

SYLLABUS FOR ONE-YEAR MASTER OF
SCIENCE (M.S.) IN BIOCHEMISTRY AND
MOLECULAR BIOLOGY
UNIVERSITY OF DHAKA

SESSION: 2016–2017 and onwards

The total number of earned credits for MS degree is 30, of which the number of credits on theory courses to be taken is 20, and for Thesis/Laboratory Work will be 6. 2 credits have been allocated for Seminar/Paper Presentation, while 2 credits have been earmarked for Viva-voce. Each 4-credit theory course will be of 100 marks comprising 60 lecture-hours, and 2-credit theory course will be of 50 marks comprising 30 lecture-hours. The students will choose 20 credits from the list of theory courses BMB-501 to BMB-510.

MS Courses

BMB-501	Advanced Molecular Biology	4 Credits
BMB-502	Bioinformatics	2 Credits
BMB-503	Drug Designing and Pharmacogenomics	4 Credits
BMB-504	Advanced Diagnostics and DNA Forensic Sciences	4 Credits
BMB-505	Agricultural Biochemistry	2 Credits
BMB-506	Environmental Biochemistry	2 Credits
BMB-507	Clinical Immunology and Immunodiagnostics	4 Credits
BMB-508	Applied Nutrition and Nutritional Biochemistry	4 credits
BMB-509	Biochemistry of Natural Products	2 Credits
BMB-510	Biotechnology Business Management	2 Credits
BMB-511	Laboratory Work (For Group A)	6 Credits
BMB-511	Thesis (For Group B)	6 Credits
BMB-512	Seminar / Paper Presentation	2 Credits
BMB-513	Viva-voce	2 Credits

BMB-501: Advanced Molecular Biology

4 Credits

- 1. Gene regulation by small RNAs:** Small RNAs and insights into a new level of gene regulation. Posttranscriptional gene silencing (PTGS) – RNA interference (RNAi) gene silencing; role of dsRNA in triggering PTGS / RNAi; formation of dsRNA; role of Dicer and RISC (RNA Induced Silencing Complex) in RNAi gene silencing system.

RNA silencing as a tool for knocking down genes and to counter foreign sequences.

Micro-RNA structure, synthesis, mechanism of action, regulation of gene expression and role in diseases.

Application of epigenetic in chromosome inheritance and human diseases.

- 2. Genomics:** Human Genome Project - brief mention of others. Physical mapping and sequencing of the genome; sequence analysis and annotations; linkage analysis; physical map-based cloning and mapping in silico; comparative homologies, evolutionary changes and single nucleotide polymorphism.

DNA microarray, preparation of microarray slides, hybridization, interpretation and application.

- 3. Proteomics:** Area and scope, experimental approaches to proteomics: “classical proteomics” - 2-D gel electrophoresis; Mass spectrometry; functional characterization of proteins: differential display, phage display, use of GFP to visualize proteins in live tissues. Human proteomics initiative: annotation of all human proteins in SWISSPROT and beyond. Role of proteomics in disease.

Books and References:

1. Genetics - A Conceptual Approach
Benjamin A Pierce
2. RNAi - A Guide to Gene Silencing
Gregory J. Hannon
3. RNA Interference in Practice: Principle, Basics and Methods for Gene Silencing in *C. elegans*, *Drosophila* and Mammals
Ute Schepers
4. Discovering Genomics, Proteomics and Bioinformatics
A Malcolm Campbell and Laurie J Heyer

5. Introduction to Genomics, 2nd edition
Arthur M. Lesk
6. Introducing Proteomics: From Concepts to Sample Separation, Mass Spectrometry and Data Analysis
Josip Lovric
7. A First Course in Systems Biology, 1st edition
Eberhard Voit
8. Proteomics in Systems Biology
Jörg Reinders
9. Epigenetic Regulation and Epigenomics
Robert A. Meyers (Editor)

BMB-502: Bioinformatics

2 Credits

1. Introduction to bioinformatics database:

- a) Organization of the databases
- b) Accessing bioinformatics database
- c) Retrieval of desired data
- d) Types of Biological data
- e) Familiarization with databases (NCBI, ENSEMBL etc.)

