			The Post Cinematic and Post Celluloid Debates Media Sensorium and Media Archaeology Debates Embodiment and Affect in Film/Media The Cultural Politics of Speed, Surveillance and Forensics in Cinema/Media The Archive Effect and Memory Digital Culture and the Internet

10. SCHOOL OF BIOTECHNOLOGY

The pattern of JNUEE 2020-21 will be based on Multiple Choice Questions (MCQs) through Computer Based Test (CBT)

Ph.D.

Sl. No.	Name of Centre	Sub. Code & Sub. Code Number	Syllabus for Entrance Examination
1	School of Biotechnology	Biotechnology – SBTH (904)	***Chemistry*** ***Chemical periodicity, Structure and bonding, Concepts of acids and bases, Properties and functions of metals and non-metals, Transition elements and coordination compounds, Characterisation of inorganic compounds, Analytical chemistry, Nuclear chemistry, Polymer chemistry,Molecular spectroscopy, Chemical thermodynamics, Electrochemistry, Chemical kinetics, Colloids and surfaces, numerical problems related to mole concept, pH, dissociation constants, emf, rate constant etc.*** ***IUPAC nomenclature of organic molecules, isomerism, Principles of stereochemistry, Aromaticity, Organic reactive intermediates, Organic reaction mechanism, Common named reactions and rearrangements, Organic transformations and reagents: Functional group interconversion, Asymmetric synthesis, common heterocyclic compounds containing one ortwo heteroatoms (O, N, S),Chemistry of natural products: (Carbohydrates, proteins and peptides, fatty acids, nucleic acids etc.),Structure determination of organic compounds.*** ***Physics, Chemistry and Mathematics*** ***Class XIIth Syllabus (As per CBSE)*** ***Biochemistry*** ***Biomolecules*** ***Amino Acids, Peptides and Proteins*** ***Nucleic Acids , Carbohydrates and Lipids*** ***Enzyme Kinetics and Inhibition*** ***Introduction about enzymes, classification, activity, cofactors*** ***Chemical Kinetics*** ***Regulation of enzyme activity by various factors such as pH, temperature etc.*** ***Enzyme Inhibition-various types with examples*** ***Kinetics of enzyme inhibition*** ***Enzyme activity and purification-sub cellular fractionation and specific activity*** ***Enzymes: Mechanism, Structure and Regulation***

			Substrate specificity of enzymes *Functional Groups Essential for Catalysis* *Reaction Mechanism of Enzyme Active sites* *Regulatory Enzymes* *Allosteric Enzymes* *Covalently modulated regulatory enzymes* *Covalent Activation of Zymogens* *Isozymes* *Introduction to Metabolism* *Metabolic Pathways* *Organic Reaction Mechanisms* *Experimental Approaches to the study of Metabolism* *Thermodynamics of Phosphate compounds* *Oxidation-Reduction Reactions* *Carbohydrate Metabolism* *Glycolysis* *Fermentation: The Anaerobic Fate of Pyruvate* *Metabolism of Hexoses Other than Glucose* *Glycogen Breakdown& Synthesis* *Gluconeogenesis* *Pentose Phosphate pathway* *Metabolic Regulation and Control* *Citric Acid Cycle* *Cyclic Overview* *Metabolic Sources of Acetyl Coenzyme A* *Enzymes of the Citric Acid Cycle* *Regulation of the Citric Acid Cycle* *Electron Transport and Oxidative Phosphorylation* *The Mitochondrion* *Electron Transport* *Oxidative Phosphorylation* *Control of ATP Production* *Lipid metabolism* *Lipid Digestion, Absorption and Transport* *Fatty Acid Oxidation& Biosynthesis* *Ketone Bodies* *Regulation of Fatty Acid Metabolism* *Amino Acid Metabolism* *Role of essential amino acids* *Amino Acid Deamination* *The Urea Cycle* *Metabolic Breakdown of Individual Amino Acids* *Amino Acids as Biosynthetic Precursors* *Amino Acids Biosynthesis* *Nitrogen Fixation* *Nucleotide Metabolism* *Synthesis of Purine Ribonucleotides* *Synthesis of Pyrimidine Ribonucleotides* *Formation of Deoxyribonucleotides* *Nucleotide Degradation* *Biosynthesis of Nucleotide Coenzymes* *Glycoproteins & Glycolipids* *Hormones & Vitamins* *Metabolic disorders and diseases*

