Semester II

(Paper 5) SCRM.1.2.1 Clinical Biochemistry and Disease Metabolism (60 hrs)

Unit I. Amino acid Metabolism (15 hrs)

Body amino acid pool, Aminoacidopathies, Amino Acid Analysis, glutathione hyperglycinemias, formation of taurine, homocystinuria, cystinuria and cystinosis, phenyl ketonuria and alkaptonuria, albinism, tyrosinemia, Inborn errors in Nucleic acids, Diseases in nucleic acid metabolic disorders.

Unit II. Protein Metabolism (15 hrs)

Proteins – Catabolism and Nitrogen Balance, Dynamic state of body proteins; Plasma proteins - Prealbumin (Transthyretin), Albumin, Globulins; Total Protein abnormalities– Hypoproteinemia, Hyperproteinemia; Methods of analysis– Total nitrogen, Total proteins, Fractionation, Identification and Quantification of specific proteins, Serum protein electrophoresis, High-resolution protein electrophoresis, Immunochemical methods; Proteins in other body fluids – Urinary proteins and Cerebrospinal fluid proteins; Non-protein nitrogen compounds (Physiology, clinical application, methods and pathophysiology)– Urea, Uric acid, Creatine, Creatinine, Ammonia, Synthesis of thyroid hormones, Synthesis and catabolism of catecholamines.

Unit III. Clinically important enzymes and related pathophysiology (15 hrs)

Enzymes of clinical significance- Creatine Kinase, Lactate Dehydrogenase, Aspartate Aminotransferase, Alanine Aminotransferase, Alkaline Phosphatase, Acid Phosphatase, Glutamyl transferase, Amylase, Lipase, Glucose-6-Phosphate Dehydrogenase, Drug-Metabolizing Enzymes, Tumour markers, Bone markers, Cardiac markers, liver markers, Inborn errors associated with carbohydrate metabolism; Inborn errors of metabolism - Glycogen storage diseases, Fructosuria, Fructose intolerance, Pentosuria, Galactosuria, Urine screening.

Unit IV. Metabolic Diseases (15 hrs)

Blood glucose regulation (fasting/pp/random)–hormones influencing carbohydrate utilization, Insulin, glucagon, glucocorticoids, epinephrine, growth hormone. Hyperglycemia, Diabetes Mellitus, Hypoglycemia-Genetic Defects in Carbohydrate Metabolism. Arteriosclerosis, Hyperlipoproteinemia, Hypercholesterolemia, Hypertriglyceridemia, Combined Hyperlipoproteinemia, Lipoprotein(a) Elevation, Hypolipoproteinemia, Hypoalphalipoproteinemia; Lipid and lipoprotein analyses - Lipid Measurement, Cholesterol Measurement, Triglyceride Measurement, Lipoprotein Methods, High- Density Lipoprotein Methods, Low-Density Lipoprotein Methods, Compact Analyzers, Apolipoprotein Methods, Phospholipid Measurement, Fatty Acid Measurement.

Recommended Textbooks and References:

1. Michael L. Bishop, Edward P. Fody and Larry E. Schoeff; (2013). *Basic Principles and Practice of Clinical Chemistry*, (7th Ed). Lippincott Williams and Wilkins.

2. Stryer, L. (2002). *Biochemistry*, (8th Ed). Freeman.
3. D.M. Vasudevan and Sreekumari, S, (2010). *Textbook of Biochemistry for Medical Students*, (6th Ed). Jaypee Brothers Medical Publishers, New Delhi.
4. Sucheta Dandekar; (2010). *Concise Medical Biochemistry*, (3rd ed), Elsevier Health.
5. Satyanarayana and Chakrapani, (2013), *Biochemistry*; (4th Ed). Elsevier.
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(Paper 6) SCRM.1.2.2. Biostatistics and Bioinformatics (60 hrs)

Unit 1. Basic concepts in biostatistics and Descriptive Statistics (15 h)

Definition – Biostatistics, Variable: Quantitative and Qualitative Variable, Applications of statistics in Biology with Examples.

Sampling: Definitions, Population Sample, Advantages of Sample Studies. Types of Samples. Methods of Sampling- Simple random sampling, stratified random sampling, systematic sampling, cluster sampling, multistage sampling, multiphase sampling, Sampling error.