2. Example and use of bioinformatics in molecular biology and biotechnology:

- a) BLAST - application and interpretation of BLAST program for homology searching
- b) Clustal W- application of multiple sequence alignment via clustal W program
- c) Codon optimization- codon usage pattern in different species, relative codon frequencies, codon usage bias, codon optimization for the synthesis of recombinant proteins.

3. Basic algorithms and their uses in bioinformatics:

Application of hidden Markov model (HMM) in designing various bioinformatics tools.

4. Evolutionary bioinformatics:

- a) Building and interpretation of Phylogenetic trees.
- b) Calculating substitution rate (Jukes Cantor model and Kimura's two parameter model).

- c) Construction of distance matrix from the pair-wise evolutionary distances.
- d) Non-synonymous vs synonymous substitution ratio (K_a/K_s) in Protein/Gene evolution.
- e) Identification of horizontally transferred genes in bacterial genomes.
- f) Use of Mega latest package for detail evolutionary analysis.
- g) Molecular Clock hypothesis.

5. Structural bioinformatics:

- a) Importance of the structures of biomolecules in biological functions.
- b) Analyzing RNA secondary structures: basic concept of stem loop RNA secondary structure, minimum free energy (MFE) calculation.
- c) Analyzing protein secondary and tertiary structures - concept of protein folding, prediction of protein 3-D structure via homology modelling and *de-novo* modelling, prediction of conserved domains via structure-function analysis.
- d) Identification of hydrophobic regions in proteins- concept of hydrophobicity index of amino acids, prediction of hydrophobic trans-membrane domain via sliding window algorithm.

6. Immunoinformatics:

- a) Basic mechanism of antigen presentation.
- b) Familiarization with immunoinformatics websites and tools.
- c) Identification of immunogenic epitopes by computational methods for designing vaccines.
- d) Identification of the proteasomal cleavage sites.
- e) Analysis of HLA-epitope interaction.

7. Analysis of microarray data:

- a) Microarray- basic principle.
- b) Gene chips.
- c) Handling processed microarray data.
- d) Clustering of genes based on their expression level.
- e) Pathway analysis and building gene/protein regulatory network.

8. Computational proteomics:

- a) Overview on LC-MS/MS.
- b) Peptide mass fingerprinting.
- c) Application of stable isotope labelling of amino acid in cell culture (SILAC) technology for quantitative proteomics.

Books and References:

1. Bioinformatics and Functional Genomics, 2nd edition
Jonathan Pevsner.
2. Bioinformatics For Dummies, 2nd Edition
Jean-Michel Claverie, Cedric Notredame
3. Genetics Databases
M. J. Bishop

BMB-503: Drug Designing and Pharmacogenomics

4 Credits

1. **Drug design:** Basic concepts; study of lead compounds: modification and identification, target validation; high throughput technologies. Molecular modeling, molecular docking and dynamics, physicochemical factors e.g. thermodynamic, electrostatic, and steric factors, molecular interaction and kinetics. Molecular method of drug design and development, screening of libraries of compounds, serendipitous observation; combinatorial chemistry in drug design.
2. **Biologic drug development and approval:** Pre-clinical and clinical trials - methodological and organizational considerations and the principle of trial conduct and reporting, sample size, delivery and assessment of clinical trials. Genetic basis of drug designing; personalized medicine (concept).
3. **Designing of selected drugs:** TB drugs, novel topoisomerase inhibitors, tyrosine kinase inhibitors, androgen receptor antagonists.
4. **Advanced drug delivery:** Basic principles, controlled and sustained release, polymer based drug carriers, lipid membrane based drug carriers, permeation enhancement, molecular approach of drug delivery.
5. **Drug transporters:** Drug transporters and drug response, transporter superfamilies, genetic variation in transporters, transporters and pharmacokinetics.
6. **Structure activity relationship of drugs:** Quantitative structure activity relationship (QSAR). Structure activity relationship of some selected drugs - sulfa drugs, antihistamine drugs, antidepressant drugs.
7. **Drug receptors:** Drug receptors and their characteristics. Non-receptor mediated drugs.
8. **Pharmacogenomics:** Pharmacogenetics as the future of drug therapy; genetic polymorphism of major drug metabolizing enzymes, allelic variation in drug metabolizing enzymes, pharmacological consequences of genetic polymorphism in the drug metabolizing enzymes, potential clinical applications of pharmacogenetics.
9. **Mechanism of action of some specialized drugs:** Chemotherapeutics, drugs affecting renal and cardiovascular functions, drug therapy for inflammation, drugs affecting gastrointestinal functions, chemotherapy for protozoal infections, chemotherapy for microbial infections, antiviral agents, anticancer drugs.

