UNIVERSITY OF CALCUTTA

Notification No. CSR/82/2026

It is notified for information of all concerned that in terms of the provisions of Section 54 of the Calcutta University Act, 1979, (as amended), and, in the exercise of his powers under 9(6) of the said Act, the Vice-Chancellor has, by an order dated 17.07.2026, approved the Syllabus for semester-7 & 8 of 4-Year Honours & Honours with Research Courses of Studies in **Biochemistry under CCF, 2022.**

The above shall take effect from the Odd Semester Examinations, 2026, and onwards.

22/07/2026

SENATE HOUSE
Kolkata-700073
22.07.2026

Prof.(Dr.) Debasis Das
Registrar

Semester 7 (for the students pursuing 4-year BSc in Biochemistry Honours and Honours with Research)

Core Paper 16: Advanced Biochemistry (Credits: 3Th+1P)

Theoretical (BCM-H-CC16-7-TH)

Unit-I (25 marks)

Introduction to Intermediary Metabolism: Pasteur effect (repression of glucose utilization by oxygen), Crabtree effect (repression of respiration at high glucose concentration in yeast), Warburg effect (lactate fermentation in the presence of oxygen).

Integration of Metabolic Pathways: Relationships between catabolic, anabolic, and amphibolic pathways via ATP/ADP, NADPH/$NADP^+$, and NADH/NAD^+; Acetyl-CoA as a central intermediate connecting converging catabolic pathways (carbohydrates, proteins, and fats) and diverging anabolic pathways; anaplerotic reactions of the TCA cycle; five general categories of biochemical reactions.

Interrelationship between Glucose and Triglyceride Metabolism: Outline of the pathways for carbohydrate and fat catabolism; anabolic roles of triose phosphate and acetyl-CoA in the biosynthesis of triglycerides, cholesterol, and ketone bodies; blood circulation as an integrator of metabolism at the tissue level; metabolic interrelationships among adipose tissue, the liver, and extrahepatic tissues.

Metabolic Regulation: Metabolic homeostasis; non-equilibrium reactions as potential control points for regulation; mechanisms of enzymatic regulation, including changes in metabolite concentrations, allosteric regulation, feedback inhibition, covalent modification, hormonal control, and regulation of enzyme synthesis (one example each). Detailed description of the coordinated regulation of glycogen synthesis and breakdown. Supply of ATP as the major controller of metabolism; energy balance and regulation via ATP/ADP ratio; AMP concentration as an indicator of metabolic state; roles of AMPK; ketosis during starvation.

Analysis of Metabolic Flux: Mitochondrial respiration—measurement of Oxygen Consumption Rate (OCR); glycolysis—Extracellular Acidification Rate (ECAR); definitions and significance.

Role of Metabolism in Disease:(Cancer and cardiovascular disease.)

Unit II (25 marks)

Metabolic Markers with Direct Effects on Health: Name, target site, and biochemical reactions; diagnostic roles of metabolites (specific metabolites to be mentioned) and enzymes (specific enzymes to be mentioned) in blood and urine, with focus on the following metabolic diseases:

Amino Aciduria: Alkaptonuria (one-gene–one-protein hypothesis; measurement of homogentisic acid), phenylketonuria (elevated phenylalanine in blood and phenylpyruvate in urine), maple syrup urine disease (elevated branched-chain amino acids and mechanism for causing neurological defects).

Urea Cycle Defects: Hyperammonemia versus elevated urea in blood.

Other Disorders: Carbohydrate storage disorders (just name and enzyme involved) and glucose-6-phosphate dehydrogenase deficiency (enzymatic assay for new born).

Lysosomal Storage Disorders: I-cell disease due to deficiency of N-acetylglucosamine phosphotransferase; discovery of Pompe disease and the reaction involved.

Mitochondrial Diseases: Discovery by Rolf Luft; mitochondrial DNA heteroplasmy.
Clinical Aspects: Remedies for metabolic defects such as lactase deficiency in infants; role of C-reactive protein in inflammation (significance only).
Xenobiotic Metabolism: Role of cytochrome P450; Lipinski's "Rule of Five."
Redox Metabolism: Principles of reduction–oxidation (redox) reactions; electron carriers (NAD(P)H, $FADH_2$, quinones, ferredoxins). Mitochondria as the major site of ROS generation (electron transport chain and monoamine oxidase). Cellular Redox Systems: Glutathione system (structure of reduced and oxidized glutathione, synthesis, glutathione redox cycle, glutathione-dependent catalysis), thioredoxin system, and peroxiredoxins. Redox activities of antioxidants in a cellular context. Functional roles of redox-active enzymes (catalase, superoxide dismutase).
ROS Metabolism: Origins, signaling functions, and homeostasis of reactive oxygen and nitrogen species.
Redox Regulation: Protein modifications (e.g., sulfenylation, disulfide bond formation), redox-sensitive transcription factors, and antioxidant defense mechanisms.
Pathophysiology: Redox imbalances in cancer metastasis, aging, and neurodegeneration.

Unit-III (25 marks)

Protein structure and folding: Levels of structure, forces stabilizing proteins (selectivity, affinity, kinetics, and thermodynamics), Ramachandran plot, domains, and motifs. Three-dimensional structure of fibrous proteins. Three-dimensional structure of Myoglobin, quaternary structure of Hemoglobin, oxygen binding curves, influence of 2,3 BPG, CO_2, Cl^-. Hill coefficient and Hill plot, Allostery, cooperativity models: Concerted (MWC), Sequential (KNF). Anfinsen experiment, Levinthal paradox, protein denaturation, and renaturation. Protein folding events: the brust phase, hydrophobic collapse, molten globule. Assisted folding by molecular chaperone (HSP70, HSP40), chaperonins (GroEL, GroES), and Protein disulfide isomerase (PDI). Protein Misfolding, Unstructured proteins, proteostasis, ubiquitin-proteasome system and autophagy, Alzheimer's, and prion-based diseases (e.g. Creutzfeldt-Jakob Disease, Mad Cow Disease,)-name, symptoms,underlying causes.

