

ACADEMIC COUNCIL : 2/2017

Item No :

UNIVERSITY OF MUMBAI



SYLLABUS FOR MSc BIOTECHNOLOGY

(REVISED)

PROGRAM: M.Sc

COURSE: BIOTECHNOLOGY

CREDIT BASED SEMESTER AND GRADING SYSTEM

WITH EFFECT FROM ACADEMIC YEAR 2016-17

UNIVERSITY OF MUMBAI

2016-17



SYLLABUS FOR SEM I

PROGRAM: M.Sc

COURSE: BIOTECHNOLOGY

CREDIT BASED SEMESTER AND GRADING SYSTEM

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PSBT 101 : Biochemistry

Unit I: Storage of Carbohydrates- Structure and Function:

Starch and Glycogen, Cellulose, Chitin, Glycosaminoglycans-Heparin, Chondroitin sulphate, Dermatan sulphate, Keratan sulphate. Formation structure and functions of Eicosanoid: Prostaglandins and Thromboxanes. Glycoproteins (N-,O-,GPI- linked and proteoglycans) & Glycolipids, and Lectins.

Unit II: Structure-function-Physiological Significance:

Haemoglobin and Myoglobin: Structure, oxygen binding, Hill equation and Hills plot, Cooperativity, Bohr effect, Allosteric regulation: Adair Equation, Symmetry model and Sequential model. Lipoproteins: Structure, types and functions. Lipoprotein Dysfunction: Atherosclerosis, Alzheimer's Disease.

Unit III: Inborn errors of metabolism and nutritional disorders:

PEM (Kwashiorkar and Marasmus). Diabetes: Type I, Type II, gestational. Glycogen storage disorders -von Gierke's disease, Cori's disease, Andersen's disease, McArdle's disease. Amino acid metabolism- PKU, Alkaptonuria. Lipids- Tay-Sachs, Gaucher's disease. Nucleic acids- Gout, Lesch-Nyhan syndrome. Role of B group Vitamins in metabolic pathways.

Unit IV: Neurobiology-neurochemistry

Structure and functions of neuron, types and physiologic anatomy of the Synapse, transmission of nerve impulses, ion channels, neurotransmitters and neuropeptides, Electrical events during neuronal excitation and inhibition. Neurotoxins. Neurochemistry: Special senses- taste, vision, odor, hearing,

References:

1. Guyton, Text book of Medical Physiology, Saunders Publishers, 12th edition, 2010
2. Textbook of Biochemistry with Clinical Correlations, 7th Edition, Thomas M. Devlin, January 2010.
3. Proteins: biotechnology and biochemistry, 1st edition (2001), Gary Walsch, Wiley, USA
4. Biochemical Calculations, 2nd Ed., (1997) Segel Irvin H., Publisher: John Wiley and Sons, New York.
5. Enzymes: Biochemistry, Biotechnology & Clinical chemistry, (2001) Palmer Trevor, Publisher: Horwood Pub. Co., England.
6. Outlines of Biochemistry: 5th Edition, Erice Conn & Paul Stumpf ; John Wiley and Sons, USA
7. Fundamentals of Biochemistry. 3rd Edition (2008), Donald Voet & Judith Voet , John Wiley and Sons, Inc. USA

8. Lehninger, Principles of Biochemistry. 5th Edition (2008), David Nelson & Michael Cox, W.H. Freeman and company, NY.
9. Biochemistry: 7th Edition, (2012), Jeremy Berg, Lubert Stryer, W.H.Freeman and company, NY

Unit I: Advanced Immunology

Antigen presentation. Secondary signaling, co-stimulation, Cell signaling in immune response. DC activation, B cells as APC, Activation of B and T cells, Complements - Lectin pathway with regulation.

