

Department of Biological Sciences, Aliah University, Kolkata

Syllabus for Course Work for PhD in Biological Sciences

S No	Paper Code**	Paper Name	Credits*	Course Coordinator
1	BSPC01	Research Methodology	4	DRC Chairperson
2	BSPC02	Soft Skills	2	DRC Coordinator
3	BSPC03	Review of Literature	4	Supervisor
4	BSPE01	Comparative & Functional Genomics	4	Dr Safdar Ali
5	BSPE02	Recent Advances in Zoology	4	Dr Md Zakir Hossain
6	BSPE03	Microbiology and Microbial Techniques	4	Dr Masrur Alam
7	BSPE04	Onco-therapeutic Proteomics	4	Dr Mehboob Hoque
8	BSPE05	<u>Nanobiotechnology</u>	4	Dr Muddasarul Hoda
9	BSPE06	Phytochemistry	4	Dr Muddasarul Hoda

BS (B**iological **S**ciences)

P (**P**hD)

C (**C**ompulsory)

E (**E**lective)

*** Guidelines for Credits (As per Aliah University PhD Regulations 2018)**

Compulsory Papers : 10

Elective Papers (Any One) : 04

Total Credits to be completed : 14

BSPC01: Research Methodology

Unit 1: Introduction to Research Methodology

Concepts of scientific Methods: Formulating a research problem; Definition, Steps of the Scientific Methods; Hypothesis; Hypothesis testing; Test of prediction

Variables in research; Validity and reliability; Double blind studies

Literature search- online search; Grant applications

Ethics in research-informed consent policy, Privacy and Confidentiality, Plagiarism including self-plagiarism.

Unit 2: Spectroscopy

Spectroscopic techniques, theory and applications of turbidometry, nephelometry, luminometry, UV-Visible, IR, NMR, Fluorescence, Atomic Absorption, CD, ORD, Mass, Raman Spectroscopy. Atomic force microscopy.

Unit 3: Separation Techniques

Theory, principles and applications of paper, thin layer, gel filtration, ion-exchange, affinity, hydrophobic, gas liquid, high pressure/performance liquid chromatography (HPLC). Automatic separation, fraction collection and UV detection technique.

Types of Centrifugation- Preparative, analytical, differential and density gradient centrifugation. Determination of Molecular weight by sedimentation velocity/sedimentation equilibrium, Methods and other applications of centrifugation.

Basic principles of electrophoresis, theory and application, agarose, native and denaturing PAGE, isoelectric focusing, capillary and 2 D electrophoresis.

Unit 4: Microscopy

Principles of Microscopy, Fluorescence, Phase contrast, Confocal, Scanning and Transmission and Cryo- Electron microscopy.

Unit 5: Molecular Biology Techniques

Plasmid/Genomic DNA isolation, Purity check. Yeast two hybrid system. Cloning and expression vectors-Plasmids, Phagemids, lambda vectors, cosmids. cDNA and genomic library. Transformation.

Screening methods, Inducers and Protein tagging. PCR-principle and applications of various PCR techniques, Primer design, RT-PCR

Principles of DNA sequencing, Nucleic acid hybridization- Southern and Northern Blotting

Gene editing by CRISPR technology

Basics of microarray technology, Identification of differentially expressed genes by differential hybridization of microarrays

Unit 6: Immunological techniques

Application and Principles of ELISA, RIA, Immunofluorescence, Hybridoma technology. Phage display method for expression of Fab/ScFv. Western blotting. IHC, ICC.

Unit 7: Cell culture technique

Cell culture- Sterile cell culture technique. Cell counting using hemocytometers. Cell adhesion and growth. Cell staining techniques- Culturing of primary cells, preparation of human chromosome, Application of primary cell culture and transformed cell lines.

Unit 8: Microbiological techniques

Nutritional requirements in bacteria and nutritional categories; types and components of culture media; preparation of different types of media.

Concept of and isolation of pure culture: streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non-culturable bacteria.

Growth of microorganisms: measurement and control of growth, factors affecting growth.

Unit 9: Radioisotopic techniques

Use of radioisotopes in life sciences, radioactive labeling, principle and application of tracer techniques, detection and measurement of radioactivity using ionization chamber, proportional chamber, Geiger- Muller and Scintillation counters, autoradiography and its applications.

Unit 10: Bioinformatics and Data analysis

Introduction to Bioinformatics; Searching database, Alignment of gene sequences, Analysis of DNA sequence, designing primers of specific gene, generation of restriction maps, Generating phylogenetic trees based on DNA sequence and evolutionary relationship;

Analysis of proteins: Protein classification, homology modeling, trading, prediction of protein structure, Computer assisted drug design-concept, methods and practical approaches. Various computational methods in drug design.