Suggested Reading:

1. Lehninger Principles of Biochemistry
2. Biochemistry by Voet and Voet
3. Harper's Illustrated Biochemistry
4. Vasudevan and Sreekumari's Textbook of Medical Biochemistry

Practical /tutorial/continuous assessment (BCM-H-CC16-7-P) Credit 1; 25 marks

1. BSA fluorescence and quenching analysis (demo)
2. Determination of binding constants (tutorial/demo)
3. Separation of amino acids by paper chromatography (may be set in the exam)
4. Electrophoresis: SDS-PAGE, Native PAGE, Agarose Gel Electrophoresis (demo)

Core Paper 17: Molecular basis of infectious diseases (3Th+1P)

Theoretical (BCM-H-CC17-7-TH)

Unit I (25 marks)

- Overview of the Immune system-Innate immunity: mechanism of immune response (anatomic, physiological, phagocytic and inflammatory barriers). Adaptive immunity: Humoral and Cell-mediated immunity, primary and secondary immune modulation, clonal selection of lymphocytes. Antigens: chemical nature, antigenicity and immunogenicity, hapten, epitopes, mitogens (definition, properties, examples); Adjuvant (definition, examples, function). Immunoglobulins: structure and function, Immunoglobin genes, generation of diversity, affinity maturation, Isotype switching, Allelic exclusion, Ig receptor of B-cells, Antigenic shift and antigenic drift.
- Viral: Viral diseases including AIDS, hepatitis (A, B, C), influenza and polio: causative agents, Pathogenesis; Dengue & chikungunya.

Unit II (25 marks)

- Source, reservoir and transmission of pathogens. Epidemiology and Public health Science of Epidemiology, Disease outbreak, Disease transmission, Diagnosis of Infectious diseases, Disease prevention.
- Bacterial: Detailed study of tuberculosis: History, causative agent, molecular basis of host specificity, infection and pathogenicity, Diagnostics, Therapeutics, inhibitors and vaccines. Drug resistance and implications on public health. Other bacterial diseases including Cholera, Typhoid, Diphtheria, Pertussis, Tetanus and Pneumonia (Mode of action of Diptheria toxin, Tetanus toxin, Cholera toxin), Food poisoning (Salmonella, Shigella, Staphylococcus, Enteropathogenic bacteria).

Unit -III (25 marks)

- Parasitic: Detailed study of Malaria, history, causative agents, Vectors, life cycle, types of infections associated with parasitic organisms, Host parasite interactions, Diagnostics, Drugs and Inhibitors, Resistance, Vaccine development. Other diseases including Leishmaniasis, Amoebiasis.
- Fungal: Common routes of fungal diseases: Examples of medically important fungi Air borne: Blastomycosis, Coccidioidmycosis, Cryptococcosis, Histoplasmosis. Direct contact: Dermatomycosis, Ringworm, Cutaneous Mycosis, Subcutaneous Mycoses, Opportunistic: Aspergillosis, Candidiasis, Pneumocystis pneumonia, Microsporidiosis (Name of the pathogen, brief pathogenesis, Drug used to combat the disease), Food borne fungal toxin: Aflatoxin.

Suggested Reading:

- Prescott, Harley, Klein's Microbiology (2008) 7th Ed., Willey, J.M., Sherwood, L.M., Woolverton, C.J. Mc Graw Hill International Edition (New York) ISBN: 978-007 126727.
- Mandell, Douglas and Bennett.S, Principles and practices of Infectious diseases, 7th edition, Volume, 2. Churchill Livingstone Elsevier.

- Sherris Medical Microbiology: An Introduction to Infectious Diseases by Kenneth J. Ryan, C. George Ray, Publisher: McGraw-Hill
- Medical Microbiology by Patrick R. Murray, Ken S. Rosenthal, Michael A. Pfaller, Elsevier Health Sciences
- Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
- Introduction to Human Physiology (2013) 8th edition; Lauralee Sherwood. Brooks/Cole, Cengage Learning.
- Genetics (2012) Snustad and Simmons,
- Cooper, G.M. and Hausman, R.E. 2009 the Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
- Gyton's medical physiology
- Principles of Microbiology (2015) Second Ed., Ronald M.Atlas

Practical (BCM-H-CC17-7-P) Credit 1; 25 marks

1. Identification of bacterial contamination (CFU) from water, soil , food & beverages.
2. Antibiotic assay by i) Cup plate method ii) Serial dilution method (Determination of MIC)
3. Dot Blot diagnosis (Demo & tutorial only)
4. Fungal staining

Core Paper 18: Advanced Cell Biology (3Th+1P)

Theoretical (BCM-H-CC18-7-TH)

Unit I (25 marks)

- Overview the cell cycle, phase specific biochemical and physiological hallmarks , Cyclins and CDKs, their discovery, spatiotemporal regulation of phase transition (role of post translational modification ,protein localization, cyclic proteolysis and periodic transcription), irreversibility of the cell cycle (APC and SCF), restriction of replication to once per cell cycle, cytokinesis ; Introduction to checkpoints- sensors and effectors, molecular mechanism of checkpoint activation, DNA damage and replication checkpoints, chromosome segregation/spindle orientation and spindle assembly checkpoint. Checkpoint override and outcomes (Mitotic catastrophe, Genomic instability, ploidy changes, cell death, uncontrolled proliferation).
- Types of cell death, apoptosis, features and pathways of apoptosis,extrinsic and intrinsic pathways, caspases, caspase dependent and independent pathways, pro and anti-apoptotic proteins, regulation of apoptosis, necrosis.
- Lipid trafficking: Lipid transfer proteins, Sterol carrier protein (SCP), PLTP (PCTP & PITP), homologue in yeast: sec14. Disorders of protein transport associated with Aging diseases.

Unit II (25 marks)

- Secretory pathway, concept of signal sequence, experimental demonstration for co-translational transport (protease protection assay), signal recognition particle (SRP), ER translocation of polypeptides (soluble and transmembrane), ER chaperons. N-glycosylation in the ER and Golgi (quality control, UPR, ERAD and proteosomal degradation).ER to Golgi transport, anterograde and retrograde transport, coat proteins their recruitment and removal, retrieval of ER resident proteins, vesicle fusion (factors involved), lysosomal biogenesis, endocytosis, protein trafficking in a polarized cell (apical & basolateral)
- Co translational vs Post Translational protein trafficking, Protein transport to Chloroplast and Mitochondria and their sub-organellar compartments. Proton gradients and chaperones in regulating transport. Co translational transport in both organelles Compare and contrast with ER; Peroxisome biogenesis and protein transport. Nucleocytoplasmic protein transport: Transport across nuclear envelope, regulation of nuclear protein import and export.; NLS and NES Large Cargo through Nuclear pores Small GTPases and regulation of transport.

