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UNIVERSITY OF MYSORE

Established: 1916

Vishwavidyanilaya Karyasoudha,
Crawford Hall, Mysore-570 005.

Dated: 19.08.2020

No.AC.2(S)/378/2020-21

NOTIFICATION

Sub: Minor changes in the syllabus of M.Sc. Molecular biology from the Academic Year 2020-21.

Ref: 1. Decision of Board of Studies in Microbiology (PG) meeting held on 03.01.2020.
2. Decision of the Faculty of Science & Technology Meeting held on 18.02.2020.
3. Decision of the Academic Council meeting held on 18.06.2020.

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The Board of Studies in Molecular biology (PG) which met on 03.01.2020 has recommended to make minor changes in the existing syllabus of M.Sc. Molecular biology program from the Academic Year 2020-21.

The Faculty of Science and Technology and Academic Council meeting held on 18.02.2020 and 18.06.2020 respectively have approved the above said proposal and the same is hereby notified.

The modified syllabus of M.Sc. Molecular biology program is annexed. The contents may be downloaded **from the University Website i.e., www.uni-mysore.ac.in**.

Draft approved by the Registrar

Deputy Registrar(Academic),
Deputy Registrar (Academic)
University of Mysore
Mysore-570 005

To:

1. The Registrar (Evaluation), University of Mysore, Mysore.
2. The Dean, Faculty of Science & Technology, DoS in Molecular biology, Manasagangotri, Mysore.
3. The Chairperson, BoS in Molecular biology, DoS in Molecular biology, Manasagangotri, Mysore.
4. The Chairperson, Department of Studies in Molecular biology, Manasagangotri, Mysore.
5. The Director, College Development Council, Moulya Bhavan, Manasagangotri, Mysore.
6. The Deputy/Assistant Registrar/Superintendent, AB and EB, UOM, Mysore.
7. The P.A. to the Vice-Chancellor/Registrar/Registrar (Evaluation), UOM, Mysore.
8. Office file.

COURSE STRUCTURE (Choice Based Credit System)
Master of Science (Five Year Integrated) in Molecular Biology
(Theory and Practical papers from first to tenth Semester) (10 semesters) (Effective from 2011-12)
All modifications done (2011-2012 to 2019-20120) consolidated : 2019-20

Sl. No	Paper Code	Title of the Paper	L	T	P	Credits
		I SEMESTER				
1	MBA110	General Botany	4	0	2	06
2	MBA120	General Zoology	4	0	2	06
3	MBA130	Mathematics for Biologists	3	0	0	03
4	MBA140	Constitution of India	3	0	0	03
5	MBA150	Communication Skills-1	1	1	0	02
		Total				**20**
		II SEMESTER				
6	MBB110	General & Inorganic Chemistry	4	0	1	05
7	MBB120	Physical Chemistry	4	0	1	05
8	MBB130	Physics	4	0	1	05
9	MBB140	Environmental Studies	3	0	0	03
10	MBB150	Communication Skills-2	1	1	0	02
		Total				**20**
		III SEMESTER				
11	MBC110	Organic Chemistry	3	0	1	04
12	MBC120	Basic Biochemistry	3	0	1	04
13	MBC130	Developmental Biology	4	0	1	05
14	MBC140	Cell Biology	3	0	1	04
15	MBC150	Computer Applications	2	0	1	03
		Total				**20**
		IV SEMESTER				
16	MBD110	Advanced Organic Chemistry	2	0	1	03
17	MBD120	Microbiology	3	0	2	05
18	MBD130	Plant Physiology	3	0	1	04
19	MBD140	Animal Physiology	3	0	1	04
20	MBD150	Macro Molecules	3	0	1	04
		Total				**20**
		V SEMESTER				
21	MBE110	Metabolism-I	3	1	1	05
22	MBE120	Biochemical Techniques	3	0	2	05
23	MBE130	Biophysics	4	0	1	05
24	MBE140	Principles of Genetics	3	1	1	05
25	MBE150	Elective 1	2	0	0	02
		Total				**22**
		VI SEMESTER				
26	MBF110	Molecular Cell Biology	3	1	1	05
27	MBF120	Metabolism-II	3	1	1	05
28	MBF130	Enzymology	3	1	1	05
29	MBF140	Molecular Genetics	3	1	1	05
30	MBF150	Elective – 2	2	0	0	02
		Total				**22**
		VII SEMESTER				
31	MBG110	Immunology	3	1	0	04

32	MBG120	Molecular Mechanism of Signal Transduction	2	1	0	03
33	MBG130	Molecular Mechanism of Gene Expression - I	3	1	0	04
34	MBG140	Genetic Engineering- I & Bioinformatics	4	1	0	05
35	MBG150	Molecular Biology Lab-1	0	0	4	04
36	MBG160	Elective – 3	2	0	0	02
		Total				**22**
		VIII SEMESTER				
37	MBH110	Molecular Pathology	3	1	0	04
38	MBH120	Biostatistics and Research Methodology	2	1	1	04
39	MBH130	Genomics and Phylogenetics	2	1	1	04
40	MBH140	Molecular Basis of Development and Differentiation	3	1	0	04
41	MBH150	Molecular Biology Lab-2	0	0	4	04
42	MBH160	Elective – 4/ minor project work	2	0	0	02
		Total				**22**
		IX SEMESTER				
43	MBI110	Genetic Engineering-II	3	1	0	04
44	MBI120	Proteomics and Drug designing	2	1	1	04
45	MBI130	Cancer biology	2	0	0	02
46	MBI140	Molecular mechanism of Gene Expression-II	3	1	0	04
47	MBI50	Molecular Biology Lab-3	0	0	6	06
48	MBI60	Elective- 5	2	0	0	2
		Total				**22**
		X SEMESTER				
49	MBJ110	Elective -6 (self study)	02			02
50	MBJ120	Project Work		01	07	08
		Total				**10**
		Grand Total- Credits				**200**

SEMESTER - I

MBA110 -General Botany - Theory 4 Credits 64 Hrs

UNIT I

Classification: ICN rules, Binomial system of nomenclature. Whittaker's five kingdom concept, Cavalier-Smith eight kngdom classification **2 hrs**

Algae: Classification (Fritsch, 1935), Thallus structure, Reproduction, Alternation of generations, Economic importance.Type study: *Chlamydomonas, Chlorella, Spirulina, Spirogyra*, Diatoms (Pinnate and Centric*), Sargassum, Polysiphonia* **10 hrs**

Fungi: Classification (Ainsworth, 1973). General characters and Economic importance **4 hrs**

