Trials – Phase I
- Clinical Trials – Phase II
- Clinical Trials – Phase III

Module 6: New Drug Application (NDA) and Regulatory Approval and Post-Market Surveillance

- Compiling and submitting an NDA
- Regulatory review process and timelines
- Post-approval commitments (Phase IV studies)

- Phase IV: Post-marketing studies.
- Drug safety monitoring and pharmacovigilance

Module 7: Clinical Trials in India

- Clinical Trial Registry of India (CTRI)
- Ethical guidelines ICMR
- GCP, GLP, Schedule Y
- Participant recruitment and informed consent in the Indian context

Module 8: Regulatory Framework in India

- CDSCO, DCGI, IPC (Indian Pharmacopoeia Commission)
- Overview of NDCT Rules 2019
- Role of Institutional Ethics Committees (IEC)
- International collaboration: US FDA, EMA, WHO
- Generics and API production
- Role of BIRAC, DBT, and Incubators.

Recommended Resources

- **Textbooks:**
 - Drug Discovery and Development by Raymond G. Hill and Duncan Richards
 - The Process of New Drug Discovery and Development by Charles G. Smith and James T. O'Donnell
- **Journals:**
 - Nature Reviews Drug Discovery
 - Journal of Medicinal Chemistry
- **Online Resources:**
 - FDA website (www.fda.gov)
 - EMA website (www.ema.europa.eu)
 - ClinicalTrials.gov

