

**UNIVERSITY OF MUMBAI**



**Syllabus  
for the  
PET Examination  
in  
Biochemistry**

**(With effect from the Academic year 2020- 2021)**

## UNIVERSITY OF MUMBAI



### Syllabus for Approval

<b>Sr. No.</b>	<b>Heading</b>	<b>Particulars</b>
1	Title of the Course	PET in Biochemistry
2	Eligibility for Admission	As per the relevant ordinance
3	Passing Marks	As per the relevant ordinance
4	Ordinances / Regulations (if any)	As per presently applicable VCD 947 dated 15 <sup>th</sup> June 2018
5	No. of Years / Semesters	As per presently applicable VCD 947 dated 15 <sup>th</sup> June 2018
6	Level	As per presently applicable VCD 947 dated 15 <sup>th</sup> June 2018
7	Pattern	As per presently applicable VCD 947 dated 15 <sup>th</sup> June 2018
8	Status	As per presently applicable VCD 947 dated 15 <sup>th</sup> June 2018
9	To be implemented from Academic Year	From Academic Year: 2020-2021

Date: 28/07/20

Signature

Name: Dr. Chinmoyee Vatsyayan  
Chairperson of BoS of Biochemistry

Dr. Anuradha Majumdar  
Dean, Science and Technology

## PREAMBLE

*Coverage: The Chairperson and members of BoS may decide to include preamble. Preamble or Preface is optional and should be framed within one page. It should mention the salient features and essence of the curriculum/syllabus and highlight the need for revision. The constitution of India and most of the acts and laws of the Indian Penal Code have only one page preambles.*

Dr. Anuradha Majumdar (Dean, Science and Technology)

Prof. Shivram Garje (Associate Dean, Science)

Name of Chairperson (BoS): Dr. Chinmoyee Vatsyayan

Member (BoS): Dr. Anita Nadkarni

Member (BoS): Dr. Alka Nerurkar

Member (BoS): Dr. Kavita Dipnaik

Member (BoS): Dr. Nupur Mehrotra

**Syllabus framework and details as per University style and template**

## PET Syllabus for Biochemistry from 2020- 2021 onwards

### Paper I - Research Methodology, Biostatistics and Lateral and Analytical Reasoning

#### 1. Research & Research design

**Research:** Concept of research; Research process; Types of research; Formulating research problem; Criteria for good research; Significance of research; Problems faced by researchers in India.

**Research Design:** Concept; Features of good research design; Types of research designs; Basic principles of experimental designs; Prospective, retrospective research and observational design, Clinical trials.

**Research planning:** Project proposal writing for the funding with budgeting details; Research funding agencies – Research grants, scholarships and funding (CSIR, DBT, DST, DST- SERB, CIFAR, DST- INSPIRE Fellowship, ICMR, Lady Tata Memorial Trust, Sree PVF, INSA, BRNS, DRDO, UGC, DSIR, ISRO, ICAR, ICRISAT, USAID/NSF- Fulbright Fellowships for Indian students, DFG- German Research Foundation, Bill and Melinda Gates Foundation, DBT-Wellcome Trust India Alliance).

#### 2. Report Writing

Significance of report writing; Different steps in report writing; Types of reports; Mechanics and precautions of writing research reports for - scientific journals, popular magazines, seminars/symposia/conferences/workshops.

Layout of research paper according to journal style, impact factor of the journal; Publication metrics like h-index, citations, citation index, Indian citation index; Abstract and citation databases like SCOPUS, Web of Science, Google Scholar, Web of Science, UGC CARE etc.

Layout for poster.

#### 3. Presentation

Types - Oral & Written; Use of digital media; Presentations in classrooms, scientific meets & public audience; Defense of research thesis.

#### 4. Presentation & Processing of Data

**Descriptive Statistics:** Presentation of Data; Diagrammatic Presentation: Graphs and Charts; Tabular

**Measures of Dispersion:** Quartile deviation, Mean deviation, Standard deviation, Standard error, Variance, Coefficient of variation.

**Normal Distribution and Normal Curve:** Function, Properties Skewness, Kurtosis and Measures of skewness (Karl Pearson, Bowley), Probability mass/density function, cumulative mass/density.

**Estimation and testing of Hypothesis :** Properties and use of Normal Tables; Testing of Hypothesis – Process; Type I and Type II errors; Level of Significance, Confidence Interval; Z- Test for testing, population mean(s) and proportion(s); t-test for testing population mean- paired & unpaired t-test.

