

## Department of Biochemistry



**Syllabus**  
**for**  
**Ph.D. Biochemistry**  
**Academic session 2019-2021**

**Central University of Rajasthan**  
**NH-8, Bandarsindri,**  
**Kishangarh-305817**  
**Dist. Ajmer**

**(Course structure of PhD syllabus: effective from academic session 2019)**

<b>Code</b>	<b>Title of the course</b>	<b>Type of Course</b>	<b>Credits</b>
BCH-701	Research Methodology in Biochemistry	Core	4
Advanced specialized area (any two from BCH-702 to BCH-707)			
BCH-702	Tools and Techniques in Biochemistry Research	Core	4
BCH-703	Advanced Cancer biology	Core	4
BCH-704	Molecular Insights of Bacterial Infection and Therapeutics	Core	4
BCH-705	Molecular Parasitology	Core	4
BCH-706	Nanobiotechnology	Core	4
BCH-707	Protein Science and Engineering	Core	4

**Total Credits: 12**

**BCH-701**

**Research Methodology in Biochemistry**

**Credit 4**

**Unit I:**

**Research Methodology:** definition, purpose and types (qualitative, quantitative, cross sectional, longitudinal, pure, applied, action, evaluation, historical, survey, exploratory and case study. Process of Research; Objectives and Dimensions of Research, Design Tools of Research: Library, Field, Laboratory; Methods of research: Qualitative and Quantitative. Systematic review of literature, Features of good research study. Research Ethics (Issues relating to referencing and documentation, copyrights, plagiarism etc), Impact Factor, H-Index, Citation Index, references/ bibliography Structuring the Ph.D. Thesis: chapter format, pagination, identification, using quotations, footnotes, abbreviations, presentation of tables and figures, referencing, documentation, use and format of appendices, indexing

**Unit II**

**Biostatistics:** Data Collection, presentation, data processing, classification and tabulation. Measures of Central tendency and Dispersion. Probability distribution : Binomial, Poisson and Normal. Confidence Interval, Errors. Sampling: types, steps; sampling errors Quantitative Techniques: Levels of significance, Regression and Correlation, Interpolation and Extrapolation, Sampling of attributes (including chi square test), Sampling of small and large sample variables (including Anova) Hypothesis Testing: fundamentals of hypothesis testing . Statistical decision theory Parametric vs. non-parametric tests, univariate analysis, Multivariate analysis

**Unit III**

**Scientific proposal and paper writing:** An Insight into Research proposal: Definition and basic concepts, defining the problem, creating a hypothesis, objectives, work plan, significance and techniques of research, , expected outcome, finding research materials – literature survey, compiling records. Definition and kinds of scientific documents – research paper, review paper, book reviews, theses, conference and project reports (for the scientific community and for funding agencies). Components of a research paper– the IMRAD system, title, authors and addresses, abstract, acknowledgements, references, tables and illustrations. Oral and poster presentation of research papers in conferences/symposia. Preparation and submission of research project proposals to funding agencies.

**Unit IV**

**Research Techniques:** Computer Based techniques: Basic Concepts of Computer, Computer applications in Biology Spreadsheet tools: Introduction to spreadsheet applications, features, Using formulas and functions, Data storing, Features for Statistical data analysis, Generating charts / graph and other features, Presentation of Power Point Presentation, Customizing presentation, Use of Computers in Quantitative analysis. Tools for digital image processing

**Books recommended:**

- Marder M P (2011) Research Methods for Science, Cambridge University Press
- Rosner B (2010) Fundamentals of Biostatistics, 7<sup>th</sup> Edition, Brooks/Cole Cengage Learning Publication
- Dunleavy P (2003) Authoring a PhD: How to Plan, Draft, Write and Finish a Doctoral Thesis or Dissertation. Palgrave Macmillan

**BCH-702 Tools and Techniques in Biochemistry Research**

**Credit 4**

**Unit I:**

**Analytical techniques:** Chemical and enzymatic methods of carbohydrate analysis, separation and identification of carbohydrates, lipids and amino acids mixtures; principle and methods of protein separation techniques, basic of chromatography-gel filtration, Ion exchange, affinity, HPLC, FPLC, Electrophoresis- SDS, AGE, IEF, protein-protein interaction, immune-precipitation, DNA-protein interaction, EMSA, ChIP assay and yeast two hybrid systems.

