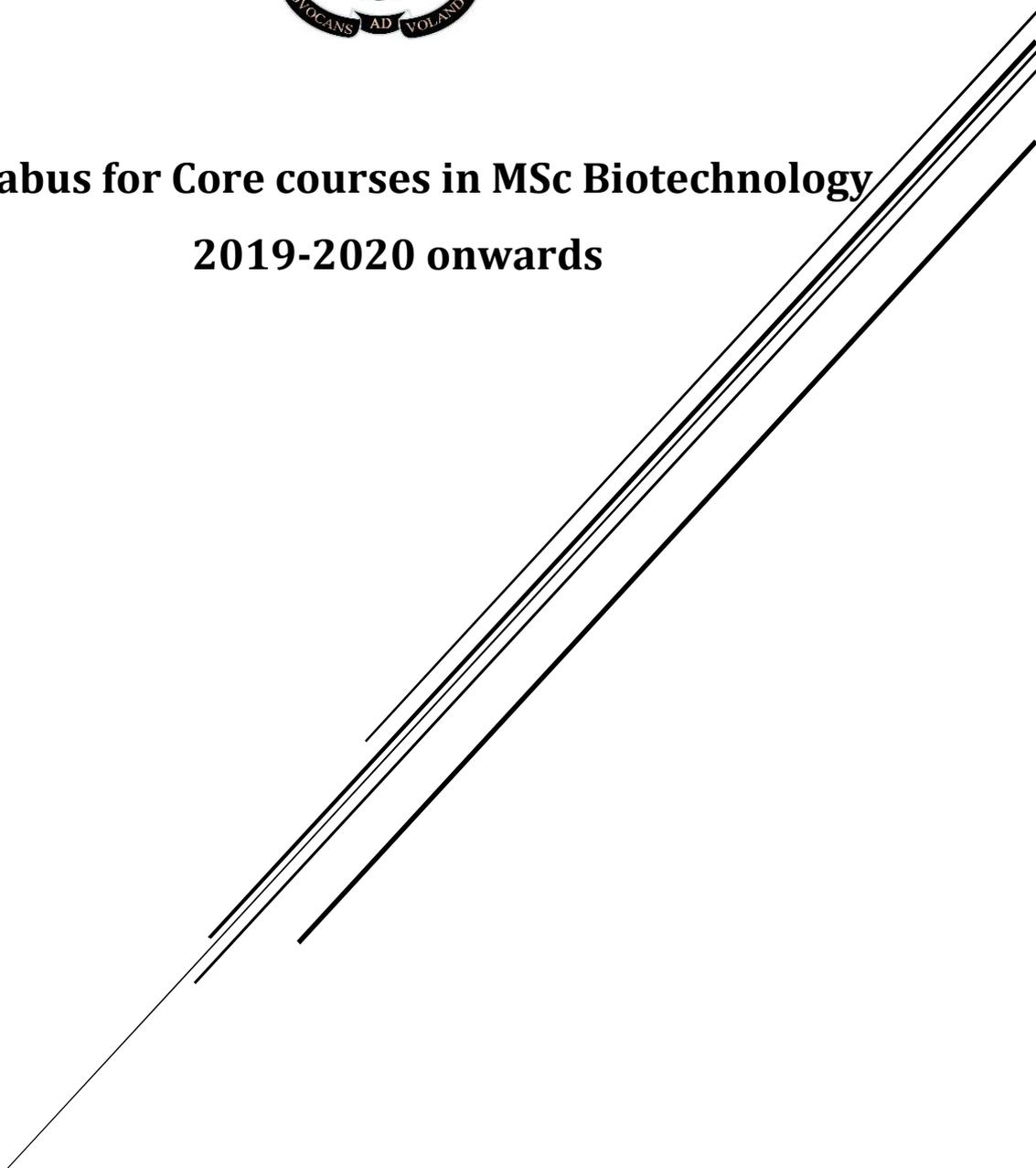


**ST XAVIER'S COLLEGE (AUTONOMOUS), MUMBAI
POST GRADUATE DEPARTMENT OF BIOTECHNOLOGY**



**Syllabus for Core courses in MSc Biotechnology
2019-2020 onwards**





ST. XAVIER'S COLLEGE – AUTONOMOUS, MUMBAI

SYLLABUS

FOR SEMESTER I COURSES IN BIOTECHNOLOGY

(JUNE 2019 ONWARDS)