Books and References:

1. Gooman & Gillman's Pharmacological Basis of Therapeutics
Laurance Brunton, Bruce Chabner
2. Biotechnology and Pharmaceuticals - Transforming Proteins and Gene into Drugs
Rodney J.Y HO and Milo Gibaldi
3. Principles of Drug Action
Avran Gold stein, Lewis Aronew and Sumner M. Kalman

BMB-504: Advanced Diagnostics and DNA Forensic Sciences 4 Credits

1. Molecular diagnostics:

- a) Introduction to molecular diagnosis (MD) and molecular diagnostic laboratory, appropriate clinical specimen for MD.
- b) Isolation and characterization of DNA/RNA from different clinical specimens - basic principle of DNA extraction by organic method, chelex method, spin columns, magnetic beads etc.
- c) Overview of the application of molecular methods for diagnosis of genetic disorders, infectious diseases and cancer.
- d) PCR in molecular diagnostics - conventional PCR and real time PCR, qualitative and quantitative PCR, PCR-ELISA.
- e) Molecular diagnosis of viral disease - HBV, HCV, HCMV, HIV and HPV.
- f) Molecular diagnosis of bacterial disease - MTB and STDs.
- g) Molecular diagnosis of cancer - hematological cancer and solid cancer.
- h) Molecular HLA Typing - SSP, SSOP and SBT methods for typing HLA Class I and Class II.

2. POCT based clinical diagnostics:

- a) Micro-nanofluids and future diagnostics -

Introduction to microfluidic/nanofluidic technology and their applications in diagnostics and life sciences.

Microfabrication and miniaturization - a basic understanding of principle and processes of microfluidic device fabrication, testing and characterization:

Lab-on-a-chip

Manufacturing technologies and development cycle of a microfluidic device from the design to the ready-to-use device.

Applications of microfluidics in point-of-care and clinical diagnostics, analytical and synthetic chemistry, biotechnology and cell biology.

- b) Lateral flow immunoassay system -
 - Introduction to lateral flow-based immunoassay systems
 - Use and application of antibodies, colloidal gold and nitrocellulose membranes in lateral flow immunoassay systems.
 - Manufacturing technologies and development cycle for lateral flow immunoassay
 - Regulatory issues in the development of lateral flow immunoassays.
- c) Mass spectrometry multiplex analytic approach in diagnostics -
 - Introduction to diagnostic application of MS & Matrix-Assisted Laser Desorption/Ionization/Time-Of-Flight (MALDI-TOF MS) technology
 - MS technology for disease screening including new born screening, diagnosis of disease and metabolic disorders, monitoring of drug therapy, identifying drug toxicity and poisoning and discovering new biomarkers, therapeutic monitoring of immunosuppressant drugs.
 - Use of MALDI-TOF MS for rapid identification of microorganisms in clinical microbiology
- d) Quality control and quality assurance system in clinical diagnostics -
 - Internal quality control system
 - External quality assessment system
 - Common pre-analytical errors
 - Common analytical errors
- e) Regulatory issues and compliances in clinical diagnostics -
 - Overview of IVD regulation
 - Regulatory compliance - FDA, CE, CLIA