UNIT III (25 marks)

- Cellular Communication: Molecular mechanisms of signal transduction, receptor tyrosine kinase and tyrosine kinase based signaling, Cytokine signalling - JAK STAT pathway, G protein signaling and sensory transduction (vision, olfaction, mechanosensing, pain sensation and gustation).
- Overview of the major functions of the cytoskeleton, the study of different cytoskeleton. Microtubules: Structure and Function, Dynamic instability of Microtubules; Microtubule associated proteins (MAPs), Motor proteins: Kinesin, Dynein, In vitro motility assay; Microtubule organizing centers (MTOCs) in animal and plant cell, Signalling pathways that involve extra-cellular matrix.

Suggested Reading:

- Molecular Biology of the Cell (Bruce Alberts et al.)
- Molecular Cell Biology (Harvey Lodish et al.)

Practical (BCM-H-CC18-7-P) Credit 1; 25 marks

1. Cell count using haemocytometer.
2. Mitosis study in onion root tip
3. Microscopic measurement of bacterial / yeast cell (micrometry)
4. Study of cell viability/death assay by use of trypan blue (**demo**)
5. Subcellular fractionation (demo)

Core Paper 19: Advanced Molecular Biology (3Th+1P)

Theoretical (BCM-H-CC19-7-TH)

UNIT I (25 marks)

- Core mechanisms of DNA Replication: Semi discontinuous synthesis (Okazaki's experiment), Bidirectional DNA synthesis (J. Cairns experiment and Experiment by Elizabeth Gyurasits and R. B. Wake on B. subtilis), Enzymatic machinery of replication-DNA polymerases (Pol I and Pol III: discovery, subunit composition of Pol III and their enzymatic roles), helicases, primases, ligases, and topoisomerases (types, role, mechanism of action and inhibitors), Processivity of Pol III: sliding clamp (β_2-clamp and PCNA- structural similarity and tethering function) and γ- complex (loading, unloading and role of ATP), Termination in E. coli (Ter and Tus), Regulation (GATC hemi methylation at origin) and Fidelity.
- Multiple origins, Assembly of the pre-replication complex (pre-RC), firing and regulation by cell cycle machinery (Cyclins and CDKs), Multiple DNA polymerases (Pol α/primase, polymerase ε and δ, function and polymerase switching), Histone dynamics during replication, End replication problem (telomere and telomerase), Mechanisms of mitochondrial DNA replication.
- Prokaryotic and Eukaryotic template-guided DNA repair pathways: Base excision repair (BER), Nucleotide excision repair, Mismatch repair (MMR), Homologous Recombination and NHEJ, Translesion DNA synthesis (TLS).

Unit II (25 marks)

- Discovery of the Genetic Code ,Comparison between Principles of Prokaryotic and Eukaryotic gene expression, Transcriptional regulation in bacteria, The three eukaryotic RNA Polymerases (Pol I, II, and III) and their target genes, Structure and function of RNA Polymerase II, Core promoters (TATA box, Inr, DPE, TATA less promoters) and the assembly of the Pre-Initiation Complex (PIC), General Transcription Factors , Structure and function of sequence-specific transcription factors (DNA-binding domains and activation domains),Various families of gene regulatory proteins: helix-turn-helix, helix-loop-helix, homeodomain, leucine zipper and zinc finger families of transcription finger the role of the Mediator complex in bridging enhancers to promoters, Transcriptional elongation, pausing, and termination-Influence of CTD phosphorylation, Regulation of transcription in eukaryotes.
- Translation Initiation, Elongation and termination: Ribosome structure and biogenesis, Cap-dependent translation initiation (eIFs, scanning mechanism), Cap-independent translation (IRES), Proofreading and Ribosome mediated decoding, Mechanisms of regulation of translation, Recognition of stop codons (UAA, UAG, UGA), polypeptide release, Ribosome Recycling, Quality control mechanisms. Practical (BCM-H-CC19-7-P).

Unit I: (25 marks)

- Evidence for Split Genes, RNA Splicing, Splicing Signals, Effect of Splicing on Gene Expression, Mechanism of Splicing of Nuclear mRNA Precursors, Spliceosome

Assembly and Function, Commitment, Splice Site Selection, and Alternative Splicing, Control of Splicing, Self-Splicing RNAs, Group I and Group II Introns, Capping (structure, synthesis and function) and Polyadenylation (Functions of Poly(A), Coordination of mRNA Processing Events: Binding of the CTD of Rpb1 to mRNA-Processing, Proteins, Effects of CTD Phosphorylation, processing of Polycistronic Precursors, rRNA and tRNA Processing .

- RNA Transport, Localization, and Decay: Nuclear export of mRNA: The Nuclear Pore Complex and export factors, ribosome assembly, t RNA transport, Cytoplasmic RNA localization and its role in development, mRNA surveillance pathways (Nonsense-mediated decay - NMD), Mechanisms of mRNA degradation (deadenylation, decapping, exosome).

RNA Interference, Mechanism of RNAi, MicroRNAs: Biogenesis, mRNA degradation and Translational repression by miRNAs, Stimulation of Translation by miRNAs, Piwi-Interacting RNAs and Transposon Control, Translation Repression, mRNA Degradation, and P-Bodies

Suggested Reading:

Fundamentals of Biochemistry, Voet and Voet

Molecular Biology, Robert F. Weaver

Molecular Biology of the Gene, Watson *et al*

Practical (BCM-H-CC19-7-P) Credit 1; 25 marks

1. RNA Isolation (demonstration)
2. DNA isolation from Goat liver (Practical/Demonstration/workshop)
3. Semi quantitative/quantitative PCR [demo]

Core Paper 20: Plant Molecular Biology and Biochemistry (3Th+1P)

Theoretical (BCM-H-CC20-7-TH)

Unit I: 25 marks

- Unique Cellular and Tissue Components in Land Plants: Cell wall: structural support, cell shape, interactions with the environment, Plastids – versatile, interconvertible organelles, Plasmodesmata, Symplast, Apoplast – communication network, Central vacuole – turgor as a biochemical and mechanical force, Stomata – dynamic pores balancing CO_2 uptake and water loss, Xylem, Phloem & Water Potential – integrated hydraulic–osmotic transport system.
- Cell Wall Synthesis: Comparative overview: plant vs fungal vs bacterial vs algal walls, Cellulose Hemicellulose Pectin Lignin Biosynthesis Wall assembly.
- Cellular plasticity (totipotency, pluripotency, dedifferentiation, redifferentiation, transdifferentiation), Lifelong meristem-based growth (SAM, RAM, axillary and intercalary meristems generating branches, flowers, inflorescences), de novo organogenesis (lateral roots, nodules, callus-derived shoots/roots, wound-induced organs), Coordinated by phytohormones such as auxin, cytokinin, GA, ABA and ethylene.

