UNIVERSITY OF CALCUTTA

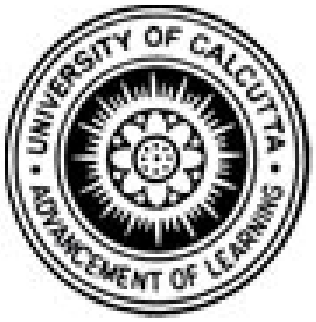
Notification No. CSR/ 58 /18

It is notified for information of all concerned that the Syndicate in its meeting held on 13.07.2018 (vide Item No.11) approved the Syllabus and Regulations of Two-Year (Four-Semester) M.Sc. Course of Study in Biochemistry under CBCS in the Post-Graduate Departments of the University and in the affiliated Colleges offering Post-Graduate Courses under this University, as laid down in the accompanying pamphlet.

The above shall be effective from the academic session 2018-2019.

(Debabrata Manna)
Deputy Registrar (Acting)

SENATE HOUSE
KOLKATA-700073
The 17th August, 2018



M.Sc. Regulations and Syllabus in Biochemistry, University of Calcutta 2018

The Regulations for two years M.Sc. course in Biochemistry, University of Calcutta (for the academic session 2018-2019 and onwards)

1. ADMISSION CRITERIA: The University of Calcutta shall provide instructions leading towards two year M.Sc. degree. A candidate who has passed the 3-year B.Sc. (Hons.) Examination will be eligible to seek admission to the course as may be approved and notified from time to time by the University. Reservation of seats will be governed by the rules of the University of Calcutta or as mentioned in admission regulations framed by the University time to time. At present, at least 55% marks in B.Sc. Hons. in Chemistry/Biochemistry/Physics/Zoology/Botany/Physiology/Microbiology/ Anthropology/Environmental Science/any Life Sc. or its equiv. All the candidates should have Chemistry as one of the General subjects (except the candidates with Hons. in Chemistry/Bio Chemistry) at the under Graduate level. All the candidates should have 60% marks in aggregate in Physics, Chemistry, and Mathematics at 10+2 level.
Part A: 60% of total seat is earmarked for C.U. BC Hons current year candidates. Part B: 40% of total seat is open to all for both C.U. & Non C.U. current year & previous year BC Hons & other eligible Hons. candidates.

2. EXAMINATION STRUCTURE: The duration of the course shall be two academic years and the examination for the M.Sc. degree shall be held over four semesters over a total of 1000 marks and 80 credits. The duration of the semesters shall be as follows:

1st Semester: July - December
2nd Semester: January - June
3rd Semester: July – December
4th Semester: January – June

Examinations would be held after the completion of curriculum at the end of each semester. However, evaluation of the practical will be based on continuous assessment as well as on the final Viva-Voce examination of the students on the experiments, to be conducted by internal and/or external examiners.

Examination timing:
Theory
Up to 25 marks: 1 hour
26 to 40 marks: 1.5 hours
41 to 50 marks: 2 hours
51 to 75 marks: 3 hours
76 to 100 marks: 4 hours

3. FEES STRUCTURE: Monthly and yearly fees to be collected from a student as per academic year July to June. Examination fees and other related fees are payable by the candidates as may be prescribed by university from time to time.
4. ATTENDANCE: A candidate shall be eligible for appearing at the examination provided he/she prosecutes a regular course of studies in the concerned Post Graduate (PG) Department for that semester in the subject and attends at least 65% of the total number of the Theoretical, Practical and Seminars separately held during the semester. A candidate failing to secure pass marks in a specific paper(s) shall not have to attend classes for appearing in the corresponding back paper(s) in asubsequent semester.
Condonable Limit: A student who has attended at least 55% of the classes but less than 65% of the classes shall, however, be eligible to appear in the examination upon payment of condonation fee as may be prescribed by the university from time to time and after obtaining condonation order from the Vice Chancellor.

A candidate who becomes ineligible to appear in a semester examination due to shortage of attendance will have to attend the classes in the corresponding semester of the following academic session by paying prescribed fees.

5. MAXIMUM PERMISSIBLE TIME FOR COMPLETING THE COURSE: Students have to clear the entire course within 4 years from the year of first admission.

6. EXAMINER: Paper setters, moderators, examiners, scrutineers for each paper will be appointed on the recommendations of the Board of Post Graduate studies in the concerned subject. Scripts will be examined by single/multiple examiner(s) for all theory papers and double/multiple (internal and external) for all practical papers, dissertation, viva voce etc.

7. PASSING CRITERIA: A candidate is required to appear at the examination in each and every paper/course/module/part/group of the respective syllabus. A candidate in order to be declared to have passed an examination, must obtain at least 40% marks in each paper/course/module/part/group. In case of a paper/course/module/part/group containing both theoretical and practical portions, a candidate is required to secure at least 35% marks separately in the theoretical and practical portions and at least 40% marks in aggregate in that paper. Candidates shall not be allowed to appear at any higher semester examination without appearing and clearing the minimum number of requisite paper(s) of all the previous semester examinations as mentioned here in after.

8. CRITERIA FOR RE-APPEARING AT SUPPLEMENTARY EXAMINATION: If a student gets 'F' in a particular paper, he/she shall be deemed to have failed in that paper only and shall be required to appear in a supplementary examination to be offered within six months of the original examination. Candidate who fails in one or two papers can clear the paper/s in two more consecutive chances **(excluding the main examination)** along with higher semester examination. If the candidate is unable to clear the same within two consecutive chances, he/she shall be dropped from the concerned course.

A candidate who has **failed** in more than two papers will have to appear at the same semester without appearing at the higher semester. In that case, attendance in the theoretical classes will not be mandatory; however, the candidate has to attend practical classes, considering the evaluation of practical is through continuous assessment. A failed candidate, intending to re-appear in a subsequent semester has to take permission from the concerned Faculty Secretary through the Head of the Department immediately after publication of result.

If all the chances of a candidate (Main + 2) has been exhausted, he/she has to drop or leave the course. He may apply for re-admission in the same course of study in the 1st Semester of the next academic session along with the fresh applicants. In any case, the candidate has to clear the entire course within 4 years from the year of first admission.

9. ABSENT CRITERIA: Failure to fill up the examination form shall be considered as missing a chance and such candidates who have not filed up the examination form shall have to appear at the same semester examination with required attendance. A candidate who has filled up the examination form but remains absent in the entire examination or more than two courses will be considered to have lost a chance and shall be required to re-appear at the same semester examination. A candidate remaining absent in one or two papers/courses but clearing the other papers/courses shall be considered to have failed in those papers/courses in which he remains absent and shall be eligible to clear those as stated above.

10. READMISSION CRITERIA: If a student is dropped from the respective course of study because of his failure to clear a particular course within 4 years, he/she may apply for readmission in the same course of study in the 1st semester of the next academic session along with the fresh applicants.

11. CONSOLIDATED MARK SHEET: After passing all the semesters a candidate may apply for a consolidated mark sheet to the Controller of Examinations upon payment of such fees as prescribed by the university.

12. DATE OF PUBLICATION OF FINAL RESULT: For a regular student who has cleared all the semesters in normal course the date of publication of final result shall be the date of publication of result of the 4th semester. The final date of publication of result for students clearing previous semester(s) subsequent to their clearing 4th semester examination will be **date of publication of the last result clearing all papers.**

13. CALCULATION OF GRADE POINTS, SGPA AND CGPA: The schedule of papers, distribution of marks and credits, for the M.Sc course shall be determined by the concerned department duly approved by the respective Faculty Council/PG Board of studies. Credit-weighted grade point system will be followed and therefore only the grade points but not the overall percentage of marks either in individual paper or in aggregate marks will be provided. The grade points will be given according to the following computation.

Grading of students' performance:
Grade scores will be calculated in a scale of 6 (six) as per the following table:

Marks (%)	Numerical Grade points	Grades	Grade Score added per each additional mark to minimum grade score in the bracket
80-100	5.00 - 6.00	Outstanding (O)	0.05
70-79	4.50 – 4.99	Excellent (A+)	0.05
60-69	4.00 – 4.49	Very Good (A)	0.05
55-59	3.75 – 3.99	Good (B+)	0.05
50-54	3.50 – 3.74	Fair (B)	0.05
40-49	3.00 – 3.49	Satisfactory (C)	0.05
00-39	Below 3.00	Fail (F)	0.075

Award of Grade Points:
For example, if a student scores 53% in theory and 68% in practical in a 3-credit course (2+1), his/her grade point for the course will be as follows:

$$\text{Grade point} = \frac{2\times(3.5+0.05\times3)+1\times(4.0+0.05\times8)}{2+1} = 3.90$$

For a credit course with no practical component, for example a 2-credit course, if a student scores say, 56%, then the grade point will be:

$$\text{Grade point} = \frac{2\times(3.75+0.05\times1)}{2} = 3.80$$

Semester Grade Point Average (SGPA):
The computation of average grade point of a student in a semester will be worked out as follows:

N_{th} Semester

Courses	Credits	Grade Scored
1	2+1	5.65
2	2+1	5.33
3	2+0	3.99
4	2+0	5.05
5	3+1	4.22
6	3+1	4.46
Average grade point		**4.76**

Semester Grade Point Average (SGPA) = 4.76

Average grade point= (5.65×3) + (5.33×3) + (3.99×2) + (4.22×4) + (4.46×4) = 4.76

Cumulative Grade Point Average (CGPA) over four semesters:
Working out simple average of SGPA obtained over four semesters, cumulative grade point average will be given after four semesters.

Significance of grades:
On the basis of the cumulative results of the student's performance, the following grades will be given in each semester as well as over four semesters.

Grade points	Grades	Class
5.00 - 6.00	Outstanding (O)	First (I)
4.50 – 4.99	Excellent (A+)	First (I)
4.00 – 4.49	Very Good (A)	First (I)
3.75 – 3.99	Good (B+)	Second (II)
3.50 – 3.74	Fair (B)	Second (II)
3.00 – 3.49	Satisfactory (C)	Second (II)
Below 3.00	Fail (F)	Fail

If a candidate gets "F" grade in one or more courses/modules/groups in a semester examination, his SGPA in that semester shall be temporarily withheld and GPW (Grade Point Withheld) shall be marked against SGPA on the mark sheet. A fresh mark sheet with duly calculated SGPA shall be issued only when a candidate clears the course subsequently but within the stipulated period.