UNIT II

Fungi: Type study*: Rhizopus, Phytophthora, Penicillium, Scccharomyces* (only cell structure), *Agaricus, Fusarium*, Mycorrhiza (VAM) **7 hrs**

Bryophytes: Classification (Rothmaler, 1951). General characters and Economic importance. Type study: *Marchantia, Anthoceros, Sphagnum*. **9 hrs**

UNIT III

Pteridophytes: Classification: General characters and Economic importance.Type study: *Psilotum, Selaginella, Equisetum, Pteris (External morphology), Azolla* (Morphology & Internal structure) **9 hrs**

Gymnosperms: Classification: General characters and Economic importance.Type study: *Pinus*. **7 hrs**

UNIT IV

Angiosperm Taxonomy: Classification (Bentham and Hooker) in brief, Plant and plant parts in brief, Study the following families: Malvaceae, Solanaceae, Lamiaceae, Euphorbiaceae, Asteraceae, Arecaceae, Poaceae, and Evolution of plant (in brief). **10 hrs**

Anatomy: Meristems, Simple permanent tissue-parenchyma, collenchymas, sclerenchyma, Complex permanent tissue-xylem and phloem. Tissue systems: Epidermal (epidermal cells, stomata, hairs) ground and vascular, Internal anatomy of dicot and monocot young stem, leaf and root. Secondary growth in root and stem in dicots and anomalous growth (*e.g.Dracaena*). **6 hrs**

Practicals - 2 Credits 64 hrs

Staining using safranine and mounting of algae:

- Type study: *Spirulina,Chlamydomonas, Chlorella, Spirogyra,*Diatoms (Centric and Pinnate) *Sargassum, Batrachospermum/Polysiphonia*
- Staining using cotton blue in lactophenol and mounting of fungi
- Type study: *Rhizopus, Phytophthora, Penicillium, Saccharomyces, Agaricus, Fusarium, Mycorrhiza* (VAM) (eg. In sorghum roots).
- Bryophytes: Morphological and anatomical, features of *Marchantia, Anthoceros, Sphagnum.*
- Pteridophytes: Morphological, anatomical, reproductive features of *Psilotum, Selaginella,Equisetum, Pteris* (External morphology), *Azolla* (Morphology & Internal structure).

- Gymnosperms: Morphological, anatomical, reproductive features of *Pinus.*
- Angiosperms: Study of one plant each belonging to e.Malvaceae, Solanaceae, Lamiaceae, Euphorbiaceae, Arecaceae, Poaceae
- Anatomy: T.S of dicot stem (eg. *Tridax*), leaf (*Zinnia*, grass), root (*Cicer, Musa*). T.S. of monocot stem, leaf and root.

References:

1. Watson, E, V.1971. The Structure & Life of Bryophytes. Hutchinson & Co. Ltd. London.
2. Prempur, 1981. Bryophytes, Morphology, Growth & Differentiation. Atmaram & Sons, New Delhi.
3. Eames, F.O. 1936. Morphology of Vascular Plants. Mac-Graw Hill Co. N.Y.
4. Sporne, K.R. 1970. Morphology of Pteridophytes. Hutchinson & Co. Ltd. London.
5. Biswas & Johri, B.M. 1997. The Gymnosperms, Narosa pub. New Delhi.
6. Sporne, K.R. 1970. Morphology of Gymnosperms. Hutchinson & Co. Ltd. London.
7. Datta, A.C. Botany for Degree Students.
8. Lawerence, George, H.M. 1964. Taxonomy of Vascular Plants. Oxford & IBH Co. Pvt.Ltd. New Delhi.
9. Rendle, A.B. 1979. Classification of Flowering Monocotyledons. Vol.I. Vikas Publishing House, New Delhi.
10. Rendle, A.B. 1979. Classification Of Flowering Dicotyledons. Vol.II . Vikas Publishing House, New Delhi.
11. Alexopoulos C. J., Mims C. W. 1979. Introductory Mycology. Third edn. Wiley Eastern Limited, New Delhi.
12. Pandey D. C. 1981. A Textbook on algae. Kitab Mahal, Allahabad.

MBA120 General Zoology- Theory 4 Credits 64 hrs

UNIT 1

Biodiversity: Definition, Numerical strength, Binomial and trinomial nomenclature. Molecular taxonomy. Definition of species. The system of hierarchy. **2 hrs**

Animal diversity: Principles of animal classification. General characters and classification up to classes with examples of the following: **14 hrs**

a) Protista- Protozoa-(Honiberg *et al*., (1964) Classification (upto classes).

b) Metazoa

Branch 1. Parazoa – Porifera

Branch 2. Eumetazoa

a) Radiata – Cnidaria, Acnidaria

b) Bilateria – Aschelminthes, Platyhelminthes, Annelida, Onychophora, Arthropoda, Mollusca, Echinodermata and Hemichordata.

UNIT II

Phylum: Chordata: Sub-phyla-1. Urochordata 2. Cephalochordata. 3. Vertebrata **16 hrs**

Sub-phylum: Vertebrata (Craniata):

i) Agnatha- Cyclostomata

ii) Gnathostomata- Class: Pisces, Amphibia, Reptilia, Aves and Mammalia

UNIT III

Type Study

i) **Cockroach**: Externals, Mouthparts, Digestive system, Respiratory system, excretory system and Reproductive system.

ii) **Man**: Skeletal system, Nervous system, Circulatory system, and Reproductive system

16hrs

UNIT IV

Tissues – Different types of Animal tissues, Functional morphology of mammalian stomach, intestine (ileum), liver, pancreas, spleen, and lung. Histopathology of liver cirrhosis and pancreas in diabetes. **16hrs**

Note- Salient features should be elaborated while giving general characters of each phylum/ group. Local examples with common and scientific names are to be mentioned.