UNIT II (25 marks)

- Photosynthesis :Light reactions Light as a signal vs light as energy : Chromophores (porphyrins, chlorophylls, carotenoids, xanthophylls); Redox basis of energy capture, light-harvesting complexes and photosystems ; linear & cyclic electron flow; Oxygenic vs Non oxygenic photosynthesis NADPH/ATP balance; chemiosmosis; photophosphorylation; Photoprotective pathways and excess energy dissipation Xanthophyll Cycle Fv/Fm RUBISCO, Carbon dioxide fixation : Calvin cycle; photorespiration; C3/C4/CAM pathways; sucrose and starch synthesis; sugar translocation.
- Nitrogen Assimilation: Nitrate assimilation (nitrate reductase → nitrite reductase); Ammonia assimilation

  vs. nitrate assimilation, Biological nitrogen fixation (nitrogenase, energy cost, O_2 sensitivity); Energy cost of

  N_2 vs. NO_3^- assimilation, Carbon–nitrogen exchange in diazotroph–plant symbiosis; Metabolic interface:

  GS/GOGAT cycle; GDH, GDC; glutamate as precursor for porphyrins and shikimate pathway.

UNIT III (25 marks)

- Sensory responses: Photoreception (phytochromes for red/far-red, cryptochromes/photol phototropins/LOV receptors, UV-B sensing via UVR8), Environmental response pat (light-regulated development, circadian rhythm, thermomorphogenesis), Mechanosenso gravitropic systems (thigmomorphogenesis via cell-wall integrity sensing and statolith· gravitropism)
- Biotic responses:_Microbial patterns & plant pattern recognition (PAMPs/MAMPs); PTI (pattern-triggered immunity) and ETI (effector-triggered immunity) immune receptors (RLKs/RLPs, NLRs); signaling components linking perception to defense or symbiosis, Resistance (R) genes & Pathogenesis-related (PR) genes, systemic acquired resistance (SAR); salicylic acid receptor & NPR1 as master regulator, hormonal regulation of immunity (SA, JA, ethylene).

Suggested Reading:

Suggested Reading

1.Plant biology Garland Science 1st Edition Smith, Alison M., George Coupland, Liam Dolan, Nicholas Harberd, Jonathan Jones, Cathie Martin, Robert Sablowski, and Abigail Amey (2009)

2. Mechanisms in plant development, . John Wiley & Sons 1st edition Leyser, Ottoline, and Stephen Day (2009).

3. Molecular life of plants. 1st Ed Jones, Russell, Helen Ougham, Howard Thomas, and Susan Waaland (2012).

4. Raven biology of plants, . W.H. Freeman/Palgrave Macmillan 8th Edition. R.F. Evert and S.E. Eichhorn. (2013)

5. Plant Physiology by Lincoln Taiz and Eduardo Zeiger; Sinauer Associates Inc. 5th edition. 2010

6. *Biochemistry & Molecular Biology of Plants* Bob B. Buchanan, Wilhelm Gruissem, Russell L. Jo Ed 2015
7.Plant Physiology by Lincoln Taiz and Eduardo Zeiger; Sinauer Associates Inc. 5th edition. 2010
8.. Biochemistry & Molecular Biology of Plants Bob B. Buchanan, Wilhelm Gruissem, Russell L. Jo Ed 2015

Practical (BCM-H-CC20-7-P) Credit 1; 25 marks

1. Estimation of Chlorophyll content from green leaves by using spectrophotometer
2. Detection of carbohydrates from plant extract
3. Separation of photosynthetic pigments from green leaves by thin layer chromatography
4. Gene transfer using different methods, reporter gene expression, selection of transformed tissues /plants, molecular analysis (tutorial)

5. Introduction to the Plant Bioeconomy: How plant science translates into economic value food, pharma, materials, energy: Case studies: Golden Rice, Bt cotton, Artemisinin Lessons from Failed GM Products Importance of regulatory acceptance Market perception Trait–environment mismatch (tutorial)
6. Basics of Plant Genetic Engineering: Expression Types: Reporter & Marker Systems , Vectors (tutorial)

Suggested Reading

1.Introduction to Plant Biotechnology By HS Chawla, 3rd Edition 2010. Enfield, NH, USA: Science Publishers
2. Introduction to Genetic Engineering of Crop Plants, by A. Rashid, 2nd Edition, 2019. Dreamtech Press

Semester 8 (without research)

Core paper 21: Fundamentals of Research Methods 3 Th + 1 (Practical)
Theoretical (BCM-H-CC21-8-TH)
Unit I (15 marks) **i) Fundamentals of Research: Research Process and Design** **a) Research Ethics and Social Impact** **Unit II (30 Marks)** **Methods in Spectroscopy and Microscopy** Spectroscopic methods: Principle and use of study of absorption spectra of biomolecules. CD Spectroscopy and determination of 2D structures, Fluorescence Spectroscopy- physical basis and application of fluorescence spectroscopy., Jablonski diagram, measurement of fluorescence, quenching, protein folding studies, resonance energy transfer, chemiluminescence. Microscopic tools & techniques: Definition, classification, workflow, applications and data analyses for visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells (confocal and immunofluorescence microscopy), scanning and transmission electron microscopy, fixation and staining techniques for light and EM, image processing. Histochemical and immunotechniques: Definition, classification, workflow, data analyses and applications of flowcytometry, FACS, in-situ hybridization techniques (FISH, GISH, IHC and detection of molecules in living cells). **Unit III (30 marks)** **Recombinant DNA Technology and Computational methods in Biology** Molecular Biology and recombinant DNA methods Definition, classification, work flow and applications of molecular cloning of DNA or RNA fragments in prokaryotic and eukaryotic systems; expression of recombinant proteins using bacterial, animal and plant vectors (Ti plasmids), isolation of specific nucleic acids sequences, generation of genomic and cDNA libraries in plasmid, cosmid, BAC, YAC vectors. Agrobacterium mediated gene transfer; Ti Plasmid, T-DNA (outline). Computational methods: Concept of homology, paralogy, orthology, analogy and xenology, Basic idea of data mining methods for sequence analyses, nucleic acid and protein sequence databases (NCBI, PDB), Web-based tools for sequence searches (sequence alignment, sequence homology). Introduction to Bioinformatics- Gene bank, NCBI, DDBJ, Swissprot, PDB. Sequence alignments-