14. GRACE MARKS: A candidate failing to obtain the pass marks in a semester examination shall be given benefit of one additional mark in the paper in which he/she secured lowest marks and the same shall be shown in the Tabulation Rolls. However, in the mark sheet, only the marks shall be shown after such addition.
A candidate failing to obtain 50% or 55% or 60% marks in the aggregate of all the semesters by one mark only shall be given the benefit of one additional mark in the result of final semester and the same shall be reflected both in the Tabulation Roll as well as in the mark sheet.

15. RANKING: Candidate unable to clear each part of all the semester examinations in one chance shall not be entitled to any position in order of merit. To be eligible for award of rank in order of merit, a candidate must pass all the semesters at first chance as regular candidate.

16. CANCELLATION OF EXAMINATION: Candidates may apply to the Controller of Examinations for cancellation of enrolment of the said examination within fifteen days from the date of completion of theory papers. The said cancelled examination will also be counted as a chance.

17. Re-Examination: There will be a provision for the candidates to apply for re-Examination of their answer scripts for core courses following the rules of the University of Calcutta.

18. CHOICE BASED CREDIT COURSE: A student will have to take two courses from Choice Based Credit Courses (CBCCs) in addition to courses offered by the department. The students will have to choose one course each from two groups: CBCC-A & CBCC-B. Each course is of 50 marks and carries 4 credits.

- No student is allowed to choose the course offered by his/her parent department.
- Intake capacity for optional papers will be as per the Common CSR-CBCC.
- Students would be given the opportunity to choose the optional courses on the basis of their M. Sc. 1st semester marks or any process framed by the department/university from time to time. This process would be supervised by the parent department.
- Attendance for the optional course would be maintained by the parent departments. Percentage of attendance will be as per University rules.

Distribution of Courses in Four Semesters for M.Sc. in Biochemistry (for the academic session 2018-2019 and onwards)

		COURSES		MARKS	CREDITS
Semester-1					
Theoretical	1.	BCT101	Metabolism-I	25	2
	2.	BCT102	Advanced Enzymology	25	2
	3.	BCT103	Microbiology	35	3
	4	BCT104	Fundamentals of Biochemistry	35	3
	5.	BCT105	Molecular Biology	25	2
	6.	BCT106	Cell Biology-I	25	2
Practical	1.	BCP101	Analytical Biochemistry	25	2
	2.	BCP102	Enzymology	25	2
	3.	BCP103	Microbiology	25	2
				245	**20**
Semester-2					
Theoretical	1.	BCT201	Bioinformatics	25	2
	2.	BCT202	Biophysical Chemistry	30	2
	3.	BCT203	Metabolism-II	30	2
	4.	BCT204	Recombinant DNA Technology	30	2
	5.	BCT205	Bioenergetics	25	2
Practical	1.	BCP201	Bioinformatics	25	2
	2	BCP202	Biophysical methods	25	2
	3.	BCP203	Protein Purification	25	2
	4.	BCP204	Molecular biology	25	2
	5.	BCP205	GRAND VIVA	25	2
				265	**20**
Semester-3					
Theoretical	1.	BCT301	Cell Biology-II	35	2
	2.	BCT302	Molecular Biology and Genetics	30	2
	3.	BCT303	Bacterial Genetics and Virology	25	2
	4.	BCT304	Developmental Biology	20	2
	5.	----------	CBCC-A	50	4
	6.	----------	CBCC-B	50	4
P	1.	BCP301	Cell Biology	25	2
	2.	BCP302	Project Presentation	25	2
				260	**20**
Semester-4					
Theoretical	1.	BCT401	Immunology	35	3
	2.	BCT402	Plant Biochemistry	35	3
	3.	BCT403	Neurobiochemistry	35	3
	4.	BCT404	Biochemistry of the Diseases	35	3
	5.	BCT405	Ecological Principles	35	3
P	1.	BCP401	Immunology	25	2
	3.	BCP403	**GRAND VIVA**	30	3
				230	**20**
				1000	**80**

Detailed Syllabus for two years M.Sc. Course in Biochemistry, Calcutta University for the academic session 2018-2019 and onwards)

A.Theoretical Courses

(Numbers in Parentheses indicate no. of lecture hours)

Semester 1

BCT 101: Metabolism-1: 25 marks

Lipid Metabolism: Lipid digestion, absorption and transport. (1)
Lipid Oxidation (β- oxidation: Staurated & Unsaturated, Minor pathways of fatty acid oxidation : α -oxidation, γ-oxidation) (2);Lipid biosynthesis (fatty acids, triacylglycerols, glycerophospholipids) (1);Ketone bodies -synthesis, functions (1);Cholesterol -utilization and synthesis(1);Liporoteins-structure, classification, functions(1);Regulation of lipid metabolism and metabolic disorders (fatty acids, cholesterol, lipoproteins) (1)
Amino acid Metabolism: An overview of source and utilization of amino acids in human body(1). Breakdown of amino acids (Amino group: transamination, oxidative deamination; Carbon skeleton: glucogenic, ketogenic). (2); Urea cycle (complete reactions, regulation of the urea cycle). (1);Biosynthesis of the nonessential amino acids, Metabolic disorders (PKU, BCAA, Hyperhomocysteinemia).(1)
Carbohydrate metabolism (6) Catabolism (EMP, HMP, Glycogen Breakdown); Anabolism (Glycogen Synthesis, gluconeogenesis); TCA Cycle (anaplerotic)
Nucleic Acid Metabolism (5)

Reference Books:
1. Lehninger's Principles of Biochemistry, David L. Nelson, Michael M. Cox. Publisher:W.H.Freeman.
2. Biochemistry-Jeremy M Berg, John L Tymoczko,and Lubert Stryer. Publisher:WHFreeman
3. Biochemistry, 4thEdition-DonaldVoet, Judith G.Voet.–Publisher: JohnWiley & Sons.
4. Biochemistry; Voet , D. and Voet, J.G. [Eds.] (1999) 3 Ed. Jhon Wiley and sons.
5. Biochemistry; David Rawn, J. (1989) Neil Patterson Publishers.
6. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.

BCT 102 : Advanced Enzymology:25 marks

Classification, comparison between chemical and biological (enzyme) catalysis, coenzyme, cofactors, concept of rate enhancement in intermolecular vs intramolecular reactions i.e. extent of randomness and reaction rate with an example, how is the enhanced rate of an enzyme catalyzed reaction explained with the help of that concept. Functional groups (R-groups of amino acids) involved in enzyme catalysis, classical approach to identify crucial amino acid(s) involved in enzyme catalysis (use of specific inhibitors of amino acids followed by limited proteolysis)-(4)
Mechanism of enzyme reactions: serine protease, carbonic anhydrase (metalloenzyme) and restriction endonuclease –(5);
Regulation of enzyme activity: Covalent modifications (examples) [PTMs and proteolytic activation of enzymes] Blood clotting cascade, Zymogens, isozymes and their significance (LDH) –(2) ; Allosteric enzymes, Sigmoidal kinetics; Aspartate transcarbamoyase (ATCase), T & R states

(quaternary structures), positive and negative modulators; PKA and role of cAMP –(3)
Transition state analogue, catalytic antibodies, suicide inactivation –(1)
Thermodynamics of enzyme-substrate interactions, Binding energy in catalysis; Fundamental principles of reaction Kinetics and equilibria. (1); Steady state enzyme kinetics; differences between a chemical equilibrium and steady state kinetics; Limitation of Michealis-Menten equation, Briggs-Haldane kinetics ; Van Slyke-Cullen behavior, Physiological significance of kinetic parameters (3); Cooperativity, allosteric enzymes and their modes of action; concerted, sequential and morpheein theory of allosterism; Ensemble models for allosterism Design of protein switches based on an ensemble model of allostery. (1)
Multisubstrate systems and their kinetics ; Multienzyme complexes (2) ; Immobilised enzyme systems(1); Enzyme Inhibition; Irreversible inhibitors. (1)
Enzyme reconstitution, Enzyme assays, Isolation, Purification and Criteria for Determining Purity of Enzymes.(2); Measurement and magnitude of enzyme rate constant; Transient kinetic methods Detection of intermediate in reactions-Relaxation methods. (1)

Reference Books:

1. Fundamentals of Ezymology; 3rd Edn. Nicholas C. Price and Lewis Stevens, Oxford University Press (2012).
2. Enzymes; Trevor Palmer, East – West Press Pvt. Ltd., Delhi (2004).
3. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis; Robert A. Copeland , Wiley-VCH Publishers (2000).
4. Enzyme Kinetics and Mechanism; Paul F. Cook, W. W. Cleland, Garland Science (2007).
5. Biochemical Calculations, Irwin H. Segel (1976) 2nd Ed. John Wiley and Sons.

BCT 103 Microbiology: 35 marks

1. Microorganisms: The unifying focus of Microbiology: Structural organization of Microorganisms: Bacterial, Archaeal and Eukaryotic cell, Evolution of Microorganisms, Millers Experiment, Carle Woese three domain classifications, Early Observation of Microorganisms, Establishing that Microorganisms are Living Organisms, Theory of Spontaneous Generation, Pasteur and the final refutation of Spontaneous Generation-Birth of Microbiology as a Science. Koch's postulates, Methods for studying Microorganisms, Identification of Microorganisms: Ribotyping.(4)

2.Microbial Physiology-Cellular Biology: Organization and structure of microorganisms: Morphology, role of Fts Z, Mre B, Cresentin shape External structure that protects the cell, cellular genetic information, Ribosomes, Sites of Cellular Energy Transformation where ATP is generated, Coordinated Material Movement and Storage in Cells: Sec Chaperone, Structures involved in attachment, strategies of cell division.(4)
Stress response, two component signaling system, and survival through the production of spores. Factors influencing bacterial growth: pH, temperature, oxygen, salt, water activity, pressure: Mechanism of survival of acidophiles, alkaliphiles, halophiles, Arc and Fnr system, Stringent response, Chemotaxis, Biofilm formation.(6)

3.Growth of bacteria: Growth of bacteria in liquid medium, methods of measurement of growth, growth kinetics, relation of growth to substrate concentration, the chemostat, synchronized growth, growth on solid medium, uses of solid media, techniques of pure cultures, differential media, selective media, synthetic media. (2).