Practicals - 2 Credits **64hrs**

1-3: Slides and specimens:

- Protozoa: Euglena, Trypanosoma, Entamoeba coli, Plasmodium vivax.
- Porifera: Sycon, Monaxon spicules and a Gemmule.
- Cnidaria: Obelia, Medusa, Fungia.
- Acnidaria – Pleurobrachia
- Platyhelminthes: Fasciola, Section of liver fluke, Tapeworm (externals).
- Aschelminthes: Ascaris male and female, Section of Ascaris male and section of Ascaris female.
- Annelida: Nereis, T.S. of Neries, Parapodium.
- Onychophora: Peripatus

- Practical4-6: Slides and specimens:
  - Arthropoda: Penaeus – externals, appendages, Trophi of a mosquito, House fly, Honeybee and cockroach.
  - Molluca: Fresh water mussel, Sepia, Octopus, Shells of Dentalium, Xancus and Cuttle bone
  - Echinodermata: Star fish, Sea urchin, Corona of sea urchin, Pedicellaria, Bipinnaria larva.
  - Hemichordata: Balanoglossus externals, T.S. through proboscis/ Branchio-genital region.
  - Chordata: Amphioxus- Externals, Section through intestine.
  - Cyclostomata: Petromyzon
  - Fishes: Shark, Ophiocephalous, Anguilla.
- Practical 7 &8: Slides and specimens:
  - Amphibia: Rana, Icthyophis
  - Reptilia: Draco, Cobra, Viper, Krait.
  - Aves: Parakeet, Woodpecker.
  - Mammals: Rat and Guinea pig

Practical 9 &10

Mountings: -

- Mounting of scales (placoid,,ctenoid or cycloid); insect larvae(mosquito,Drosophila)
- Identification of any 5 fresh water planktons from the given water sample.

Practical – 11 & 12

Human : Nervous system, Arterial and Venous system.(Study by charts & photographs)

- Collection and Study of any 6 harmful and beneficial insects.

Practical – 13 & 14

- Osteology: Skull of Rabbit
- Vertebrae: Atlas, Axis, Procoelous, Amphicoelous, Acoelous vertebrae; Girdles and limbs skeleton of Rabbit.

Practical – 15 & 16

Tissues: Types of animal tissues-epithelial tissues(squamous,cuboidal, columnar,ciliated and stratified), striated, smooth and cardiac muscles, bone, cartilage and nervous tissue

Organ Histology: Section of mammalian ovary , testes, intestine (ileum), pancreas (normal and diabetic) and thyroid, Liver (normal and diabetic).

References:

1. Bhamrah H.S. & Juneja. K. 2001. A Textbook of Invertebrates, Annual publications Pvt. Ltd.
2. Ekambernath Ayyar. M., Anantha Krishnan, T.N. 1990. A Manual of Zoology- Vol-I, Invertebrate (Part I & II) S.Vishwanathan. Pvt. Ltd.
3. Ekambernath Ayyar. M., Anantha Krishnan, T.N. 1990. A Manual of Zoology- Vol-II Chordata (Part I & II) S.Vishwanathan. Pvt. Ltd.
4. Parker, T.J & Haswell W.A. 1972. A Textbook of Zoology, Vol-II, Mac Milan Press.
5. Gauba, R.K. 1987. An introduction to histology, Tata Mc-Graw Hill Pub.
6. Rogers, A.W. 1983. Cells & tissue: Introduction to histology and cells. Academic press.

MBA130 Mathematics for Biologists -Theory 03 Credits 48 hrs

UNIT I

NUMBERS AND CO-ORDINATES: Integers, Rational and Real numbers, Postula0tes for real numbers and their consequences, inequalities, absolute values, bounded and unbounded sets, open and closed intervals, complex numbers, indices and logarithms. Cartesian co-ordinates, distance formula, polar co-ordinates, relation between Cartesian and polar co-ordinates. **06 hrs**

FUNCTIONS: Functions and their graphs. (i) Trigonometric Functions – Trigonometrical ratios, identities, certain standard angles, signs of trigonometric ratios in all four quadrants, compound angles, multiple and sub-multiple angles, half angles, simple problems. Inverse trigonometric functions, simple problems.

(ii) Polynomial, rational and radical functions. (iii) Exponential and logarithmic functions. (iv) Linear functions in biology. **06 hrs**

UNIT II

Limits and continuity – definitions, geometric illustrations, statements and illustrations of various theorems on limits and continuity. Problems on limits and continuity. Applications to biological problems, e.g., modeling rates of reactions, allometric scaling. **04hrs**

DIFFERENTIATION: Definition of derivative of a function, rules for differentiation of a sum, product and quotient of two functions. Differentiation of composite functions (chain rule), polynomials, trigonometric, logarithmic, exponential and hyperbolic functions, inverse trigonometric and hyperbolic functions, parametric differentiation. Second and higher order derivatives.
08 hrs

UNIT III

Increasing and decreasing functions, maxima and minima, points of inflexion, - problems. Partial differentiation of a function of more than one variable. **4hrs**

INTEGRATION: Definition and standard integrals, rules of integration – illustrative problems. Integration by the method of substitution, Integration by parts, standard formulae of integrals of algebraic functions – illustrative problems.

Definite integrals, integral of a function as the area under a curve, Fundamental theorem of integral calculus – illustrative problems. Applications to biological problems, e.g., growth of a microbial culture **8 hrs**

UNIT IV

DIFFERENTIAL EQUATIONS: Definition and examples, order and degree of a differential equation. Differential equations of first order and first degree – Variable separable method, Homogeneous equations, Equations reducible to homogenous form, exact differential equations. Applications to biological problems, e.g., growth of microorganisms, plants and animals.
4 hrs

MATRICES AND DETERMINANTS: Types of matrices, Algebra of matrices, properties of determinants – illustrative problems. Transpose of a matrix, symmetric matrix, singular and non-singular matrices, inverse of a matrix (using co-factors).

Rank of a matrix (by reducing to echelon form), consistency of a system of simultaneous linear equations, characteristic equation, characteristic roots, Cayley-Hamilton theorem (without proof). Applications to biological problems. **8 hrs**

References:

1. Causton D. R. 1992. A Biologist's Basic Mathematics. Cambridge University Press, Cambridge.
2. Murray J.D. 2007. Mathematical Biology. 3rd Edition. Springer Verlag, New York.
3. Lipman Bers 1969. Calculus. Holt, Rinehart and Winston New York.
4. Shanti Narayan 1996 Differential Calculus 14th Edition S. Chand & Co., Delhi.
5. Shanti Narayan. 1999. Integral calculus. S. Chand and company limited, Delhi.
6. Rainville E. D., Bedient P. E. 1981. A short course in differential equations. Collier Macmillan. London.
7. Manicavachagam Pillai, T.K. Natarajan T. Ganapathy K.S. 2004. Algebra Printers & Publishers. Pvt. Ltd. Chennai

MBA 140 Constitution of India Theory 3 Credits 48 hours

Unit I

1. Meaning and importance of Constitution
2. Making of Indian Constitution
3. Salient features and the Preamble

Unit II

1. Fundamental rights
2. Fundamental duties
3. Directive Principles

Unit III

Union Government

1. Lok Sabha & Rajya Sabha (Composition, Powers & Functions)
2. President & Prime Minister (Powers,Functions, position)
3. Supreme Court-Composition, Powers & Functions

Unit IV

Major Functionaries

1. Union Public Service Commission
2. Election Commission
3. Plannig Commission (NITI)

References:

1. Indian Constitution-Durga Das Basu.
2. Indian Constitution – M.V. Pylee.
3. Indian Government and Politics- J.C. Johri.
4. Indian Government- S.R. Maheshwari.
5. Indian Government and Politics- J.C. Joohri.
6. India's Constitution -- Faida
7. Indian Government and Politics - Dr. S.N. Dubey.
8. Indian Political System- R.C. Agarwal.
10. Indian Constitution --Vidhya Bhushan and Vishnu Bhagawan.
11. Bharathada sarkara matthu Rajakiya- Dr. H.M. Rajshekara
12. Bharathada sarkara matthu Rajakiya- Dr. K.J. Suresha.