Contents

Syllabus for the following courses:

THEORY COURSES

SBTS0701	BIOMOLECULES
SBTS0702	IMMUNOLOGY
SBTS0703	GENETICS
SBTS0704	CELLULAR PROCESSES

PRACTICAL COURSE

SBTS07PR	TECHNIQUES IN BIOTECHNOLOGY AND SCIENTIFIC COMMUNICATION SKILLS
----------	---

SUBJECT (THEORY): BIOTECHNOLOGY

CLASS: SEMESTER I COURSE CODE: SBTS0701 TITLE: BIOMOLECULES

NO OF HOURS: 60 (inclusive of self-study)

CREDITS: 4

COURSE OBJECTIVES:

The objective is to build upon the base knowledge level regarding biomolecules. The course will emphasise upon the structural features and intermolecular interactions. The course will also introduce the students to recent trends in the understanding of biomolecular structure and interactions.

UNIT 1: PROTEIN STRUCTURE AND FOLDING

15 lectures

- Primary structure of proteins and their determination – end group analysis; cleavage of disulphide bond; separation, characterization of polypeptide chain; specific peptide cleavage reactions
- Secondary structure – Ramachandran plot, helical structure, beta structure
- Tertiary structure- fibrous (Collagen) and globular (Myoglobin) structure, Protein stability,
- Quaternary structure – (Haemoglobin) subunit interaction, symmetry, subunit composition determination
- Protein folding: The different pathways of protein folding and its co-relation with protein stability, Molecular chaperons
- Effects of misfolding protein on human diseases; unfolded protein response

UNIT 2: PROTEIN PURIFICATION AND DENATURATION

15 lectures

- Protein purification:
 - Separation by Precipitation, protein quantification
 - Non-affinity absorption techniques – IXC, Hydroxyapatite chromatography, HIC;
 - Affinity procedures for purifying proteins - Affinity chromatography, Dye ligand, IMAC
 - Non-absorption techniques for purifying proteins- Size exclusion chromatography
 - Monitoring the purity of protein solutions- Electrophoresis of proteins, PAGE, SDS PAGE
- Protein denaturation – temperature, pH-dependent, pressure induced, pressure induced and chemical denaturation, adaptation of Proteins to extreme Environments.

UNIT 3: DNA TOPOLOGY

15 lectures

- Different forms of DNA, - A/B/C/Z and RL form of double helical DNA, Triple Helix
- Nucleic acid binding protein – Leucine Zipper, Zinc fingers
- OB-fold, Beta Barrel, Helix-turn-helix, Helix-loop-helix
- Linking number, Supercoiling, Topoisomerases
- DNA Packaging: Nucleosomes and Chromatin
- DNA – protein interaction
- Methods to study DNA – protein interaction

UNIT 4: MEMBRANE ARCHITECTURE

15 lectures

- Membrane Structure and dynamics
 - Composition and Architecture of membrane: lipid types and the lipid bilayer, membrane proteins (integral and peripheral), conformation of membrane proteins, the association of membrane proteins in the lipid bilayer, Hydropathy index
 - Dynamics- lipid movements, flippase, FRAP, Lipid raft, Membrane fusion.
 - Lipid-Protein interactions
 - Liposomes
- Solubilisation of the membrane by using different detergents- Structure and behaviour of detergents, Detergents, and biological membranes

References:

- Amit Kessel and Ner Ben Tal, Introduction to proteins (2011), CRC Press, Taylor & Francis Group
- David E. Metzler, Biochemistry, The chemical reactions of living cells, Volume I and II., Elsevier, 2003
- Donald Voet and Judith Voet. Biochemistry 3rd Ed, John Wiley and sons, Inc publisher, 2004
- J. Berg, J. Tymoczko & L. Stryer, Biochemistry, 5thEd, W. H. Freeman & Company publisher, 2002
- Nelson and Cox, Lehninger's Principles of Biochemistry, fourth edition, Macmillan Worth Publisher, 2004
- Robert K. Scopes, Protein Purification, Springer Science, 1982,
- Philip L. R. Bonner, Protein Purification, Taylor & Francis Group, 2007
- Arthur M Lesk,(1998) Introduction to Protein Science Architecture, Function and Genomics, Oxford publishers.