3. DNA technology in forensic sciences:

- a) DNA polymorphism -
 - Minisatellite sequences or Variable Number of Tandem Repeats (VNTRs)
 - Microsatellite sequences or Short Tandem Repeats (STRs)
 - Biology and nomenclature of STR markers
 - Single Nucleotide Polymorphism (SNPs)
 - SINEs and LINEs
 - Mitochondrial DNA variations
 - Y-Chromosome STRs
 - X-Chromosome STRs
 - Amelogenin: the sex typing marker
- b) DNA typing methods -
 - DNA profile - definition (DNA fingerprinting/DNA testing)
 - Restriction Fragment Length polymorphism (RFLP)
 - Single locus and multi-locus DNA typing

Allele specific oligonucleotides (ASO)
Polymerase Chain Reaction (PCR): An overview
Analysis of minisatellites by PCR, STR analysis by PCR
DNA detection methods - silver staining, fluorescent dyes
Capillary electrophoresis, principles and
Instrument platform for capillary electrophoresis e.g. 310/3100 Genetic analyzer

c) DNA extraction and quantitation from forensic samples -

DNA extraction from liquid blood, soft tissues, bone, teeth, buccal cells, semen, blood stains, and semen stains etc. FTA card, differential extraction
DNA quantitation by - Spectrophotometry, Fluorometry, Slot-blot, Real-time PCR

d) Applications of DNA profiling -

Identity test, parentage test, sib ship analysis, kinship analysis
identification of dead bodies resolving immigration and inheritance disputes

Books and References:

1. An Introduction to Forensic Genetics
William Goodwin, Adrian Linacre, Sibte Hadi
2. Forensic DNA Typing
John M. Butler

BMB-505: Agricultural Biochemistry

2 Credits

1. Responses to plant pathogenesis:

- a) Ways in which plant pathogenesis cause disease, b) Plant defense systems,
- c) Genetic basis of plant-pathogen interactions, biochemistry of plant defense reactions,
- d) Systemic plant defense responses,
- e) Control of plant pathogen by genetic engineering.

2. Responses to abiotic stresses:

- a) Plant responses to abiotic stresses.
- b) Stresses involving water deficit.
- c) Osmotic adjustment and its role in tolerance to drought and salinity.
- d) Impact of water deficit and salinity on transport across plant.
- e) Additional genes induced by water stress.
- f) Freezing stress.
- g) Flooding and oxygen deficit.
- h) Oxidative stress.
- i) Heat stress.

3. Mineral nutrient acquisition, transport, and utilization:

- a) Overview of essential mineral elements

- b) Mechanisms and regulation of plant K[⊕] transport
- c) Phosphorus nutrition and transport
- d) The molecular physiology of micronutrient acquisition
- e) Plant responses to mineral toxicity, plants as bioreactors.

4. Crop improvement, yield enhancement and uses of novel plant products:

Uses and modifications of fatty acids & lipids, plants as sources of biodegradable plastics, plants as factories for chemical drug.

Books and References:

1. Biochemistry and Molecular Biology of Plants, 2nd Edition
Bob B. Buchanan (Editor), Wilhelm Gruissem (Editor), Russell L. Jones (Editor)
2. Plant Biotechnology: The genetic manipulation of plants, Second Edition
Adrian Slater, Nigel Scott, and Mark Fowler
3. Plant Biotechnology and Agriculture: Prospects for the 21st Century, 1st Edition
Editors: Arie Altman Paul Hasegawa
4. The Molecular Life of Plants, 1st Edition
Russell L. Jones, Helen Ougham, Howard Thomas, Susan Waaland
5. Journals with recent articles on topics covered:
Nature, Nature Biotechnology, PNAS, Plant Physiology, Nature Scientific Reports, Frontiers in Plant Sciences. Specific articles or references will be provided as and when published and where relevant.