Basic of Spectroscopy-UV-Vis, Fluorescence, CD, FTIR, NMR, X-ray crystallography, SPR; Basic of Microscopy- light, fluorescence, confocal, electron microscopy, phage-contrast, super-resolution

**Unit II:**

**Recombinant DNA technology:** Isolation and purification of nucleic acids; amplification of DNA using PCR, recombinant PCR, Asymmetric PCR, nested PCR, use of restriction and modification in enzymes in cloning, plasmid vectors,  $\lambda$  phage, BAC, PAC, random and site directed mutagenesis, DNA sequencing, next generation sequencing, Principle and applications of southern, northern and western blotting, Recombinant protein expression and purification in different host systems.

**Unit III:**

**Genomics and proteomics:** Whole genome analysis of mRNA and protein expression, real time PCR to monitor changes in gene expression profile, concept of micro arrays, PCR & microRNA array and its application.

**Animal and plant transformation:** Plant transformation methods including tissue culture, non-tissue culture based, Agrobacterium mediated co-cultivation, plant vectors, particle bombardment. Methods of making transgenic and knockout animals, global knockout, conditional knockout, Cre-loxp and CRISPER/CAS knockout systems, codon biased and optimization, animal cell line and cell culture techniques.

**Unit IV:**

Molecular evolution and enhancement of protein's function, personalized medicine, pre-clinical and clinical trial, Homology modeling, basic of molecular docking, computer aided ligand-protein and DNA-protein interaction.

**Books recommended:**

- Voet D., Voet J.G, *Biochemistry* 4<sup>th</sup> Edition., John Wiley and Sons, 2011.
- Nelson, D. C. and Cox, M.M., **Lehninger Principles of Biochemistry**, 5<sup>th</sup> Edition, W. H. Freeman, 2010.

- *Berg J.M., Tymoczko J.L. and Stryer L., Biochemistry. 7<sup>th</sup> edition, W.H. Freeman and Co. New York, 2011.*
- *Molecular biology by Robert F. Weaver McGraw-Hill 4 edition (2007)*
- *Advanced molecular biology by R. M. Twyman, (1998)*
- *Genes VII by B. Lewin Oxford University Press, Cell Press, London (2000)*

**BCH-703**

**Advanced Cancer Biology**

**Credit 4**

**Unit I:**

The Biology and Genetics of Cells and Organisms  
The Nature of Cancer  
Tumor suppressors and oncogenes  
Multistep tumorigenesis  
Migration, Invasion and metastasis  
Epithelial to Mesenchymal Transition  
Angiogenesis, Apoptosis and Autophagy

**Unit II:**

Microenvironment of Tumor cells  
Stroma Interaction  
Tumor immunology  
Animal models for cancer growth and metastasis  
Cancer stem cells

**Unit III:**

Abnormal cell signalling for cancer growth  
Signalling for metastasis and stem cells  
Reprogramming of metabolism and rewiring of signaling network  
Osteoblastic and osteolytic metastasis  
Role of PTHrP, CSF-1 and RANKL in cancer progression and metastasis.

**Unit IV:**

Therapeutic Intervention  
Success and failure of present therapies  
Immunotherapy  
Micro-RNA mediated cancer treatment and targeted drug delivery,  
Drug resistance  
Molecular diagnosis, prognosis and stem cell therapy.

**Books recommended:**

- *The Biology of Cancer, 2nd Edition, Robert AWeingberg, ISBN-10: 0815342209, ISBN-13: 978-0815342205*

- Cancer Biology, 4th Edition, Raymond W Ruddon, ISBN-10: 0195175441 | ISBN-13: 978-0195175448

**BCH-704 Molecular Insights of Bacterial Infection and Therapeutics Credit 4**

**Unit-I:**

**Mechanism of bacterial infection:** Molecular basis of bacterial pathogenesis and virulence, bacterial biofilm, bacterial persistence, bacterial secreting systems, cell wall biosynthesis, hospital acquired infections and ESKAPE pathogens, biology and distribution of infection caused by *A. baumannii*, *P. aeruginosa*, *S. aureus*, *K. pneumoniae*, *S. typhi*, *S. typhimurium*, *M. tuberculosis*, *E. coil*, *H. pylori*, and *V. cholera* etc.

**Unit II:**

**Host-pathogen interaction:** Interaction of host and microbes process of recognition and entry in host cells by different pathogens, human microbiome and their symbiotic relation, alteration of host cell behaviour and signaling by pathogens, Sensors of bacterial colonization, mechanisms of immune tolerance and alteration of host cell behavior by pathogens, mechanism of bacterial co-infection like tuberculosis with HIV etc.