Descriptive statistics: Types of data - Qualitative, Quantitative, Categorical, Raw and grouped data. Averages - Arithmetic mean, Geometric mean, Median, Mode (Calculations, merits, demerits and uses). Measures of dispersion - Range, Mean deviation, Variable standard deviation, Coefficient of Variation (Computation, merits, demerits and application) Graphical Presentation of data - Pie chart, Bar diagram, Line graph, Histogram, Frequency polygon, Frequency Curve

Unit 2. Probability distributions, correlation and regression, Testing of significance (15 h)

Definition of probability - Classical relative frequency. Conditional probability. Addition theorem, Multiplication theorem and Baye's theorem (only statements) Discrete probability distributions-Binomial and Poisson (concept and list of applications.) Continuous probability distribution-Normal distribution concept, properties and applications.

Tests of significance: Null hypothesis, Alternate hypothesis, Type I error, Type II error, Level of significance, p-value, Power of the test, Concept of test of significance. Chi-Square test, Normal test, Student's t-test (paired and unpaired). Confidence interval for arithmetic mean and proportion. One-way analysis of variance (only introduction) Correlation and Regression: Dependent Variable, Independent variable, Definition and properties of simple Pearsons correlation co-efficient, Test of significance of correlation co-efficient, concept of simple linear regression, scatter graph with regression line.

Unit 3. Bioinformatics basics (15 hrs)

Bioinformatics basics: Computers in biology and medicine; Introduction to Unix and Linux systems and basic commands; Database concepts; Protein and nucleic acid databases; Structural databases; Biological XML DTD's; pattern matching algorithm basics; databases and search tools: biological background for sequence analysis; Identification of protein sequence from DNA sequence; searching of databases similar sequence; NCBI; publicly available tools; resources at EBI; resources on web; database mining tools.

Unit 4. Bioinformatics analysis (15 h)

DNA sequence analysis: gene bank sequence database; submitting DNA sequences to databases and database searching; sequence alignment; pairwise alignment techniques; motif discovery and gene prediction; local structural variants of DNA, their relevance in molecular level processes, and their identification; assembly of data from genome sequencing .Protein database, Sequence alignment programs, FASTA and BLAST Searches, Gene expression analysis using microarray , MiRNA sequencing, Sequence analysis using BIOPERL, Biochemical pathway database, Finding useful resources on the www.

References:

1. Wayne W. Daniel,Chad L. Cross- Biostatistics: A foundation for analysis in the health science, 10th edition (2013), John Wiley & sons
2. Richard J. Sundar P. S. Rao S. Introduction to Biostatistics and Research Methods, 4th edition (2006), Prentice-Hall of India Pvt.Ltd. publication
3. Armitage P and Berry G - Statistical methods in medical Research, 4th edition (2008), Oxford Blackwell scientific publication 4. Sokal P R and Rohlf F. R.-Biometry: The principles and practice of statistics in Biological, 3rd edition (1981), Freeman and company Sanfranscisco
4. Lesk, A. M. (2002). *Introduction to Bioinformatics*. Oxford: Oxford University Press.
5. Mount, D. W. (2001). *Bioinformatics: Sequence and Genome Analysis.* Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
6. Baxevanis, A. D., & Ouellette, B. F. (2001). *Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins*. New York: Wiley-Interscience.
7. Pevsner, J. (2015). *Bioinformatics and Functional Genomics*. Hoboken, NJ.: Wiley-Blackwell.
8. Bourne, P. E., & Gu, J. (2009). *Structural Bioinformatics*. Hoboken, NJ: Wiley-Liss.
9. Lesk, A. M. (2004). *Introduction to Protein Science: Architecture, Function, and Genomics.* Oxford: Oxford University Press.
10. Meeting Educational Needs with "Course" Remodelled Biotech Curricula
May, 2017Copyright © Deptt. of Biotechnology Ministry of Science & Technology Government of IndiaCompiled and Coordinated Ms. Shreya Malik, DM, BCIL
Edited Dr. Suman Govil, Adviser, DBT Dr. Purnima Sharma, MD, BCIL

11. Jaype Brothers, (2011), Methods in Biostatistics for Medical Students and Research Workers (English), 7th Edition.
Edited Dr. Suman Govil, Adviser, DBT Dr. Purnima Sharma, MD, BCIL

(Paper 7) SCRM.1.2.3 Biomedical instrumentation and Nanobiotechnology (60 hrs)

Unit I. Biomedical Instrumentation-I (15 hrs)

Partition and adsorption Chromatography- Paper, TLC,GLC, Gel filtration, Ion exchange chromatography, Gas Chromatography, HPLC, HPTLC, affinity chromatography, DNA cellulose chromatography and MAK hydroxyl-apatite chromatography. UV-Visible Spectroscopy, Mass Spectrometry, Lyophilizer.