MBA150 Communication skills I– Theory 01 Credit (16 hours) Tutorial 1 Credit (32 hours)

UNIT I and II (8 hrs)

Basic Grammar

1. Noun: Kinds of nouns, noun number, noun gender and correct usage.
2. Pronoun: Types of pronouns and their correct usage.
3. Adjective: Kinds of Adjectives, Degrees of comparison and correct usage.
4. Verb:
   a. Different kinds of verbs, Forms of Verbs: Present. Past and Past participle
   b. Tenses: Present, Past and Future and their correct usage.
   c. Subject Verb Agreement (Concord)
5. Adverb :Kinds of Adverbs and their correct usage
6. Conjunction
7. Preposition: Kinds of preposition and Correct usage
8. Articles

9. Active and Passive voice
10. Direct and Indirect Speech
11. Punctuation

UNIT III and IV **(8 hrs)**

12. **Oral communication** is the ability to explain and present ones ideas in clear English, to diverse audiences; Speaking effectively, Effective **Listening** and Readingskills to be taught.
    a. Listening skills and Speaking skills to be taught with audiotapes.
    b. Short and long conversation involving two or more people: Greeting, introducing, making an enquiry, casual/formal telephone conversation, Conversation at the bank, at the department store, at the post office, at the doctor's, at the travel agent, at the railway station/bus stop etc
    Informal conversation between friends.
    c. Storytelling: the construction of fictional examples to illustrate a point, can be used to effectively in teaching listening and speaking skills.

References:

1. Siddney Greenbaum, The Oxford English Grammar, Oxford University Press,
2. Cowie, A.P. & R. Mackin, Oxford Dictionary of Phrasal verbs, Oxford University Press,
3. Cowie, A.P. & R. Mackin & I.R. Mc Caig, Oxford Dictionary of Phrasal English Idioms, Oxford University Press,
4. Sturat Redman, English Vocabulary in Use pre-intermediate and intermediate; low price editions, Oxford University Press,
5. Rosemary T., Fruehling & Joan M. Lacombe, Communication for Results, A.I.T.B.S. Publishers and Distributors,
6. How to write and speak better, Reader's Digest
7. Modern Grammar with Practical Exercises, Vikas Publishing House Pvt. Ltd.

Semester-II

MBB110 General and Inorganic Chemistry - Theory -04 Credits 64Hrs

UNIT I

1. Behavior of Gases-Gas Laws: Kinetic theory of gases- assumptions. Gas laws statement and equation- Boyle's law, Charle's law, Gay-Lussac's law, The combined gas law, Dalton's law of partial pressures, Avogadro's law and molar gas volume, The ideal gas law, Graham's law of diffusion. Kinetic molecular theory and kinetic gas equation (noderivation), deviation of real gases from the ideal gas law and Vander Vaal's equation- a qualitative treatment, Simple Problems. **4 hrs**

2. Atomic structure: Quantum numbers and their significance. Shapes of s, p and d-orbitals. Modern Periodic law, Aufbau principle, Hund's rule of maximum multiplicity, Pauli's exclusion principle and Hund's rule, (n+l) rule. Periodic table based on electronic configuration. Electronic configuration of elements. Ionization energy, electron affinity, electronegativity. **4hrs**

3. Chemical bonding: Definitions, formation of ionic bond, covalent bond (sigma and pi bonds), co-ordinate bond with examples. Van-der-Waal's interactions, hydrogen bond-its significance in biological systems. Hybridization- Hybrid orbitals, sp, sp^2 and sp^3 hybridization taking (C_2H_2), $BeCl_2$, ethylene (C_2H_4), BF_3, methane (CH_4), $SiCl_4$ as examples. **5 hrs**

4. Fundamentals of chromatography: general description, definition, terms and parameters used in chromatography, classification of chromatographic methods, criteria for selection of stationary and mobile phases-nature of adsorbants, factors influencing the adsorbants, nature and types of mobile phases and stationary phases. **4 hrs**

UNIT II

5. **Coordination Compounds**–simple, double and complex salts-definition, differences with examples. Transition metals- properties (oxidation states, magnetic properties, complex formation).Werner's theory, ligands- uni, bi, and polydentate. Coordination number, stereochemistry of different coordination numbers, Isomerism in coordination compounds, geometrical isomerism, optical isomerism. Bonding in coordination compounds, valence bond theory, crystal field theory, color in transition metal complexes, stability of complexions.**10 hrs**

6. Concentration units: methods of expressing concentration of solutions Definition and equation-Mole, Mole fraction, Molarity, Molality, Avagadro's number, Equivalent weight, Normality, Percentage composition, Theoretical yield, Percentage yield. Problems based on preparation and inter-conversion of these solutions. **6 hrs**

UNIT III

7. Biologically important elements: Nitrogen (Nitrogen cycle), Calcium, Mg & Zn. Phosphorous (Phosphorous cycle), Oxygen (Ozone), Reactive oxygen, oxygen free radicals.Sulphur. **5 hrs**

8. Bioinorganic chemistry: Trace metalsin biological systems: Selenium, Molybdenum, cobalt.Toxicity of heavy metals: Lead,mercury,cadmium,arsenic. Bulk elements in biological systems (Na, K, Ca, Mg, Fe, Co, Zn and I). Role of Na and K in biological systems. Structural role of calcium, zinc in enzymes. **5 hrs**

9. Porphyrin nucleus and classification: Important metalloporphyrins occurring in nature; structure and their biological importance (Haemoglobin, cytochrome, chlorophyll, myoglobin, vitamin B12). Bile pigments, chemical nature and their role in physiology. **5 hrs**

UNIT IV

10. Acids-bases and buffers: Statement & Examples: Lowry-Bronsted concept, Lewis concept of acids and bases, General theory of solvent system, ionic product of water, pH scale, buffers, Henderson-Hasselbach equation, buffer capacity, preparation of buffers. Theory of acid base indicators, choice of indicators, pH titration curves, calculation of isoelectric points, strengths of acids and bases. Ionization constant, formation constants, stepwise ionization constants for polyprotic acid. **8 hrs**