BMB-506: Environmental Biochemistry

2 Credits

1. **Introduction to ecology and ecosystem:** Brief treatment.
2. **Environmental pollution (water, soil and air):** Noise and thermal pollution, their sources and effects. Pollution due to arsenic, tannery and textile industry waste, lead and sulphur- rich coal.
3. **Wastewater (sewage and industrial effluents) treatments:** Anaerobic and aerobic treatment, conventional and advanced treatment technology, methanogenesis, methanogenic, acetogenic, and fermentative bacteria-technical process and conditions, emerging biotechnological processes in waste - water.
4. **Solid waste management:** Landfills, composting, earthworm treatment, recycling and processing of organic residues. Treatment of heavy metal wastes, development of industrial waste treatment system. Anaerobic digestion of agroindustrial byproducts and wastes.
5. **Bioremediations:** Biotransformation of toxic wastes to harmless products.

6. **Wasteland:** Uses and management, bioremediation and biore restoration of contaminated lands.
7. **Environmental genetics:** Degradative plasmids, release of genetically engineered microbes in environment. Environmentally friendly biofertilizers and biopesticides, biofuels and biogas.
8. **Bioengineered foods:** GM foods; Regulation and safety.

Books and References:

1. Environmental Science, 8th Edition
Daniel B. Botkin and Edward A. Keller
2. Microbial Biodegradation and Bioremediation, 1st Edition
Surajit Das
3. Biodegradation and Bioremediation, 2nd Editin
Martin Alexander
4. Environmental Microbiology, 3rd Edition
Ian L. Pepper, Charles P. Gerba, Terry J. Gentry
5. Soil and Water Contamination, 2nd Editin
Marcel van der Perk
6. Environmental Science, 8th Edition
Daniel B. Botkin and Edward A. Keller

BMB-507: Clinical Immunology and Immunodiagnostics

4 Credits

1. **Autoimmunity and autoimmune disease:** Characteristics, pathogenesis, genetic susceptibility to autoimmunity; role of infection in autoimmunity, pathogenic role of autoantibodies, control mechanisms, treatment, autoimmune diseases like autoimmune diabetics, autoimmune hemolytic anemia, rheumatoid arthritis, hereditary angioneurotic edema etc; diagnostic and prognostic value of autoantibodies.
2. **Allergy and hypersensitivity:** Coombs and Gell classification.
 - a) Type I- Immediate hypersensitivity - induction and effector mechanisms; allergens, atopy; IgE involvement, control of IgE production; immune response to inhalent allergens; role of mast cells, mediators and the reactions involved; genetic susceptibility and immunopathology; diagnosis; skin prick test; immunotherapy and new approaches for treatment.
 - b) Type II- Antibody dependent cytotoxicity - mechanism of tissue damage; reactions involving hemolytic diseases in newborn, autoimmune hemolytic anemia and hyper acute graft rejection; treatment.
 - c) Type III- Immune complex mediated hypersensitivity - types of immunecomplex diseases; inflammatory mechanisms involved; experimental models to study; persistence of deposition and detection of immune complexes.