**Unit-III:**

**Current therapeutics and their resistance:** Antibiotics: classes and mechanism of action, Surveillance model for prediction of antimicrobial susceptibility; Bacterial drug resistance mechanism; Diagnosis of bacterial infection: 16S sequencing, PCR, ELISA, microscopy, antimicrobial susceptibility assay, model systems to understand pathogenic mechanisms

**Unit IV:**

**Design of new therapeutics and their validation:** In-silico approach to develop new therapeutics, Identification of drug targets; Vaccine design and validation; synthesis, characterization, mechanism and delivery of nanomedicine; screening, characterization and development of secondary metabolites based herbal medicine; screening of novel antibiotics from novel sites like soil etc using metagenomics, experimental validation of novel therapeutics in animal model.

**Books recommended:**

- Michael J Pelczar, Microbiology, Tata McGraw, India.
- Prescott's Microbiology 8th Edition by Joanne Willey, Linda Sherwood, Chris Woolverton

**BCH-705 Molecular Parasitology Credit 4**

**Unit I:**

Introduction: Fundamental knowledge of infectious diseases, Bacterial and viral infectious diseases, Parasitic infectious diseases, Neglected tropical diseases, emerging infectious diseases

**Unit II:**

Leishmaniasis: Types of leishmaniasis, Indian scenario of leishmaniasis, Epidemiology and geography of leishmaniasis, Vector and transmission of leishmaniasis, Host-pathogen interaction, diagnosis and treatment for, B cell and T cell immunology of visceral and cutaneous leishmaniasis, Genetics of leishmaniasis, Host factor role in visceral leishmaniasis, Mechanism of drug resistance and drug susceptibility for promastigotes and amastigotes.

**Unit III:**

Malaria: Life cycle of Plasmodium, factors affecting Transmission of parasite, Vectors and epidemics, host-parasite interactions, asymptomatic malaria, host-vector interactions, parasite metabolisms, secondary endosymbiosis, Drug-resistant parasites, identification of drug targets.

**Unit IV:**

Prevention and Treatment: Current Scenario of available treatment, measures to prevent infectious diseases; advance diagnostic methods, chemotherapy, drug and vaccine development against causative agents of parasitic diseases, Drug designing by bioinformatics, Reverse vaccinology, adjuvant, drug and vaccine trials.

**Books recommended:**

- Stefan H.E. Kaufmann, Novel Vaccination Strategies Ed. Wiley-VCH Verlag GmbH & Co., 2004.
- Irwin W. Sherman, Malaria Parasite Biology, Pathogenesis, and Protection, American Society for Microbiology., 1998. [www.plasmodb.org](http://www.plasmodb.org)
- WHO technical series-949; Control of the leishmaniasis (ISBN 978 92 4 120949

**BCH-706**

**Nanobiotechnology**

**Credit 4**

**Unit I:**

**Chemistry of Nanomaterials**

Photochemistry and Electrochemistry of nanomaterials –Ionic properties of nanomaterials Nanocatalysis- Classifications of nanomaterials- Zeolites, mesoporous materials, nanomembranes - Carbon nanotubes and graphene - Core shell and hybrid nanocomposites.

Theory of advanced drug delivery: Fundamentals of Nanocarriers - Size, Surface, Magnetic and Optical Properties, Pharmacokinetics and Pharmacodynamics of Nano drug carriers. Critical Factors in drug delivery.

## **Unit II:**

### **Synthesis of Bionanomaterials**

Bulk synthesis: Top down and bottom up approaches

Chemical approaches: Sol gel processing-Solvothermal, hydrothermal, precipitation, Spray pyrolysis, Electro spraying and spin coating routes, Self-assembly, self-assembled monolayers (SAMs).

Synthesis -Nanoscale containers- Dendritic Nanoscaffold systems Biocompatibility of Dendrimers, Gene transfection. pH based targeted delivery- chitosan and alginate. Copolymers in targeted drug delivery- PCL,PLA, PLGA. Liposomes, niosomes and solid lipid nanoparticles.