			Integration of Metabolism & Organ Specialization ***Major Pathways and Strategies of Energy Metabolism: A Summary*** ***Organ Specialization & Metabolic Homeostasis*** ***Structural Biology and Biophysical Chemistry*** ***Interactions in Biological Systems*** ***Intra and inter molecular forces, electrostatic interactions*** ***and hydrogen bonding interactions*** ***van der Waals and hydrophobic interactions*** ***Disulfide bridges*** ***Role of water and weak interactions*** ***Structure of Proteins*** ***Conformational properties of polypeptides*** ***Primary and secondary structure (α-helix and β-sheet structures etc.)*** ***Tertiary and quarternary structure*** ***Structural features of membrane proteins*** ***Secondary and tertiary structure prediction of protein conformation*** ***Multiple equilibrium*** ***Titrations of proteins to evaluate net and total charge*** ***Scatchard and Hill plots*** ***Folding-unfolding equilibrium and denaturation of proteins*** ***Effect of temperature and solvent conditions on the thermodynamics of protein*** ***folding-unfolding equilibrium*** ***Kinetics of protein folding*** ***Techniques for the study of Macromolecular structure*** ***Analytical Ultracentrifugation: Sedimentation velocity and equilibrium,*** ***determination of molecular weights*** ***Microcalorimetry (DSC and ITC) and its applications*** ***Circular Dichroism spectroscopy*** ***UV, Visible and Fluorescence spectroscopy*** ***X-ray diffraction*** ***Nuclear Magnetic Resonance (NMR)*** ***Mass Spectrometry*** ***Microbiology*** ***Bacterial diversity*** ***How to classify bacteria*** ***Chemical/Biochemical reactions*** ***Nutrient preference and other biochemical properties*** ***16S rRNA based classification*** ***Three domain classification of microorganisms*** ***Microbial ecology*** ***Carbon and Nitrogen cycles*** ***Phosphorus and Sulfur cycles*** ***Manganese and Mercury cycles*** ***Interaction between elemental cycles*** ***Biogeochemical cycles in relation to climate change*** ***Diversity of bacterial flora in humans*** ***Diversity of microorganisms associated with different anatomical aras in humans*** ***Alterations in microbiome diversity with disease*** ***Structure and Function of the Prokaryotic cell*** ***Peptidoglycan structure and biosynthesis*** ***Cell surface proteins and their role in bacterial pathogensis*** ***Structure and biosynthesis of cell surface organelles*** ***Chaperone – Usher pili in Gram negative bacteria*** ***Covalent anchorage of cell-surface proteins in gram positive bacteria*** ***Ultrastructure and assembly of motility structures: Type IV pili and bacterial flagellum*** ***Atomic structure of the bacterial ribosome*** ***Bacterial Host-Parasite relationships***