11. X-ray Crystallography: Laws of Crystallography, symmetry elements, axial ratio and interfacial angles, Miller indices, basic crystal systems, lattice points and planes, unit cell Bravais lattices, X-ray diffraction by crystals, Bragg's law, X-ray spectrometer, determination of NaCl structure by rotation method, indexing of powder photographs of crystals. **8 hrs**

Practicals - 01 Credit **32 hrs**

1. Weighing using analytical balance and Calibration of Pipettes and Burette.
2. Preparation of Normal and Molar solutions
3. Preparation of standard sodium carbonate solution, standardization of HCl (methyl orange Indicator) and estimation of NaOH (Phenolphthalein Indicator)

4. Preparation of standard Oxalic acid solution, standardization of potassium permanganate solution and estimation of H_2O_2 in solution.
5. Preparation of standard $K_2Cr_2O_7$ and standardization of $Na_2S_2O_3$. Estimation of Fe^{2+} (ferrous) and Fe^{3+} (Ferric) ions in a mixture using diphenylamine indicator.
6. Preparation of standard potassium phthalate solution. Standardization of NaOH and estimation of oxalic acid in given solution (phenolphthalein).
7. Preparation of standard $ZnSO_4$ solution, Standardization of EDTA and estimation of totalhardness of water.
8. Determination of alkali content in antacid tablets.
9. Estimation of Calcium in milk
10. Estimation of starch in Potato
11. Estimation of Vitamin C by Chloromine-T method
12. Estimation of iron content in commercially available drug
13. Estimation of Glucose by DNS method
14. Estimation of phosphate in biological sample.

References:

1. Daniel F., Mathematical preparation for physical Chemistry. Mc. Graw HillPublication.
2. C.N. R. Rao. University General Chemistry. Mc. Millan Publication.
3. Maron and Pruton. Principles of Physical Chemistry. 4th Ed. Oxford andIBH publication.
4. G.M. Barrow. Physical Chemistry.

B.S. Bahl, ArunBahl and G.D. Tuli, Essentials of Physical Chemistry, S. Chand and Company, New Delhi

MBB120 Physical Chemistry – Theory - 4 Credits 64 hrs

UNIT I

1. Radiochemistry: Natural and artificial radioactivity, characteristics of radioactive elements, units of radioactivity, disintegration constant, half-life period,alpha, beta and gamma radiations-their characteristics. Detection of radioactivity by GM counter. Applications of radioisotopes – 3H, 14C, 131I, 60Co and 32P. Biological effects of radiation. Safety measures in handling radioisotopes. Radioactive series. Applications24 sterilization, activation of drugs, detection of flow of fluids, induced chemical reactions. Nuclear fission and fusion. **6 hrs**

2. Colligative properties: Lowering of vapor pressure, Raoult's law, definition and equations - elevation of boiling point, Ebullioscopic constant, depression of freezing point, cryoscopic constant, their application in determination of molecular weight of non-volatile solute-relationship between the constants and molecular mass, experimental methods of determining molecular mass by Walker-Lumsden's method and Rast's method Osmotic pressure and its measurement by Berkley and Hartley's method, relationship between osmotic pressure and molar mass. Hypo, hyper and isotonic solutions. Donnan membrane equilibrium. Abnormal molecular weights. Vant Hoff factor, degree of association and dissociation. Problems based on above concepts. **10 hrs**

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UNIT II

3. Photochemistry: Definition, electromagnetic radiations – different regions of EMR and properties of the radiations , Lambert – Beer's law Photochemical reactions- definition and examples, laws of photochemistry– Grotthus Draper law, Einstein's law of photochemical equivalence, quantum efficiency – high quantum yield and low quantum yield with one example each. Chemiluminescence and bioluminescence with examples, Phosphorescence, Fluorescence, Photosensitizers – Examples in natural systems **8 hrs**

4. Pharmacokinetics: Plasma concentration, Plasma level- time curve, drug dissolution rate, physicochemical factors affecting bioavailability. Pharmacokinetics applied to one component open model. Caluculation of elimination rate constant and metabolism, constant apparent volume of drug distribution, drug distribution and kinetics of drug clearance. Protein binding of drugs, bioavailability, and bioequivalence. Factors affecting bio-avilability route of drug administration and kinetics of protein binding. **8 hrs**.

UNIT III

5. Distribution law: Statement - Nernst's Distribution law, Equation – example – Iodine in water and carbon disulphide, Partition co-efficient, simple problems – limitations of Nernst's law, applications of distribution law with emphasis on solvent extraction **3 hrs**

6. Electrochemistry: Definition and equations - Specific, equivalent and molar conductance, SI units for each, Determination of equivalent conductance of a strong electrolyte – theory and experimental method, Transport numbers. Applications of conductance measurements – a) Ionic product of water, b) Ionisation constant and degree of ionisation, c)conductometric titrations: i) strong acid v/s. strong base ii) weak acid (amino acid) v/s. strong base.

Electrochemical cell - definition and representation of a cell. Single Electrode potential, standard electrode potential, EMF, Nernst's equation for single electrode potential. Electrochemical series, concentration cells

Reference electrodes-(primary–hydrogen electrode and secondary-calomel electrode).Secondary electrodes – quinhydrode and glass electrode -construction and working, redox potential and redox electrode (Fe^{2+}/Fe^{3+} as examples). Concentration cell- Liquid junction potential. Application of EMF measurements. i) Determination of pKa values of weak acids ii) Determination of pH of a buffer by potentiometric method using quinhydrone electrode & glass electrode iii) Potentiometric titration (Redox titration) **13hrs**

UNIT IV

7. Chemical kinetics: Rate of reaction, order of reaction, molecularity, first order and second order reactions-definition and rate equation, half-life period characteristics of 1^{st} and 2^{nd}order reaction constants. Methods of determining order of a reaction - differential rate method, half-life period method, types of reactions - Elementary reactions, reaction mechanism, rate determining steps - qualitative treatments, complex reactions - consecutive, parallel, reversible, chain reactions; surface reactions - definition & examples. Theories of elementary reaction process - collision theory and transition state theory. Temperature dependence of reaction rates. Arrhenius equation-energy of activation**.** **13 hrs**

8. Catalysis: Homogeneous and Heterogeneous – Definition and examples. Inhibitors. Enzyme catalyzed reactions – examples. Mechanism of enzyme- catalysed reactions. Effect of substrate concentration, Effect of pH, temperature, Inhibitor on enzyme catalyzed reactions. **3 hrs**

Problems in all units have to be solved

Practicals – 1 Credit **32 hrs**

1. Conductometric titration of strong acid and strong base
2. Conductometric titration of weak acid and strong base
3. Verification of Beer-Lamberts Law and calculation of extinction co-efficient –($CuSO_4$ solution + NH_4OH).
4. Determination of molar conductance of the given strong electrolyte
5. Determination of molar conductance of the given weak electrolyte
6. Determination of pKa of weak acid by potentiometric method.