Unit II: Molecular immunology

T and B cell (antigenic properties, receptors and activation), Generation of antibody diversity, MHC and antigen presentation- Exogenous and Endogenous pathway, non-peptide antigens. Histocompatibility Complex, Polymorphism transplantation

Unit III: Clinical immunology

Cytokines: properties, receptor, antagonists, diseases, Therapeutic use of cytokines
Experimental immunology: Vaccine development (Recombinant, Combined and polyvalent vaccines), Antigen Antibody reactions in diagnostics. Cancer Immunology

Unit IV: Effector mechanisms:

Mucosal immunity, Peyer's patches, gut barriers, oral immunization, Oral tolerance, Cytotoxic response, ADCC, NK cells, CTL, Th, T regulation, Immunoregulation, anergy, tolerance, anti idotype, Mechanisms of antiviral innate immune response

References:

1. Immunology 5th ed Janis Kuby, W.H.Freeman & Co Ltd; 5th Revised edition.
2. Fundamental Immunology 5th edition (August 2003): by William E., Md. Paul (Editor) By Lippincott Williams & Wilkins Publishers
3. Essential Immunology, Ivan M. Roit (1994) - Blackwell Scientific Pub, Oxford.
4. Cellular and Molecular Immunology, 3rd edition Abbas, Saunders.

Unit I Chromatin structure and gene expression

Transcription in prokaryotes and Eukaryotes

Types of RNA polymerases, Promoters, initiation, elongation, termination and anti-termination.

Initiation factor, role of transcription factors, Regulation of RNA polymerase Chromatin structure and transcription. Transcription in cell organelles

Unit II: Post Transcriptional events

RNA processing in eukaryotes: modifications, splicing and splicing machinery, processing of RNA. Editing and amplification Translation in Prokaryotes and Eukaryotes

Codon assignments, Wobble hypothesis, initiation, elongation, and termination, Modification folding and transport protein Molecular chaperons in folding, Protein sorting and trafficking using signal proteins

Unit III: Translation and mobile DNA elements

DNA rearrangement, RNAi, regulation of translation. Post translational modification. Mobile DNA elements, Transposable elements in bacteria,

Controlling elements in Tn A and Tn 10 transposition. SINES and LINES, retrotransposons

Unit IV Genomics and Proteomics: an overview

Omics and omics, Concepts and applications Genome overview at the level of Chromosome (with model organisms as example); Strategies for large scale DNA sequencing- Whole genome analysis techniques, Next generation sequencing methods; Organization, structure and mapping of genomes (with model organisms as example)

Reference Books

1. Genes XI, 11th edition (2012), Benjamin Lewin, Publisher - Jones and Barlett Inc. USA
2. Molecular Biology of the Gene, 6th Edition (2008), James D. Watson, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA
3. Molecular Biology, 5th Edition (2011), Weaver R., McGraw Hill Science. USA
4. Fundamentals of Molecular Biology, (2009), Pal J.K. and Saroj Ghaskadbi, Oxford University Press. India
5. Molecular Biology: genes to proteins, 4th edition (2011), Burton E Tropp Jones & Bartlett Learning, USA
6. Discovering genomics, Proteomics and Bioinformatics (2006) A. Malcolm Campbell, Laurie J. Heyer Benjamin Cummings; 2nd edition

PSBT 104 Biochemical and Biophysical techniques (4 credits 1 lecture / week)

Unit I Microscopic techniques:

AFM, Fluorescence Microscopy, Confocal microscopy, cryotomy scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze- fracture methods for EM, image processing methods in microscopy, single cell imaging. Environmental SEM, and its advantages

Unit II: Spectroscopy

Introduction, principle and analysis using UV/visible Spectrophotometer, fluorescence spectroscopy, circular dichroism, ORD, NMR and ESR spectroscopy, Molecular structure determination using X-ray diffraction, X ray crystallography and NMR, Molecular analysis using light scattering, mass spectrometry and LC-MS, GC-MS, and surface plasma resonance methods, IR.

