PONDICHERRY UNIVERSITY

Biochemistry & Molecular Biology

CURRICULUM / SYLLABUS

2015-2016 ONWARDS

Puducherry - 605014, India
PONDICHERRY UNIVERSITY
SCHOOL OF LIFE SCIENCES
DEPARTMENT OF BIOCHEMISTRY AND MOLECULAR BIOLOGY

Admission Process
Selection of students to M. Sc. Programs is based on National Level Entrance Examination conducted by Pondicherry University at 40 different centers in the country. The test consists of objective type questions in Biochemistry, Molecular Biology, Zoology, Botany, Chemistry, Biophysics, Microbiology, Genetics, Physiology and allied areas. Students desirous to join Ph.D. Program also have to take the National level Entrance exam and based on their merit in the rank list, are entitled to receive the University Research Fellowship. Project Fellows desirous of registering for the Ph.D. program need to appear for the Entrance Examination. In addition, UGC/CSIR- NET qualified students are admitted directly to the Ph.D. program.

Curriculum goals/Objectives: The curriculum of this Department incorporates classical to recent concepts within different areas of each subject offered, and updates syllabus with periodic revision exercises, ensured by the Board of Studies and ratified through the School Board. The curriculum is made with a view to impart fundamental and advanced knowledge in the field of Biochemistry and Molecular Biology to students admitted from diverse academic backgrounds. The theory and practical sessions augment their ability to understand the implications of the scientific and technical approaches involved in this domain of knowledge, enabling to mold them into prospective skillful scientific workforce for the future.

EVALUATION
The student assessment followed in this department is as per the regulations notified by the Office of the Controller of Exams, Pondicherry University.
All subjects in the PG program carry an internal assessment component (40%) and an End Semester External component (60%). Each teacher is expected to organize
continuous assessment modes for each course assigned to him/her. The internal assessment is categorized into 30 marks for internal tests/term papers and 10 marks for Seminars/Assignment/ Presentation/Write ups/Viva, etc. There is double evaluation of answer scripts for the end semester exams. Where the difference in evaluation is more than 15% of marks, the answer paper shall be revalued by an Examination Committee. Students are expected to secure at least 40% marks in the end semester external component and 50% marks (sum of the internal and the end semester external marks) for passing the course. Students who have failed due to insufficient attendance (less than 70%) and / or secured less than 40% in internal assessment marks should repeat the course as when it is offered. Performance of students in each paper is expressed in terms of marks as well as in letter grades. A student is not permitted to repeat any course only for the purpose of improving the grade. The grades are arrived at by dividing the difference between the highest mark secured and the minimum pass mark by 6 (as there are six passing grades). The formula is as given below:

\[ K = \frac{(X-50)}{6} \]

where, \( K \) = class interval, \( X \) = the highest mark in the subject.

**GRADING**

**TABLE I**

<table>
<thead>
<tr>
<th>Range of Marks in %</th>
<th>Letter Grade</th>
<th>Points for Calculation of GPA/CGPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>( X ) to ( (X-K)+1 )</td>
<td>A+</td>
<td>10</td>
</tr>
<tr>
<td>( (X-K) ) to ( (X-2K)+1 )</td>
<td>A</td>
<td>9</td>
</tr>
<tr>
<td>( (X-2K) ) to ( (X-3K)+1 )</td>
<td>A-</td>
<td>8</td>
</tr>
<tr>
<td>( (X-3K) ) to ( (X-4K)+1 )</td>
<td>B+</td>
<td>7</td>
</tr>
<tr>
<td>( (X-4K) ) to ( (X-5K)+1 )</td>
<td>B</td>
<td>6</td>
</tr>
<tr>
<td>( (X-5K) ) to 50</td>
<td>C</td>
<td>5</td>
</tr>
<tr>
<td>Below 50</td>
<td>F</td>
<td>0</td>
</tr>
<tr>
<td>Failure due to lack of attendance</td>
<td>FA</td>
<td>0</td>
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</tbody>
</table>
K should not be rounded off to less than two decimal places. The numbers given in range of Marks column, (X-K), (X-2K), (X-3K), etc., can be rounded off to the nearest whole number.

In courses where the number of students who have secured 50 marks and above is less than 10 then grading may be given based on Table II.

### TABLE II

<table>
<thead>
<tr>
<th>Range of Marks in %</th>
<th>Letter Grade</th>
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<td>71-80</td>
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<td>56-60</td>
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<td>50-55</td>
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<tr>
<td>Below 50</td>
<td>F</td>
<td>0</td>
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</tbody>
</table>

The GPA and CGPA will be calculated as weighted average of points secured by the student in all papers registered. The weights are number of credits for each paper. For example, a student getting an A grade in 4 credit course, A- grade in 2 credit course, A+ grade in a 3 credit course and F grade in a 3 credit course will have a GPA as (9x4 + 8x2 + 10x3 + 0x3)/(4 + 2 + 3 + 3) = (36 + 16 + 30 + 0)/12 = 82/12 = 6.83 out of 10.0; GPA = 6.83. The CGPA shall also be calculated in similar lines including all the subjects taken by a student in all semesters. Students with CGPA of 9.0 and above, without fail in any of the courses taken shall be awarded distinction. A CGPA of 6.0 and above shall be placed in first class. Students who secure less than 50% marks in any paper get F grade and are treated as failed in the particular paper.
# PONDICHERRY UNIVERSITY

## SCHOOL OF LIFE SCIENCES

## DEPARTMENT OF BIOCHEMISTRY AND MOLECULAR BIOLOGY

## SYLLABI FOR M. Sc. BIOCHEMISTRY AND MOLECULAR BIOLOGY

(Applicable from Academic Year 2015-16 Onwards)