Unit II. Biomedical Instrumentation -II (15 hrs)

Types of electrophoresis: moving boundary electrophoresis and zone electrophoresis(Paper, Cellulose -Acetate Electrophoresis, Gel Electrophoresis (Starch Gel, Native PAGE, Gradient PAGE, SDS-PAGE, Agarose Gel Electrophoresis, Iso-Electric Focusing, 2D Gel Electrophoresis), Biosafety cabinets, PCR, Flow Cytometer.

Unit III. Principles of Nanobiotechnology (15 hrs)

Biological Nanostructures and natural biological assemblies at nanoscale: Bacterial S layers, phospholipidmembranes, viruses, Nucleic acids, Oligosaccharides, polysaccharides, biological polymers, Proteins. Biological nanomotors, protein assemblies: Kinesin and dynein, cilia. Bacterial flagella: structure andfunction; nanomotor. Ion channels: nanopores of high specificity. Bioinspired nanomaterials: DNA and peptide based. Interaction between biomolecules and nanoparticle surfaces. Self-Assembly, Self-Organization, Molecular Recognition.

Unit IV. Biomedical applications of Nanobiotechnology (15 hrs)

Diagnosis: Bio MEMS, Nanochips-Gene chip and Protein chip, Ultrasensitive biobarcode, Nanobiosensors. Therapeutics: Nanobiotechnology in imaging, Woundcare products, Implantable materials and bionics for medical application, Implantable materials for orthopedics and dentistry. Nanorobotics, Nanotechnology based chemotherapy.

References:

1. David Friefelder, (1983), *Physical Biochemistry*, 2nd edition, W.H. Freeman and Co., USA.
2. G.H. Jeffery, J. Bassett. J. Mendham, R.C. Denney, (1991), *Vogel's Textbook of Quantitative Chemical Analysis*, 5th Edition, ELBS, England.
3. P.W. Atkins, (1996), *The Elements of Physical Chemistry,* Oxford University Press.
4. Jack A. Tuszynski Michal Kurzynski, *Introduction to Molecular Biophysics*, CRC Press. 370 | Remodelled Biotech Curricula
5. R.A. Day, A.L. Underwood*, Quantitative Analysis*, 1999, 6th Edition; Prentice-Hall of India Pvt. Ltd., New Delhi.
6. Plummer, 2002. *An Introduction to Practical Biochemistry,* 3rd edition, Tata Mc Graw Hill.
7. K Wilson and J Walker (eds.), 1999. *Principles and Techniques of Practical Biochemistry*, 4th edition, Cambridge Univ.Press.
8.GeroDecher, Joseph B. Schlenoff, (2003); *Multilayer Thin Films: Sequential Assembly of Nanocomposite Materials,* Wiley-VCH Verlag GmbH & Co. KGaA
9.David S. Goodsell, (2004); *Bionanotechnology: Lessons from Nature*, Wiley-Liss
10. Neelina H. Malsch, *Biomedical Nanotechnology,* CRC Press Greg T. Hermanson, (2013); *Bioconjugate Techniques*, (3rd Edition); Elsevier Recent review papers in the area of Nanomedicine.
11. Meeting Educational Needs with "Course" Remodelled Biotech Curricula

(Paper 8) SCRM.1.2.4 Stem Cell Biology (60 hrs)

Unit I. Introduction and basic biology of stem cells (15 h)

History of stem cell research, Stemness, Type of stem cells, Stem cell markers, Types of adult stem cells: Bone marrow, adipose tissue, cord blood, placenta etc, Differentiation and trans-differentiation of stem cells, Stem cell niches and regulation of stem cell niche in different adult tissues.

Unit II. Pluripotent stem cell and molecular mechanism of Self renewal and differentiation (15h)

Isolation and maintenance of embryonic stem cell isolated from: Mouse, Human, Extracellular signaling involved in embryonic vs adult stem cells, induced Pluripotent stem cells (iPSCs), Telomerase and its regulation, Symmetric and asymmetric division.