Natural and artificial synthesis of nanoparticles in microorganisms; Use of microorganisms for nanostructure formation

## **Unit III :**

### **Physiochemical Properties of Nanomaterials**

Electron Spin Resonance Spectroscopy; New Applications of NMR Spectroscopy; Dynamic Nuclear Magnetic Resonance; Dynamic light scattering (DLS), SEM. Basic principles - Modes of operation – Specimen preparation – Structure of Grain boundaries and interfaces HRTEM use in nanostructures. Basic concepts-Interaction force-AFM and the optical lever- Scanning Force Microscopy-Shear force Microscopy-Lateral Force Microscopy-Magnetic Force microscopy. Principle- Instrumentation- importance of STM for nanostructures – surface and molecular manipulation using STM -3D map of electronic structure

## **Unit IV:**

### **Application of Bionanomaterials**

Nanotechnology in gene therapy. Stem Cell technology. PCR, ELISA, DNA Profiling and Blotting techniques-Nanoprobes-Nanoimmunoassay and nano-immunosensors- Bio-Barcode Assay- use of magnets, gold, DNA and antibodies. Immunodiagnosics for cancer and central nervous system disorders. -Improved diagnosis by in vivo imaging - detection of tumors, plaque and genetic defects. Nanobot medical devices. Cantilever Sensors. Prosthesis and implants. neural, ocular, cochlear, dental implants. implants and prosthesis of skin, limb, bone. Artificial organ and Organ transplant. Nanofibre scaffold technology. Nano-bioconjugates and their significance. Nanoscaffolds. Magnetic Nanoparticles. Multifunctional Inorganic and organic nanoparticles and their biomedical applications.

Understanding Nanotechnology- the industrial structure giving rise to Nanotechnology- Societal and Ethical Implications-Environmental Regulation - National Security and Export Controls- Federal Funding-Conclusions.

### **Books recommended:**



- K.W. Kolasinski, —Surface Science: Foundations of Catalysis and Nanoscience, Wiley, 2002.
- G. Cao, Nanostructures & Nanomaterials: Synthesis, Properties & Applications, Imperial College Press, 2004.
- Joel I. Gersten, —The Physics and Chemistry of Materials, Wiley, 2001.
- A. S. Edelstein and R. C. Cammarata, —Nanomaterials: Synthesis, Properties and Applications, Institute of Physics Pub., 1998.
- S. Yang and P. Shen: —Physics and Chemistry of Nanostructured Materials, Taylor & Francis, 2000.
- G.A. Ozin and A.C. Arsenault, —Nanochemistry : A chemical approach to nanomaterials, Royal Society of Chemistry, 2005.
- 8. Physical Chemistry – Atkins Peter, Paula Julio.
- S.P. Gaponenko, Optical Properties of semiconductor nanocrystals, Cambridge University Press, 1980.
- W. Gaddard, D. Brenner, S. Lysherski and G.J. Infrate (Eds.), Handbook of NanoScience, Engg. and Technology, CRC Press, 2002.
- K. Barriham, D.D. Vvedensky, Low dimensional semiconductor structures: fundamental and device applications, Cambridge University Press, 2001.

## **BCH-707**

## **Protein Science and Engineering**

**Credit 4**

### **Unit-I:**

Protein structural families Introduction; Basic structural principles: amino acids and their conformational accessibilities, Ramachandran Plot; Motifs of protein structures and their packing; Schematic and topology diagrams; Families of protein structures: alpha, alpha/beta, beta, small etc.

### **Unit-II**

Protein folding and assembly Protein folding pathways in prokaryotes and eukaryotes; Single and multiple folding pathways; Protein folding of single domain and multi-domain proteins; Inclusion bodies and recovery of active proteins; Osmolyte assisted protein folding; Structure of chaperones and role of chaperones in protein folding

### **Unit-III**

Protein engineering Strategies for protein engineering; Random and site directed mutagenesis; Various PCR based strategies; Role of low-fidelity enzymes in protein engineering; Gene shuffling and Directed evolution of proteins; Protein backbone changes; Antibody engineering; All topics will deal with case studies.

### **Unit-IV**

Prediction and design of protein structures Similar structure and function of homologous proteins; Role of multiple alignment; Homology and ab-initio method for protein structure prediction; Phage display systems; Structure based drug design and case studies, Rational protein design

**Books recommended:**

- Introduction to Protein structure, 2nd Ed by Carl Branden and John Tooze, Garland Press, 1999.
- Structure and Mechanism in Protein Science, Alan Fersht, Freeman, 1999.
- Protein engineering handbook. Edited by Stefan Lutz - Uwe Bornscheuer. Weinheim: Wiley-VCH, 2009. xli, 409-9. ISBN 9783527318506.
- Protein engineering in Industrial biotechnology, Ed. Lilia Alberghina, Harwood Academic Publishers, 2002.