Unit III: Chromatography and Radioisotopy

Introduction, principle and analysis using HPTLC, HPLC, GLC, Affinity chromatography and its types IEF and 2 D electrophoresis. Applications of the above techniques. Radioisotopes techniques- Radio assay (nature of radioactivity, units, decay, half-life, detection/measurement), scintillation counting, safety aspects and applications of radioisotopes.

Unit IV: Histochemical and Immunotechniques

Antibody generation, blotting techniques, Immuno - precipitation, Flow cytometry and immunofluorescence, detection of antigens in living cells, *in situ* localization by techniques such as FISH and

Reference Books

1. Principles and Techniques of Biochemistry and Molecular Biology, 7th edition Wilson K.M., Walker J.M., Cambridge University Press, UK (2010),
2. Biochemical spectroscopy. Vol 46 of Methods in Enzymology. (1995) Kenneth Sauer. Academic Press, USA
3. Modern experimental biochemistry 3rd edition Publisher, USA.edition. (2000) Rodney Boyer. Prentice Hall
4. Analytical Biochemistry, 3 edition, (1998), David Holmes, H.Peck , Prentice Hall, UK.

Reference Books

PSBT101

2 Credits

1. Isolation of starch from potato and its estimation by Anthrone method.
2. Preparation of haemoglobin from blood.
3. Phosphorolysis of glycogen in the muscular tissue.
4. The isolation and assay of glycogen from liver and skeletal muscles of bird / mammal.
5. Estimation of Vitamin C from fruits.
6. Estimation of Creatinine in blood / urine. Estimation of urate/creatinine ratio to diagnose Lesch-Nyhan syndrome.
7. Chemistry of thinking:
 - a. Study of different regions of brain using models.
 - b. Stroop test and blind spot test.
 - c. Color blindness and optical illusions

Reference:

1. Biochemical Methods for Agricultural Sciences - Sadasivam and Manikam. Wiley Eastern Limited, 1992..
2. Practical Clinical Biochemistry Harold Varley, CBS; 6 edition (1 December 2006)
3. An Introduction to Practical Biochemistry (3rd Edition) - David T Plummer. Tata McGraw-Hill Publishing Company Limited, 1992.

PSBT 102 Immunology:

2 credits

1. Preparation of TAB or any other vaccine.
2. Antigen antibody reactions: one of each type: precipitation (VDRL setup in tube or gels), WIDAL.
3. Quantification of antigen using Single Radial Immuno-Diffusion.
4. Double Immuno-diffusion.
5. Immuno-diffusion and immune-electrophoresis (electrophoresis of serum and then reaction with anti-whole human serum antiserum).
6. Serum electrophoresis.

Reference:

1. Practical immunology, Frank Hay, 4th Edition , Blackwell Science
2. Medical Microbiology, Anantnarayan
3. Introduction to Practical Biochemistry, D.T. Plummer, Tata MacGraw Hill
4. A Handbook of Practical Immunology - G P Talkwar
5. Text Book of Medical Biochemistry, Praful Godkar. Bahalani

PSBT 102 Immunology:

2 credits

Publishers.

PSBT 103 Molecular Biology:

2 credits

1. Extraction of genomic DNA from bacteria and blood
2. Perform transformation of bacteria.
3. Expression of recombinant protein
4. Problems on RE digests / RFLP; Demonstration of ligation reaction.
5. Conjugation
6. Induction of Galactosidase in *E. coli* (and effect of inducers).