4.Staining of bacterial cells: Stains and Staining, dyes, chromophoric and auxo-chromic groups, classification of biological stains, basic dyes, acid dyes, principle of staining: physical and chemical, mordants, simple staining, Differential staining, Gram staining, Mechanism of Gram and acid- fast staining, Endospore staining, (2)

5.Control of microorganisms by physical agents : The rate of death of bacteria, condition influencing antimicrobial action, high temperature, Thermal death time (TDT), decimal reduction time (D value), F value, 12-D Process, Pasteurization and Z-value; low temperature, Desiccation, Osmotic pressure, Radiation, Surface Tension, filtration. (2)

6.Control of microorganisms by chemical agents: Characteristics of an ideal antimicrobial chemical agent and its selection for practical application. Sterilization, disinfectant, antiseptic, sanitizer,

germicide, bactericide, bacteriostatic, Major groups of antimicrobial agents and their mode of action: phenol and phenolic compounds, alcohols, halogens, Heavy metals and their compounds, Dyes, synthetic detergents, quaternary ammonium compounds, aldehydes, Gaseous agents, Evaluation of antimicrobial chemical agents, tube dilutions and agar diffusion techniques, phenol coefficient methods. (3)

7.Antibiotics and other chemotherapeutic agents: Historical highlights of chemotherapy, Classes of antibiotics and their properties; Structure and mode of action of antimicrobial agents: Aminoglycosides, Carbapenems, macrolids, β-lactam antibiotics, Quinolones and fluoroquinolones, Sulphonamides, Tetracyclines, Chloramphenicol, Chloroquine, Rifampicin, Streptolydigin, Puromycin; Inhibitors of nucleic acid and protein synthesis, Inhibitors of DNA and RNA polymerases, Anti-fungal agents: affecting terminal respiration of microbes, inhibitors of ergosterol synthesis (Polyenes etc.), Antiviral drug structures and their mode of action, microbiological assay of antibiotics, nonmedical uses of antibiotics. (6)

8. Resistance to antimicrobial drugs: mechanisms; β-lactamase inhibitors, the genetics of drug resistance, biochemical mechanisms of drug resistance, practical approaches to the control of drug-resistance. (2)

9. Water microbiology; Characteristics of pollution indicator microorganisms, Definitions for indicator and index micro-organisms of public health concern, Microbiological characteristics of pollution indicator microorganism, Growth pattern of fecal and non-fecal coliforms on differential media, IMViC test. (1)

Reference Books:

1. Gottschalk G(1986). Bacterial Metabolism, Springer,
2. Caldwell DR(2002).Microbial Physiology and Metabolism, 2nd ed., Star
3. Moat AG, Foster JW & Spector MP(2002). Microbial Physiology,4th ed., John Wiley and Sons
4. Nelson DL & Cox MM(2008). Lehninger's Principles of Biochemistry, 5th ed., WH Freeman & Company
5. Berg JR, Tymoczko CZ & Stryer L(2006). Biochemistry, 6th ed., W.H. Freeman and Company
6. Prescott LM, harley JP & Klein DA(2005).Microbiology, McGraw Hill International Edition, USA.
7. Willey JM, Sherwood LM & Woolverton CJ DA(2008). Prescott, Harley & Klein's Microbiology, 7th ed., McGraw Hill International Edition, USA.
8. Brown AE (2005). Benson's microbiological applications. TataMacGrawHill
9. Microbiology by Pelczar M.J., Ried, RD and Chan, ECS.
10. Microbiology by Gerard J. Tortora, Berdell Ra. Funke and Christine L. Case. Publ: Pearson Education Inc

BCT 104: Fundamentals of Biochemistry: 35 marks

pH and Buffers: (Three Lectures: 1 hour each)

Bronsted-Lowry Concept of Acids and Bases, Buffers: HendersonHasselbalch equation, Biological buffer systems: The phosphate buffer system, The bicarbonate buffer system, The protein buffer system, The amino acid buffer. system, The hemoglobin buffer system.

Biomolecules: (Total Twenty Lectures: 1 hour each, Average 4-6 lectures [1 hr. each] per Biomolecule)

Carbohydrates: Importance,Nomenclature, Classification, Asymmetry,Optical Isomerism, Mutarotation, General structure of monosaccharide, disaccharide, oligosaccharides, polysaccharides (Lactose, Maltose, Cellobiose, Isomaltose, Trehalose, Starch, Glycogen, Cellulose, Pectin, Chitin, Heparin.

Proteins: Importance, Amino Acids: Structure, Distribution in Proteins, Location in proteins, Physical properties, Electrochemical properties, Classification, Nonprotein Amino Acids, Peptide bonds, Chemical Bonds involved in Protein structure. Protein Configuration: Primary Structure, Secondary Structure, Tertiary Structure, Quaternary Structure, Physical Properties of Proteins: Shape and Size, Molecular weight, Colloidalnature, Denaturation, Amphoteric nature, Solubility, Optical Activity, Chemical Properties of Protein: Hydrolysis, Reaction involving COOH group, NH2 group, R group, SH group.

Lipids: Importance, Definition, Alcohols and Fatty Acids, Biological roles oflipids,Classification: Simple Lipids and Compound Lipids, Properties of Fats and oils: Solubility, Melting Point, Insulation, Emulsification, Surface Tension, Chemical Properties: Reactions involving COOH group, Hydrolysis, Saponification, Rancidity, Hydrogenation, Halogenation, Oxidation, Oxidative Rancidity, Reactions involving OH . group, Dehydration.
Nucleic Acids: Nucleosides, Nucleotides, DNA, Intemucleotide linkages, Basecomposition, Evolution of Watson-Crick model; Double helical structure, Denaturation and renaturation, Molecular weight, Length, Shape and Size, Variants ofDouble helical DNA, DNAs with unusual structures, Single stranded DNA, RNA. Differences with DNA, Ribosomal RNA, Transfer RNA, Messenger RNA, Heterogeneous nuclear RNA.
Analytical Biochemistry: (Total Five Lectures: 1 hour each) (Average 1-2 lecture/s [1 hr. each] per section)
Principles and application: equipments, sample preparation, Homogenization, Differential centrifugation, Ultracentrifugation, Spectrophotometry. Chromatography, Electrophoresis.

Reference Books:
1. Nelson DL & Cox MM (2008). Lehninger's Principles of Biochemistry 5th ed., WH Freeman & Company
2. Berg JR, Tymoczko CZ & Stryer L(2006). Biochemistry, 6th ed., WH Freeman & Company
3. Conn E.E. & Stumpf PK (1988) Outline of Biochemistry John Wiley & Sons.
4. Freifelder. Physical biochemistry, freeman company.
5. David Sheehan(2009). Physical Biochemistry: Principles and Applicatons, John Wiley & Sons Ltd, Chichester, England,
6. Skoog, Holler & Nieman. Principles of Instrumental Analysis.
7. Biochemistry; Voet, D. and Voet, J.G. [Eds.] 3rd Ed. Jhon Wiley and sons, (1999).

BCT 105 Molecular Biology: 25 marks

DNA replication (7): Models of DNA replication (Semi-conservative, semi-discontinuous, bidirectional replication, rolling circle, mitochondrial D loop), Enzymolozy, Mechanisms and control.
Recombination (2): Homologous recombination, transposition and site specific recombination
Mutation (1): Classification, random or spontaneous, agents,
Repair (2): Proofreading and MMR, postreplication repair and SOS, photoreactivation repair, excision and DSB repair,
Mechanism of Transcription (5) **:**RNA Polymerase; Sigma Subunits; The Structure of Promoters; Enhancers and Enhancer-Binding Proteins; DNA, Abortive Initiation; Pre-Initiation complex assembly in Eukaryotes and general transcription factors; Initiation. Elongation and termination,PolII CTD phosphorylation and PolII recycling during eukaryotic transcription; Inhibitors of transcription.
Discovery of the genetic code (1)
Protein Synthesis (4): Ribosome composition; tRNA; Fidelity of aminoacylation; Shine Dalgarno hypothesis and its experimental verification; Initiation; Ribosome translocation and translational elongation; EF-Tu –GTP regeneration; Termination and nonsense suppression; Messenger instability; Stringent Response, inhibitors of protein synthesis. Cap dependent initiation, IRES, uORFs and role of eIF2 kinases in translation initiation.
Regulation of Gene expression in Prokaryotes (4):Overview of regulatory strategies; araBAD Operon, trp Operon: DNA looping and unlooping; Riboswitches ;Heat shock response in *E.coli*, Flagellar variation in salmonella; Lux Operon and quorum sensing, Two component systems in nutrient sensing; Ordered gene expression,Lac operon: Model to understand the logic of experimental design for investigating various aspects of gene expression and its regulation , RNA as a regulator of gene expression
Problem solving and concept integration (2): Includes the various techniques involved in assessment of gene expression levels and regulatory effects.

Reference Books:

1. Genes VIII, Lewin, B, Publish Oxford University Press
2. Molecular Biology of the Gene by Whatson JD, …..Losick R. Pub Pearson Education
3. Nelson DL & Cox MM(2008). Lehninger's Principles of Biochemistry 5th ed., WH Freeman & Company
4. Berg JR, Tymoczko CZ & Stryer L(2006). Biochemistry, 6th ed., WH Freeman & Company

BCT 106 Cell biology-I: 25 marks

Visualization of cell: Evolution of techniques, stains and dyes, power of microscopy, concept of marker proteins, immuno-staining, immunofluorescence staining (direct and indirect), choice of antibodies, immuno-EM (gold labeled antibodies) ---- (6)

Subcellular fractionation: Cell lysis methods, Differential centrifugation, enrichment of organelles i.e. organelle marker proteins, assay of marker enzyme/proteins in the subcellular fractions, Western blotting ------ (6)

A brief history of studies on Plasma Membrane structure: Fluid Mosaic Model (1)

The chemical composition of membranes: Membrane lipids, The asymmetry of membrane lipids, membrane carbohydrate, Liposome.(1)

The structure and function of Membrane Proteins: Cell fusion experiment, FRAP, SPT. Two Classes.