ASSESSMENT:

Continuous Internal Assessment (CIA) = 40%

End Semester Assessment (ESE) = 60%

SUBJECT (THEORY): BIOTECHNOLOGY

CLASS: SEMESTER I COURSE CODE: SBTS0702 TITLE: IMMUNOLOGY

NO OF HOURS: 60 (inclusive of self-study)

CREDITS: 4

COURSE OBJECTIVES:

The objective is to learn about structural features of components of the immune system as well as their function. The core emphasis will be on the development of the immune system and mechanisms by which the human body elicits an immune response. The course will also introduce the students to recent trends in the field towards diagnostics and therapy.

UNIT 1: OVERVIEW OF THE IMMUNE SYSTEM

15 lectures

- Haematopoiesis
- Innate immunity: Cells involved, signal transduction pathways, soluble molecules and membrane-associated receptors (Pattern recognition, TLRs, NLRs), Phagocytosis
- Antigens: immunogens, haptens
- Immunoglobulin:
 - fine structure and superfamily
 - Multigene organization of Ig gene, Variable region gene rearrangement and generation of antibody diversity, Class switching among the constant region
- Synthesis, assembly, and secretion of Immunoglobulins

UNIT 2: IMMUNE EFFECTOR MECHANISMS

15 lectures

- MHC and Regulation of Immune Response:
 - Cellular distribution of MHC molecule
 - Antigen processing and presentation
 - Self - MHC restriction of T cells
 - Presentation of non-peptide antigens
- Activation of B and T lymphocytes
- Complement system: Functions of Complement, Components, Activation, and Regulation.
- Cytokines: Properties, Receptors, Antagonists, Diseases, Therapeutic use of cytokines
- The inflammatory process: the role of neutrophils and other mediators in inflammation, the role of NF-kb and STATs in inflammation, localised, systemic and chronic inflammation and role of anti-inflammatory agents
- Autophagy

UNIT 3: CLINICAL IMMUNOLOGY

15 lectures

- Hypersensitivity: Type I, II, III, IV hypersensitivity
- Autoimmunity: Organ-specific, systemic, mechanism, treatment
- Tolerance
- Transplantation immunology: Basis of Graft rejection, clinical manifestation of graft rejection, Immune tolerance, Immunosuppressive therapy, and clinical transplantation

- Tumour immunology: tumours of the immune system, Tumour antigens and tumour evasion of the immune system
- Immune response to infectious agents: Bacteria, Virus, Parasites, and Fungi
- Primary and secondary immunodeficiency

UNIT 4 ADVANCES IN IMMUNOLOGY

15 lectures

- Vaccines: Vaccination and immune response; Adjuvants in Vaccination; Modulation of immune responses: Induction of Th1 and Th2 responses by using appropriate adjuvants and antigen delivery systems - Microbial adjuvants, Role of soluble mediators in vaccination; Oral immunization and Mucosal Immunity, Active and passive immunization; live, killed, attenuated, subunit vaccines; recombinant DNA and protein based vaccines, peptide vaccines, conjugate vaccines; dendritic cell based vaccines, vaccine against cancer, T cell based vaccine, Disease specific vaccine design: Tuberculosis Vaccine; Malaria Vaccine; HIV/AIDS vaccine; New emerging diseases and vaccine needs (eg Ebola, Zika).
- Immunotherapy for Clinical conditions
- Ag-Ab interaction assays for understanding immune biology, diagnostics, and therapeutics (ELISA, Flow cytometry, SPR, RIA, Immunoprecipitation, Immunofluorescence - cytochemistry, and histochemistry)

References:

- Abbas, Abul K. & Lichtman, Andrew H.: Cellular and molecular immunology. (5th Ed.) Philadelphia. W.B. Saunders Company, 2003. 0-7216-0008-5--(616.079ABB/LIC)
- Elgert, Klaus D.: Immunology: Understanding the immune system. (2nd edition) Hoboken. John Wiley & Sons, Inc., 2009. 978-0-470-08157-0--(616.079Elg)
- Kuby, Janis: Immunology. (7th ed.) New York. W.H. Freeman and Company, 2013. 978-1-4641-3784-6--(616.079Kub)
- Tizard, Ian R.: Immunology: an introduction. (4th Ed.) Singapore. Thomson Asia Pte Ltd., 2004. 981-243-516-6--(616.079TIZ)
- Janeway, Charles A., Jr.; Murphy, Kenneth & Weaver, Casey: Immunobiology. (9th ed.) New York. Garland Science, 2017. 978-0-8153-4551-0--(616.079Jan)
- Male, David; Brostoff, Jonathan; Roth, David B. & Roitt, Ivan M.: Immunology. (8th ed.) Amsterdam. Elsevier Ltd., 2013. 978-0-7020-4548-6--(616.079Roi)
- Recent trends – research articles.