7. Determination of molecular weight of non-volatile solute by Walker Lumsden method.
8. Determination of viscosity of a liquid (general/gum solution/ sugar syrup/ salt solution) by viscometric method - two liquids in a class).
9. pH titration of strong acid by strong base using pH meter.
11. Potentiometric titration of ferrous ammonium sulphate v/s. $K_2Cr_2O_7$ solution
12. Determination of protein concentration using Bi-uret solution by colorimetric method.
13. Kinetics of acids hydrolysis of ethyl-methyl acetate and determination of order ofreactions.
14. Determination of partition coefficient of distribution of iodine between water and carbon-di-sulphide.

References:

1. Rao C.N.R., 1997. University Chemistry, Mc MiI1an Co,
2. Emeleus and Anderson, 1992; A Text Book of Inorganic Chemistry, New Age Publishers.
3. Puri B.R. and Sharma L., 2000, A Text Book of Inorganic Chemistry, ShubanlallNagin Chand Co.
4. Jain M. K. A Text 'Book of Organic Chemistry, XVI 2000, S. Chand and Co. New Delhi.
5. Soni P. L. A Text Book of Organic Chemistry, XVW 2000, S. Chand and Co. New Delhi.
6. Bahl and Bahl. A Text Book of Organic Chemistry, XVI 2000, S. Chand and Co. New Delhi.
7. Jayaraman, Laboratory Manual of Organic Chemistry, III, 1998, S. Chand & Co. New Delhi.
8. Bansal R. K. Laboratory Manual of Organic Chemistry, , XVIII; 1999, New Age. Publication, Bangalore.
9. Finar I. L. 1959. Organic Chemistry, Vol1 am4 Vol. II, LL. 2000, ELBS
10. Kundan M., Jain S.K. Physical Chemistry, III, 1986, S. Chand & Co, UP.
11. Sharma K.K., Sharma C.K., Text Book of Physical Chemistry, VIII 1998.Vani Educational Books.

MBB130 - PHYSICS – Theory 04 CREDITS 64 hrs

UNIT I

I. **Viscosity**: Streamline flow, explanation of Bernoulli's theorem. Coefficient of viscosity and Poiseuille formulae for capillary flow. Measurement of Viscosity by capillary flow, Reynold number and Ostwald's Viscometer.

II. Thermodynamics: Definitions, Reversible and irreversible processes, Inter conversionof heat and work.

III. **First law of Thermodynamics**: Concept of internal energy, Work done in adiabatic and isothermal expansion of an ideal gas. State functions. Exact or Perfect differentials. Thermodynamic criteria of an ideal gas.

IV. **Enthalpy**: Concept of Enthalpy (H), Heat capacity of gases at constant volume and constant pressure and relationship between them. Kirchhoff's equations and their applications.

V. **Second law of Thermodynamics**: Statement in different forms. Carnot cycle and the concept of entropy (S). Work function (A) and free energy (G), their concepts. Variation of free energy with pressure and temperature. Gibb's- Helmholtz equation, Free energy change and its applications. Clausius- Clapeyron equation and its applications using Maxwell's thermodynamic relations. **16hrs**.

UNIT II

VI. Optical Instruments: Refractive index and its determination, Critical angle, Abbe's and Pulfrich refractometer. Compound microscope, oil immersion objective and Epidiascope. Colorimeter, Nephelometer and Fluorimeter. (Only basic principles).

VII. Physical optics: Huygen's principle of wave propagation. Young's experiment, expression for fringe width, Fresnel's biprism and Newton's rings (theory and experiment). Colours of thin films, Air wedge.

VIII. Diffraction: Elementary idea of diffraction and half period zones. Fresnel's and Fraunhoffer diffraction. Illustrations of diffraction patterns due single slit, circular aperture and circular obstacle. Diffraction grating- theory. Measurement of wavelengths of spectral lines. Resolving power of microscope, Telescope. Dispersive power of prism and grating. **16 hrs**

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UNIT III

IX. **Polarization:** Plane polarized light. Double refraction, dichroism, Nicol prism. Mention of linear, circular and elliptical polarization and their production, quarter and half wave plate, Polarimeter. Molar refraction, Optical rotation, Optical activity and its measurement. **3 hrs**.

X. Electricity: Motion of a charged particle in electric and magnetic field- Application to Cathode ray Oscilloscope, Aston mass spectrograph and Electron microscope (with theory). Dipole moments and Dielectric constant, Dipole moment of biomolecules. **4 hrs**

XI. Electronics: Characteristics of Diode, Zener diode, brief account of Power supply Transistor, BJT, FET, Amplifier, Oscillator, Op-Amp Integrated circuits, GM counters, Scintillation counters.

XII. Ultra Sonics: Properties, Production by Magnetostriction Oscillator and applications

XIII. Introduction to lasers: General principles, semiconductor laser, He-Ne gas laser. Applications. **9 hrs**

UNIT IV

XIV. Atomic Physics: Concept of Quantum theory of radiation. Bohr's theory of atomic structure of Hydrogen like atoms. Origin of spectral lines. Energy level diagram. Emission and absorption spectra. Fraunhoffer spectra. Comparative study of electromagnetic spectra (properties and applications). Continuous and Characteristic X-rays. **10 hrs**.

XV. Introduction to lasers: General principles, semiconductor laser, He-Ne gas laser. Applications. **2 hrs**

XVI. Molecular spectra: Rotational, vibration and electronic spectra of molecules. Associated quantum members and selection rules. Theory of pure rotation spectra, rotation – vibration spectra applications. **4 hrs**

PRACTICALS – 1 Credit 32 hours

(A minimum of 12 experiments to be carried out by the student)

1. Determination of density of liquids using density bottle.
2. Verification of inverse square law for ɤ-rays.
3. Linear absorption coefficient for ɤ-rays.
4. Verification of inverse square law for β –rays.
5. Linear absorption coefficient for β-rays.
6. Determination of wavelength of spectral lines (Hg) using diffraction grating.