BLAST and FASTA (Demonstration).

Suggested reading

Practical (BCM-H-CC21-8-P) (Practical):1 Credit; 25 marks

1.Cloning (Restriction digestion, Ligation, Blue white screening)

2. Working with BLAST (blastx, blastn, blastp, tblastn)

3. Multiple Sequence Alignment and construction of phylogenetic tree by using different webtool.

4. Cell cycle analysis by Flow cytometry. (Demo)

Core Paper 22: Microbial Genetics and Virology 3Th + 1P

Theoretical (BCM-H-CC22-8-TH)

Unit-I (25 marks)

Genome Organisation and Mutations

Genome organisation: *E. coli, Saccharomyces, Tetrahymena*

Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes Plasmids: Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 μ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids.

Mechanisms of Genetic Exchange

Transformation: Discovery of Transformation, Competence, Regulation of competence in B. subtilis, Experimental evidence for models of natural transformation, Plasmid transformation and phage transfection of naturally competent bacteria, Role of natural transformation, Importance of natural transformation for forward and reverse genetics, artificially induced competence.

Conjugation: Classification of self-transmissible plasmids, Mechanism of DNA transfer during conjugation in Gram negative bacteria, Chromosome transfer by plasmids, Formation of Hfr strains, Transfer of chromosomal DNA by integrated plasmids, Chromosome mapping of genes by interrupted mating.

Transduction: Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers

Unit-II (25 Marks)

Introduction to viruses: Discovery of viruses. General nature and important features. Viral assays. One-step growth curve and its implications. Properties of viruses, subviral particles, viroids, prions and their importance, isolation and cultivation of viruses.

Bacterial viruses: Understanding the molecular basis of decision making using temperate phage Lambda as a model: the role of the phage repressor, anti-termination factors in regulating the life cycle of the phage.

Phage Genetics: Transposable elements: Prokaryotic transposable elements – Insertion Sequences, composite and noncomposite transposons, Replicative and Non replicative transposition, Mu transposon Eukaryotic transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds) Uses of transposons and transposition

Anti-phage systems: E. coli PrrC- Anticodon nuclease, Rex-dependent exclusion, CRISPR immunity: adaptation (acquiring foreign DNA), crRNA biogenesis (processing RNA), and interference (cutting targeted DNA). CRISPR types, and their mode of action.

Unit-III

Animal viruses: Classification based on genomic material (Baltimore classification), Examples of viruses caused by each class and the diseases caused by them. Capsid structure (icosahedral or helical/ naked or enveloped). Morphological characters: capsid symmetry, Triangulation number.

The life cycle of Animal viruses. Naked DNA viruses: Adenovirus, naked RNA viruses: Picornaviruses. Enveloped DNA virus; Herpes/Pox. Enveloped RNA virus, Influenza, Dengue, HIV, Corona.

Antiviral immunity and drugs.

Viral immunity: The role of interferons in preventing viral growth**.** Cell-mediated and humoral immunity against viruses**.** Prevention and control of viruses: viral vaccines (inactivated or attenuated, adenoviral, and mRNA vaccines) and antiviral compounds.

Plant viruses: Historical aspects. Classification, Modes of transmission. Mechanical (sap transmission) Vector-mediated: Insects (aphids, whiteflies, leafhoppers) Nematodes Fungi Seed and pollen transmission. Host Virus interaction: Host specificity Resistance mechanisms: Hypersensitive response (HR), RNA silencing (RNA interference). Symptoms of Plant Viral Diseases: Mosaic patterns, Chlorosis (yellowing), Necrosis, Leaf curling and distortion, Stunting of plants.

Suggested Reading

Molecular Biology of the Gene (7th Edition) by James Watson, Tania Baker, Stephen Bell, Alexander Gann, Michael Levine and Richard Losick

Molecular Genetics of Bacteria, 4th or later editions by Snyder et al.

Genetic Switch, by Mark Ptasne

Virology – Molecular Biology and Pathogenesis by Norkin

Principles of Virology, 4th Edition, 2 Vol set by S. Jane Flint, Lynn W. Enquist, Vincent R. Racaniello, Glenn F. Rall, Anna Marie Skalka

N.J. Dimmock, A.J. Easton, and K.N. Leppard MODERN VIROLOGY, Blackwell Publishing SIXTH EDITION

Practical (BCM-H-CC22-8-P) Credit 1; 25 marks

1. Growth curve of bacteria in different conditions
2. Demonstration of Bacterial Conjugation
3. Demonstration of bacterial transformation and transduction
4. Plaque Assay

Core Paper 23: Molecular basis of non- infectious diseases (3Th+1P)

Theoretical (BCM-H-CC23-TH)

Unit-I

Classification of diseases: Infectious diseases (communicable and non-communicable), Non-infectious diseases, Genetic diseases, Metabolic diseases, Degenerative diseases, Deficiency diseases; **Risk factors:** Age, Gender, Genetics/family history (Familial genetics), Life style (Smoking , Alcohol consumption), Obesity, Physical inactivity, Stress (eustress vs distress), Hypertension; **Role of environmental factors:** Pollution, Toxic chemicals (addiction), Sedentary lifestyle, Junk food/high-fat diet, urbanization, Occupational stress, Socioeconomic conditions.