Reference: Molecular Cloning a laboratory manual. Sambrook and Russel

References :
PSBT 104 Biochemical and Biophysical techniques: 2 credits

1. Extraction of pigments from biological sources - plants and/or microorganisms and study of their absorption spectrum in visible light.
2. Verification of Beer lamberts law and calculation of molar extinction coefficient of a coloured chemical compound of known molecular weight.
3. Use of UV spectrophotometry to determine the concentration of protein.
4. Demonstration and interpretation of NMR, HPLC, GC read-outs.
5. Separation of sugars in coconut water using TLC
6. Use of affinity chromatography for purification of antibodies from serum.
7. Visit to a facility housing EM and other analytical tools

1. An Introduction to Practical Biochemistry (3rd Edition) - David T Plummer. Tata McGraw-Hill Publishing Company Limited, 1992.
2. Principles and techniques in biochemistry, Wilson and Walker

UNIVERSITY OF MUMBAI



SYLLABUS FOR SEMESTER II

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2016-17

PSBT 201 Metabolism:

4 credits (1 lecture/ week)

Unit 1 Carbohydrate and lipid metabolism

HMP and gamma amino butyrate shunt, glycogenesis and glycogenolysis. Control of glycogen metabolism: Allosteric control, covalent modification of enzymes by cyclic cascades, maintenance of blood glucose levels. Uronic acid pathway.

Lipid metabolism: Biosynthesis of fatty acids (saturated, monounsaturated, polyunsaturated), triglycerides and phospholipids. FAS Complex, regulation of fatty acid metabolism.

Unit II Physiological biochemistry

Regulation of acid-base balance, types and functions of acid-base buffers, respiratory mechanism of acid-base balance, renal control of acid base balance, clinical abnormalities associated with acid base imbalance. Water and electrolyte balance, clinical abnormalities. Mineral metabolism: Dietary macro elements- Calcium, Phosphorus, Iron, Magnesium. Trace elements- Iron, Iodine, Zinc, Copper.

Unit III Stress metabolism in plants

Environmental stresses, salinity, water stress, heat, chilling, anaerobiosis, and heavy metals, and their impact on plant growth and

metabolism, criteria of stress tolerance. Secondary metabolites in plants- Nature, distribution and their role in plant protection.

Unit IV Plant and microbial metabolism

Hatch slack pathway, Crassulacean acid metabolism, photorespiration and glyoxylate pathway with significance. Photosynthetic formation of hydrogen. Nitrogen fixation and role of nitrogenase, anammox reactions. Plant symbiosis with fungi: Arbuscular, mycorrhiza, Ectomycorrhiza

References:

1. Biochemistry, L Stryer, Freeman and Co, NY
2. Biochemistry, Zubay, Addison Wesley and Co.
3. Textbook of Physiology, Guyton
4. Physiology, Berne and Levy
5. Harper's Biochemistry- 27th edition
6. Text book of Human Biochemistry- Ed. G. P. Talwar

8. Essentials of food and nutrition M Swaminathan Vol. II, Applied aspects (1974), Ganesh Pub, Madras
9. Human biochemistry - James Orten and Otto Neuhaus, 10th ed , CV Mosby co London
10. Human nutrition and dietetics-Davidson and Passmore
11. Plant physiology, Salisbury and Ross (2007) CBS publishers and distributors
12. Biochemistry and Physiology of Plant Hormones, Thomas Moore, Springer Verlag New York
13. Plant Biochemistry- Hans Walter Heldt, 3rd Edition, Elsevier Academic Press
14. Introduction to Plant Biochemistry- T.W. Goodwin and E.L. Mercer
15. Plant Physiology- Devlin, CBS Publishers
16. Plant Biochemistry- Dey, Academic Press, 1999

PSBT 202: Immunology

Unit I. Immunological diseases

Autoimmunity mechanisms, altered antigens, Systemic Lupus erythematosus, Graves diseases, Rheumatoid arthritis, Myasthenia Gravis, Multiple sclerosis, animal models of autoimmunity Transplantation immunology, GvH, Immunodeficiency: phagocytic, humoral, CMI, combined HLA association with disease.

Unit II: Molecular immunology and animal models

Animal models and transgenic animals and their use in immunological studies, Routes of Inoculation, Antibody engineering, Chimeric antibodies, Phage display.