**Estimation and Testing of Population Parameters:** Estimator of population proportion and mean and their sampling distribution.

**Measures of outcome of clinical interventional studies:** Relative Risk (RR), Relative Risk Reduction (RRR) and Odds Ratio (OR)

**Sampling:** Representative sample and sample bias; Sampling techniques- Simple, random, systematic, Stratified, Cluster, multistage.

**Correlation:** Types; Coefficients

**Regression analysis:** Types, Coefficients

**Demography & Vital Statistics:** Collection of demographic data; Vital statistics at state & national levels; Reports of special demographic surveys; Measures of vital statistics: Rate of mortality, fertility, reproduction, morbidity, comprehensive indicators, indices of health population growth rates and density of population.

**Non-Parametric tests & Analysis of Data:** Non-parametric tests; Importance of non-parametric tests; Chi square test of goodness of fit; Chi square test for independence of attributes; Yate's correction.

**ANOVA:** ANOVA and partitioning of sum of squares-assumptions, hypothesis tests with ANOVA; Constructing F Ratios; ANOVA Tables; Analysis of categorical data, two way; Contingency tables.

**Power Analysis:** Power analysis for contingency tables, t tests, ANOVA; Correlation & regression models. Sample size calculation

## 5. Lateral and Analytical Reasoning

**Mathematical Reasoning and Aptitude:** Types of reasoning; Number series, letter series, codes and relationships; Mathematical aptitude (fraction, time & distance, ratio, proportion and percentage, profit and loss, interest and discounting, averages etc.)

**Logical Reasoning:** Understanding the structure of arguments: Argument forms, structure of categorical propositions, mood and figure, formal and informal fallacies, uses of language, connotations and denotations of terms, classical square of opposition; Evaluating and distinguishing deductive and inductive reasoning, Analogies; Venn diagram: Simple and multiple use for establishing validity of arguments.

## 6. Ethical Values

Ethics/ Values/ Morals; Nurturing work ethics; Gender, neutrality; Human Rights.

## Paper II: Core Subject – Biochemistry

### 1. Biomolecules and catalysis

Physico-chemical interactions in biological systems (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.),

Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics), Importance of water

Structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).

Bioenergetics and thermodynamics: Role of high energy phosphates in bioenergetics and energy capture, Theories of ATP biosynthesis. Electron Transport Chain in plants, eukaryotes and prokaryotes, Significance of redox potentials, mechanism of oxidative phosphorylation. Uncouplers and inhibitors of energy transfer. Laws of thermodynamics as applied to biological systems, enthalpy, entropy, free energy, standard free energy.

Conformation of proteins, Levels of protein structure, Ramachandran plot, domains, motif and folds, Fibrous and globular proteins, Structural features of membrane proteins, Protein folding, Protein engineering, Stability of proteins and nucleic acids.

Principles of catalysis, enzymes and enzyme kinetics, Enzyme assays, enzyme inhibition and regulation, mechanism of enzyme catalysis, isozymes, Multi substrate enzymes, Multisite and allosteric enzymes.

Metabolism of carbohydrates, lipids, amino acids, nucleotides and vitamins. Integration of metabolism of carbohydrates, proteins and lipids.

Plant Biochemistry:

Photosynthesis - Light and Dark Phases, Schemes-I, II & Z, Cyclic and Non-Cyclic Photophosphorylation, C-3 & C-4 Pathways, CAM pathway.

Plant physiology -Plant growth hormones- Auxins, Gibberellins, Cytokinins, Abscisic Acid and Ethylene, Artificial plant growth hormones.

### 2. Cell organization and function

Cell theory, Structural organization and function of intracellular organelles (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility, extracellular matrix). Structure and function of enveloped animal viruses.

Cell division and cell cycle (Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle).

Cell signalling, hormones and signal transduction.

An overview of classical genetics: Mendelian genetics - Mendelian laws and basis of inheritance; dominance, recessivity, genotype, phenotype, Chromosomal theory of heredity, sex-linked inheritance, multiple alleles, lethal genes, genetic heterozygosity; Gene linkage & crossing over, tetrad analysis.