			Mechanism of bacterial pathogenesis ***Bacterial structure in relation to pathogenicity*** ***Bacterial protein toxins/endotoxins*** ***Antimicrobial agents used in the treatment of infectious disease*** ***Mechanism of antibiotic action*** ***Antibiotic resistance*** ***Virology*** ***Basic concepts of virus structure*** ***Helical, Icosahedral and Complex structures*** ***Viral genome replication*** ***Viral entry to exit from the infected cells with reference to VSV, adenovirus and retrovirus*** ***Cellular defences against virus infections*** ***Strategies devised by viruses to escape the innate and adaptive immune responses*** ***Antiviral chemotherapy*** ***Antiviral drugs targeting attachment to release of virus particles and their mechanism of action*** ***Modern approaches of virus control*** ***Antisense RNA,siRNA,ribozymes, miRNA*** ***Introduction to feukaryotic viral vectors*** ***Industrial Microbiology*** ***Isolation and Presentation of Microorganism*** ***Improvement of strains*** ***Primary metabolism*** ***Secondary Metabolism*** ***Recombinant proteins*** ***Sterilization*** ***Media Design*** ***Scale up principles*** ***Prokaryotic Molecular Biology*** ***Brief introduction to molecular biology & processes. Denaturation and renaturation of DNA. Tm. GC content from Tm. Renaturation kinetics of DNA and complexity of DNA. Cot curves. DNA-DNA hybridization-relatedness of difference genes and species.*** ***Bacterial Genome organization:*** ***Evolution of genome, Genome content, C-value paradox, Packing ratio, density of genome. Bacterial genome. Short and long range organization, Proteins associated with bacterial genome and their function.*** ***Bacteriophages: Genome and infection and Biology*** ***Bacteriophage T4: Unique properties of genome, Presence of modified bases. Terminal redundancy and Circular permutation. Genetic map of T4 is circular. T4 life Cycle. Transcription: Temporal expression of genes. Replication: Degradation of host genome and generation of modified cytosine for its own perpetuation in T even phages. Assembly of Phage particles. T4 DNA polymerase and regulation of transcription Bacteriophage T7: Gene organization and Infection Controlled Injection of DNA. Transcriptional regulation. Classes of genes. Taking over the cells and production of T7 Polymerase. Differential Affinity with Class II and III promoters. Bacteriophage ϕX174: Genome. Circularity of genome. Infection and Growth. Conversion of single stranded circular DNA viruses into double stranded RF form. Synthesis of viral plus strand from RF DNA. Packaging of genome in phage head. Transcriptional regulation, Overlapping genes.*** ***Plasmids:*** ***Microscopic and Genetic-F plasmid first plasmid to be detected. Counter - selection, Transfer accompanied by replication, Purification of plasmids. Mobilizable and non-mobilizable plasmids. Incompatibility- reasons of incompatibility. Copy number control. Replication of Plasmids: Use of host and plasmid encoded proteins. Uni- and Bi directional replication, Butterfly mode of replication. Replicon. Control of plasmid replication- Iteron regulated and RNA regulated replication. Antisense RNA for primer RNA and replicase protein. Role of replication on incombatibility in Iteron regulated. Drug-resistance plasmid: R- and RTF determinant. Colicin plasmid: Types of plasmids.***

			Action of colicins. Colicin genes. Immunity and Lysis proteins. Export and Action ***Insertion sequences and Transposons*** ***Significance of moving elements of the genome. Bacterial transposable element: General organization of Simple insertion sequence and transposable elements Mechanisms of transposition: Non-Replicative and Replicative transposition, IS transposition a regulated event? Bacteriophage Mu: Replication by transposition.*** ***Replication.*** ***Elucidation of DNA structure and lead to copying mechanism. Models for DNA replication, Meselson and Stahl experiment 1957. Replication of the E. coli genome: John Cairns experiments: Single origin of replication, and bidirectional replication, Ross Inman's experiment- denaturation mapping studies, Mechansims of replication : Theta, rolling circle (sigma), D-loop, Semi discontinuous replication: Pulse chase experiment, Okazaki's experiment on T4 bacteriophage DNA , Use of T4 ligase mutants. Origin of replication– Commonality among E. coli, yeast and SV40 origin of replication*** ***Enzymes of DNA replication: DNa polymerases: DNA polymerase I not the primary enzyme: Its other role in maintenance of DNA integrity. Processivity,direction of DNA polymerization, fidelity, E. coli DNA polymerase I and its components, Klenow fragment and other domains.*** ***DNA polymerase II and its function in DNA replication and repair DNA polymerase III: subunit structure and function: core and holoenzyme. DNA polymerase IV and V. Stages of DNA replication: Initiation- role of DNA methylases, types of E. coli methylases; elongation and proteins involved in elongation, termination. Priming: Mechanisms of priming. RNA primed DNA synthesis – experimental evidences, E. coli primase, Types of primosomes _ E. coli type and PhiX174 type, PAS sequences, Prepriming proteins Endonucleolytic priming: PhiX 174 gene A protein dual activity. Terminal protein priming. Other proteins of replication. DNA helicase, SSB protein and its effect on replication, DNA ligase, topoisomerases Types I & II, Nick translation.*** ***DNA recombination.*** ***Definition, applications of natural recombination, Classification of recombination, Various possibilities of recombination, Models of homologous recombination, Steps involved in homologous recombination, Recombination events during Single and double strand breaks,Holliday Junction and resolution, Protein machinery of recombination, branch migration and resolution*** ***Mutations and Repair.*** ***Mutants, Mutations and Mutagenesis: definition, reasons, measuring mutagenicity. Classifications of mutations: On the basis of location, structure, function and phenotype. Conditional, spontaneous and induced mutations, Missense, nonsense, frameshift mutations, Reversions. Mutagenic agents_ high energy, chemical and natural, Suppressor tRNA, missense repressors, frameshift suppressors*** ***Repair: DNA repair: Mismatch repair, Base excision repair, nucleotide excision repair, direct repair, enzyme of repair, Error prone repair, SOS response*** ***Transcription*** ***Flow of information from DNA to protein. Organization of genes in bacteria. Colinearity of genes and proteins. Operon concept. Process of transcription: RNA polymerase subunit structure and function role of sigma factor in differential expression of genes in bacteria. Transcription units and Cis elements. Promoter: Consensus sequences affecting the promoter function. Constitutive and inducible promoters. Operator sequences as regulatory cis sequences. Initiation : Interaction of polymerase with the promoter and control at initiation. Attenuation. Elongation. Termination : Rho dependent and Rho independent termination. Control at termination : Attenuation. Antitermination. Processing of primary transcripts in prokarytoes :*** ***Processing of tRNA and rRNA. Cleavage of T7 early mRNAs by RNase III. Control at***