Statistical data sets Basic concepts of hypothesis testing, two kinds of errors, level of significance, p value, t-test for mean and difference between two means, partial t-test and Chi square test for goodness of fit. Analysis of variance (ANOVA) for one way and two way classified data

BSPC02: Soft Skills

Basic of Computer Operating System: Using Windows – Directory structures – command structure (Document preparation, EXCEL, Power Point Presentation). Word Processing: Basics of Editing and Word processing. Numerical analysis. Figure Plotting: Figure insertions in documents.

Web Browsing for Research: Usage of Webs as a tool for scientific literature survey. Error Analysis: Basics of a measurement and its interpretation, mean, standard deviation, variance, correlation coefficient; Usage of packages (e.g. ORIGIN; EXCEL) for data analysis. Curve Fitting: Linear and Non-linear fitting of data.

The relevance of the research work from the perspective of the subject – Possible ways to apply the research work in future.

BSPC03: Review of Literature

Extensive survey of published literature relevant to the chosen topic of research which appeared in referred research journals of national and international repute, edited books, reference books, monographs, survey / study reports, dissertations / theses published in book form, and books / reports containing proceedings of national and international conferences / seminars / symposia.

BSPE01: Comparative & Functional Genomics

Finding protein-coding genes within genomes: How many are there? How are they distributed along chromosomes? How do you find out what function they have?

Finding genes that do not code for proteins: How much of the genome is transcribed? Do they produce stable noncoding RNAs? What roles do they play in the cell (regulatory and enzymatic)?

Finding evolutionary signatures of function: Do protein-coding genes account for all or most of the functional sequences? How can you use genome comparisons between species to estimate the amount of functional sequence – and to identify it? This noncoding DNA inferred to be functional can be considered “dark matter” of the genome.

Finding non-genic functional sequences: How can we illuminate the dark matter? How do you use high throughput genomics to find DNA sequences likely to be involved in gene regulation? This section will emphasize genomic approaches to mapping epigenetic features associated with gene regulation, such as histone modifications, DNase hypersensitive sites, and transcription factor occupancy.

Finding function by phenotype: Genetic association studies are currently identifying with high precision and statistical support loci that contribute to complex traits, such as disease susceptibility. How can you find these results easily? How can you use the data and insights from the earlier topics to develop testable hypotheses about how variations among humans at these loci lead to increased susceptibility to disease?

BSPE02: Recent Advances in Zoology

Unit 1: Biodiversity

Levels of biodiversity, value of biodiversity, regional, national and global status of biodiversity, threats to biodiversity, conservation and management of biodiversity, biodiversity act and related international conventions, biogeographical classification of India

Unit 2: Environmental stresses and their management

Global warming; atmospheric ozone, Biodegradation and bioremediation of chemicals; Pesticides: brief history, pesticide industries and markets. Dose response relationship, insecticide, carcinogenic, teratogenic effects

Unit 3: Social behaviour of animals

Costs and benefits of group-living, types of social acts, individual adjustments of group-living, parental care and socio-functional organization in apes & monkeys

Unit 4: Different models in research

Animal models; Cells culture: requirements for cell culture, aseptic technique, primary culture, etc

Unit 5: Study of major human diseases

Problems in the cardiovascular, respiratory, hematopoietic, reproductive, and gastrointestinal systems; Pathophysiology of common parasitic diseases, manifestations and treatment; Endocrinology relation of diseases

Unit 6: The Biological Basis of Human Nutrition

Review of the biochemistry of carbohydrates, fats, proteins, vitamins, and minerals in the context of human disease. Role of diet in the causation or prevention of ischemic heart disease, diabetes, obesity, hypertension, and cancer, etc

Unit 7: Overview of Pharmacology and Pharmacokinetics

Adsorption, Metabolism, Excretion and Toxicology; Drug design and development, Vaccination

BSPE03: Microbiology and Microbial Techniques

Development of microbiology as a discipline: Prokaryotic diversity: Unseen Majority, Great Plate Count Anomaly, Molecular techniques for studying prokaryotic diversity (culture dependent & independent approaches).

Prokaryotic Cellular Structure and Organization: Cell size, shape and arrangement; Detailed structural information of prokaryotes.

Bacterial Systematics: Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, Characters used in bacterial systematic: rRNA oligonucleotide sequencing, Signature sequences. Brief idea about different phylum of prokaryotes, species concept in prokaryotes, concept of Candidate phylum etc.

Microorganisms and their Habitats, Microbial Interactions, Biogeochemical Cycling.