Unit III. Hematopoeitic stem cells and their differentiation (15h)

Bone marrow microenvironment, Hematopoietic stem cell mobilization, Isolation of Hematopoietic stem cells, Ex vivo expansion, Characterization of Hematopoietic stem cells, Transcriptional regulation of Hematopoietic stem cells, Side population phenotypes, endothelial progenitor cells, Multipotent adult progenitor cells, Differentiation of stem cells *in-vivo* and *ex-vivo*, Differentiation of hematopoietic stem cell lineages.

Unit IV. Cancer stem cells and their regulation (15h)

Introduction to cancer, Cancer stem cells, Pathways involved in cancer stem cells and their tumor progression, Pericytes and tumor angiogenesis.

References:

1. Ann A. Kiessling, (2003) *Human Embryonic Stem Cells: an Introduction to the Science and Therapeutic Potential*, Jones and Bartett.
2. Peter J. Quesenberry (1998), *Stem Cell Biology and Gene Therapy*, (1st Edition), Willy-Less.
3. Robert Lanja, (2006) *Essential of Stem Cell Biology,* 2nd Edition, Academic Press.
4. A.D.Ho., R.Hoffiman, (2006) *Stem Cell Transplantation Biology Processes Therapy*, illy-VCH.
5.C.S.Potten, (2006) *Stem Cells*, Elsevier
6. S. Indumathi- Stem cell therapy for organ failures, 1st edition (2015), Springer Verlag.
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Practical

(Practical 6) SCRM. 1.2.P.1 Clinical Biochemistry and Disease Metabolism (15 hrs)

1. Sugar estimation (fasting/post-pradial-random)
2. Total lipid profile
3. Blood cell count
4. Kidney Function Test: Urea - Diacetyl monoxime method
5. Creatinine test- Jaffe's Kinetic method
6. Protein Estimation: Total Protein- Biuret method, Albumin- BCG method
7. Determination of Km and Vmax for given enzyme.
8. Lipid: Cholesterol – by CHOD-POD Method
9. Body Elements: Calcium – CPC method, Phosphorus-Ammonium phosphomolybdate method
10. Liver Function Test: Bilirubin (total, direct and indirect)- Diazo Method, SGPT, ALP

(Practical 7) SCRM. 1.2.P.2 Biostatistics and Bioinformatics (15 hrs)

1. Using NCBI and Uniprot web resources.
2. Introduction and use of various genome databases.
3. Sequence information resource: Using NCBI, EMBL, Genbank, Entrez, Swissprot/ TrEMBL, UniProt.

4. Similarity searches using tools like BLAST and interpretation of results.
5. Multiple sequence alignment using ClustalW.
6. Phylogenetic analysis of protein and nucleotide sequences.
7. Use of gene prediction methods (GRAIL, Genscan, Glimmer).
8. Using RNA structure prediction tools.
9. Use of various primer designing and restriction site prediction tools.
10. Use of different protein structure prediction databases (PDB, SCOP, CATH).
11. Construction and study of protein structures using Deepview/PyMol.
12. Homology modelling of proteins.
13. Use of tools for mutation and analysis of the energy minimization of protein structures.
14. Use of miRNA prediction, designing and target prediction tools.

(Practical 8) SCRM. 1.2.P.3 Biomedical instrumentation and Nanotechnology (15 hrs)

1. Live cell imaging by microscopic technique
2. UV-spectrophotometer estimation of Protein
3. Paper Chromatography of proteins
4. Column Chromatography of Proteins
5. Preparation of Alginate beads.
6. Preparation of biopolymer functionalized particles.
7. Preparation of Hydrogel
8. Synthesis of silver NPs form different plant extracts.
9. Synthesis of gold NPs from different Plant extracts.
10. Antimicrobial activity of silver NPs.

(Practical 9) SCRM. 1.2.P.4 Stem Cell Biology (15 hrs)

1. Isolation of stem cells from cord blood
2. Isolation of stem cells from bone marrow
3. Isolation of stem cells from adipose tissue
4. Isolation of stem cells from cord tissue
5. Isolation of stem cell from endometrial tissue
6. Stem cell counting and viability checking
7. Cell proliferation assay
8. Growth curve and PDT analysis

(Practical 10) SCRM. 1.2.P.5 Industry Visit and Report