Membrane fluidity, Transition temperature, Factors influencing membrane fluidity, Role of Cholesterol in membrane fluidity, Lipid Rafts.(2)

Movement of substances across cell membrane, ion channels, potassium ion channel, Sodium Potassium ATPase pump. (2)

Overview of the major functions of the cytoskeleton, the study of different cytoskeleton. (1)

Microtubules: Structure and Function, Dynamic instability of Microtubules. (1);Microtubule associated proteins (MAPs), Motor proteins: Kinesin, Dynein, In vitro motility assay(1);Microtubule organizing centers (MTOCs) in animal and plant cell(1)

Reference Books:

1. Molecular Cell Biology, 4th edition. Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell. New York: W. H Freeman

Semester 2

BCT 201: Bioinformatics:25 marks

1. Biostatistics (6)

Testing of hypothesis: null and alternate hypotheses, type – I and type – II errors, power of test; Examples of testing problems based on normal distribution: t-test (one-sample, two-sample, and paired sample), test for equality of variances, ANOVA (one- and two-way); Test for checking normal distribution; Basic idea of large sample tests: test for binomial proportion for one-sample and two-sample; Chi-square tests with examples of different problems. Examples from Bioinformatics and Biomedical cases

2. Bioinformatics (19)

Concept of homology, paralogy, orthology, analogy and xenology

Comparison of sequences of biological macromolecules – Pairwise alignment: local and global alignment; Concept of indel, affine gap penalty; Database search algorithm, significance of hits, Karlin Altschul equation; Multiple sequence alignment, concept of consensus, interpretation with regular expression, concept of protein profile and PSSM, algorithm of PSI-BLAST. PHI-BLAST and other forms of BLAST.

Concept of tree, reading and interpreting phylogenetic trees, distance-based and character-based

methods for the construction of phylogenetic trees, judging strength of clades (with BS or PP values) in a tree.

Kyte-Doolittle plot and Hopp-Woods plot- prediction of localization of a protein, prediction of TMD. Secondary, tertiary and quaternary structure prediction –concept of propensity in Chou-Fasman method; Homology modeling, threading and ab initio method; Docking – rigid and flexible, protein-protein and protein-ligand.

References

1. Rosne B(2005). Fundamentals of Biostatistics, Cengage Learning
2. Zar JH(2009). Biostatistical Analysis, Pearson Education 5th ed.
3. Campbell RC (1989).Statistics for Biologists, Cambridge university press.
4. Daniel WW (1995). Biostatistics: A Foundation for Analysis in Health Science, 6th ed., John Wiley
5. Snedecar GW & Cochram WG (1967). Statistical Methods, Oxford Press.

BCT202 Biophysical Chemistry: 30 marks

Application of Spectroscopic techniques to study biomolecular interaction: Structural elucidation of the electromagnetic spectrum - quantization of energy. Regions of the spectrum. Basic principles of electronic, vibrational and rotational transitions.(1);
UV- Vis spectroscopy, Fluorescence spectroscopy-Stern-Volmer Equations and quenching-Life time decay--Energy transfer-Fluorescence anisotropy, Infrared spectroscopy, Raman spectroscopy, Mass spectrometry and their biological applications. (11)
Circular Dichroism spectroscopy and application in the study of proteins and nucleic acids, determination of structural parameters by these techniques and limitations and precautions. Surface plasmon spectroscopy and its application to study biomolecular interaction. (4)

Methods to study Proteins - Protein Separation and Characterization, Detection and analysis of protein-protein interactions. Basic techniques like mass spectrometry, X-ray crystallography, NMR, and protein microarrays. Proteomics. (7)

X Ray crystallography - Bragg's Law - What's in a crystal (1); Space group symmetry, non-crystallographic symmetry, impossible symmetry (2); Growing crystals, sample preparation, X-ray sources, data collection (1); Reciprocal Space vs. Real Space - Fourier Transforms- The Phase Problem (2) • Specific problems of protein crystals (2)
NMR: Quantum mechanical description of nuclear magnetic resonance - Pauli spin matrices - Step up and step down operators - Dirac notation - time independent and dependent Schrodinger equation (4); Bloch equation - concept of relaxation time (2); MRI - the basic principle (1); Examples of ^{1}H and ^{13}C NMR of simple organic compounds J-coupling - NOE (2); Higher dimensional NMR - protein structure using high dimensional NMR (3).

Reference Books:

1. Freifelder. Physical biochemistry, freeman company.
2. Wilson K & Walker J(2005). Principles and Techniques of Biochemistry and Molecular Biology, 6th ed.,Cambridge University Press.
3. David Sheehan(2009). Physical Biochemistry: Principles and Applicatons, John Wiley & Sons Ltd, Chichester, England,
4. Upadhyay, upadhyay & Nath. Biophysical chemistry.
5. Sawhney SK & Singh R(1996). Introductory Practical Biochemistry, Narosa Publishing House Pvt Ltd, New Delhi.
6. Skoog, Holler & Nieman. Principles of Instrumental Analysis.

BCT 203 Metabolism-II: 30 marks

1. Macro nutrients: Carbohydrates, proteins, lipids, essential lipids and amino acids; Protein sparing foods, Calorific value of nutrients; Caloric metabolism, activity, BMR; Factors affecting BMR, Body mass index (BMI), Food safety and toxicity. (8)
2. Metabolism of micro nutrients: Vitamins- Water soluble Vitamins, Fat soluble Vitamins metabolism [Vitamins in relation to coenzyme concept and one carbon metabolisms] (3); Elements: Ca^{2+}, Phosphate, I^- ; Trace elements: Fe, Cu (Uptake, transport, storage and homeostasis); Metal overload and toxicity, Remediation through chelate therapy. (3)
3. Heme metabolism: Biosynthesis (focus on precursor site), catabolism (porphyrins and bilirubin metabolism); disease involved. (1)
4. Xenobiotics metabolism. (1)
5. Factors regulate metabolic homeostasis. (1); Importance of different organs and tissues in metabolism-With special emphasis on liver, skeletal muscle, brain, heart; brown and white adipocytes etc. (2); Importance of endocrine organs and hormones in metabolic regulations with special emphasis on Leptin and obesity (2). Interconnections between carbohydrate, protein and lipid metabolism (1). Inborne errors of metabolism. (1)
6. Redox metabolism. Glutathione S-transferases in Redox Regulation and Glutathione Dependent Catalysis; Glutaredoxin and Thioredoxin Systems; Structural Basis of Redox Active Enzymes; Redox Activities of Antioxidants in a Cellular Context; Mitochondria, Reactive Oxygen Species and Human Disease (5)
7. Detection and characterization of metabolites-Concept of metabolomics. (1)

Reference Books:

1.Lehninger's Principles of Biochemistry, David L.Nelson, Michael M. Cox. Publisher:W.H.Freeman.
2. Biochemistry-Jeremy M Berg, John L Tymoczko,and Lubert Stryer. Publisher:WHFreeman
3. Biochemistry,4th Edition-Donald Voet, Judith G.Voet.–PublisherJohnWiley & Sons.
4. Biochemistry; Voet , D. and Voet, J.G. [Eds.] (1999) 3 Ed. Jhon Wiley and sons.
5. Biochemistry; David Rawn, J. (1989) Neil Patterson Publishers.
6. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.

BCT204- Recombinant DNA Technology: 30 marks

PCR and its applications, construction of CDNA libraries, differential cloning, sequencing genes and short stretches of DNA, genetic, cytological and physical maps of chromosome, map position based cloning of genes, mapping and sequencing of human genome, RNA and protein assays of genome function (functional genomics), gene transfer to animal cells and genetic manipulation of animal.

Restriction Endonucleases; characteristics, properties & mode of action of type I, II, III & IV; characteristics & mode of action of dam and dcm methylase; Three-step recognition mechanism by *Eco*RV, Binding Energy of *Eco*RV Endonuclease Bound to Cognate Versus Non-cognate DNA; Blunt vs Sticky Ends; NOMENCLATURE of RE; Isoschizomers and Neoschizomers; Star Activity; Construction of a restriction map; RFLP, VNTR, Minisatellite & Microsatellite DNA; Detection of sickle-cell gene by the *Dde*I RFLP; Establishing linkage between a dominant trait and an RFLP allele; Diagnosis of β-thalassemia Deletion by Southern Blotting; Procedure for DNA typing as used for a paternity case; Several problems are given on restriction enzyme mapping. (4)

Cloning Vectors, plasmid, phage, BAC, YAC, PAC, FOSMID; Retroviral vectors; methods of cloning; conjugative, nonconjugative, relaxed and stringent plasmids; plasmid incompatibility; advantages and disadvantages of these cloning vectors; shuttle vectors; yeast vector development, Yep, YRP, Ycp, Yip, 2μ plasmid; Characteristics & properties of Enzymes required in RDT: *E. coli* DNA polymerase I, Klenow fragment, Reverse transcriptase, Terminal transferase, T4 polynucleotide kinase, alkaline phosphatase, DNAse I footprinting, ligation reaction: T4 & E. coli DNA ligase**.** (2)

Cloning foreign DNA by adding linkers and adaptors, Terminal transferase to add polynucleotide tails to foreign DNA and vector DNA; Generalized overview of cloning strategies; How many recombinant DNA molecules are required in a library to get complete coverage of a genome? Clark

and Carbon method; Cloning *Taq* PCR products; Directional cloning; Easy cloning: PCR products; Maniatis' strategy for producing a representative gene library; *Chromosome walking;* Creation of a genomic DNA library using the phage-λ vector EMBL3A; Early library construction; Improved library construction. (3)