Organization of genes and chromosomes (Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons, telomeres), chemistry of nucleic acids, DNA replication, repair and recombination, RNA synthesis and processing, RNA editing, RNA transport, Catalytic roles of RNA, Protein synthesis and processing, inhibitors, Post- translational modification of proteins, Control of gene expression (in phages, viruses, prokaryotic and eukaryotic genomes), role of chromatin in gene expression, gene silencing, SOS response.

### **3. Bio-membranes**

Membrane lipids, Membrane proteins and carbohydrate, Membrane composition, structure and function, Structure of model membrane, lipid bilayer, Transport of small molecules and macromolecules. Liposome technology and its applications.

### **4. Immune System**

Introduction of immune system- Adaptive and innate immunity, Cells and organs of immune systems; Antigens, antigenic determinants; Antigenicity and immunogenicity; Immunoglobulins – basic structure, classes, subclasses, function; Antibody receptors; Organization and expression of immunoglobulin genes and its regulation; Monoclonal antibodies; Antigen-Antibody interaction; Experimental animal models; Cell culture system; Molecules involved in Immunology; MHC and complement system; Cytokines; Immune response to infectious diseases; Immunological tolerance, Autoimmunity and autoimmune diseases, Immunotherapy and immunodeficiency , vaccines.

### **5. Cancer Biology**

Cancer Initiation, Promotion and Progression, Stages of Tumour Progression, Initiators and Promoters of Cancer development, Cancer genetics: Oncogenes, Tumour suppressor genes, Benign vs malignant neoplasms, Programmed Cell Death (apoptosis) involving onco-genes and tumour suppressor genes.

### **6. Recombinant DNA Technology**

Gene cloning, isolation of genes, obtaining genes from eukaryotic and prokaryotic organisms, problems of isolation of genes, isolation of gene fragments.

cDNA synthesis, PCR, designing of primers for PCR, chemical synthesis of genes, shotgun experiments, gene bank, gene library.

Vectors for cloning in bacteria – plasmids, bacteriophages, phages, cosmids, phagemids.

Cloning in yeast vectors: Yep, Yrp, Ycp.

Cloning in plant cells, suitable vectors – caulimoviruses, Ti plasmids.

Cloning in mammalian cells, viral vectors, shuttle vectors.

Introducing DNA into cells, transformation, microinjection, electroporation, selection of recombinant clones, colony hybridization, Southern & Northern hybridization, use of probes.

Medical and Biological applications of recombinant DNA technology (RDT), Diagnostic probes for genetic and other diseases, Anti-sense technology and therapeutics, Environmental (degradation of toxic compounds), agricultural, industrial and commercial applications of RDT.

## 7. Nutrition

Role of macronutrients and its nutritional significance

Nutrigenomics

Techniques in Nutrition

## 8. Bio- Physical and bio-analytical techniques

Buffers; Methods of cell disintegration; Enzyme assays and controls; Detergents and membrane proteins; Dialysis, Ultrafiltration and other membrane techniques.

**Chromatography:** TLC and Paper chromatography; Chromatographic methods for macromolecule separation – Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and affinity chromatography; HPLC and FPLC; Criteria of protein purity.

**Centrifugation:** Basic principles; Mathematics & theory (RCF, Sedimentation coefficient etc.); Types of centrifuge – Micro centrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods.

**Electrophoresis:** Theory and application of Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis.

**Spectroscopy:** UV, Visible and Raman Spectroscopy; Theory and application of Circular Dichroism; Fluorescence; MS, NMR, PMR, ESR and Plasma Emission spectroscopy.

**Radioisotope studies:** Radioisotope and their use in biology, autoradiography, radioactive labelling of biological macromolecules, radioimmunoassay.

**Advanced Techniques:** Protein crystallization; Theory and methods; API-electrospray and MALDI-TOF; Mass spectrometry; Enzyme and cell immobilization techniques; DNA & Peptide Synthesis and sequencing, confocal microscopy, atomic force microscopy.



## 9. Bioinformatics

Biological databases: Primary databases and Secondary databases, Sequence databases, Protein structure database, sequence analysis tools.

## 10. Advances in Biochemistry

Bioprocess Technology & Fermentation Technologies in Cell & Tissue Culture (plant, animal, microbial).

Unusual Biomolecules and Natural Bioactive Compounds.

**Stem cell Biology:** Classification of stem cells, Properties of stem cells, Stem cell-based regenerative medicine.

### Reference material:

As prescribed for Mumbai University M.Sc. syllabus for Biochemistry.