<table>
<thead>
<tr>
<th>CODE</th>
<th>NAME OF THE COURSE</th>
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<td>METABOLISM &amp; REGULATION</td>
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<td>BMB 425</td>
<td>MOLECULAR ENDOCRINOLOGY</td>
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<td>MOLECULAR BASIS OF CELLULAR DISORDERS</td>
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<td>BMB 531</td>
<td>PROTEOMICS</td>
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<td>BMB 419</td>
<td>BIOSTATISTICS &amp; SCIENTIFIC WRITING</td>
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<td>CANCER BIOLOGY</td>
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<td>NEUROBIOLOGY</td>
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Syllabus for Pre-Ph.D. Part I

| RESEARCH METHODOLOGY | 31 |
UNIT- I
Dynamics of the eukaryotic cell- Molecules of life- Cellular evolution - assembly of macromolecules and Origin of life- integrated structural organization of prokaryotic and eukaryotic cells- Concept of a composite cell and Molecular composition of cells.
Biomembranes- Structural organization- Models of a plasma membrane, Membrane permeability- Transport across cell membranes- Transmembrane signals- Artificial membranes- liposome.

UNIT- II
Micro bodies-Peroxisomes, Glyoxysomes and Lysosomes and their functions.  6 h
The Cytoskeleton-microtubules and microfilaments.
The extracellular matrix-collagen, elastin, fibrillin, fibronectin, laminin and proteoglycans.

UNIT- III
Molecular organization and function of mitochondria- components of respiratory chain- Chemiosmotic theory- Kinetics of electron transport, ATP formation- uncouplers of oxidative – phosphorylation- mitochondrial DNA and Semiautonomy.

UNIT- IV
Endomembrane system- Endoplasmic reticulum- protein segregation- microsomes- functions of endoplasmic reticulum- Golgi complex and cell secretion- Protein glycosylation.
Ribosomes- Structural organization.
Nucleus- Internal organization- Nuclear pore complex- Nucleosomes, Chromatin.

UNIT- V
Cell cycle - Different stages of mitosis – significance of meiosis - Cohesins and condensins in chromosome segregation, Microtubules in spindle assembly, Structure of kinetoshore, centrosomes and its functions, Components in cell cycle control - Cyclin, CDKs, Check points in cell cycle, phase dependent cyclic CDK complexes.

Text Book:

Suggested Reading:
UNIT - I

UNIT - II

UNIT - III

UNIT - IV

UNIT - V

Text Book:

Suggested Reading:
UNIT-I

UNIT-II

UNIT-III
Centrifugation- basic principles - instrumentation - centrifugation units - types of centrifuges- rotors- accessories- colloids-centrifugation methods - sedimentation velocity-sedimentation equilibrium-cell fractionation methods.

UNIT-IV
Chromatography & Electrophorsis - types of chromatography - column, thin layer, paper, adsorption, partition, gas liquid ion exchange, affinity, HPLC- principles of each type- instrumentation and accessories- detection methods & systems- qualitative and quantitative aspects-applications; types of Electrophoresis - paper and gel- agarose and PAGE - pulsed field-capillary- isoelectric focusing- blotting techniques - western- southern & northern- application methods in life sciences and biotechnology.

UNIT-V
Radioactivity- types of radioisotopes- half life- units of radioactivity- uses of radioisotopes in life sciences & biotechnology- detection and measurement techniques - liquid scintillation counting- solid state counting- Geiger counter - Radiation hazard & laboratory handling methods.


Suggested Reading:
UNIT I
Introduction- Internal environment and homeostasis- coordinated body functions.
Digestion- digestive processes at various regions of digestive system, regulation of -
gastric secretion and motility- intestinal secretion and motility-role of gastrointestinal
hormones.

UNIT II
Cardiophysiology- functional anatomy of heart- genesis and spread of cardiac
impulses- cardiac cycle- heart sound- cardiac output- cardiovascular regulatory
mechanisms- basic E.C.G.

UNIT III
Respiratory physiology- functional anatomy of air-passages and lung- respiratory
muscles- mechanism of respiration- lung volumes and capacities- gas exchange in
the lungs- regulation of respiration.

UNIT IV
Renal physiology- structure of nephron- glomerular filtration- tubular reabsorption
and secretion- formations of urine- regulation of water and mineral excretion-
counter current multiplier and exchanger- renal role in acid base balance.

UNIT V
Nerve physiology- Structure of neuron and synapse- excitability- action potential-
conduction of never impulse-synaptic transmission- neurotransmitter systems.
Muscle physiology- skeletal and smooth muscle- electrical properties and ionic
properties- types of muscle contraction- Neuromuscular transmission.

Text Book:
   2011.

Suggested Reading:
1. Barrett KE, Brooks HL, Boitano S and Barman SM, Ganong’s Review of Medical Physiology,
UNIT - I
Introduction to Enzymes - Historical perspective- Nomenclature and Classification of Enzymes – Properties of Enzymes, Enzyme Activity and Units, Specific Activity, Catalytic Power and Specificity, Lock and Key Theory, Induced Fit Model, Transition State and Strain Theory of Enzyme Action.

UNIT - II
Bi-substrate Reactions- Sequential – Ping-Pong reactions- rate equations, examples – Differentiating Bi-substrate Mechanisms.

UNIT - III
Enzymatic Catalysis- Acid-Base Catalysis- Covalent Catalysis- Metal ion Catalysis- Electrostatic Catalysis- Catalysis through Proximity and Orientation effects- Catalysis by Transition State Binding, Coenzymes – NAD(P)⁺, FMN & FAD, CoA.SH, TPP, PLP, Biotin, THF, Methylcobalamin, Ascorbate, Menaquinone - Structure & Function.
Catalysis in Model Enzymes – Ribonuclease A – Chymotrypsin - Carbonic anhydrase – Carboxypeptidase A - Lysozyme.