ASSESSMENT:

Continuous Internal Assessment (CIA) = 40%

End Semester Assessment (ESE) = 60%

SUBJECT (THEORY): BIOTECHNOLOGY CLASS: SEMESTER I

COURSE CODE: SBTS0703

TITLE: GENETICS

NO OF HOURS: 60 (INCLUSIVE OF SELF-STUDY)

CREDITS: 4

COURSE OBJECTIVES:

The core objective is to provide in-depth insight on DNA synthesis and transfer of information from genes to RNA to protein. The course will also help in developing an understanding of regulatory mechanisms governing genome activity. An overview of eukaryotic genetics will be also be included in the course.

UNIT 1: DNA REPLICATION, REPAIR, AND RECOMBINATION 15 Lectures

- DNA Replication (prokaryotes and eukaryotes) and mutations involved.
- DNA Repair mechanisms
- DNA recombination mechanisms

UNIT 2: TRANSCRIPTION AND TRANSLATION IN PROKARYOTES AND EUKARYOTES 15 Lectures

- DNA-Protein interactions during Transcription Initiation and regulation of transcription initiation
- Synthesis of eukaryotic mRNAs by RNA polymerase II, Intron splicing, Processing of Pre-RNA, Degradation of mRNAs
- Synthesis and processing of Non-coding RNAs: Transcript elongation and termination by RNA polymerases I and III, Introns in eukaryotic pre-rRNA and pre-tRN
- Basic mechanisms of RNA to Protein conversion
- Post-translational Processing
- Processing by proteolytic cleavage
- Processing by chemical modification
- Protein Degradation

UNIT3: REGULATION OF GENE EXPRESSION 15 Lectures

- Regulation in prokaryotes- operons, riboswitches, antisense RNA
- Eukaryotes:
 - Genome rearrangements, Gene silencing by modification of histones and DNA
 - Transcriptional activators, Co-activators & repressors, enhancers and insulators
 - Regulation of Genome Activity during Development: Vulva development in *Caenorhabditis elegans* and Development in *Drosophila melanogaster*
 - Regulation through RNA interference
 - Concept of Epigenetics

UNIT 4: EUKARYOTIC GENETICS 15 lectures

- Yeast genetics: Meiotic crosses, tetrad analyses, non-Mendelian and Mendelian ratios, gene conversion, models of genetic recombination, yeast mating type switch; dominant and

recessive genes/mutations, suppressor or modifier screens, complementation groups, transposon mutagenesis, synthetic lethality, genetic epistasis.

- Drosophila genetics: Monohybrid & dihybrid crosses, back-crosses, test-crosses, analyses of autosomal and sex linkages, screening of mutations based on phenotypes and mapping the same, hypomorphy, genetic mosaics, genetic epistasis in context of developmental mechanism
- Transmission genetics: single gene inheritance, beyond Mendel's law, genetics of immunity: blood grouping

References:

- Griffiths, Anthony J.F., Wessler, Susan R., Lewontin, Richard C. & Gelbart, William M.: An introduction to genetic analysis. (8th Ed.) New York. W.H. Freeman and Company, 2005. 0-7167-4939-4--(575.1GRI)
- Lodish, Harvey F.; Berk, Arnold; Kaiser, Chris A. & Krieger, Monty: Molecular cell biology. (7th ed.) New York. W.H. Freeman and Company, 2013. 978-1-4641-0981-2--(574.87Lod)
- Snustad, D. Peter & Simmons, Michael J.: Principles of genetics. (5th ed.) Hoboken. John Wiley & Sons, Inc., 2010. 0-470-39842-5--(575.1Snu/Sim)
- Brown, T.A.: Genomes 3. New York. Garland Science Publishing, 2007. 0-8153-4138-5--(575.1Bro)
- Watson, James D., Baker, Tania A., Bell, Stephen P. & Gann, Alexander: Molecular biology of the gene. (6thed.) New York. Pearson Education Inc., 2008. 0-321-50781-9--(574.88Wat)
- Alberts, Bruce, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, and Peter Walter: Molecular Biology of the cell (6th Ed) Garland Science Publishing., 2015
- Lewis (2010) – Human genetics: concepts and applications, 9th Ed, Tata McGraw- Hill Publishing