- d) Type IV-Delayed hypersensitivity - contact hypersensitivity; tuberculin-type and granulomatous hypersensitivity; cellular reactions and disease manifestation in delayed hypersensitivity.
3. **Transplantation immunology:** Immunology of allogenic transplantation; recognition of alloantigens, activation of alloreactive T cells; effector mechanisms of allograft rejection - hyperacute acute and chronic rejection, prevention and treatment - immunosuppression, inducing donor-specific tolerance or suppression; xenogeneic transplantation; blood transfusion; bone marrow transplantation - graft-versus-host disease.
 4. **Tumor immunology:** Immune surveillance, tumor antigens, tumor associated antigens, immune responses to tumors, immune evasion by tumors, immunodiagnosis, immunotherapy for tumors.
 5. **Immunodeficiencies:** Primary (congenital) immunodeficiencies; B and T cell deficiencies - SCIDs, X-LA, selective IgA and IgG deficiencies, hyper IgM syndrome, common variable immunodeficiency, X-linked immunoproliferative disease, defective class I and II MHC expression, Wiskott-Aldrich syndrome, ataxia-telangiectasia, chronic granulomatous disease, leukocyte adhesion deficiency, defects in complement proteins, defects in phagocytosis; therapeutic approaches. Acquired (secondary) immunodeficiency - HIV and AIDS, treatment and prevention.
 6. **Immunoassays:** Enzyme immuno assays, MEIA for detection of anti-HCV, immunoassay for HIV envelope proteins, detection of HBsAg, HBeAg, IgM-anti-HBc, anti-HBe, immunoelectrophoresis, radioimmunoassay for hormones - insulin, hCG, etc. immunoturbidometry, microtiter-haemagglutination, detection and quantitation of immunocomplexes, cancer markers. Complement deficiencies, hemolytic assays for complement, hereditary angioneurotic edema, flow cytometry and FACS analysis.
 7. **Diagnostic application of monoclonal antibodies:** Progression of treatment, side effects of antibody therapy.
 8. **Immunohematology:** Full blood count, clinical utility of ESR determination, hemoglobinopathy, glycosylated hemoglobin (HbA1c), blood transfusion, transfusion reactions, acute kidney shutdown, haemostasis, cross-matching, tissue typing.

Books and References:

1. Cellular and Molecular Immunology
Abul K Abbas, Andrew H Lichtman and Shiv Pillai
2. Immunology, 7th edition
David Male, Jonathan Brostoff, David B Roth and Ivan Roitt
3. Essential Immunology
Ivan Roitt

4. Kuby Immunology
Thomas J Kindt, Richard A Goldsby and Barbara A Osborne
5. Immunology
Ian R Tizard
6. Basic and Clinical Immunology
Daniel P Stites, John D Stobo, H H Fudenberg and J V Wells
7. Manual of Clinical Laboratory Immunology
Noel R Rose, Herman Friedman and John I Fahey

BMB-508: Applied Nutrition and Nutritional Biochemistry 4 Credits

- 1. Malnutrition and immunity:**
 - a) Role of nutrition in immune response to infection
 - b) Malnutrition and immunity
 - c) Nutrition and immunodeficiency disorders
 - d) Dietary modification in infection
- 2. Nutrition and genomics:**
 - a) Genetic and environmental variations and nutrient composition of foods.
 - b) Role of nutrients in gene expression and regulation
- 3. Nutrient–drug interaction:**
 - a) Effect of Food on drug pharmacokinetics
 - b) Effects of drugs on nutrition: drugs which affect food intake, absorption, metabolism and excretion.
- 4. Nutrition and IT:**
 - a) Nutrition Information, Education and communication – IT offers a new approach
 - b) IT & Nutritional support for patients with chronic illnesses
- 5. Malnutrition and psychosocial development:**
 - a) Introduction: Definition of terms
 - b) Impact of PEM on brain development and psychosocial development
 - c) Nutritional rehabilitation and mental development
 - d) Malnutrition and cognitive development - A multifaceted problem
- 6. Current topics in nutrition:**
 - a) Eating disorders; Anorexia nervosa and Bulimia nervosa
 - b) Total parenteral nutrition (TPN)
 - c) Sports nutrition
 - d) Poverty and nutrition
 - e) Nutrition in emergencies - famine, war, flood and natural disasters.
 - f) International nutrition - nutrition in developing economies

- g) Globalization and nutrition
- h) Nutritional enhancement of plant foods

7. Applied nutrition:

- a) Diet, nutrition and lifestyle-related chronic non-communicable diseases (NCDs)
- b) Low birth weight - increased risk of morbidity, mortality and retarded cognitive development
- c) Nutrition and HIV/AIDS
- d) Street food as meal of millions
- e) Nutrition intervention programs in Bangladesh.