Design of nucleic acid probes; A degenerate oligonucleotide probe; "guessmers": long, degenerate oligo probes; α –complementation, Blue-white screening system; Marking Recombinant DNA by Inactivating a Gene; An early cDNA cloning strategy; Full length cDNA synthesis; Efficient cDNA cloning (Heidecker & Messing); Addition of two different restriction sites at the ends of duplex cDNA; Homopolymer tailing; Types of expression systems; Transcribable vector containing a cDNA insert (T7 promoter). (2)

Transfection into mammalian cells; COMMONLY USED MAMMALIAN CELLS; TISSUE CULTURE; EXPRESSION VECTOR; RBS, START, and STOP codons; Genetic Elements Essential for Expression; Selectable Marker for mammalian cells: Selection conditions +Basis for selection+ Comments→ADA, CDA, hisD, DHFR, TK, HGPRT, APRT, XGPRT, APH, HPH: Reporter genes & reporter assay→ CAT, GFP, GAL, LUC, SEAP (secreted human placental alkaline phosphatase), hGH, GUS; Transformation methods-$CaCl_2$ and electroporation, Chemical transfection using $Ca_3(PO_4)_2$ & DEAE dextran, Lipofection - liposome mediated transfection, transfection by Viral infection, Stable and transient transfection. (2)

Screening of recombinant: Sequence-dependent screening→Screening by hybridization& Screening by PCR; Screening of expression libraries→. Immunological screening, Screening with alternative ligands, Functional cloning, Screening by functional complementation, Screening by 'gain of function'. South-western and north-western screening, Hybrid arrested translation and hybrid released translation**.** (2)

Using yeast to study Eukaryotic gene function→ Yeast biosynthetic genes are cloned by complementation of *E. coli* mutations, Shuttle vectors replicate in both *E. coli* and yeast, complement strategies, Homologous recombination, Cloning genes required for mating reveals signalling pathway similar to that seen in higher organisms, Genetic experiments in yeast (answer precise biochemical questions and exploited to identify and study genes from higher organisms). (2)

Gene transfer to plants →Plant callus culture, plant cell culture and protoplasts, Agrobacterium and genetic engineering in plants, Crown gall disease, Tumour inducing principle and the Ti-plasmid, Incorporation of T-DNA into nuclear DNA of plant cells, Gene maps and expression of of T-DNA, Disarmed Ti-plasmid derivative as plant vectors, Selectable markers for inclusion in T-DNA, Insertion of foreign DNA into T-DNA, Binary Ti-vectors, Microprojectiles for transfecting living cells: biolistics. (2)

Application of RDT in agriculture, medicine and industry; Gene therapy. (2)

Reference Books:

1. Old & Primrose (1994). Principles of gene manipulation. Blackwell Scientific Publications.
2. Sambrook & Russel (2001). Molecular Cloning, 3rd volume. CSH Press.
3.Genome Analysis. 4th volume. (2000). CSH Press.
4. Lewin B (2004). Genes VIII, International Edition, Pearson Education
5. Alberts B, Johnson A, Lewis J, Raff M, Roberts K, & Walter P(2008). Molecular Biology of the Cell, 5th ed., Garland Science Publishing

BCT205 Bioenergetics: 25 marks

Boltzman versus Darwin - the relation between biological evolution and approach to equilibrium (2);Kinetics and thermodynamics - Free energy of reaction and free energy of activation - Marcus relation(2);Microscopic reversibility -Onsager reciprocal relation -Linear phenomenological equations describing coupled thermodynamic processes (2); Thermodynamic description of membrane transport - thermodynamics of osmosis , carrier mediated diffusion and active transport (2);Debates centring chemiosmotic process - protonmotive force as a thermodynamic driving force - Thermodynamic insights for uncoupling (3); Entropy Enthalpy compensation in biomolecular interactions (1); Neuron firing as a thermodynamic processes- Fokker Planck equation (2);Thermodynamics of small systems - muscle contraction as example.(2);

Oxidative phosphorylation(7):Mitochondria ultrastructure, Energy harnessing cascade from nutrients, Reducing equivalents, Electron transport and its carriers-Complex I, II, III, IV; Mitchell's Hypothesis—experimental verification, Determination of P:O ratio, ATP synthesis by $F1\text{-}F_O$ ATP synthase, E. Racker's experiment. Relation of proton movement and ATP synthesis. Experimental demonstration of the movement of ATP synthase.

Reference Books:

1.Lehninger's Principles of Biochemistry, David L. Nelson, Michael M. Cox. Publisher:W.H.Freeman.

2. Biochemistry-Jeremy M Berg, John L Tymoczko,and Lubert Stryer. Publisher:WHFreeman

3. Biochemistry, 4th Edition-Donald Voet, Judith G.Voet.–PublisherJohnWiley & Sons.

4. Biochemistry; Voet , D. and Voet, J.G. [Eds.] (1999) 3 Ed. Jhon Wiley and sons.

5. Biochemistry; David Rawn, J. (1989) Neil Patterson Publishers.

6. Bioenergetics; A Practical Approach, G.C. Brown and C.E. Cooper (1995) IRL- Oxford University Press.

Semester 3

BCT 301: Cell Biology-II: 35 marks

Co-translational protein trafficking:Secretory pathway, concept of signal sequence, experimental demonstration for co-translational transport (protease protection assay), signal recognition particle (SRP), ER translocation of polypeptides (soluble and transmembrane), ER chaperons –(5).

N-glycosylation in the ER and Golgi (quality control, UPR, ERAD and proteosomal degradation)(3)

ER to Golgi transport, anterograde and retrograde transport, coat proteins their recruitment and removal, retrieval of ER resident proteins, vesicle fusion (factors involved), lysosomal biogenesis, endocytosis, protein trafficking in a polarized cell (apical & basolateral)-(5)

Nucleocytoplasmic protein transport; Protein transport to Mitochondria ,Chloroplast and Peroxisomes (6)

Co translational vs Post Translational protein sorting(1); PTMs regulating protein transport (1)

Methods of studying Protein Transport (1); Disorders of protein transport and diseases (1)

Cellular Communication:

Introduction to cell signaling, fundamental commonalities and evolution of signaling pathways ; Role of PTMs in signaling; Subcellular localisation and signaling molecules; Second messengers, Sensors and effectors ; The modular architecture and evolution of signaling proteins; Methods for studying signaling networks (5)

Signaling enzymes and their allosteric regulation Receptor Tyrosine kinases , Receptor Ser/Thr Kinase Receptor histidine kinases, Heterotrimeric and monomeric and G protein signaling (2)

Lipid modifying enzymes in signaling; Light mediated signaling; Regulated protein degradation mediated signaling (3)

Information transfer across membrane ;Information processing and networks (2)

Cell Cycle, Cancer and Apoptosis:

Introduction to the cell cycle, phases, why cells divide, biochemical and physiological hallmarks of each phase. (1 lecture); Introduction to Cyclins and CDKs, their discovery, Principles of regulation of CDK activity. Experimental approaches to study cell cycle (2lectures)

Molecular basis of START/Restriction point, Transcriptional regulation of cell cycle, protein degradation and irreversibility of the cell cycle (APC and SCF), spatiotemporal regulation of phase transition. Restriction of replication to once per cell cycle, Cytokinesis (2 lectures)
Introduction to checkpoints- sensors and effectors, molecular mechanism of checkpoint activation, DNA damage and replication checkpoints, chromosome segregation checkpoint, spindle orientation and assembly checkpoint. Checkpoint override and outcomes. (2 lectures)
Cell Junctions, Cell Adhesion and the Extracellular Matrix. (2)
Cancer: Introduction, epigenetic and genetic regulation; defective control of cell death and differentiation, cancer stem cell , cancer critical genes,Infection and cancer (3)
Apoptosis: introduction, caspases, Pro and anti apoptotic genes, Fas mediated apoptosis; Mitochondria dependent pathways, inhibitory pathways of apoptosis, regulation, implication in diseases; Autophagy, senescence (4)

References Books:

1. The Biochemistry of Cell Signaling, Helmreich JM, Oxford Press
2. Cell signaling – John T Hancock, Oxford University press
3. Cell biology. Second edition: Edited by C A Smith and E J Wood. Chapman & Hall publ
4. Molecular Cell Biology, 4th edition. Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell. New York: W. H Freeman
5. Biochemistry 5th Edn. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer.
6. Harper's Illustrated Biochemistry; 27th Edn. Robert K. Murray, Daryl K. Granner, Victor W. Rodwell _ The McGraw-Hill (2006).
7. Biochemistry of Lipids, Lipoproteins and Membranes; 5th Edn. Dennis E. Vance and Jean E. Vance, Elsevier (2008).
6. Membrane Proteins,; Douglas Rees, Academic Press (2003).
7. Introduction to Biological Membranes; William Stillwell, Elsevier (2013).
8. Molecular Biology of the Cell; 6th Edn. Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts and Peter Walter; Garland Science (2014).
9. Molecular Cell Biology; Lodish et al., 7th Edn. W.H. Freeman and Co. (2012).