UNIT - IV
Regulation of enzyme activity- Regulation by availability, Importance of Compartmentalization, Isoenzymes – Isoenzymes of Clinical Importance, Regulation by reversible covalent modification- proteolytic activation- Sequential, Concerted and Cumulative Feedback Control - Allosteric Control.

UNIT - V

Text Book:

Suggested Reading:
1. Laboratory safety methods
2. Determination of Absorption Maximum
3. Verification of Beer-Lambert’s Law
5. Estimation of protein by Lowry’s method
6. Isolation and estimation of DNA by Diphenylamine (DPA) method
7. Isolation and estimation of RNA by Orcinol method
8. Isolation and estimation of Casein in milk
9. Estimation of inorganic pyrophosphatase
10. Estimation of free proline by Bate’s method
11. Estimation of cholesterol by Zak’s method
12. Determination of the isoelectric point of amino acid.

REFERENCE
1. Introduction to practical Biochemistry. David T. Plummer

BMB 472 ENZYMEOLOGY LAB 1 CREDIT

1. Estimation of enzyme activity.
2. Effect of pH on enzyme activity.
3. Effect of Temperature on enzyme activity.
4. Effect of substrate concentration on enzyme activity.
5. Determination of $K_m$ & $V_{max}$ of an enzyme.
6. Coupled enzyme assay.
7. Partial purification of enzyme and determination of specific activity.
8. Determination of catalytic efficiency.

REFERENCE
BMB 473  CELL BIOLOGY LAB       1 CREDIT

1. Observation of prokaryotic and eukaryotic cells with the help of light microscope.
2. Permanent slide preparation and preparation of slide for Dicot leaf section.
3. Assessment of plasma membrane function: 1) Selective permeability 2) Osmosis
4. Cell counting and viability (Yeast/Bacteria).
5. Mitosis and the cell cycle in Onion root-tip cell.
6. Isolation of mitochondria and assay for function.
7. Isolation of peroxisomes and assay for function.
9. Determination of osmotic fragility of cell (Goat RBC).

REFERENCE

BMB 474  HUMAN PHYSIOLOGY LAB       1 CREDIT

1. Microscopy
2. RBC count & WBC count
3. Differential leucocyte count by Leishman’s staining
4. Estimation of Haemoglobin by Sahli’s acid haematin method
5. Determination of Packed cell volume (PCV)
6. Determination of Erythrocyte sedimentation rate (ESR)
7. Determination of Coagulation time & Bleeding time
8. Determination of blood group
9. Determination of Blood Pressure by Sphygmomanometry

REFERENCE
1. Buffer preparation
2. pH titration
3. Protein purification by ammonium sulfate precipitation.
4. Molecular modeling using modeling kit.
5. Absorption spectra - UV-Visible.
6. Paper Chromatography of amino acids, carbohydrates, nucleic acid.
7. Ion exchange chromatography.
8. SDS Gel electrophoresis.

REFERENCE:
UNIT-I

UNIT-II
Metabolism of Lipids: Oxidation of fatty acids - Beta oxidation, alpha oxidation and omega oxidation, Oxidation of fatty acids with odd number of carbon atoms. Ketogenesis. Biosynthesis of saturated fatty acids and unsaturated fatty acids. Regulation of fatty acid biosynthesis. Biosynthesis of triacylglycerol and phospholipids. Cholesterol biosynthesis, transport and excretion, Regulation of cholesterol biosynthesis.

UNIT-III
Metabolism of Amino acids: Overview of biosynthesis of non-essential amino acids from amphibolic intermediates- Alpha- ketoglutarate, oxaloacetate, 3-phosphoglycerate. Glucose - alanine cycle, Urea cycle reactions.

UNIT-IV

UNIT-V

Text Book:

Suggested Reading:
UNIT -I
Definition and scope of Endocrinology- Historical and anatomical aspects of mammalian endocrine system. Definition of a hormone- chemical nature of mammalian hormones- types of hormone receptors- secondary messenger system- general mechanism of peptide and non- peptide hormones action. Feed-back regulation of Endocrine System.

UNIT –II

UNIT –III

UNIT –IV

UNIT –V

Text Book:

Suggested Reading:
UNIT I
History and scope of molecular biology- Discovery of DNA- evidence for DNA as the genetic material. The genomes of bacteria, viruses, plasmids, mitochondria and chloroplast- Gene transfer in microorganisms- conjugation- transformation, transduction - protoplasmic fusion.

UNIT II
Organisation of eukaryotic genome- components of eukaryotic chromatin- chromatin and chromosome structure- DNA-supercoiling -linking number- satellite DNA-possible functions- Cot curve- C-value paradox.

UNIT III
DNA replication- Prokaryotic and eukaryotic DNA replication, mechanism of replication. Enzymes and necessary proteins in DNA replication. Telomeres, telomerase and end replication. Role of telomerase in aging and cancer.
DNA Repair- Mismatch, Base-excision, Nucleotide-excision and direct repair
DNA recombination- Homologous, site-specific and DNA transposition

UNIT IV
Transcription- Prokaryotic and eukaryotic Transcription- RNA polymerases- general and specific transcription factors- regulatory elements- mechanism of transcription regulation- Transcription termination. Post transcriptional modification- 5’ cap formation-3’ end processing and polyadenylation- splicing-editing- nuclear export of mRNA- mRNA stability.

UNIT V
Translation- Genetic code- Prokaryotic and eukaryotic translation- translational machinery- Mechanism of initiation- elongation and termination- Regulation of translation.