Books and References:

1. Essential of Nutrition and Diet Theraphy, 8th or 12th Edition
S.R. Williams and E.D. Schlenker. Evolve-Elsevier.
2. Understanding the Brain and Its Development: A Chemical Approach
Harun K.M. Yusuf,
World Scientific, Singapore, New Jersey, London, Hong Kong, 1st Edition
Published in 1992.
3. Basic Neurochemistry, Edited by G J Siegel, R.W. Albers, B W Agranoff and R. Katzman: Little, Brown and Company, Boston, Any up dated Edition.
1st Published in 1972.
4. Human Nutrition and Dietetics by J S Garrow W P T Jones, A. Ralph: Churchill Livingstone. 10th or more up dated edition.
Bjorklund, David F. Children's Thinking: Cognitive Development and Individual Differences, Stamford, CT: Wodsworth Publishing, 2004 or More Up dated Edition.
5. Recent Trends in Agriculture and Food Security in Bangladesh. FAO, Bangladesh, Spijkers, Ad 2009.

BMB-509 Biochemistry of Natural Products

2 Credits

1. NMR: Spectroscopy -

- a) Chemical shifts. factors affecting the chemical shift, coupling constants: vicinal coupling, geminal coupling, long range coupling, use of coupling constant values in the determination of stereochemistry of some important natural and biochemical substances. AB and ABX system, two dimensional NMR: NOE, COSY.
- b) Use of NMR in Biochemistry and Molecular Biology: use of ¹³C NMR in the elucidation of Biochemical pathways including the biosynthesis of cephalosporin, bikaverin, penicillin, chlorophyll and Vitamin B₁₂; use of NMR in the determination of 3 dimensional structure of proteins, enzymes, DNA, RNA and protein signaling.

- c) Use of NMR in Designing lead compounds (drugs): Use of NMR in drug screening. Clinical use of ^{31}P NMR – Detection of abnormalities in different organs by the use of ^{31}P NMR. Magnetic resonance tomography (MR) – use of MR to locates tumors, Vascular dilations and many other pathological abnormalities.

2. Mass spectroscopy: Mass fragmentation of some important natural products.

3. Structure determination of some medicinally important alkaloids: Quinine, atrophine, morphine by synthetic and digradative methods. Biosynthesis of some complex alkaloids.

4. Molecular mechanism of actions of some selective antibiotics and prodrugs: Advantages of prodrugs, semisynthetic antibiotics, synthesis of antibiotics, mechanism of antibiotic action, allergic reactions. Chemical synthesis of some medicinal steroids progesterone, cortisol, vitamin D.

5. Structure of vitamins: Vitamin B₁₂, Biological reactions with participation of vitamin B₁₂ and coenzyme of B₁₂. Chemical synthesis of vitamin E - α -tocopherol and β -tocopherol.

Books and References:

1. Natural products Chemistry Vol. I and Vol. II
O.P. Agarwal
2. Organic Chemistry Vol. II
Finar
3. Spectroscopic Methods in Organic Chemistry 4th Edn
Williams and Fleming
4. The Antibiotics
Betina
5. Spectroscopic Methods in Organic Chemistry 4th Edn
Williams and Fleming
6. Medicinal Chemistry, 2nd Edition
Graham L Patrick
7. Basic one and two Dimensional NMR Spectroscopy
Horst Friebolin

BMB-510: Biotechnology Business Management

2 Credits

- 1. Business management:** The Company, its environment, stakeholders; corporate strategies; some basic economic principle (e.g. profit maximization, shareholder value); business planning and decision making processes and supporting tools, methods of business analysis. Introduction to: Technology development; Procurement; Operation management; Marketing and Sales.
- 2. Project management:** Fundamentals of project management; project life cycle (definition, planning, execution and controlling; close out); tools and methods of project

management e.g. planning methods, problem solving methods; social competence in project management (team work, communication).