Genetic disorder Causes: Symptoms, mode of inheritance: Huntington disease, Cystic Fibrosis, Albinism, Autism, Hemophilia, Myotonic dystrophy, Perkinson disease, Fragile X syndrome; Treatment or management

Unit-II

Life style disorder Causes, symptom, diagnosis, treatment / management:

a) Diabetes: Insulin deficiency, Insulin resistance, Genetic factors, model for diabetics ($db^{-/-}$ mice)

b) Obesity: Eating disorder, Excess calorie intake, Physical inactivity, Hormonal imbalance (leptic, etc.), Genetic model ($ob^{-/-}$ mice).

c) Cardio vascular disease: Atherosclerosis (feed-back regulation of cellular lipid metabolism, arterial inflammation, atherosclerotic plaque, role of LDLR, SREBP); fibrosis, myopathy, Ca2+, β-adrenergic signalling, mitochondrial defects; hypertension (angiotensin), Smoking, Diabetes, High cholesterol; marker troponin, ANP, BNP etc.

d) PCOS/PCOD: Hormonal imbalance, Insulin resistance, hormonal treatment

e) Stroke: What is stroke, Types of strokes, Pathophysiology of stroke, *in vivo* & *in vitro* models of stroke, Emerging Biomarkers in Stroke Diagnosis and Prognosis.Stroke Therapy: From Acute Interventions to Chronic Disease Management, Neuroprotective

Strategies for Stroke, Neuroplasticity in recovery after stroke.
f) other diseases: Age related diseases (osteoarthritis, COPD)

Unit-III

Cancer Biology: Definition and classification of cancer, Hallmarks of cancer. Oncogenes: Definition, function and activation, oncogene addiction and therapeutic targeting, Tumour suppressor genes: Retinoblastoma and two-hit paradigm, Loss of heterozygosity, Copy number changes and CGH array, Epigenetic silencing of Tumour suppressor genes, Key TSGs: p53, APC, BRCA1/2. Evasion of apoptosis in tumour cells.

Genomic and microsatellite Instability: Mechanisms responsible for chromosomal instability and abnormal karyotypes; telomere biology; DNA damage; and defects in the repair machinery underlying a variety of cancer-prone genetic disorders. Genome-wide view of cancer: application of modern techniques providing Cytogenetic, somatic sequence changes, epigenetic and gene expression changes; Cancer stem cell (CSC) properties, drug resistance and relapse. Cancer progression (EMT, angiogenesis and immune evasion). Translational Oncology: Targeted therapies (e.g., tyrosine kinase inhibitors) and precision medicine

Suggested Reading

1. Textbook of Biochemistry for Medical Students. DM Vasudevan, Sreekumari S, Kannan
2. Ganong's Review of Medical Physiology
3. Basic Neurochemistry: Principles of Molecular, Cellular, and Medical Neurobiology, 8th Edition by Scott Brady, George Siegel, R. Wayne Albers, Donald Price.
4. Biomarker panels in ischemic stroke. Glen C Jickling, MD and Frank R Sharp, MD Stroke. 2015 March; 46(3): 915–920. doi:10.1161/STROKEAHA.114.005604.
5. Neuroprotective strategies and the underlying molecular basis of cerebrovascular stroke. Michael Karsy, MD, PhD, Andrea Brock, MD, MSci, Jian Guan, MD, Phillip Taussky, MD, M. Yashar S. et. al. Neurosurg Focus 42 (4): E3, 2017. DOI: 10.3171/2017.1. FOCUS 16522.
6. Molecular Mechanisms of Ischemic Stroke: A Review Integrating Clinical Imaging and Therapeutic Perspectives. Sana Rehman, Arsalan Nadeem, Umar Akram, et al. Biomedicines 2024, 12, 812. https://doi.org/10.3390/biomedicines12040812

PRACTICAL (BCM-H-CC23-8-P) Credit 1; 25 marks

1.Estimation of glycosylated Hb in human blood
2. Estimation of serum cholesterol
3.Estimation of Blood Urea by enzymatic method
4.Permanent slides of different types of cancer

Core Paper 24: Genetics and Biostatistics (3Th+1Tu)

Theoretical (BCM-H-CC24-8-TH)

UNIT I (15 marks)

Mendel's Principle of Segregation and Independent Assortment, Statistical Analysis of Genetic Data, Analysis of inheritance patterns, Pedigree Analysis. Extension of and Deviation from Mendelian Genetics: Multiple Alleles, Modifications of Dominance Relationships, Essential Genes and Lethal Allele, Penetrance and Expressivity, Effects of the Environment, Maternal Effect, Gene Interactions and Modified Mendelian Ratios, Epistasis and Modifier Genes, Extranuclear Inheritance, Inbreeding and Inbreeding coefficients.

Unit II (30 marks)

- Chromosome Theory of Heredity, Nondisjunction, sex-linked genes in humans (haemophilia, colour blindness). Sex chromosomes and Sex Determination (humans, *drosophila,* other animals), Dosage compensation of X-linked Genes, Hyperactivation of X-Linked Genes In male *Drosophila,* Inactivation of X-Linked Genes In female mammals.

  Genetic Mapping in Eukaryotes: Recombination and the Role of Chromosomal Exchange, Constructing Genetic Maps, Detecting Linkage through Testcrosses (Two-Point and Three-point), Mapping functions: Haldane's and Kosambi's, Distinction between Genetic Maps and Physical Maps. 15 marks

- Histones, Nucleosomes, The 30-nm Fiber, Higher-Order Chromatin Folding, The Effects of Histone modification on Transcription, Nucleosome Positioning, Chromatin Remodelling, Heterochromatin and Silencing. Application of epigenomics: epigenetics and environment, epigenetics in human diseases such as cancer, and addiction. 15marks

UNIT III: (30 marks)

- Population Genetics: Genetic Structure of Populations, Genotype and allele Frequencies, The Hardy–Weinberg Law Derivation of the Hardy–Weinberg Law (Loci with multiple alleles and X-Linked alleles), Measuring Genetic variation at the DNA Level (RFLP, SNPs, microsatellites, sequencing), Forces That Change Gene Frequencies in Populations (Mutation, Random Genetic Drift, Migration, Natural Selection), Balance between Mutation and Selection, Assortative Mating, The Role of Genetics in Conservation, Biology, Speciation, Barriers to Gene Flow, Genetic Basis for Speciation. 15 marks
- Biostatistics: Scope of statistics: utility and misuse. Principles of statistical analysis of biological data. Sampling parameters. Difference between sample

and Population, Sampling Errors, difference between parametric and non-parametric statistics; Statistical evaluation of results-mean, mode, median calculation, standard deviation calculation, Correlation and regression, student t-test, correlation coefficient, Chi-square tests with examples of different problems. 15 marks