BCT302 Molecular Biology and Genetics: 30 marks

Laws of inheritance: Mendel's Laws, concept of dominance, segregation, independent assortment; Chromosome theory of inheritance(3)
Extensions of Mendelian Genetics: Concept-Multiple alleles, lethal alleles, Epistasis, penetrance, expressivity, pleiotropy, phenocopy (3)
Linkage: Concept-recombination, genetic mapping eukaryotes (Drosophila).(2)
Sex-linked inheritance: Conceptual basis, sex influenced traits, mechanism of sex determination(2)
Cytoplasmic (extranuclear) inheritance: Basis and mechanism(1)
Changes in Chromosome number and structure: Polyploidy, aneuploidy, chromosomal rearrangements - deletion, duplication, inversion, and translocation(2)
Population genetics: Random mating population, Hardy-Weinberg principle, Sources responsible for changes in gene frequencies: Mutation, selection, migration and random genetic drift.(4)
Molecular Techniques for Studying Gene Expression (2):Northern blot, RNase protection assay, S1 mapping, primer extension, run-off transcription, IVT, nuclear run-on, semi-quantitative and quantitative PCR
Functional analysis of cloned DNA fragments: (5):Major approaches of DNA delivery in cells, functional analyses of regulatory and coding sequences, site-directed mutagenesis, gene targeting, Site-specific recombination for manipulating of the genome, gene inactivation without modifying target gene, Gene inhibition at protein level
Post-transcriptional processing: mRNA processing -5' and 3' modifications, Splicing, Editing and RNAi (4);tRNA and rRNA processing (2)
Epigenetics : Nucleosomes and histones , Levels of packaging of DNA to Chromosome. DNAse I sensitivity of locus, Dnase I hypersensitivity, boundary elements experimental methods, and model organisms. (2)

Histone Modifications. Discussion of the histone code. DNA methylation, Nucleosome positioning, shifting and chromatin remodeling complexes Chromatin associated proteins, the formation and maintenance of heterochromatin, Model locus like PHO, Globin etc (2)
Role of epigenetics in biological phenomena such as imprinting, X-inactivation, cellular reprogramming, tumorigenesis, and the onset of certain types of neurological disorders. (2)

Reference Books:

1. Maloy SR, Cronan JE &Freifelder D(2009). Microbial Genetics, Jones& Bartlett publishers.
2. Nucleosome Histone, and Chromatin; Part-A; Carl Wu and C. Allis, Academic Press (2012).
3. Lewin B(2008). gene XI , Oxford University press.
4. Freifelder D (2008). Molecular Biology Jones and Bartlett Publishers USA
5. Lodish et al (2007). Molecular Cell Biology W.H freeman.
6. Genetics, Strick Berger, M.W. (1990) 3rd edn. McMillan.
7. Introduction to Genetics: A Molecular Approach; T A Brown, Garland Science (2011).

BCT303 Bacterial Genetics and Virology: 25 marks

Transformation: Discovery of Transformation, Competence, Regulation of competence in B. subtilis, Experimental evidence for models of natural transformation, Plasmid transformation and phage transfection of naturally competent bacteria, Role of natural transformation, Importance of natural transformation for forward and reverse genetics, artificially induced competence.(3)
Conjugation: Classification of self-transmissible plasmids, Mechanism of DNA transfer during conjugation in Gram negative bacteria, Chromosome transfer by plasmids, Formation of Hfr strains, Transfer of chromosomal DNA by integrated plasmids, Chromosome mobilization, Prime factors, mapping genes by interrupted mating, fine structure analysis of genes, Transfer system of Gram positive bacteria, Plasmid attracting pheromones.(5)
Bacteriophage genetics: Basics concepts of bacteriophage growth and assay methods. Classical concepts of gene structure and function derived from bacteriophage genetics. (2)
Host-phage interaction mechanisms. Understanding gene regulatory circuits using bacteriophages as model systems.Decision making modules that control fate of lysogenic bacteriophages such as .Re-appropriation of host metabolism by bacteriophages using T4 as the model system.(3)
Evolution of host immune responses against bacteriophages. Innate immunity and the role of altruism in host defensive mechanism. Acquired immunity against bacteriophages – CRISPr-Cas based immunity.(2)
Horizontal gene transfer mediated by bacteriophages. Specialized and generalized transduction.(1)

Reference Books:

1. Maloy SR, Cronan JE &Freifelder D(2009). Microbial Genetics, Jones& Bartlett publishers.
2. Dale JW(2001). Microbial Genetics of bacteria, Jones& Bartlett publishers.
3. Snyder L & Champness W(2007). Molecular Genetics of Bacteria, 3rd ed., ASM Press
4. Gardner JE, Simmons MJ & Snustad DP(1991). Principles of Genetics. John Wiley & Sons
4. Mackie & McCartney Practical Medical Microbiology (1996). Collee, J.G., Fraser, A.G., Marmion, B.P. and Simmons, A (eds.), Churchill Livingstone, Edinburgh.
5. Dorman CJ (1994).Genetics of Bacterial Virulence, Blackwell.
6. Henderson et al.(1999). Cellular Microbiology. Wiley.
7. De Bruijn et al.(1998). Bacterial Genomes. Chapman & Hall.
8. Carter JB & Saunders VA (2007) Virology-Principles and Applications, John Wiley and Sons
9. Principles of Virology, (Vol I & II) Flint SJ, Enquist LW, Racaniello VR, Skalka AM Pub ASN Press
10. Introduction to Modern Virology – Dimmock
11. Bacterial and Bacteriophage Genetics; Edward A. Birge, 5th Edition, Springer (2006).

BCT304 Developmental Biology: 20 marks

A) Basic concepts of development : Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development

B) Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination.

C) Morphogenesis and organogenesis in animals : Cell aggregation and differentiation in *Dictyostelium*; axes and pattern formation in *Drosophila*, amphibia and chick; organogenesis – vulva formation in *Caenorhabditis elegans*, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination.

D) Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in *Arabidopsis* and *Antirrhinum*

E) Programmed cell death, aging and senescence

Developmental processes: Embryonic development, Morphogen gradient, asymmetric cell division (3);Maternal effect genes, Polarity development (dorsoventral and anterior-posterior): Dorsal (ventral), Dpp (dorsal), Bicoid (anterior), Hunchback (anterior), Nanos (posterior)(4);Pattern formation: Notch-Delta (lateral inhibition), Hedgehog, Wnt (5).

Reference Books:

1. Developmental Biology" by Scott F Gilbert, 10th Edition. ISBN-13: 978-0878939787
2. Developmental Biology: A Very Short Introduction 1st Edition, by Lewis Wolpert, Oxford.

Choice Based Credit courses:

CBCC-A & CBCC-B. A student will have to take two courses from Choice Based Credit Courses (CBCCs) in addition to courses offered by the department. The students will have to choose one course each from two groups: CBCC-A & CBCC-B. Each course is of 50 marks and carries 4 credits.

Detailed syllabus for Choice Based Credit Courses will be followed by Common CSR-CBCC, 2018.

Semester 4

BCT 401: Immunology: 35 marks

1. Introduction: overview of the Immune system. (1)
2. Innate immunity - mechanism of immune response (anatomic, physiological, phagocytic and inflammatory barriers). Adaptive immunity: Humoral and Cell-mediated immunity, primary and secondary immune modulation, clonal selection of lymphocytes. (2)
4. Antigens: chemical nature, antigenicity and immunogenicity, hapten, epitopes, mitogens (definition, properties, examples); Adjuvant (definition, examples, function). (2)
5. Immunoglobulins : structure and function, Immunoglobin genes, generation of diversity, affinity maturation, Isotype switching, Allelic exclusion, lg receptor of B-cells, B-cell maturation, activation and differentiation, T dependent and independent antigen, Idiotype network. Monoclonal and polyclonal antibody, antibody engineering. (4)

6. Antigen-Antibody interactions: Precipitation reactions, Radial immunodiffusion, double immunodiffusion, immunoelectrophoresis; Agglutination reactions-Hemagglutination, passive agglutination, bacterial agglutination, agglutination inhibition, Radio immunoassay, ELISA, Immunofluorescence :FACS, Immunohistochemistry, ELISPOT. (2)
7. Major histocompatibility complex, MHC antigens, allograft rejection, inbred and congenic mice, MHC locus in mice and human, MHC antigen structures and genes, HLA typing and disease association. Antigen processing and presentation. (2)
8.T cell activation : MHC restriction, T cell receptor complex and genes, TCR gene rearrangement, T-cell differentiation, thymic selection, super antigens, T-cell cytotoxicity. (2)
9. Complement: The complement components, function, complement activation- (i) Classical, (ii) Alternate and (iii) lectin pathways. Regulation of complement activation pathways. (1)
10. Hypersensitivity reactions. (2)
11. Vaccines. (2)
12. Cells and organs of Immune system. (2).
13. Stem cell, Cell-mediated effectors function, Cytokines, Chemokines, Leucocyte migration, T cell receptor function. (2+2+2)
14. Immunological tolerance. Autoimmunity (2)
15. Immunodeficiency. Immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections. (2)
16. Cancer and immune system, Cancer Immunotherapy. (1)
17. Problem solving(1)

Reference Books:

1. Goldsby, kindt & Osborne(2006). Kuby's Immunology WH Freeman & co.
2. Tizard(1995). An Introduction to Immunology.Harcourt Brace College Publication
3. Delves PJ & Roitt IM(2006). Roitt's Essential Immunology, 11th ed., Wiley-Blackwell

BCT 402 Plant Biochemistry : 35 marks

1. Major plant bio-polymers; cellulose, pectin and lignin; structure, function and sites of deposition in the cell wall; precursors and introduction to macromolecular assemblies and directional deposition. (1)
2. Cellulose synthase(s), structure, active sites, transmembrane domains, assembly, recognition of distinct CesA proteins in primary and secondary cell walls. (3)
3. The Cellulose Synthase Complex; trafficking of the complex, role of microtubules for site directed fibre deposition. (2)
4. The CesA associated protein CSL, Sucrose synthase and Korrigan. Deciphering the nature and specificity of their interaction.(2)
5. Assembly and synthesis of pectin; pectin synthase and methyl transferases, properties of enzymes and finished pectin, association between enzyme components and control of production. (3)
6. The lignin biosynthesis pathway; control points and effects of mutations on lignin production. (2)
7. Overall control of the lignin-cellulose- pectin production; genetic master switches. (1)
8.Bio-engineering plants for production of bio-mass for industrial usage (1)
9.Photosysthesis:Basics of photosynthesis, Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystems, Light harvesting complex, Quantum yield, Evolution of oxygenic photosynthesis(1);Photosystem I and II, reaction center, linear and cyclic Electron transport, EMF scale and Z scheme, NADPH/ATP ratio , Inhibitors(1); Regulation of light harvest, Several lines of defense, Photoinhibition, State Transition and NPQ (2); C3, C4 and CAM pathways of carbon fixation; Photorespiration(1);N fixation (1) ;Evolution of N fixing intracellular symbiosis, Intracellular vs Intercellular symbiosis(1);Nif gene regulation in symbiont. Nif mutants.(1);Rhizobial invasion of plants and Nodule organogenesis, Forward genetics.(1);Establishment of Symbiotic signaling (1)
Metabolic interface between host and symbiont (1);Plant development:Meristems-Plant Stem cells (1) ;Effect of light on plant development-Phytochromes(1).