			the processing level. Regulation of transcription in bacteria : Introduction and repression. Represser as a regulatory molecule. Coordinated control of gene clusters. Positive and negative regulation : Regulation of transcription of lac, trp, ara, his, and gal operons. Regulation through catabolite repression. CAP protein as a positive control factor. ***Transcriptional regulation in bacteriopohage Lambda: Lytic and Lysogenic switch. role of various regulatory proteins.*** ***Translation*** ***Genetic code. Origin of genetic code. Essential components of translation. Ribosome : the site for translation, subunit composition and assembly. Role of ribosomal RNA in translation. tRNA : Salient features of tRNA. Aminoacyl tRNA synthetases. Difference between initiator fmet-tRNA and met-tRNA, Suppressor tRNAs, frameshift suppression. Codon-Anticodon recognition : Wobble hypothesis.Process of translation: Activation, Initiation, elongation translocation and termination. Factors involved in various steps.Peptidyltransferases. Co-translational and Post - translational mechanisms. Control of gene expression at translational level.*** ***Eukoryotic Molecular biology & Molecular Genetics*** ***Introduction to Eukoryotic Molecular Biology: How to read a paper. The evolution of a Cell with Nucleus,. Hypothesis vs speculation in science,, Rationalization of hypothesis, Experimental tools, Eukaryotic genome, gene expression and cell fate.*** ***Dynamic genome – 3 D cell, dynamic genome architecture in nuclear space, chromatin movement, microscopes , mictrorrays and chromosome capture assays chromatin mobility and principle of nuclear organization, Nuclear architecture and gene-gene interaction, gene kissing, transcription factories, structural constraints on chromatin mobility*** ***Nuclear Matrix and gene regulation: Nuclear matrix, nuclear matrix proteins, nuclear-matrims, structure and function, DNA Binding Properties of the Nuclear Matrix and Individual Matrix Prose.*** ***Ins, Association of chromosome territories with the nuclear matrix: Disruption of human chromosome territories correlates with the release of a subset of nuclear matrix proteins, nuclear matrix targeting, signal, higher order chromatin structure and unclear matrix, transcriptional repression and nuclear lamina nuclear matrix and expression of globin gene*** ***Principle of eukaryotic Gene regulation: gene regulating sequences, promoter, enhancers, regulatory elements, locus control region, gene activation and gene repression, transcription activators and repressors, TBP,GTFs, TBP associated factors (TAFs),RNA polymerases I,II,III, structure and function, mediators, general transcription factors, classes of transcription factors, structure and function, DNA-protein recognition in genome, Transcriptional regulatory networking, gene expression and Cancer progression*** ***Programmed cell death- Apoptotic and necrotic cell death, apoptotic and anti-apoptotic genes, tumore suppressor genes, cell fate through decision between cell cycle arrest and apoptosis*** ***Gene regulation and disease: order vs disorder in transcriptional regulation, network disfunction and disease, transcriptional therapeutics in diseases control.*** ***Cell Biology*** ***Composition and organization of biological membranes:*** ***Membrane lipids: Properties and how they affect the curvature and fluidity of the membrane lipid rafts: composition, a platform for organization of signaling complexes*** ***Membrane proteins: Properties and orientation in biological membranes*** ***Membrane asymmetry*** ***Practice questions and discussion*** ***Cellular transport mechanisms***