3. Commercialization, marketing and management of products:

Fundamentals of marketing and sales of products; creating and marketing the image of the company; positioning of the company name and products; the art of negotiation; workable marketing and the strength of distribution; effective advertizing and marketing; opportunities of international marketing; steps involved in commercialization of biotechnology products.

4. Intellectual property rights:

- a) Introduction, general introduction; patent claims; legal decision making process, ownership of intellectual property.
- b) Basic requirements of patentability, patentable subject matters, novelty and the public domain.
- c) Special issues in biotechnology patents, disclosure requirements, collaborative research, competitive research, foreign patents.
- d) Patent litigation, substantive aspects and procedural aspects of patent litigation, recent development in patent system and patentability of biotechnological invention.

Books and References:

1. BUSINESS for the 21st Century, Steven J. Skinner and John M. Ivancevich 2003, Richard D. Irwin, Inc.
2. Building Biotechnology: Biotechnology Business, Regulations, Patents, Law, Policy and Science, Yali Friedman, Logos Press (USA), 4th Edition 2014.
3. Projects- *Planning, Analysis, Selection, Financing, Implementation, and Review*, Prasanna Chandra, McGraw Hill Education (India) Private Limited. Eight edition 2014.
4. Marketing Management, Philip Kotler, Kenin Lane Keller, and Abraham Koshy, MithileshwarJha, Pearson edition, (Latest Edition).
5. Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies, Craig D. Shimasaki, Springer USA, 1st Edition, 2014
6. The Business of Bioscience: What goes into making a biotechnology product, Craig D. Shimasaki, Springer USA, 2014.

BMB-511: Laboratory Work (For Group A)

6 Credits

A. Molecular Biology

1. Isolation and quantification of plasmid DNA
2. Restriction mapping of DNA
3. Agarose gel electrophoresis of DNA and RNA
4. Isolation of Taq polymerase
5. Sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE)

6. Polymerase chain reaction (PCR) of a specific target gene from genomic DNA
7. DNA fingerprinting of bacterial strains.
8. Gel electrophoresis of proteins from normal & stressed plants.

B. Bioinformatics

1. Retrieve at least 3 different types of gene sequences from database using name/accession number of the genes
2. Find ORFs, promoter sequences and transcription termination signals
3. Find restriction enzyme sites and construct restriction maps of the genes
4. Translate the nucleotide sequence into amino acid sequence. Analyze the amino acid content in the protein sequence.
5. Do multiple alignment of the proteins and analyze their homology and conserved sequences. Prepare dendrograms of the homologous proteins.
6. Design primers in order to clone a gene through PCR amplification.

C. Biochemistry

1. Identification and isolation of central and peripheral tissues of mammals.
2. Assay of neurotransmitter mediating enzyme, Dopamine β - hydroxylase (DBH) from the brain and serum of mammals.
3. Principles and practical applications of Column Chromatography using various types of resins

D. Immunology

1. Determination of serum immunoglobulin G by ELISA method.
2. Detection of HBsAg by ELISA method.
3. Determination of serum complement C3 by immunoturbidometric method.
4. Immunoelectrophoresis of major serum immunoglobulins.

E. Natural Products

1. Plant lignin extraction and estimation.
2. Estimation of dichlofenac sodium from pharmaceutical preparation
3. Estimation of metronidazole from pharmaceutical preparation
4. Estimation of tolbutamide from pharmaceutical preparation
5. Estimation of acyclovir from pharmaceutical preparation
6. Estimation of Al_2O_3 and $Mg(OH)_2$ from pharmaceutical preparation
7. Extraction & Identification of alkaloids from *Polyathia longifolia* (Devdaru) leave or bark.

F. Nutrition

1. Determination of toxin (ODAP) in Khesari seed
2. Field level estimation of blood hemoglobin
3. Determination of serum vitamin A and E by HPLC

BMB-511: Thesis (For Group B)	6 Credits
BMB-512: Seminar / Paper Presentation	2 Credits
BMB-513: Viva-voce	2 Credits