Reference Books:

1. A Textbook of Plant Physiology, Biochemistry and Biotechnology by S K Verma & Mohit Verma
2. Plant Biochemistry, by Hans-Walter Heldt, Birgit Piechulla in cooperation with Fiona Heldt. Academic Press
3. Principles of Gene Manipulation, by R.W. Old, S.B. Primrose, Wiley-Blackwell Publications
5. Photosynthesis, D.O. Hall and K. K. Rao, (1999), 6th Edn. Cambridge University Press.
5. Plant Biochemistry, P.M. Dey & J.B. Harborne(2000) Hart Court Asia Pte Ltd.
6. Introduction to plant Biochemistry. Goodwin and Mercer, CBS Publisher (2000).
7. Biochemistry and Molecular Biology of Plants. Buchanan, Greussem and Jones, AAPS (2000).
8. Plant Cell Tissue and organ Culture: Fundamental Methods, O.L. Gamborg & G.C. Phillips Narosa Publishers, New Delhi (1995)
9. Plant Biochemistry; P. M. Dey and J. B. Harborne, Academic Press (1997).
10. Plant Biochemistry and Molecular Biology; Peter J. Lea, Richard C. Leegood, 2nd Edition, Wiley (1998).
11. Plant Biochemistry; Hans-Walter Heldt and Birgit Piechulla, Academic Press (2004).

BCT403: Neurobiochemistry: 35 marks

1. Synapse (synaptogenesis, synaptic functions), Neurotransmitters and their receptors, Neurotransmission, Neuroplasticity. (7)
2. Blood brain barrier (structure & functions), Glucose uptake - utilization and Transport of amino acids in brain, Cerebrospinal fluid (composition and functions) (3)
3. Mechanism of action of drugs in CNS. (2)
4.Introduction to brain development, Brain morphogenesis, Neuronal differentiation, Myelinogenesis, Nerve growth factor, BDNF and other growth factors (importance in brain development), Steroid superfamily(mode of action – role of thyroid hormones, glucocorticoids and retinoic acid in brain development), Role of Vitamin D3 in brain development. (8)
.Biochemistry of normal aging, Neurodegenerative disorders (Parkinson's, Alzheimer's, Huntington's) (5)

Reference Books:

1.Basic Neurochemistry: Principles of Molecular, Cellular, and Medical Neurobiology, 8th Edition by Scott Brady, George Siegel, R. Wayne Albers, Donald Price. ISBN-13: 978-0123749475
2. Neuroscience: Exploring the Brain (4th Edition)by Mark F. Bear, Barry W. Connors, Michael A. Paradiso. ISBN-13: 978-0781778176

BCT404: Biochemistry of the Diseases: 35 marks

Malaria:

Plasmodium Life Cycle and General Morphology, Vertebrate Phases and Invertebrate stages, Classification of Plasmodium, Disease Pathogenesis, Host-Pathogen Interaction: Immunity and Resistance, Control and treatment, Metabolism, Drug target, Action and Drug Resistance.

Tuberculosis:

Mycobacterium tuberculosis: Cell description, Pathogenesis: Primary tuberculosis, Tuberculin reactivity, Post-primary tuberculosis, tuberculosis in immunocompromised individuals, Diagnosis, treatment, Host-Pathogen Interaction: Immunity and Resistance, Control and treatment, Drug target, Action and Drug Resistance. Multi drug resistant tuberculosis: Drug resistance mechanism.

Cholera:

Vibrio cholerae, Cholera, pathogenesis and epidemiology of cholera, Mechanisms involved in environmental survival, virulence factors, Evolution and transmission of virulence factors, Transmission and identification of toxigenic *V. cholerae*, Molecular mechanism of acquisition of the cholera toxin genes, transcriptional regulation of virulence genes, Pathogenecity Island, Host-

pathogen interaction: *V. cholerae* infections and the outcome of cholera, molecular aspects of *V. cholerae* infections, Pro-inflammatory phase of infection, changes in the *V. cholerae* c-di-GMP pool during infection, Type III secretion system; Control of cholera: conceptions of cholera vaccines, Drug resistance, treatment and prevention.

Stroke: What is stroke, Types of stroke, Pathophysiology of stroke, *in vivo* & *in vitro* models of stroke , Bio-markers, Therapy, stroke and neuroprotection.

Genetics of cancer: Types and development of cancer, characteristics of cancer cells, tumor viruses, oncogenes and tumor suppressor genes, cancer as a multistep process (Knudson's hypothesis), genomic instability and somatic mutations, driver and passenger gene mutations, genetic pathways in cancer progression, cancer stem cells and therapy resistance

Diabetes: Brief historical perspective of diabetes, Current scenario, WHO-delared Life-style disorder; Types of Diabetes mellitus, differences & similarities between the types; Causes of the disease: genetic (metabolic disorder) & environmental (stress, food habit etc) [2]; Factors regulating blood glucose level, Hormonal factor: Insulin, glucagon and others, brief introduction of their sources, structures and functions-hyper & hypo activities, Insulin receptor and its role (brief structure, function & desensitization-insulin resistance), Biochemical changes in lipid metabolism in diabetes - causes and molecular mechanisms, Role of gut derived hormones and micriobiome in diabetes. [5]; Associated Pancreatic disorders, different molecular mechanisms of beta-cell loss; Brief clinical aspect of this disease (symptoms, management & precautions) [3]

Text and Reference Books:

1. Mims CA(2004). Medical Microbiology, 3rd ed, Mosby
2. Paniker CKJ(2007). Ananthanarayan and Paniker's Textbook of Microbiology, Orient Longman Pvt. Limited, India.
3. Greenwood D, Slack RCB & Peutherer JF(2006). Medical Microbiology, A Guide to Microbial Infections: Pathogenesis, Immunity, Laboratory Diagnosis & Control, Churchill Livingstone, Elsevier, India.
4. Brooks GF, Butel JS, Morse SA, Melnick JL, Jawetz E & Adelberg EA (2004). Jawetz M &Adelberg's Medical Microbiology, 23rd ed, Lange Publication.
5.Basic Neurochemistry: Principles of Molecular, Cellular, and Medical Neurobiology, 8th Edition by Scott Brady, George Siegel, R. Wayne Albers, Donald Price. ISBN-13: 978-0123749475
6. Neuroscience: Exploring the Brain (4th Edition)by Mark F. Bear, Barry W. Connors, Michael A. Paradiso. ISBN-13: 978-0781778176

BCT405: Ecological Principles: 35 marks

The Environment: Physical environment; biotic environment; biotic and abiotic interactions.

Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.

Population Ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (*r* and *K* selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations.

Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.

Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.

Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax.

Ecosystem Ecology: Ecosystem structure; ecosystem function; energy flow and mineral cycling (C,N,P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine).

Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.

Applied Ecology: Environmental pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches.
Conservation Biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).
Metagenomics – Introduction; Pure culture and in consortium; Cultivable and Non-cultivable microbial analysis; Molecular fingerprinting techniques (RFLP, T-RFLP, ARISA, DGGE, 16S rDNA based library screening, and FISH); Stable isotope probing (SIP); Microarrays & Metagenome sequencing; Next-generation sequencing approaches to metagenomics, Sequence-based Metagenomics Analysis and Function based Metagenomics Analysis; Phylogenetic analysis
Metagenomic case strudies-Metagenomic analysis of soil microbial communities; Metagenomic analysis of marine, microbial communities; Metagenome of the Microbial Community in Acid Mine Drainage, Human Microbiome, Bioprospecting Novel Genes

Reference Books:
1. Mitchell RG & Ji-Dong (2010). Environmental Microbiology, 2nd ed, Wiley-Blackwell
2. Barton LL & Northup DE (2008). Microbial Ecology, John Wiley & Sons
3. Martin Alexander (1977). Soil Microbiology. John Wiley.
4. Paul EA (2007). Soil Microbiology, Ecology and Biochemistry. 3rd Ed. Academic Press.
5. Campbell R (1983). Microbial Ecology. Blackwell.
6. Atlas RM & Bartha R (1993) Microbial Ecology, Benjamin Cummings Publishing Co, Redwood City, CA.
7. Concepts of Applied Ecology (Heidelberg Science Library) by R. S. DeSanto.
8. Introduction to Systems Ecology (Applied Ecology and Environmental Management Book 4) 1st Edition, by Sven Erik Jorgensen, CRC Press.
9. Ecology and Environment Paperback – 2017 by P D Sharma.

B. Practical Courses

Semester 1

BCP101 Analytical Biochemistry: 25 marks

Analysis of some important biomarkers in blood...glucose, urea, creatinine, cholesterol, triglyceride, total protien, albumin, bilirubin, transaminase, alkaline phospatase and few others. analysis of some food component...like total carbohydrate content in chow, cholesterol content of egg yolk, protien content in egg, vitc content in citrus food, MDA content in commercially available fats and oil, moisture content of grains(spice),oleo resin content of spice...and few more. Estimation of lycopene from fruits/veg sorces, blanching of raw vegetable.

References:
1. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
2. Basic Methods for the Biochemical Lab; Martin Holtzhauer, Springer, (2007).
3. Practical Clinical Biochemistry –Varley, H. CBS Publications

BCP102 Enzymology: 25 marks

1. Determination of Specific activity of ALP
    a) Protein estimation by Lowery method
    b) Standard curve of Paranitrophenol

c) Calculation of Specific activity

2. Estimation of Km and Vmax of ALP by Michealis-Menten curve.
3. Determination of Progress curve of ALP
4. Determination of pH Optima of ALP.
5. Inhibition of ALP by EDTA and recovery of enzyme activity by Magnesium ion.

Reference: Methods of Enzymatic Analysis; Berg Meyer Vol. 1-X, (1974).

BCP103 Microbiology: 25 marks

Experiment No. 1 Preparation of Media, Preparation of Nutrient Agar Slant, Autoclave Handling, Laminar Airflow Handling, Observation: Bacteria, Yeast, Fungus.