			Principles of transport of small molecules across membrane: organization and functioning of carriers and channels, membrane excitability ***Practice questions and discussion*** ***Protein transport across membranes:*** ***Transport across nuclear pore*** ***Transport across ER and from ER to other organelles by vesicular transport*** ***Post-translational modifications of proteins and their role in protein transport*** ***Endocytosis, phagocytosis, exocytosis*** ***Practice questions and discussion*** ***Cell cycle*** ***Components of cell cycle regulatory mechanisms: Cyclin-CDK complexes, CKIs and ubiquitin ligases in cell cycle regulation*** ***Cell Cycle control mechanisms: Checkpoints, Regulation and maintenance of G1, control of genome replication, DNA damage and cell cycle regulation*** ***Cell cycle defects and cancer*** ***Practice questions and discussion*** ***Cell Signalling*** ***Molecular Cell Biology of Cell Surface Receptors: molecular pharmacology, regulation and signaling of G-protein-coupled receptors and tyrosine kinase-linked receptors.*** ***Proteolysis based signaling (Wnt, Notch, Hedgehog): Structural and functional basis for normal and abnormal signaling*** ***Cross-Talk Between Different Intracellular Pathways: Interactions between GPCRs and tyrosine kinase receptors; cross-cascade signaling of proteins involved in gene transcription. (Example: Cross talk between pattern-recognition receptors and Toll-like receptors.*** ***Molecular biology of ionic signaling: Calcium signaling in excitation-contraction coupling in cardiomyocytes; Neutrophils and inflammation*** ***Cytoskeleton:*** ***Cytoskeleton networks: actin, Microtubules and intermediate filaments.*** ***Physical and biochemical properties of extracellular matrices: Collagen, Fibronectin (Tensional homeostasis and fibrosis)*** ***Role of cytoskeleton network and extracellular matrix in cell migration, cell polarity, and cancer*** ***Cell junctions:*** ***Type of junctions: tight junction, anchoring junction, and Communicating junction*** ***Composition and function of junctions*** ***Cell junctions: tissue development, and disease*** ***Analytical Techniques*** ***Concept of pH buffer and solutions*** ***Electrophoresis techniques*** ***Chromatography techniques*** ***Protein and DNA estimation*** ***Sequencing of proteins and DNA*** ***Spectroscopic techniques (UV – Visible, IR fluorescence, CD, NMR and Mass Spectrometry)*** ***GENETIC ENGINEERING AND ITS APPLICATIONS*** ***Introduction to genetic engineering, general work flow, potentials and its limitations.*** ***Host, vector and steps in cloning. Cloning of cDNA, and construction of cDNA library.*** ***Analysis of a cloned DNA fragment using restriction digestion and DNA sequencing.*** ***Concept, strategies, general workflow and variant of the PCR.*** ***The use of PCR in gene recombination, deletion, insertion and site directed***