Text Book:

Suggested Reading:
UNIT- I
Introduction to Plant cells
Photosynthesis: Chloroplast- structure and function; Photosynthetic pigments and light harvesting complexes, Photo inhibition of photosynthesis, Photosynthetic carbon reduction (PCR) cycle, C4 syndrome and Crassulacean acid metabolism. Oxidative respiration, Alternate electron pathways and Respiration rate. 8 h

UNIT- II
Nitrogen metabolism: Physical and biological nitrogen fixation, Ammonification, Nitrification, Denitrification, Biochemistry and Genetics of nitrogen fixation and Ammonium assimilation. 10 h

Plant Hormones: Biosynthesis, Physiological effects and mechanism of action of Auxins, Gibberellic acids, Cytokinins, Absciscic acid, Ethylene, brassinosteroids and Polymines.

UNIT- III
Plant Stress physiology: Plant stress, Plant responses to abiotic and biotic stresses, Water deficit and drought resistance, Flooding, Temperature stress, Salt stress, Ion toxicity, Pollution stress and potential biotic stress (insects and diseases). 6 h

UNIT- IV
Introduction to tissue culture- Media composition and preparation. 6 h
Culture types callus culture cell suspension culture, protoplast culture and etc., Somatic embryogenesis, organogenesis, Embryo culture and embryo rescue. Micropropagation.
Protoplast isolation, Protoplast culture and fusion, selection of hybrid cells, cybrids, somaclonal variation. Germplasm storage and cryo- preservation.

UNIT- V
Application of transgenesis in crop improvement – Insect resistance, disease resistance, virus resistance herbicide resistance, and resistance to abiotic stress. 6 h
Transgenesis for male sterility and terminator seed. Transgenic plant-Bt cotton, Bt brinjal, Plant genome-Rice

Text Book:

Suggested Reading:
BMB 476  MOLECULAR BIOLOGY LAB  1 CREDIT

1. Isolation & purification of genomic DNA from bacteria
2. Isolation & purification of plasmid DNA
3. Spectrophotometric analysis of purity of isolated DNA
4. Agarose gel electrophoresis of genomic DNA
5. Agarose gel electrophoresis of plasmid DNA
6. Restriction digestion of chromosomal DNA
7. Restriction digestion of plasmid DNA
8. Isolation of DNA fragment from agarose gel

REFERENCE

BMB 477  METABOLISM AND REGULATION LAB  1 CREDIT

1. Preparation of lactalbumin from milk
2. Estimation of reducing sugar by DNSA (dinitrosalicylic acid) method
3. Estimation of glucose by Benedict’s method
4. Estimation of urea by Diacetyl monoxime method
5. Estimation of uric acid
6. Estimation of creatinine in urine
7. Estimation of cholesterol by ZAK’s method
8. Estimation of calcium by Clarke and Collip method
9. Estimation of pyruvate by DPNH (2,4-dinitrophenylhydrazine) method

Reference:
Harold Varley, 1988, Practical Clinical Biochemistry, 6th edition, edited by H. Govenlock with the assistance of Janet R. McMurray and Donald M. McLauchlan, Heinemann Medical in London
1. Plant tissue culture (Only demonstration-Report)
2. Isolation of chloroplast and estimation of total chlorophyll, chlorophyll a and chlorophyll b pigments from leaves.
3. Determination of Gibberelllic acid in growing shoot.
4. Assay of starch hydrolysis in germinating seeds.
5. Test the different phytohormone in seed germination.
6. Determination of protein quantity under different stress conditions.
7. Estimation of starch content in plants grown in different stress conditions by Anthrone reagent.
8. Spectrophotometric estimation of Indole acetic acid in different plant tissues.

REFERENCE:
UNIT I
Introduction and Historic perspectives of Immunology: Types of Immunity – Innate, acquired; Basic defenses-physical and physiological, role of acute phase proteins, complements and interferons, PAMPs and PRRs-Toll like receptors; Acquired Immunity-natural, artificial, active and passive immunity; hematopoietic stem cells, myeloid and lymphoid lineage; Role of Granulocytes, macrophages –Phagocytosis and Inflammatory response. Humoral and Cell mediated immunity- types of B and T lymphocytes and their role in innate and adaptive immunity; primary and secondary immune response; Pathways of activation of complement cascade and their significance.

UNIT II
Organs and cells of Immune system- Primary and Secondary Lymphoid organs- development and maturation of T cells and B cells in primary lymphoid organs. Types and significance of MHC molecules; Role of professional antigen presenting cells-macrophages, dendritic cells; mechanism of antigen processing and presentation; B cell and T cell activation in secondary lymphoid organs.

UNIT III
Humoral Immunity- Antigens – nature of antigens, immunogenicity, antigenicity, epitopes; Immunoglobulins- Structure, types and biological functions; Molecular basis of antibody diversity- arrangement of light chain and heavy chain genes, multiple germline gene segments, somatic gene rearrangement, somatic hypermutation and junctional diversity; T cell B-cell interaction and Class Switching; Antigen-Antibody reactions - mechanism of Ag-Ab interaction; principle and applications of tests based on Ag-Ab reactions-precipitation, agglutination, complement fixation, immunoelectrophoresis, RIA, ELISA, Western Blotting, and immunofluorescence techniques; Hybridoma technique - development of monoclonal antibodies and their applications

UNIT IV
Cell mediated Immunity -MHC restriction - T-cell receptors ;T-cell activation & differentiation into effector T cells; Tolerance mechanisms-central and peripheral tolerance- positive and negative selection, Clonal deletion and Clonal anergy; Lymphocyte recirculation; Functions of T cell subsets-TH1, TH2, CTLs - mechanism of killing by CTL and NK cells in antiviral and antitumor immunity; Role of Treg, lymphokines and cytokines in immune regulation; Vaccines- conventional vaccines- attenuated, killed and subunit vaccines; modern vaccines-recombinant vaccines, DNA vaccines and edible vaccines

UNIT V
Immunopathology -hypersensitivity reactions- types, causes and mechanism of immediate and delayed type reactions; Immunodeficiency diseases – types and causes; Autoimmunity - types and causes autoimmune diseases; Transplantation immunity- mechanism of graft rejection and prevention of graft rejection; Types and applications of immunosuppressive agents-physical, chemical and biological immunosuppressants.