Microbial genomics and proteomics

Metagenomics: Concept, Approach & application

Laboratory exercises:

1. Isolation of Genomic DNA, Plasmid DNA from bacterial cultures. Isolation of metagenome from environmental sample(s).
2. Amplification of 16S rRNA gene from bacterial genomic DNA or environmental DNA.
3. Phylogenetic analysis of a model bacterium.

BSPE04: Onco-therapeutic Proteomics

Unit 1: Biomembranes

Composition and organization of various constituents in prokaryotic and eukaryotic membranes. Recent strategies and techniques used in the study of membrane structure. Membranes as targets of drug delivery. Membrane proteins as therapeutic targets. Artificial membranes.

Unit 2: Protein purification

Strategies used in the purification of recombinant proteins. Criteria of purity. Characterization of protein. Strategies and procedure of protein sequencing. Study of secondary and tertiary structure of macromolecules using CD, fluorescence, MALDI/TOF, NMR, X-ray diffraction etc.

Unit 3: Moonlighting and intrinsically unstructured proteins (IUPs)

Definition, properties of moonlighting proteins including AGO4, Ubp6, tuf, CD26/DPPIV. Role of proteomics in the identification of metabolic enzymes. Cancer cell targeted proteins including antibodies.

Unit 4: Drug delivery systems

Synthetic and natural polymers, microcapsules, nanoparticles. Drug targeting with help of various ligands and antibodies. The pro-drug approach. Drug delivery systems and cancer therapy.

Unit 5: Tumoricidal proteins

Structure and nutraceutical properties of milk proteins. Discovery of the oleic acid complex of α -lactalbumin (HAMLET) and mechanism of its tumoricidal action. Role of the protein and/or fatty acid components in HAMLET. Potential of HAMLET as antitumor drug and hurdles of development. Lectins- types, occurrence and anticancer properties.

Unit 1: Introduction

History, & concepts of nanotechnology- nanoscale determination, identification of nanoscale in nature, first generation artificial nanosystems, evolution of nanotechnology, concept of nanofluidics, understanding biophysicochemical interactions at nano-bio interface.

Unit 2: Nanomaterials & tools

Various types of materials, non-biodegradable & biodegradable materials, inorganic & organic compounds-related nanomaterials. One-, two-, & three-dimensional nanosystems. nano dots, origami, nanoparticles, nanocapsules, dendrimers, nanorods, nanotubes, and nanofibres, concept of multifunctional nanosystems. Protein & DNA-conjugated nanosystems.

Unit 3: Synthesis & characterization methods of nanosystems

Conventional & sophisticated synthesis techniques of various nanosystems, green synthesis. Nanosystems and their size, shape, and surface chemistry's influence on biological systems. Influence of stabilizers on nanoparticles synthesis. Dynamic-light scattering technique, scanning & transmission electron microscopy, atomic-force microscopy, fluorescent microscopy, Fourier-transform infra-red spectroscopy, Raman spectroscopy, X-ray diffraction technique, surface tension, zeta potential, and concept of contact angle, introductory computational approach to nanotechnology.

Unit 4: Prospects and applications of nanobiotechnology

Applications of nanosystems in medicine, drug-delivery vehicles, diagnostics, biosensors, nanochips, imaging tools, agriculture, bioremediation. Various toxicity and environmental issues related to nanotechnology. Economic potential of nanobiotechnology.

Practical-

- i. Particle size analysis using dynamic light scattering
- ii. Demonstration of Scanning and transmission electron microscopes
- iii. Synthesis of polymeric nanoparticles using solvent evaporation method
- iv. Demonstration of green synthesis of nanoparticles from plant extract
- v. Estimation of percent nanoparticles yield drug-entrapment in nanoparticles
- vi. Estimation of bioremediation using nanosystems

BSPE06: Phytochemistry

Introduction of alkaloids, classification, physical, chemical and general methods for isolation of alkaloids

Introduction to polyphenols, classification, physical, chemical and general methods for isolation of polyphenols

Psychoactive plants: stimulants (cocaine, caffeine), Hallucinogens (Marijuana, LSD), depressants (opium), tobacco, ergot, Khat, nutmeg, *Daturastramonium*

Anticancer plants: *Peganumharmala* (harmine, harmaline), *Catharanthus roseus*, *Colchicum autumnale*, *Taxus brevifolia*

Anti-diabetic plants: *Curcuma longa*, *Phyllanthusamarus*, *Withaniasomnifera*, bitter gourd

Definition of functional food and nutraceuticals. Classification of nutraceuticals. Source, name of marker compounds and their chemical nature, medicinal uses and health benefits of following used as Nutraceuticals/Functional foods- i) Spirulina ii) Soya bean iii) Ginseng iv) Garlic v) Broccoli vi) Ginkgo vii) Flax seeds viii) Black cohosh ix) Turmeric x) Tea