			mutagenesis. ***PCR in molecular diagnostics: Defection of the pathogens, and its potentials*** ***PCR based diagnostics of the minimum residual disease (MRD) with case study*** ***Application of real time (RT) PCR in the study of gene expression.*** ***Use of genetic engineering for recombinant protein technology*** ***Expression of foreign gene in E. coli, Baculovirus and Pichia expression systems.*** ***Inclusion bodies formation and strategies for the production of soluble proteins.*** ***Cell synchronization and its importance in the genetic engineering.*** ***Methods of introduction of DNA into mammalian cells.*** ***Transient and stable integration of foreign DNA into mammalian cells.*** ***The viral vectors and their use in gene delivery*** ***The Adeno viral vector, unarmed Herpes and vaccinia viral vectors and their importance*** ***Principles and methods of the gene targeting for model organism.*** ***Strategies for Gene knockouts in animals.*** ***Gene disorder and Gene therapy*** ***The packaging of retroviral vectors and helper cells for gene therapy*** ***Development of animal models for gene therapy.*** ***Detection of mutations in neoplastic diseases*** ***Immuno – Suicide gene therapy in neoplastic diseases.*** ***Somatic and germ line gene therapy in vivo and ex-vivo experiments, Bioethics*** ***Role of integrated OMICS in the genetic engineering*** ***Importance of computational tools and system biology for genetic engineering*** ***Use of genome wide screening in the functional genomics*** ***Recent breakthrough and advances in the genome engineering.*** ***Recent trends and development in the gene therapy.*** ***Plant Genetic Engineering: Introduction to plant tissues culture; Agrobacterium infection biology; Explant selection and regeneration; Plant transformation (Agrobacterium-mediated, Microprojectile bombardment-mediated and Floral-dip method of plant transformation); Transgenic Selection and Regeneration; Discussion.*** ***Applications of plant genetic engineering: Understanding issues encountered in plant biotechnology Germplasm Improvement; Plant and human health; Plant Molecular farming (Bioreactors); Bio-fortification; Discussion. Precise genome engineering.*** ***Immunology*** ***Introduction to the Immune System*** ***Historical background, cellular and molecular components of immune system*** ***Innate Immunity*** ***Innate immune cells, Pathogen associated molecular pattern (PAMP), Pathogen recognition receptors (PRR), Type 1 IFN, Interferon Stimulated Genes (ISGs), Complement system.*** ***The Recognition of Antigen*** ***Structure of a typical antibody molecule, Antigen recognition by T cell and B cells, Generation of lymphocyte antigen receptors, TCR gene rearrangement, Antigen presentation to lymphocytes, MHC/HLA complex.*** ***The Development and Survival of Lymphocyte*** ***The development of T lymphocytes in the thymus, Development of B lymphocytes, Positive and negative selection of T cells, Maturation of lymphocytes in peripheral lymphoid tissue*** ***The Adaptive Immune Response*** ***T cell mediated immunity, Entry of naïve T cells and APCs into peripheral lymphoid organs, Naïve T cells priming by pathogen-activated dendritic cells,T cell-mediated toxicity, Macrophage activation by TH1 cells, humoral immune response, Immunological memory, Cytokines*** ***Immune system in Disease*** ***Self tolerance, autoimmune diseases, transplant rejection, allergy and anaphylactic shock, AIDS immunology***

			Immune aging ***Immunosenescence, Immune-exhaustion during aging and chronic infection, Gut Immunology*** ***NK cells and Diseases*** ***Inhibitory receptors, KIR receptors, CTL responses in cancer, Immunotherapy*** ***Characterization of lymphocytes specificity, frequency and function*** ***Lymphocyte isolation, ELISPOT assay, Multicolor flow cytometry, HLA-tetramer assay*** ***Plant Biotechnology*** ***Prologue to Plant's World*** ***Plant and human society; Growth and development; Plant hormones; Photosynthesis*** ***An Introduction to Plant Genetics*** ***Plant genome organisation; Polyploidy; Genetic diversity; Molecular markers and mapping; Phylogenetics and genomics; Breeding and methods; Discussion; Forward vs. reverse genetics;*** ***Basic Aspects/Techniques of Plant Tissue Culture*** ***Introduction; Totipotency and Regeneration; Nutritional media and growth regulators; Problems in plant tissue culture; Discussion.*** ***Transgenic Crops*** ***Global status of transgenic crops; Traits under development; Case Studies; Challenges; Discussion*** ***Applications*** ***Plant Molecular farming (Bioreactors);Renewable energy crops and biofuels; Bio-fortification for Human Health; Discussion*** ***Safety and Regulations*** ***Understanding issues encountered in plant biotechnology; Risk assessment; Environmental impact and gene flow; Regulation and labelling; Discussion.*** ***Bioinformatics*** ***Biological Databases*** ***Overview of biological databases, types, nucleic acid databases, NCBI: PubMed, Entrez, Blast, OMIM, Taxonomy, Structure, Locuslink. Protein databases - primary, functional, composite, secondary, structural classification database, Sequence formats & storage, Errors in databases, Submissions to databases.*** ***Pairwise and Multiple sequence alignments*** ***Local alignment, Global alignment, Scoring matrices - PAM, BLOSUM, Gaps and penalties, Dot plots. Dynamic programming approach: Needleman and Wunch Algorithm, Smith and waterman Algorithm, Hidden Markov Model: Viterbi Algorithm. Heuristic approach: BLAST, FASTA.*** ***Genome Analysis*** ***Polymorphisms in DNA sequence, Introduction to Next Generation Sequencing technologies, Whole Genome Assembly and challenges, Sequencing and analysis of large genomes, Gene prediction, Functional annotation, Comparative genomics, Human genome project*** ***Bioprocess Technology*** ***Introduction: A systems approach to Biology*** ***Introduction to material and energy balances*** ***Elemental balances in biological systems: Degrees of reductance*** ***Energy balance in biological systems: Enthalpy efficiencies*** ***Growth kinetics in batch systems*** ***Growth and substrate utilization in continuous systems*** ***Concept of maintenance*** ***Product formation in anaerobic systems***