Text Books:

Suggested Reading:
UNIT I

UNIT-II
Cloning vectors used with Bacillus subtilis, Properties of yeast as host for cloning, Types of vectors designed for cloning in yeast, Vectors for cloning in animal cells- SV 40, Adenovirus, Baculovirus, Retrovirus vectors. Types of vectors used in higher plants – Caulimoviruses vectors, Geminiviruses vectors, Agrobacterium tumefaciens based Ti plasmid vectors. Ligation of DNA fragments– using DNA ligases, homopolymer tailing, linkers and adaptors.

UNIT-III

UNIT-IV

UNIT-V

Text Books:

Suggested Reading:
UNIT- I

**Genome organization:** Prokaryotes, eukaryotes, karyotype, viral genome - DNA & RNA virus, extrachromosomal genome - plasmids, mitochondria and chloroplast, repetitive elements - LINES and SINES.

UNIT- II

**Gene mapping:** Linkage maps, tetrad analysis, mapping with molecular markers and using somatic cell hybrids.

UNIT-III
**Microbial genetics:** Structure of DNA and flexibility, primosome and replisome organization and function, D-loop replication, operons, positive and negative control, lac, ara and trp operon regulation, Methods of genetic transfers - transformation, conjugation, transduction, mapping genes by interrupted mating, Gametes - Genetics of Virus, Bacteria and yeast.

**Mobile genetic elements:** Discovery, simple and complex transposons, insertion sequence in prokaryotes, Transposons, complex transposons (Tn10, Tn5, Tn9 and Tn3 as examples), mechanisms and importance.

UNIT- IV
Genetic testing in individuals and populations - Direct testing - Gene tracking - Population screening - DNA profiling - DNA methylation & gene activity, chromatin modification, dosage compensation, X inactivation in Human female - Use of mouse embryonic stem, gene targeting and gene trapping

UNIT- V
**Genetics of Cancer:** Types, causes of DNA mutation, detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants.

**Text Books**
Introduction to Genetic Analysis: Griffiths et al. 10th edition, 2011
Principles of Genetics: D. Peter Snustad, Michael J. Simmon, 2008

**Suggested Readings**
Human Molecular Genetics, 4th Edition 2012 by Tom Strachan, Andrew Read
Human Molecular Genetics: 2010, Peter Sudbery.
BMB-554 GENETIC ENGINEERING LAB 1 CREDIT

1. Culture of *E. coli* cells & plasmid isolation
2. Preparation of competent cells
3. Calcium chloride mediated transformation
4. Ligation of DNA
5. Polymerase chain reaction
6. Restriction fragment length polymorphism
7. Random amplified polymorphic DNA
8. Cloning of GFP protein

REFERENCE


BMB 556 IMMUNOLOGY LAB 1 CREDIT

1. Agglutination reactions- Active bacterial agglutination-Widal Test
2. Agglutination reactions- Passive agglutination -Latex agglutination Test
3. Precipitation reactions on gel-Double Immuno diffusion to check antigen cross reactivity
4. Single Radial Immuno Diffusion (SRID) to determine the quantity of an Antigen
5. Immunoelectrophoresis (IEP) of serum proteins
6. Preparation of antigens from microbes
7. Isolation of antigens by SDS PAGE
8. Isolation and partial purification of IgG fraction from immune serum by ammonium sulphate precipitation and ion exchange chromatography using DEAE cellulose
9. Detection of specific antigens by Indirect ELISA technique
10. Identification of specific antigens by Immunoblotting technique

UNIT- I
**Inflammation and Repair/Wound healing:** Acute inflammation-Vascular changes-cellular events-chemical mediators of inflammation-chronic inflammation-morphologic patterns in acute and chronic inflammation-systemic effects of inflammation-wound healing-mechanism of wound healing-pathologic aspects of inflammation and response.  

UNIT- II

UNIT- III

UNIT- IV

UNIT- V
**Hepatic disorders:** Hepatic injury-Hepatitis a through E-Alcohol liver disease-Drug and toxin induced liver disease- cirrhosis- pregnancy associated-transplantation associated-adenomas and primary carcinoma.

**Text Books:**

**Suggested Readings:**
UNIT I
Proteomics Introduction: Human genome - Genomes to Proteomes - HUPO – Branches of proteomics - Protein extraction Methods: Subcellular fractionation, Density gradients, Ultrafiltration, - Protein fractionation - Affinity purification – Combined Fractional Diagonal Chromatography (COFRADIC) - Removal of interfering compounds, salts, DNA, lipids, Protein solubilization methods, chaotropes, detergents, etc - Preparation of Sample - Sample handling and storage - Protein detection and quantification methods – Stable Isotope Labeling with Aminoacids in Culture (SILAC) - Chemical tagging, fluorescence, negative staining, radio-labeling – Chemical modifications.

UNIT II
Structural Proteomics: Protein structure-function relationship – Disulfide bonds, Post translational modifications, Glycosylation, Phosphorylation, other modifications, Applications - methods for detection of protein-protein interactions - Yeast 1, 2 and 3 hybrid systems – Phage display – Surface Plasmon Resonance (SPR) - Fluorescence Resonance Energy Transfer (FRET) - Algorithms for proteomics –OMSSA - SEQUEST - MASCOT.