Experiment No. 2 Inculation of Bacteria in nutrient Agar Slants. Preparation of Media for slants and Endospore preparation. Streaking for Single colony isolation.

Experiment No. 3 Simple Staining of the bacteria and yeasts (budding and fission yeast). Preparation of Czapekdox Medium for plating and slant preparation.

Experiment No. 4 Gram Staining of Bacteria.

Experiment No. 5 Endospore Staining, Repeat Gram Staining.

Experiment No. 6 Estimation of viable cells in a bacterial suspension: Pore Plate and Spread Plate Technique. Preparation of Media for Biochemical Tests.

Experiment No. 7 Inoculation of Bacteria for biochemical tests; Indole production, Acetyl methyl carbinol formation, Methyl red test, Starch hydrolysis. Inoculation of Molds.

Experiment No. 8 Biochemical tests. Preparation for qualitative examination of Milk.

Experiment No. 9 Qualitative examination of Milk.

Experiment No. 10 Preparation of Plaque Assay. Plaque Assay.

Experiment No. 11 Staining of Fungus.

Experiment No. 12 Microbiological assay of tetracycline: determination of unknown concentration of antibiotic by cup plate method.

Experiment No. 13 Determination of MIC & MBC of different antibiotics against Gram-positive and Gram-negative bacteria.

Experiment No. 14 Microbiological examination of water: i) Inoculation of water sample into lactose broth. Observation of gas formation at 24 and 48 h. Preparation of EMB agar and Endo agar.

Experiment No.15 ii) Inoculation of bacterial culture taking from lactose broth (48 h) into EMB and Mackonkey agar medium. Incubation for 24 h.

Experiment No. 16 iii) Observation of EMB and Endo agar plates. Inoculation of single colony into NA medium, Isolated bacteria are tested for biochemical tests (IMViC), Acid and gas production in lactose broth, Gram character, Endospore staining, Growth at elevated temperature (45^{o}C), Motility test, Catalase and oxidase tests. Results will be compared with a reference faecal coliform bacteria like *E. coli***.**

Experiment no. 17 Partial identification of some given Gram+ve and Gram-ve bacterial isolates.

Experiment no. 18 Comparative growth kinetics with respect to bacterial isolates and different media composition.

Experiment no. 19 Antibiotic susceptibility test by disc diffusion assay method.

Reference Books:

1. Atlas RM, Parks LC & Brown AL (1995). Laboratory Manual of Experimental Microbiology. Mosby-Year Book,Inc., Missouri.
2. Cappuccino JG & Sherman N (2005). Microbiology-A Laboratory Manual, Pearson Education Inc

Semester 2

BCP201 Bioinformatics: 25 marks

1) Use of Databases
2) Sequence retrieval and format conversion
3) BLAST based logical searches
4) Sequence alignment and deductions
5) Basic sequence analysis
6) Phylogenetic trees
7) Structure prediction

Reference

http://girke.bioinformatics.ucr.edu/GEN242/mydoc_Rbasics_10.html
https://link.springer.com/article/10.1186/gb-2004-5-10-r80

BCP202 Biophysical methods: 25 marks

Module I : Using small optical interfaces - low cost spectral detectors using Rasberry Pie and other affordable interfaces - Study of oscillatory chemical reactions. Module II: Basic Spectroscopy (Simple Chormophores/ Proteins) - isosbestic points in absorption and luminescence spectromentry
Module III:DNA and protein melting Module IV: Study of emerging biophysical phenomenon - emergence of miceller forms /liposomes (using dynamic light scattering studies).

BCP203 Protein Purification: 25 marks

1. Alkaline Phosphatase purification from goat liver
2. Homogenisation , preparation of soluble extract
3. Butanol extraction and dialysis
4. Salting out and dialysis of AP enriched fraction
5. DEAE Cellulose Chromatography
6. Each step is followed by AP ASSAY and protein estimation for calculating Yield and fold purification

References:

Protein Purification Applications, S.L.V. Harris and Angal IRL Press, (1990)

BCP204 Molecular biology: 25 marks

Preparation of competent cells, transformation, isolation of plasmid DNA, restriction digestion, agarose gel electrophoresis, isolation of genomic DNA and Polymerase Chain Reaction, qPCR, Recombinant protein expression in *E.coli*, Plaque assay.

Reference Book.

1. Fritsch J & Maniatis EF(1999). Molecular Cloning A laboratory Manual, Cold Spring Harbor Laboratory

BCP205 GRAND VIVA: 25 marks

Semester 3

BCP301 Cell Biology: 25 marks

Subcellular fractionation of goat liver tissue by differential centrifugation up to 15000x g, Assay of marker enzymes for mitochondria (cytochrome c oxidase), 5`-Nucleotidase for membrane fraction, visualization of nuclei in the fractions by DAPI staining, Demonstration of the tissue culture facility----description of the theoretical aspect---showing growing cells in a T-flask under phase contrast microscope, DAPI staining of nuclei using cells growing on cover slips

BCP302 Project Presentation: 25 marks

Semester 4

BCP401 Immunology : 25 marks

1. Blood film preparation and identification of cells.
2. Separation of blood cells by Ficoll-Hypaque.
3. Purification of IgG from serum.
4. Precipitation reaction by double immunodiffusion (Ouchterlony method) and radial immunodiffusion (Mancini's method).
5. Detection of antigens or antibodies by ELISA (Indirect/Sandwitch ELISA).
6. Detection of antigens by Western-blotting techniques.
7. Blood typing.
8. Quantative precipitation assay.
9. Immunoelectrophoresis.
10. Latex agglutination test.
11. Rocket immunoelectrophoresis.
12. Dot ELISA.
13. Immunohistochemistry.

Reference: Immuno Assay Hand Book; David Wild, Elsevier (2013).

BCP402 GRAND VIVA: 30 marks

CBCC offered by Department of Biochemistry, University of Calcutta

Fundamentals of Biochemistry

1. **pH and Buffers:** Bronsted-Lowry Concept of Acids and Bases, Buffers: Henderson-Hasselbalch equation, Biological buffer systems: The phosphate buffer system, The bicarbonate buffer system, The protein buffer system, The amino acid buffer system, The hemoglobin buffer system **(Three Lectures:** 1 hour each)

2. Biomolecules:Carbohydrates: Importance, Nomenclature, Classification, Asymmetry, Optical Isomerism, Mutarotation, General structure of monosaccharide, disaccharide, oligosaccharides, polysaccharides(Lactose, Maltose, Cellobiose, Isomaltose, Trehalose, Starch, Glycogen, Cellulose, Pectin, Chitin, Heparin.

Proteins: Importance, Amino Acids: Structure, Distribution in Proteins, Location in proteins, Physical properties, Electrochemical properties, Classification, Nonprotein Amino Acids, Peptide bonds, Chemical Bonds involved in Protein structure, Protein Configuration: Primary Structure, Secondary Structure,Tertiary Structure, Quaternary Structure, Physical Properties of Proteins: Shape and Size, Molecular weight, Colloidal nature, Denaturation, Amphoteric nature, Solubility, Optical Activity, ChemicalProperties of Protein: Hydrolysis, Reaction involving COOH group, NH2 group, R group, SH group.

Lipids: Importance, Definition, Alcohols and Fatty Acids, Biological roles of lipids, Classification: Simple Lipids and Compound Lipids, Properties of Fats and oils: Solubility, Melting Point, Insulation, Emulsification, Surface Tension, Chemical Properties: Reactions involving COOH group, Hydrolysis, Saponification, Rancidity, Hydrogenation, Halogenation, Oxidation, Oxidative Rancidity, Reactions involving OH group, Dehydration.

Nucleic Acids: Nucleosides, Nucleotides, DNA, Internucleotide linkages, Base composition, Evolution of Watson-Crick model, Double helical structure, Denaturation and renaturation, Molecular weight, Length, Shape and Size, Variants of Double helical DNA, DNAs with unusual structures, Single stranded DNA, RNA. Differences with DNA, Ribosomal RNA, Transfer RNA, Messenger RNA, Heterogeneous nuclear RNA. **(Twenty Lectures**: 1 hour each)

3. Enzymes: Importance, Nomenclature and Classification, Isoenzymes, Multienzyme system. Biological roles of enzymes. Chemical nature of enzyme, Characteristics of enzymes, Specificity of enzyme action, Thermostability, Reversibility of a reaction, pH sensitivity, MichaelisMenten Hypothesis, Michaelis Menten equation, Lineweaver-Burk equation, Significance of Km and Vmax values, Active site, Enzyme reaction rates, Modifiers of Enzyme activity, Enzyme Inhibitors (Competitive, Noncompetitive, Uncompetitive), Allosteric enzymes. **(Six Lectures**: 1 hour each)

4. **Nutrition:** Energy turnover, Assessment of nutrient transport and fate, Biochemical effects of neutraceuticals. **(Four Lectures:** 1 hour each)

5. Bioenergetics and Metabolism: Definition of metabolism, Catabolic pathways, Anabolic pathways, Carbohydrate metabolism, Amino acid metabolism, Lipid metabolism, Nucleic acid metabolism. Regulation of metabolic pathways, Bioenergetics. **(Ten Lectures:** 1 hour each**)**

6. Analytical Biochemistry: Principles and application: equipments, sample preparation, Homogenization, Differential centrifugation, Chromatography, Spectrophotometry, Electrophoresis, Ultracentrifugation. **(Five Lectures:** 1 hour each)

Reference Books:

1. Nelson DL & Cox MM (2008). Lehninger's Principles of Biochemistry 5th ed., WH Freeman & Company
2. Berg JR, Tymoczko CZ & Stryer L(2006). Biochemistry, 6th ed., WH Freeman & Company
3. Conn E.E. & Stumpf PK (1988) Outline of Biochemistry John Wiley & Sons.
4. Freifelder. Physical biochemistry, freeman company.
5. David Sheehan(2009). Physical Biochemistry: Principles and Applicatons, John Wiley & Sons Ltd, Chichester, England,
6. Skoog, Holler & Nieman. Principles of Instrumental Analysis.
7**.** Biochemistry; Voet, D. and Voet, J.G. [Eds.] 3rd Ed. Jhon Wiley and sons, (1999).