Unit III: CMI and imaging

Cell Cytotoxicity, mixed lymphocyte reaction, Apoptosis, Cytokine expression; Cell cloning, Reporter Assays, *In-situ* gene expression techniques; Cell imaging Techniques- *In vitro* and *In vivo*; Immuno-electron microscopy; *In vivo* cell tracking techniques; Microarrays

Unit IV: Cancer Immunology and Psychoneuroimmunology

Types of cancer, malignant transformation of cells, tumour antigens, immune response to cancer, immunotherapy. Connections of CNS to immune system and *visé versa*. Psychological modulation of immunity, stress and immunity, implication for diseases, functional significance - inflammation and acute phase response, role of glucocorticoids, stress response, energy demand and balance,

References:

1. Immunology 5th ed Janis Kuby
2. Fundamental Immunology 5th edition (August 2003): by William E., Md. Paul (Editor) By Lippincott Williams & Wilkins Publishers
3. Essential Immunology, Ivan M. Roit (1994) Blackwell Scientific Pub, Oxford.
4. Cellular and Molecular Immunology, 3rd edition, Abbas.
5. Psychoneuroimmunology, Stress, and Infection, By Herman
6. Friedman, Thomas W. Klein, Andrea L. Friedman, CRC Press, 1996

PSBT 203: Bioprocess technology

Unit I: Concepts of basic mode of fermentation processes

Strain improvement for increased yield and other desirable characteristics; Upstream processing: Media formulation, Sterilization. Bioreactor designs; classification of fermenters; Batch, fed batch and continuous; Conventional fermentation v/s biotransformation; Solid substrate, surface and submerged fermentation; Fermenter design- mechanically agitated; Pneumatic and hydrodynamic fermenters; Large scale animal and plant cell cultivation; Aeration and agitation in bioprocess; Measurement and control of bioprocess parameters.

Unit II: Downstream processing

Bio separation - filtration, centrifugation, sedimentation, flocculation; Cell disruption; Liquid-liquid extraction; Purification by chromatographic techniques; Reverse osmosis and ultra-filtration; Drying; Crystallization; Storage and packaging; Treatment of effluent and its disposal.

Unit III: Applications of enzymes in food processing

References

Mechanism of enzyme function and reactions in process techniques;
Enzymic bioconversions e.g. starch and sugar conversion processes;
High-Fructose Corn Syrup; Interesterified fat; Hydrolyzed protein etc.
and their downstream processing; baking by amylases, deoxygenation
and desugaring by glucoses oxidase, beer mashing and chill proofing;
cheese making by proteases and various other enzyme catalytic
actions in food processing.

Unit IV: Applications of Microbes in food process operations and production

Fermented foods and beverages; Food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; Microbes and their use in pickling, producing colours and flavours, alcoholic beverages and acids; Process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; Bacteriocins from lactic acid bacteria - Production and applications in food preservation.

1. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.
2. Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engelwood Cliffs, 2002.
3. Stanbury RF and Whitaker A., Principles of Fermentation Technology, Pergamon press, Oxford, 1997.
4. Baily JE and Ollis DF., Biochemical Engineering fundamentals, 2nd Edition, McGraw-Hill Book Co., New York, 1986.
5. Aiba S, Humphrey AE and Millis NF, Biochemical Engineering, 2nd Edition, University of Tokyo press, Tokyo, 1973.
6. Comprehensive Biotechnology: The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine, Vol 1, 2, 3 and 4. Young M.M., Reed Elsevier India Private Ltd, India, 2004.
7. El-Mansi, Bryle CFA. Fermentation Microbiology and Biotechnology, 2nd Edition, Taylor & Francis Ltd, UK, 2007.

PSBT 204 IPR & Biosafety

Unit I: Introduction to Intellectual Property

Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP

Biotechnology & the law: objective, evolution, basic structure of gene techniques, applications, commercial potential of biotech inventions, rationale for IPR protection.