7. Determination of specific rotation of sugar solution by using polarimeter.
8. Determination of wavelength of laser light by diffraction grating.
9. Charging and discharging of a condenser.
10. Characteristies of junction diode.
11. Characteristics of BJT.
12. Characteristics of FET.
13. Characteristics of Zener diode.
14. IC-741 as an amplifier.
15. Verification of basic logic gates using diodes & transistor.
16. Determination of Voltage and frequency using CRO.
17. Determination of radius of curvature of the convex lens by Newton's rings method.
18. Determination of thickness of the paper by air wedge method.

References

1. Alonso M. and Finn E.J. 1967. Fundamental of University Physics. Addison - Wesley Reading, Massachusetts, Reprinted New Edition.
2. Halliday D., Resnick R.and Merryl J. 1988. Fundamentals of Physics, Extended 3rd Edn. John Wiley, New York.
3. Horowitz P. and Hill W. 1995. The Art of Electronics: Second Edition, Cambridge University Press.

MBB140 - ENVIRONMENTAL STUDIES Theory - 3 CREDITS 48 Hrs

UNIT I

1. **The Multidisciplinary nature of Environmental resources**: Definition, scope and Importance, Need for Public awareness. **2 hrs**

2**. Natural Resources and associated problems:** Forest Resources: Use and overexploitation, deforestation, case studies, Timber extraction, mining dams and their effects on forests and tribal people.

a) Water resources: Use and over-utilization of surface and ground water, floods,drought,conflicts over water, dams-benefits and problems.

b) Mineral Resources: Use and exploitation, environmental effects of extracting andusing mineral resources, case studies.

c) Food resources: World food problems, changes caused by agriculture andovergrazing, effects of modern agriculture, fertilizer-pesticide problems, waterlogging, salinity, case studies.

d) Energy Resources: Growing energy needs renewable and non-renewable energy resources use of alternate energy sources. Case studies.

Land Resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. **10 hrs**

UNIT II

3. Ecosystems: Concept of ecosystem

- Structure and function of an ecosystem.
- Producers, consumers and decomposers
- Energy flow in the ecosystem
- Ecological succession
- Food chains, food webs and webs and ecological pyramids.
- Introduction, types, characteristic features, structure and function of thefollowingecosystem.

a) Forest Ecosystem b) Grassland Ecosystemc) Desert ecosystem

Aquatic Ecosystems (pond, streams, lakes, rivers, oceans, estuaries) **4 hrs**

4. Biodiversity and its conservation: Introduction- Definition: genetic, species andecosystem diversity.

- Biogeographical classification of India
- Value of Biodiversity: consumptive use, productive use, social, ethical aesthetic and option values.
- Biodiversity at global, National and local levels.
- India as a mega-diversity nation.
- Hot-spots of biodiversity

Threat to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts.

- Endangered and endemic species of India.

Conservation of bio-diversity: In-situ conservation of biodiversity. **8 hrs**

UNIT III

5. Environmental Pollution: Definition, Causes, effects and control measures of:
a) Air pollution b) Water pollution c) Soil pollution d) Marine pollution e) Noise pollution f) Thermal pollution g) Nuclear hazards

- Solid waste management: causes, effects and control measures of urban and industrial waste.
- Role of an individual in prevention of pollution
- Pollution case studies

Disaster management: floods, earthquakes, cyclone and landslides **4 hrs**

6. Social issues and the Environment:

- From unsustainable to sustainable development
- Urban problems related to energy
- Water conservation, rain water harvesting, watershed management.
- Resettlement and rehabilitation of people; its problems and concerns. Case studies.
- Environmental ethics: issues and possible solutions.
- Climate change, global warming, acid rain, ozone depletion, nuclear accidents and holocaust. Case studies.
- Wasteland reclamation
- Consumerism and waste products
- Environment protection Act.
- Air (prevention and control of pollution) act.
- Water (Prevention and control of pollution) Act.
- Wildlife protection Act.
- Forest Conservation Act.
- Issues involved in enforcement of environmental legislation.
- Public awareness. **8 hrs**

UNIT IV

7. Human population and Environment: Population growth, variation among nations.

- Population explosion - Family welfare programme.
- Environment and human health
- Human Rights
- Value Education
- HIV/AIDS
- Women and Child Welfare

Role of Information Technology in Environment and human health.Case studies. **8 hrs**

8. Field Work:

- Visit to a local area to document environmental assets -river/forest/grassland/hill/mountain.
- Visit to a local polluted site - Urban/Rural. Industrial/Agricultural
- Study of common plants, insects, birds.

Study of simple ecosystems - pond, river, hill slopes, etc (Field work Equal to 5 Lecture hours)

4 hrs

References:

1. Agarwal, K. C. 2001 Environmental Biology, Nidi publications Ltd. Bikaner.
2. Bharucha E., The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad -380 013,
3. Mckinney, M. L. and School, R. M. 1996 Environmental Science System & solutions Web enhanced edition.
4. Miller T. G. Jr. Environmental Science, Wadsworth publishing house
5. Odum, E. P. 1971. Fundamenta1s of Ecology, W.B. Saunders co, USA
6. Trivedi R. K. Handbook of environmental laws, rules, guidelines, compliances and standards. VoL 1 and n enviro media.
7. Kaushik A. and Kaushik C. P. 2008. Environmental Studies. NewAge International Publishers.

MBB150 - Communication Skills–2
Theory 1 Credit (16 hours) Tutorial 1 credit (32 hours)
UNIT I and UNIT II

1. Written communication: The ability to write effectively in a range of contexts and for different audiences and purposes, with a good command of the English language is taught.

1. Idioms and Phrases
2. Antonyms, Synonyms,
3.Homonyms, Homophones
4. Figures of Speech **8hrs**

UNIT III and UNIT IV

2.Writing skills to be taught through:

A. Guided Composition
B. Expansion of an Idea/ Proverb
C. Letter Writing:Personal letters, Leave note, Application for a job, Letter to the editor, Letters of complaints, Placing orders,
C.Letter to the editor, Letters of complaints, Placing orders
D. Precis Writing
E. Short Essay writing
F. Comprehension **8 hrs**

References:

8. Siddney Greenbaum, The Oxford English Grammar, Oxford University Press,
9. Cowie, A.P. & R. Mackin, Oxford Dictionary of Phrasal verbs, Oxford University Press,
10. Cowie, A.P. & R. Mackin & I.R. Mc Caig, Oxford Dictionary of Phrasal English Idioms, Oxford University Press,
11. Sturat Redman, English Vocabulary in Use pre-intermediate and intermediate; low price editions, Oxford University Press,
12. Rosemary T., Fruehling & Joan M. Lacombe, Communication for Results, A.I.T.B.S. Publishers and Distributors,
13. How to write and speak better, Reader's Digest
14. Modern Grammar with Practical Exercises, Vikas Publishing House Pvt. Ltd.