			Product formation kinetics ***Continuous reactor systems with recycle*** ***Fed batch reactors*** ***Feed design in fed batch reactors and its analysis*** ***Heat transfer in bioreactors*** ***Mass transfer in bioreactors: Concept K_La*** ***K_La estimation methods*** ***Scale up principles*** ***Downstream Processing*** ***Thermodynamic requirements of separation . Classification of separation processes – equilibrium and non-equilibrium processes. Chief characteristics of bio-separation processes. RIPP – removal of in-solubles , isolation of products, purification and polishing.*** ***Cell harvesting – Cell disruption – ball mill, chemical lysis, homogenization, selection of unit operation for insoluble removal . Centrifugation – general theory of centrifugation – final settling velocity, critical particle diameter, sigma factor. Types of centrifuges: tubular bowl, disc stack, basket, Sharples super-centrifuge. Theory of disc-stack centrifuges. Filtration . Types of filtration –rotary vacuum drum, plate and frame , leaf filters. Compressible cakes and filter aids. Theory of filtration .*** ***Product isolation – extraction, principle of extraction, partition coefficient, extraction factor, batch extraction, cascades , idealized stage operation, differential extraction, height of a transfer unit ,number of transfer units ,adsorption, adsorption isotherms ,batch adsorption, adsorption in a CSTR.*** ***Product Purification – Chromatography, yield and purity and resolution*** ***Principles of elution chromatography, ion-exchange, hydrophobic interaction, reverse-phase chromatography, gel-filtration chromatography. The concept of resolution, plate height. Protein purification. Synthesis of chromatography trains.*** ***Membrane filtration: tangential flow filtration , micro-filtration , ultra-filtration , reverse osmosis. Transport equations, gel layer formation, osmotic pressure. Time required for filtration in T.F.F.*** ***Polishing - Crystallization – separation, purity, nucleation, crystal growth, characteristic length, crystal size distribution, dominant crystal length.*** ***Lyophilisation and drying.*** ***Scale –up: Basic ideas of scale –up , Geometric , Kinematic, Dynamic similarity. Why scale up of bioprocesses is difficult? Typical time constants for mixing, kinetic, heat transfer, mass transfer phenomena in bioreactor. Criteria for scale-up P/V, kla , N, rules of thumb .***

11. SCHOOL OF SANSKRIT AND INDIC STUDIES

The pattern of JNUEE 2020-21 will be based on Multiple Choice Questions (MCQs) through Computer Based Test (CBT)

SYLLABUS

I. REGULAR COURSES

B.Sc.-M.Sc. Integrated program in Ayurveda Biology

Sl. No.	Name of Centre	Sub. Code & Sub. Code Number	Syllabus for Entrance Examination
1	School of Sanskrit and Indic Studies (SSIS)	Ayurveda Biology - AYBU (411)	**Syllabus:** The syllabus is 10+2 level CBSE for Sanskrit, Science and General Aptitude questions.