ASSESSMENT:

Continuous Internal Assessment (CIA) = 40%

End Semester Assessment (ESE) = 60%

SUBJECT (THEORY): BIOTECHNOLOGY

CLASS: SEMESTER I

COURSE CODE: SBTS0704

TITLE: CELLULAR PROCESSES

NO OF HOURS: 60 (INCLUSIVE OF SELF - STUDY)

CREDITS: 4

COURSE OBJECTIVES:

The objective is to learn about the basic principles and mechanisms involved in cellular transport and communications. The course will also emphasise on understanding the molecular mechanism of the cell cycle and molecular basis of cancer development.

UNIT 1: MEMBRANE STUDIES

15 Lectures

- Membrane functions
- Membrane transport: facilitated diffusion (Glut 1) and Primary and Secondary active transport (P, F, ABC, symporter and antiporter)
- Intracellular membrane transport: Transport of molecules between nucleus and cytosol, Endoplasmic reticulum
- Transport across mitochondria and chloroplast
- Transport related to nutrient uptake.

UNIT 2: BIOSIGNALING

15 Lectures

- Cell signalling pathways that control gene activity-
 - TGF-Beta and activation of Smads, regulation of TGF-Beta by negative feedback loops, cancer and loss of TGF-Beta signalling
 - Activation of gene transcription by seven-spanning cell surface receptors: Wnt and Hedgehog
 - Notch, NF- κ b signalling
- Sensory transduction in vision, olfaction, and gustation

UNIT 3: NEURONAL COMMUNICATION

15 Lectures

- Organization of brain, Anatomy, and functions of a neuron, Ion conducting channels
- Neuronal pathways and Propagation of nerve impulse: Synapses and gap junction, synaptic transmission, Neuromuscular junction: Physiologic anatomy, molecular biology of acetylcholine formation and release, Drugs enhancing and blocking the transmission at NMJ, Myasthenia Gravis
- Neurotoxins, Neurotransmitters

UNIT 4: CELL CYCLE AND CANCER BIOLOGY

15 Lectures

- Cell cycle phases, Control of mitosis by cyclins, MPF activity and cyclin-dependent kinases, checkpoints in cell cycle regulation
- Apoptosis pathways, its regulation, and techniques to study apoptosis

- Cancer-
 - genetic basis (oncogenes, tumor suppressor genes)
 - Signalling pathways involved (overview)
 - Senescence, telomeres, carcinogens
 - Tumorigenesis, Tumor progression, metastasis
 - EMT

References:

- Karl Branden and John Tooze, introduction to Protein structure, 2nded, garland publishers, 1999.
- Lodish, Harvey F.; Berk, Arnold; Kaiser, Chris A. & Krieger, Monty: Molecular cell biology. (7th ed.) New York. W.H. Freeman and Company, 2013. 978-1-4641-0981-2--(574.87Lod)
- Mathews, Christopher K.; van Holde, K.E. & Ahern, Kevin G.: Biochemistry. (3rd Ed. Indian reprint) Delhi. Pearson Education (Singapore) Pte. Ltd., 2003. 81-297-0215-0--(574.192MAT)
- Watson, James D., Baker, Tania A., Bell, Stephen P. & Gann, Alexander: Molecular biology of the gene. (6th ed.) New York. Pearson Education Inc., 2008. 0-321-50781-9--(574.88Wat)
- Alberts, Bruce, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts and Peter Walter: Molecular Biology of the cell (6th Ed) Garland Science Publishing., 2015
- David E. Metzler, Biochemistry, The chemical reactions of living cells, Volume I and II., Elsevier, 2003
- Robert A. Weinberg: The Biology of Cancer, 2nd Edition
- John E. Hall, Guyton and Hall Textbook of Medical Physiology (13th Edition)
- Devlin, Thomas M.: Textbook of biochemistry with clinical correlations. [ed. by] (7th ed.) Hoboken. John Wiley & Sons, Inc., 2011. 978-0-470-28173-4--(612.015Dev)