Suggested reading

1. Principles of Genetics, Snustad & Simmons
2. Genetics: Principles and Analysis, Hartl & Jones
3. iGenetics: A Molecular Approach, Peter J. Russell
4. Genetics: Analysis and Principles, Robert J. Brooker

Tutorial (BCM-H-CC24-8-Tu) Credit 1; 25 marks

Genetics: Analysis of inheritance patterns, Application of probability principles (e.g., product and sum rules) to predict inheritance outcomes and analyse genetic crosses, Examination of genetic diseases through case studies to understand inheritance patterns, diagnosis, and genetic risk assessment, Assessment of population genetic structure through Hardy–Weinberg equilibrium; identification and evaluation of factors causing deviations

Statistical Analysis in Biology: Types of biological data (categorical and continuous), Graphical representation of data (Bar charts and pie charts (categorical data), Histograms and frequency polygons (continuous data), Box-and-whisker plots (data distribution and outliers), Scatter plots (relationships between variables), Hypothesis testing (t-test, Chi-square test and ANOVA) and data correlation, Application of Microsoft Excel (basic statistics and charts).

Literature Review (BCM-H-CC25-8) (3 Th+1 Viva) 100 marks

Students shall have to do background research on a topic of their choice and compile their findings in the form of a written minireview in the prescribed format. They shall also have to deliver a presentation on this. Both the dissertation as well as the presentation shall be evaluated as per the following modalities:

Assessment of the write up shall be done internally as follows:

Total 50 marks [Clarity of background information: 30 marks+ bibliography-10 marks, plagiarism and AI check-10 marks]

Assessment of the oral presentation shall be done in the presence of external experts

(scientists from reputed research institutes/ faculty from reputed universities) as per the following modalities:

Total 50 marks [Presentation skill: 20 marks, audio visual aida: 10 marks, Time management- 5 marks, VIVA-15 marks]

Dissertation format

Word limit: 4000

1. Title Page

- Title: Concise and descriptive, clearly indicating the main focus.
- Author Details: Full names, institutional affiliations, and the author's contact info.

2. Abstract & Keywords

- Abstract: A single, unstructured paragraph summarizing the review question, the major literature covered, and the main conclusions (typically 50–200 words).
- Keywords: 3 to 7 relevant terms

3. Introduction

- Define the topic in a broad context.
- Clearly explain why the topic is important and highlight recent developments

4. Body (Subtopics)

- Arrange the information from literature survey thematicalls thematically using clear, informative section headings.
- Discuss different schools of thought, compare methodologies, and evaluate how major studies were conducted.

5. Conclusions

- Summarize the major findings and state the significance of the subject matter.
- Highlight current knowledge gaps and provide the author's opinion on future developments in the field.

6. References

- Typically, around 50–60 references, heavily weighted toward recent publications. Must be formatted consistently (e.g., APA or Vancouver style)

Semester 8 (with research)

Core paper 21: Research Methodology (RM1) 3 Th+1 (Practical + Viva)
Theoretical (BCM-H-8-RM1-TH)
Unit I (15 marks) **i) Fundamentals of Research: Research Process and Design** **a) Research Ethics and Social Impact** **Unit I (30 Marks)** **Methods in Spectroscopy and Microscopy** Spectroscopic methods: Principle and use of study of absorption spectra of biomolecules. CD Spectroscopy and determination of 2D structures, Fluorescence Spectroscopy- physical basis and application of fluorescence spectroscopy., Jablonski diagram, measurement of fluorescence, quenching, protein folding studies, resonance energy transfer, chemiluminescence. Microscopic tools &techniques: Definition, classification, workflow, applications and data analyses for visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells (confocal and immunofluorescence microscopy), scanning and transmission electron microscopy, fixation and staining techniques for light and EM, image processing. Histochemical and immunotechniques: Definition, classification, workflow, data analyses and applications of flowcytometry, FACS, in-situ hybridization techniques (FISH, GISH, IHC and detection of molecules in living cells). **Unit III (30 marks)** **Recombinant DNA Technology and Computational methods in Biology** Molecular Biology and recombinant DNA methods Definition, classification, work flow and applications of molecular cloning of DNA or RNA fragments in prokaryotic and eukaryotic systems; expression of recombinant proteins using bacterial, animal and plant vectors (Ti plasmids), isolation of specific nucleic acids sequences, generation of genomic and cDNA libraries in plasmid, cosmid, BAC, YAC vectors. Agrobacterium mediated gene transfer; Ti Plasmid, T-DNA (outline). Computational methods: Concept of homology, paralogy, orthology, analogy and xenology, Basic idea of data mining methods for sequence analyses, nucleic acid and protein sequence databases (NCBI, PDB), Web-based tools for sequence searches (sequence alignment, sequence homology). Introduction to Bioinformatics- Gene bank, NCBI, DDBJ, Swissprot, PDB. Sequence alignments-

BLAST and FASTA (Demonstration).
Suggested reading
Practical (BCM-H-8-RM-1-P)(Practical + Viva) Credit 1; 25 marks
1.Cloning (Restriction digestion, Ligation, Blue white screening) 2. Working with BLAST (blastx, blastn, blastp, tblastn) 3. Multiple Sequence Alignment and construction of phylogenetic tree by using different webtool. 4. Cell cycle analysis by Flow cytometry. (Demo)

Core Paper 22:Research Methodology (RM2) 3 Th+1 (Practical + Viva)
Theoretical (BCM-H-8-RM2-TH)
Unit I (15 marks) **i) Fundamentals of Research: Research Process and Design** **a) Literature Review** **b) Citation & Bibliography** **Unit II (25 marks)** **Methods & underlying principles ofMicrobial Genetics** **Genome Organisation and Mutations** Genome organisation: *E. coli, Saccharomyces, Tetrahymena* Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes Plasmids: Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 µ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids. **Mechanisms of Genetic Exchange** **Transformation:** Discovery of Transformation, Competence, Regulation of competence in B. subtilis, Experimental evidence for models of natural transformation, Plasmid transformation and phage transfection of naturally competent bacteria, Role of natural transformation, Importance of natural transformation for forward and reverse genetics, artificially induced competence. **Conjugation:** Classification of self-transmissible plasmids, Mechanism of DNA transfer during conjugation in Gram negative bacteria, Chromosome transfer by plasmids, Formation of Hfr strains, Transfer of chromosomal DNA by integrated

plasmids, Chromosome mapping of genes by interrupted mating.