UNIT III

UNIT IV

UNIT V
Proteomic approach for Clinical studies: Protein Biomarker Discovery and Validation - Body fluid profiles, blood disease profiles, diabetes profiles, infectious diseases, stroke and myocardial infarction, nervous system, Alzheiner, low abundance and hydrophobic proteins. High through put techniques to identify protein molecules in sample - Emerging technologies: Proteomics in Biotechnology - Microfluidics.

Text Books
2. David O’Connor and David Homes, Proteomics, Scion Publishing Limited, Bloxham, Oxfordshire OX15 4FF.

Suggested Reading:
UNIT- I
Introduction - definition of statistics-population and universe - the sample and population- statistical inference- parameter and statistics
Handling of bulky data- construction a histogram- interpretation of histogram- the normal distribution- the mean-mode-and standard deviation- representing the normal curve as straight line- uncertainties in estimating a mean.

UNIT- II
Proportion data- Examples of Proportion data- MPM- sterility testing of medicines- animal toxicity- infection and immunization studies e.g., LD50, ED50, PD50 statistical treatment to proportion data- Chi-square test- goodness of fit to normal distribution.
Count data- Examples of count data (bacterial cell count, radioactivity count, colony and plaque count, etc.). Statistical treatment to count data- poisson distribution- standard error- confidence limits of counts.

UNIT- III
Analysis of variance- Introduction—procedure-F and t test.

UNIT- IV
Correlation regression and line fitting through graph points- standard curves-correlation- linear regression (fitting the best straight line through series of points)- standards curves and interpolations of unknown y-values thereon.

UNIT- V
Methodology for writing science report and oral presentation- compilation of experimental record- program of writing- use of vocabulary- use of good english-art of illustration- report writing- editing and correcting- technique of oral presentation.

Text Book:

Suggested Reading:
UNIT I
History and Scope of Microbiology: Contributions of Anton van Leeuwenhoek, Joseph Lister, Paul Ehrlich, Edward Jenner, Louis Pasteur, Robert Koch and Alexander Fleming; spontaneous generation, germ theory of disease, Koch’s postulates; Microscopy – lenses and bending of light; Microscopes- bright field, dark field, fluorescence, phase contrast and electron microscopes. Fixation and staining-principle and uses of simple staining-acidic and basic stains, differential staining-Gram’s, negative and spore stains.

UNIT II
Microbial diversity: Carl Woese’s three domain classification system. Major groups of bacteria- Archaeabacteria, Eubacteria- Bergey’s Manual of Systematic Bacteriology – identification of bacteria based on phenetic, physiologic/metabolic characteristics and molecular phylogeny. Classification of Viruses; General account on major groups of Fungi, Protozoa and algae; Economic importance of fungi and algae.

UNIT III
Structure and functions of Prokaryotic cellular components- cell wall composition of Gram positive and Gram negative bacteria, cell membrane, Cytoplasm, nucleoid, plasmids, types of inclusion bodies, endospore formation, flagella, pili, capsule and slime layer; Types and replication of animal viruses-DNA, RNA viruses; bacteriophages - Lysogeny and Lytic cycle; virus like agents- satellites, viroids and prions.

UNIT IV
Bacterial growth; sterilization methods-physical and chemical methods-disinfectants antiseptic agents; Culture media - composition and uses of solid, liquid, simple complex, differential and selective media; continuous and synchronous culture bacterial growth kinetics; Effect of pH, temperature and radiation on growth Antimicrobial agents: antibacterial, antiviral antifungal antihelminthic and antiprotozoan drugs; development of antibiotic resistance in microbes

UNIT V
Major microbial diseases in humans: Respiratory diseases-diphtheria, tuberculosis, pneumonia, Influenza and mumps; Skin diseases-measles, chickenpox, human papilloma virus, herpes Virus and dermatophyte (tinea) infections; Diseases affecting GIT- Oral thrush, typhoid, cholera, shigellosis, amoebiasis, giardiasis, hepatitis and pathogenic E. coli infections; Genitourinary infections – Trichomoniasis, syphilis, HIV, candidiasis; Diseases caused by protozoan and helminthic parasites- malaria, filariasis, trypanosomiasis and leishmaniasis.

Text Books:

Suggested Reading:
UNIT – I
**Automation in the clinical biochemistry:** Precision, reliability, reproducibility and other factors in quality control. Values in health and diseases.  
6 h

UNIT- II
Kidney function tests, osmolarity and free water clearances, acute and chronic renal failure.  
Liver function tests: clinical features and test based on bile pigments level, plasma changes, SGOT, SGPT, prothrombin time.  
8 h

UNIT- III
**Disorders of carbohydrate metabolism:** Diabetes mellitus, insulin receptors and c-peptide, assay of insulin, proinsulin and insulin antibodies. Hemoglobin A1c; fructosamines, insulin tolerance test. Glycogen storage diseases, galactosemia, fructosuria, pentosuria.  
6 h

UNIT- IV
**Prenatal Diagnosis:** Newborn screening: PKU, cystic fibrosis and sweat tests.  
8 h

UNIT – V
**Molecular diagnosis of genetic defects:** DNA probes; restriction fragment length polymorphism (RFLP); polymerase chain reaction (PCR); amplification of mRNA. Diagnosis of genetic diseases by molecular biology techniques (cystic fibrosis, Hemachromatosis, thalassemias, sickle cell diseases), Clinical diagnosis of AIDS.  
8 h

**Text Books**

**Suggested Reading**
1. Introduction to sterilization techniques- sterilization of glass wares, autoclaving.
2. Preparation of liquid and solid media
3. Isolation of Bacteria and fungi from soil samples – serial dilution technique
4. Establishment of pure cultures by spread plate, streak plate technique and pour plate techniques
5. Identification of bacteria by morphological and Biochemical characteristics
6. Smear preparation and staining of bacteria- simple staining, Grams staining and spore staining
7. Measurement of bacterial population by spectrophotometer and colony counting methods
8. Determination of Bacterial growth curve
9. *In vitro* antibiotic sensitivity tests for selected bacterial cultures
10. Methods for preserving microbial cultures: slant, glycerol stock and lyophilization

**REFERENCE:**

Unit I

**Overview of Genomics**: Introduction to Genomics, Structural genomics; Organelle genome-mitochondria and chloroplast; C- value, number of genes and complexity of genomes, Comparative genomics, Concepts of metagenomics Conservation and diversity of genomes.