Unit II Concept of 'prior art'

Patenting biotech inventions: objectives, concept of novelty, concept of inventive step, microorganisms, and moral issues in patenting biotech inventions; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, EPO, India etc.); Analysis and report formation

Unit III: Patent filing and Infringement.

Patent application- forms and guidelines, fee structure, time frames;

Types of patent applications: provisional and complete specifications;

PCT and convention patent applications; International

patenting-requirement, procedures and costs; Financial assistance for

patenting-introduction to existing schemes; Publication of patents-

gazette of India, status in Europe and US

Patenting by research students, lecturers and scientists-

University/organizational rules in India and abroad, credit sharing by

workers, financial incentives

Patent infringement- meaning, scope, litigation, case studies and

examples

Unit IV Biosafety

Historical Background; Introduction to Biological Safety Cabinets;

Primary Containment for Biohazards; Biosafety Levels of Specific

Microorganisms; Recommended Biosafety Levels for Infectious

Agents and Infected Animals; Biosafety guidelines Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk Management and communication.

<http://www.w3.org/IPR/http://www.wipo.int/portal/index.html.en>

http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html

www.patentoffice.nic.in/www.iprlawindia.org/ - 31k - Cached -

Similar page <http://www.cbd.int/biosafety/background.shtml>

<http://www.cdc.gov/OD/ohs/symp5/jyrtxt.htm>

<http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html>

PSBT 201 Metabolism :

1. Estimation of Niacin by the CNBr method.
2. Isolation of cholesterol and lecithin from egg yolks.
3. Effect of different types on stresses on plant growth using an appropriate plant model system.
Stresses: Salinity, water stress, temperature stress (heat / cold), heavy and metal stress. Appropriate controls to be used and data analysed using appropriate software for analysis.
4. Isolation of Rhizobia from root nodules of leguminous plants.
5. Estimation of leghaemoglobin.
6. Proline estimation in germinated seeds with and without stress.
7. Estimation of phospholipids.
8. Assay of superoxide dismutase in salt stressed and normal plant.
9. Estimation of $\text{Ca}^{++} / \text{Zn}^{++}$ by EDTA titrimetric method.

PSBT 202: Immunology

1. *In-vitro* demonstration of phagocytosis and calculating phagocytic index.
2. Demonstration of HLA typing.

6.Video demonstration or field visit

3. Latex bead agglutination / precipitation test for detection of rheumatoid factor (RF).

4. Separation of lymphocytes on Ficoll-Histopaque, viability count and separation of B and T lymphocytes using Fenwall wool.

5. Assay for plaque forming cells.

a. Raising antibodies in laboratory animals

b. Cell imaging Techniques- *In vitro* and *In vivo*; Immuno-electron microscopy; *In vivo* cell tracking techniques; Microarrays.

PSBT 203: Bioprocess technology

1. Demonstration of: Plackett-Burman design for formulation of fermentation media.

2. Pigment production and isolation from a microbial source (yeast, fungi or bacteria)

3. Physico-chemical characterization of an industrial effluents.

4. Detection of different food enzymes by simple tests (amylase, catalase, invertase, papain, pectinase, pepsin).

Reference : <http://www.ableweb.org/volumes/vol-6/10-miller.pdf>

5. Study of pickling process (sauerkraut / pickled cucumbers) with respect to physical, chemical / biochemical and biological changes occurring during the pickling process.

6. Video demonstration or field visit
PSBT 204 IPR & Biosafety

1. Study of a patent and developing a hypothetical patent application for a hypothetical product / process. (To be submit for exam)
2. Writing of SOP for 3-4 laboratory equipment's / instruments.
3. Use of Microsoft PowerPoint / Corel Draw to prepare a poster (ideally on a topic to be pursued for Sem IV project, otherwise to prepare a poster on a paper from peer-reviewed journal no more than 5 years old - to be brought for practical exam and if possible presented as in a poster presentation at a conference)
4. Compilation of information on recommended biosafety practices in a biotechnology laboratory (demonstration by field visit or video)