ASSESSMENT:

Continuous Internal Assessment (CIA) = 40%

End Semester Assessment (ESE) = 60%

SUBJECT (PRACTICALS): BIOTECHNOLOGY

CLASS: SEMESTER I

COURSE CODE: MSBTS07PR

TITLE: TECHNIQUES IN BIOTECHNOLOGY AND SCIENTIFIC COMMUNICATION SKILLS

CREDITS: 8

COURSE OBJECTIVES: The course is designed to teach students the utility of a set of experimental methods in biotechnology in a problem-oriented manner. This course will introduce the students to basic laboratory skills, good laboratory practices and different techniques commonly used in biotechnology experimentation. It will also orient students to learn the basic techniques of separation, quantification, purification, and characterisation of proteins and study the theoretical aspects of proteins and nucleotides using computational tools.

COURSE CODE: MSBTS07PR

Techniques in Biotechnology and Scientific communication Skills

Contents:

1. Introduction to good laboratory practices
2. Laboratory techniques and quality assurances
 - Preparation of solutions and buffers
 - Calibration of instruments: pHmeter, analytical balance, UV-spectrophotometer, colorimeter
 - Calibration of apparatus used for measuring: glass pipettes, auto pipettes and measuring cylinders
 - Validation: Autoclave, Laminar air flow
 - Introduction to principles of Quality assurance and Quality control
3. Microbial techniques: Identification of microorganisms, Sterility testing
4. Nucleic Acid extraction techniques:
 - Extraction of Genomic DNA Extraction from Bacteria, Yeast, human samples (Cheek cells, Blood) and quantification of biomolecules using UV (nucleic acids and proteins)
 - Isolation of RNA from yeast/ E. coli
5. Immunological techniques:
 - Isoagglutination titre study
 - Single Radial Immunodiffusion
 - Dot-ELISA/ Antibody/ antigen capture ELISA
 - Western Blot Technique
6. Techniques in Protein Chemistry:
 - Protein Estimation using the following methods:
 - ✓ Biuret assay
 - ✓ Bradford's assay
 - ✓ Folin-Lowry assay
 - Protein Separation and Purification techniques:
 - ✓ Polyacrylamide gel electrophoresis (native and SDS)
 - ✓ Horizontal gel electrophoresis (Slide and Slab)
 - Protein gel staining techniques:
 - ✓ Coomassie brilliant blue, Silver staining, TCA and Ponceau staining

- ✓ Activity staining: LDH
- Protein Purification techniques:
 - ✓ Protein Precipitation
 - ✓ Ion exchange Chromatography
 - ✓ Gel filtration
 - ✓ Affinity Chromatography
 - ✓ Study of purified Immunoglobulins using SDS PAGE
- Viscosity studies of proteins
- 7. Introduction to computational tools in biology:
 - Retrieval of protein, nucleotide and protein structural data for analysis
 - Protein sequence analysis
 - Primary protein sequence analysis
 - Secondary sequence analysis
 - Tertiary structure analysis
- 8. Scientific communication:
 - Gathering scientific data from various sources.
 - Written communication: Guide to clear writing, forms and styles of writing
 - Scientific publication writing
 - Oral communication variants
 - Concept of Plagiarism

References:

1. Rodney Boyer, Biochemistry Laboratory (2nd Ed, 2012), Pearson's Publication
2. Sheppler J and Cassin P, Biotechnology explorations (2000), ASM Press
3. Segel, Irwin H.: Biochemical calculations: how to solve mathematical problems in general biochemistry. (2nd Ed.) Singapore. John Wiley & Sons (Asia) Pte. Ltd., 2004. 9812-53-149-1--(574.1920151SEG)
4. Wilson, Keith & Walker, John: Principles and techniques of biochemistry and molecular biology. [ed. by] (7th ed.) Cambridge. Cambridge University Press, 2010 (2013). 978-0-521-73167-6--(574.19285Wil/Wal)
5. Anthony Wilson, Handbook of Science Communication, IOP Publishing Ltd. CRC Press (1999)
6. Online resources
7. Relevant SOPs from USP and IP

Assessment:

CIA: 80M

ESE: 120M