Unit II

**The Genome project**: History, organization and goals of human genome project, Strategies for sequencing genomes, Genetic and physical map, DNA segment nomenclature, Human genome diversity, Organization of human genome: Mitochondrial genome, Gene density, CpG islands, RNA-encoding genes, Functionally identical/similar genes, Diversity in size and organization of genes, Annotation. Human Microbiome Project, 16S rRNA analysis, Synthetic Genomes.

Unit III


Unit IV

**Molecular markers in genome analysis**- for disease monitoring. Tools for genome analysis- RFLP, RAPD, AFLP, SSLPs, STR, EST and SNPs, Linkage and Pedigree, disease prognosis, genetic counseling.

Unit V

**Pharmacogenomics**: pharmacogenetics, cancer genomics; immunogenomics; somatic cell genomics; biochemical genomics; single cell analysis, genetics of globin triplet repeat disorders, polygenic inheritance; Effects of drugs in individual and susceptibility, Personalized medicine, Ethics and issues of synthetic life.

**Text Books**

**Suggested Reading**
UNIT- I

**Introduction** – Definition and Criteria for Stem Cells; Pluripotent, Multipotent and Totipotent Stem cells; Primordial Germ Cells, Embryonic Stem Cells; Amniotic Fluid Derived Stem Cells; Cord Blood Stem Cells.

UNIT- II

**Biology and Mechanisms** – Molecular Basis of Pluripotency, Mechanisms of Self Renewal, Chromatin signature of pluripotent cells, Cell cycle regulators in Stem Cells; Stem Cell Niches, Change of Phenotype and Differentiation, Senescence of Dividing Somatic Cells, Aging and stem cell renewal, Quiescent Stem Cells.

UNIT – III

**Tissue and Organ Development** – Differentiation in Early Development, Potency, Commitment, Polarity and the specification of asymmetric divisions, induction, competence determination and differentiation, morphogenetic gradients, cell fate and cell lineages, Epigenetic silencing and lineage commitment; Cellular differentiation of the Nervous system, Neuronal and Glial Progenitors in Adult Brain, Epithelial Stem Cells; Adult Progenitor Cells, Mesenchymal Stem Cells, Plasticity; De-differentiation, Cancer Stem Cells.

UNIT – IV

**Stem Cell Technology** – Characteristics and Characterization of Human Pluripotent Cells; Fluorescence and Magnetic bead Assisted Cell Sorting, Derivation, Characterization and Maintenance of Murine and Human Embryonic Stem Cells, Differentiation of Embryonic Stem Cells; Derivation of Induced Pluripotent Stem Cells; Derivation and Differentiation of Human Embryonic Germ Cells; Genomic Reprogramming, Fate Mapping of Stem Cells.

UNIT – V

**Stem Cells and Regenerative Medicine** - Neural Stem Cells in Neurodegenerative Diseases; Hematopoietic Stem Cell Transplantation; Epithelial Stem Cells and Burns; Stem Cells and Heart Disease; Pancreatic Stem Cells and Diabetes; Liver Stem Cells and Cell Therapy for Liver Disease; Embryonic Stem Cells in Tissue Engineering, Stem Cell Banking, Ethical Concerns in Stem Cell Research.

**Text Book:**


**Suggested Readings:**

UNIT – I

UNIT- II
Cancer biology and biochemistry- Aberrant metabolism during cancer development; Paraneoplastic syndromes; Tumor markers; cellular protooncogenes- oncogene activation. Growth factors-EGF, TNF-α and TGF-β and growth factor receptors–Signal transduction in cancer – Role of transcription factors.

UNIT- III
Carcinogenesis- radiation and chemical carcinogenesis- stages in chemical carcinogenesis- Initiation, promotion and progression. Free radicals, antioxidants in cancer; Viral carcinogenesis -DNA and RNA Viruses and human cancer; Cancer endocrinology.

UNIT- IV
Cell Cycle Regulation-Tumor suppressor genes p53, p21, Rb, BRACA1 and BRACA2. Telomeres, Telomerase, and Immortality; cell- cell interactions, cell adhesion-invasion and metastasis - VEGF signaling, angiogenesis; Epigenetics-Role of DNA methylation in gene silencing- epigenetic silencing of tumor-suppressor genes; Apoptosis in cancer-Cell death by apoptosis–role of caspases; Death signaling pathways-mitochondrial and death receptor pathways.

UNIT- V

Text Book:

Recommended Reading:
UNIT - I
Developmental Neurobiology: Organogenesis and neuronal multiplication, axonal and
dendritic growth, glial multiplication and myelination, growth in size, regeneration and
repair mechanisms, plasticity.

UNIT – II
Neuromorphology and neurocellular anatomy: Central nervous system – General features
of neurons, cellular organization of neurons, Dendrits and Axons, neurotubules,
neurofilaments, synapse neuronal, astrocytes, oligodendrocyte, ependymal cells, Schwann
cells.
Peripheral nervous system (PNS): Muscle, nerve endings, sensory receptor and effector
endings; peripheral nerves, spinal and cranial nerves: Plexuses ganglia, afferent pathways
and sense organs.
Spinal cord: Topographical anatomy, spinal nerves, spinal meanings, joint reflexes, gray
and white matter of spinal cord.