Transduction: Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers

Unit-III (35 Marks)

Methods and principles of Virology

Introduction to viruses: Discovery of viruses. General nature and important features. Viral assays. One-step growth curve and its implications. Properties of viruses, subviral particles, viroids, prions and their importance, isolation and cultivation of viruses.

Bacterial viruses: Understanding the molecular basis of decision making using temperate phage Lambda as a model: the role of the phage repressor, anti-termination factors in regulating the life cycle of the phage.

Phage Genetics: Transposable elements: Prokaryotic transposable elements – Insertion Sequences, composite and noncomposite transposons, Replicative and Non replicative transposition, Mu transposon Eukaryotic transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds) Uses of transposons and transposition

Anti-phage systems: E.coli PrrC- Anticodon nuclease, Rex-dependent exclusion, CRISPR immunity: adaptation (acquiring foreign DNA), crRNA biogenesis (processing RNA), and interference (cutting targeted DNA). CRISPR types, and their mode of action.

Unit-III

Animal viruses: Classification based on genomic material (Baltimore classification), Examples of viruses caused by each class and the diseases caused by them. Capsid structure (icosahedral or helical/ naked or enveloped). Morphological characters: capsid symmetry, Triangulation number.

The life cycle of Animal viruses. Naked DNA viruses: Adenovirus, naked RNA viruses: Picornaviruses. Enveloped DNA virus; Herpes/Pox. Enveloped RNA virus, Influenza, Dengue, HIV, Corona.

Antiviral immunity and drugs.

Viral immunity: The role of interferons in preventing viral growth**.** Cell-mediated and humoral immunityagainst viruses**.**Prevention and control of viruses: viral vaccines (inactivated or attenuated, adenoviral, and mRNA vaccines) and antiviral compounds.

Plant viruses: Historical aspects. Classification, Modes of transmission. Mechanical (sap transmission) Vector-mediated: Insects (aphids, whiteflies, leafhoppers) Nematodes Fungi Seed and pollen transmission. Host Virus interaction: Host specificity Resistance mechanisms: Hypersensitive response (HR), RNA silencing (RNA interference). Symptoms of Plant Viral Diseases: Mosaic patterns, Chlorosis (yellowing), Necrosis, Leaf curling and distortion, Stunting of plants.

Suggested Reading

Molecular Biology of the Gene (7th Edition) by James Watson, Tania Baker, Stephen

Bell, Alexander Gann, Michael Levine and Richard Losick
Molecular Genetics of Bacteria, 4th or later editions by Snyder et al.
Genetic Switch, by Mark Ptasne
Virology – Molecular Biology and Pathogenesis by Norkin
Principles of Virology, 4th Edition, 2 Vol set by S. Jane Flint, Lynn W. Enquist, Vincent R. Racaniello, Glenn F. Rall, Anna Marie Skalka
N.J. Dimmock, A.J. Easton, and K.N. Leppard MODERN VIROLOGY, Blackwell Publishing SIXTH EDITION

Practical (BCM-H-8-RM2-P)(Practical + Viva): Credit 1; 25 marks

1. Growth curve of bacteria in different conditions
2. Demonstration of Bacterial Conjugation
3. Demonstration of bacterial transformation and transduction
*4.*Plaque Assay

Research Internship (3Th + 1 Viva) 100 marks

(BCM-H-8-RI)

Candidates will have to undertake research projects of 6 weeks duration under the supervision of faculty from recognized university or educational institution / scientist in reputable research institute on any area related to Biochemistry. They shall submit the findings in the form of a research project report and also present the findings to an *externalexpert* (scientists from reputed research institutes/ faculty from reputed universities)

Evaluation will be based on following components:

a) Evaluation by the research supervisor: 25 marks (1 credit)

b) Presentation of the findings: 25 marks (1 credit)

c) Project Report:25, (1 credit)

d) VIVA after presentation-25 marks (1 credit)

Dissertation/Project (6 Th + 2 Viva) 200 marks

(BCM-H-8-PROJECT: (Project)
Research Proposal Writing

Students shall have to do background research on a topic of their choice (different from their internship topic), identify the lacunae in the existing knowledge in that are

and formulate a grant proposal leading to enhancement of knowledge in that area.

They shall have to submit this in the form of a research proposal in the prescribed format.

Subsequently they shall have to defend the proposal

The modalities of evaluation shall be as follows:

a) Proposal writeup – 100 marks [novelty-35, objectives: 25, plagiarism report-10 marks, Bibliography-10- work plan-20]
b) Proposal defense—100 marks [Background knowledge-15 + technical knowledge-20 + clarity of presentation-15, **VIVA -50**].

Format of the research proposal

- **Project Title**: Concise and specific, limited to **500 characters** or **25 words** depending on the vertical.
- **Project Summary**: A comprehensive abstract covering the problem statement, scientific challenges, and novelty. Max limit is **3,000 characters** or **500 words**.
- **Keywords**: Provide between **3 to 6 keywords** that best define your project area (max 30 characters per keyword).
- **Origin of the Proposal & Problem Statement**
  >**Scientific Rationale**: Intellectual background out of which the project arises.
  >**Novelty and Significance**: Explicitly detail how your approach solves a unique problem or closes a critical scientific gap.
- **Review of Status & Literature Survey**
  >**International Status**: Current global research standing on the topic.
  >**National Status**: Overview of work happening within India.
  >**Gaps in Knowledge**: Clear identification of unaddressed issues from literature
- **Objectives**: Bulleted lists specifying targeted work milestones (limited to 4 **bullet points**).
- **Research Work Plan & Methodology**
- Including experimental design and protocols and analysis methods.
- **Expected Outputs & Outcomes**: Clear statements on what the project will deliver and its long-term scientific or commercial impact.