UNIT- III
Neurotransmitters: Acetylcholine, Dopamine, Norepinephrine, Serotonin, Histamine,
Epinephrine, Gamma-aminobutyric acid, Glycine, Glutamate, Aspartate, NO2, and CO
Chemistry, synthesis, storage and release of neurotransmitters, transmitter action, synaptic
modulation and mechanism of neuronal integration. Secondary Messengers: Importance of
cyclic nucleotides and protein phosphorylations in nervous system. Involvement of protein
kinases and calcium in neuronal metabolism.
Neuropeptides: Classes of neuropeptides, mode of action, role of neuropeptides in obesity
and pain neuropeptide receptors.

UNIT- IV
Learning and Memory: Correlation of behavioral and biochemical events, measurement of
learning and memory, agents affecting learning and memory, biochemical correlates of
excitation, learning and behavior.

UNIT- V
Neurodegenerative diseases: Parkinson’s, Alzheimer’s disease, amyotrophic lateral
sclerosis, senile dementia. Psychopharmacology and Biochemical theories of Mental
Disorder: Chemistry of neuroleptics and anxiolytics, antidepressants, hallucinogenic agents,
biochemical theories of mental disorders.

Text Books:
1. Basic Neurochemistry: Principles of Molecular, Cellular, and Medical Neurobiology (Eighth
Donald L. Price. ISBN: 978-0-12-374947-5

Suggested Readings:
Basic Science): Kim E Barrett, Susan M. Barman, Scott Boitano, Heddwen L. Brooks. ISBN-10:
UNIT- I
The stages of animal development, Human spermatogenesis and oogenesis, 8 h
Structure of the human sperm and the egg. Molecular events during mammalian fertilization:
Action at a distance, Induction of the mammalian acrosomal reaction, Translocation and
capacitation, Hyperactivation and chemotaxis, Fusion of genetic material in mammals,
Prevention of Polyspermy.

UNIT- II
An introduction to early developmental processes in mammals: The unique nature of 8 h
mammalian cleavage, Mammalian gastrulation, Formation of extra embryonic membranes,
Mammalian anterior-posterior axis formation, Mammalian dorsal-ventral and
left-right axes formation.

UNIT- III
Chromosomal sex determination in mammals: Primary and secondary sex determination, 8 h
Temperature-dependent sex determination in reptiles, Induction and competence.
Postembryonic development- Metamorphosis of frog: Morphological changes associated
with metamorphosis, Biochemical changes associated with metamorphosis,
Epimorphic regeneration of Salamander limbs.

UNIT- IV
Embryological origins of the gene theory, Mechanism of X chromosome inactivation, 6 h
Theories of ageing: Evolutionary theories of ageing, Integrated theory of ageing in the
nematode Caenorhabditis elegans.

UNIT- V
Properties of stem cells, Pluripotency of human embryonic stem cells, Embryonic stem cell 6 h
lines, Hematopoietic stem cells, Markers commonly used to identify stem cells, Embryonic
stem cells and their applications.

Text Books

Recommended reading
SYLLABUS FOR
Ph.D. DEGREE PROGRAMME

Pre-Ph.D. Examination
PAPER I – RESEARCH METHODOLOGY

UNIT I - ANALYTICAL METHODS  
Principles – Techniques and Applications of Electron Spin Resonance – Nuclear Magnetic resonance - Circular Dichroism (CD) – Optical Rotatory Dispersion (ORD)

UNIT II – GENOMICS AND PROTEOMICS  

UNIT III – BIOSTATISTICS  

UNIT IV – BIOINFORMATICS AND COMPUTER APPLICATIONS  
Computer Forms of biological information - Types of Nucleotide Sequence - Sequence databases: Nucleic acid sequence databases - Protein sequence databases: Uniprot-KB: SWISS-PROT, TrEMBL, UniParc; Sequence file formats: Various file formats for biomolecular sequences: GenBank, FASTA, GCG, MSF etc. Proteomics tools at the ExPASy server, GCG utilities and EMBOSS, Computation of various parameters
Sequence Analysis: Basic concepts of sequence similarity, definitions of homologues, orthologues, paralogues and xenologues - Basic concepts of sequence alignment: Measurement of sequence similarity; Identity, Similarity and homology. Pairwise Sequence Alignment, Needleman and Wunsch, Smith and Waterman algorithms for Pairwise Alignments, gap penalties, use of pairwise alignments for analysis of Nucleic acid and protein sequences and interpretation of results.

UNIT V: RESEARCH ETHICS AND INTELLECTUAL PROPERTY RIGHTS  
Regulatory Procedures: Good laboratory practice, Good manufacturing practice and FDA regulations - Regulations for recombinant DNA research and manufacturing process – Biosafety and Bioethics –
Intellectual Property Rights on Biotechnology by Singh KC, BCIL, New Delhi
Regulations for clinical trials, Documentation and Compliance, in India and selected countries - Rules for import and export of biological materials.
IPR - Definition - Forms of IPR Protection, WTO - Definition - Functions - International Treaties for IPR Protection - Other forms of IPR protection : Copyright - Trademark - Designs - Importance in Indian Scenario and laws in India for IPR protection
Patents - Definition - conditions for patentability - test of novelty patents - composition of a patent - Patenting of Biotechnological discoveries

References:
11. Bioinformatics: Sequence and Genome Analysis by Mount D., 2004 Cold Spring
15. Intellectual Property Rights by Deborah E. Bouchoux, Delmar Cenage Learning, 2005