Semester-III

MBC110 - ORGANIC CHEMISTRY I – THEORY – 3 CREDITS **48 hrs**

UNIT I

1. Qualitative and quantitative analysis: Detection of carbon, hydrogen, nitrogen and sulphur. Estimation of Sulphur and halogens by Carius method, Nitrogen by Kjeldhals method.

3 hrs

2. Organic reactions and intermediates: Classification of organic reaction, arrow notations and their significance, homolytic and heterolytic bond breaking. Basic concepts of electrophiles, nucleophiles with examples. Reactive intermediates: Definition, structure, stability of free radicals, carbocation, carbanions, carbenes and nitrenes. Electronic effects: Inductive effect, resonance effect, hyper conjugation, steric effect and their influence on the acidity and basicity of molecules with examples (acid and amines). **8hrs**

UNIT II

3. Aliphatic hydrocarbons

Alkanes: Mechanism of chlorination of methane.

Alkenes: Mechanism of addition of HBr to propene, Markovnikoffs rule and antiMarkovnikoff's rule (peroxide effect), allylic Substitution by NBS, polymerization (types) free radical, cationic and anionic including the mechanism.

Alkynes: Acidity of alkynes in comparison with alkanes and alkenes, formation of acetylides, oxidation, ozonolysis and hydroboration, polymerization. **4 hrs**

4. Alicyclic Hydrocarbons: Hydrogenation and halogenation reactions, comparison of the stabilities of cycloalkanes – Bayer's Strain theory postulates and limitations) Sasche-Mohr's theory of strain less rings) chair and boat conformations of cyclohexane, axial and equatorial bonds.

2 hrs

5. Aromatic hydrocarbons: Modem concept of structure of benzene including molecular orbital theory. Aromaticity, resonance energy, electrophilic substitution reaction of benzene with mechanism (halogenation, sulphonation, nitration, Friedel-Crafts' reaction). Electronic interpretation of orienting influence of electron donating groups (CH_3, Cl, NH_2, OH) and electron withdrawing groups ($-NO_2$,-COOH, $-SO_3H$,-CHO) on electrophilic substitution reaction. **6 hrs**

UNIT III

6. Organo-metallic compounds: Definition with examples, preparation and synthetic application of ethyl magnesium iodide (Synthesis of alkane, alcohols, aldehydes, ketones and carboxylic acid) preparation of TEL and uses. **3 hrs**

7. Amines: Classification with examples, separation of mixture of amines by Hinesburg's method. Action of nitrous acid on different amines (both aliphatic and aromatic – primary, secondary and tertiary amines).Effect of substitutes on the basicity of aliphatic and aromatic amines, Hoffmann Martius rearrangement. Diazonium compounds: Preparation and synthetic applications of benzene diazonium chloride. **4 hrs**

8. Hydroxy compounds: Alcohols: Classification with example.

Monohydric alcohol: Preparation and reaction of alcohol by hydroboration method. Distinguishing test between primary, secondary and tertiary alcohol (oxidation & Lucas

method).Dihydric alcohols: Preparation (alkenes with potassium permanganate) & uses of glycol Tri hydric alcohols: Glycerol - synthesis from propylene, reaction of glycerol with concentrated HNO3, Concentrated H2SO4) oxalic acid and HI - uses of glycerol. Phenols: Acidity of phenols – Effect of substituents (CH3, NO2 on acidity of phenols) Mechanism of Reimer Tiemann reaction – Kolbe's reaction, Electrophilic substitution reactions of phenols, nitration, bromination. **6 hrs**. .

UNIT IV

9. Carbonyl compounds: Addition reaction with HCN, $NaHSO_3$, condensation reaction with 2,4-dinitrophenyl hydrazine, NH_2OH.Reaction mechanism, Aldol condensation, Perkin's reaction, Cannizaro's reaction, Claisen condensation, base catalysed halogenations of ketones. **4 hrs**

10. Active methylene compounds: Preparation and synthetic application of: ethyl acetoacetate and malonic ester. (Monocarboxylic, dicarboxylic and unsaturated carboxylic acids) Ketoenol tautomerism in ethyl aceto acetate. **2 hrs**

11. Carboxylic acid: Classification with examples, synthesis by Arndt – Eistert reaction, acidity of carboxylic acids, effect of substituents on acidity (both aliphatic and aromatic carboxylic acids), hydroxy acids – synthesis of lactic, citric and tartaric acids and their importance, effect of heat on alpha, beta, gamma hydroxy acid **6 hrs**

Practicals - 1 Credit 32 hrs

Systematic qualitative analysis of Mono and bi-functional Organic compounds. The following classes of organic compounds may be given i) Amides- urea and benzamide ii) Carboxylic acids- benzoic acid, hydroxyl acids- salicylic acid, iii) Phenols – meta cresol, alpha and beta naphthol iv) Amines-aniline and toulidine v) Aldehydes - benzaldehyde vi) Ketones – acetophenone and benzophenone vii) Alcohols – benzyl alcohol viii) Hydrocarbons - naphthalene ix) Halogenated Hydrocarbons – chloro benzene x) Nitro compounds – nitrobenzene xi) Anilides acetanilide.

References:

1. Clayden. Organic Chemistry. Oxford University Press.
2. Morrison R T. Boyd R N. 1998. Organic Chemistry 6th Edn, Prentice-Hall Ltd., New Dielhi.
3. Sykes P., A 1981.Guidebook to Mechanism in Organic Chemistry, 5th edition, Longman, London.

MBC120 - BASIC BIOCHEMISTRY – THEORY – 3 CREDITS 48 hrs

UNIT I

1. Carbohydrates: Definition, empirical formula, Classification and examples, monosaccharides - Trioses, Tetroses, Pentoses, and Hexoses. Aldo and Keto sugars, structure (open chain, ring and boat conformations) anomers, epimers. Determination of ring size by methylation, reactions of sugars with HCN, HNO3, bromine water, Phenyl hydrazine, acetylation, ascending and descending series.

2. Stereochemistry of Glucose: Qualitative tests for sugars, reducing properties of sugars like Benedicts, Tollens, Fehling's and Barford's tests. Quantitative estimation of glucose by DNSmethod and by Glucose oxidase method, occurrence, extraction from biological sources. Amino sugars, sialic acid, muramic acid and uronic acids. **12 hrs**..

UNIT II

3. Structure elucidation of Disaccharides: Lactose, Maltose and Sucrose, structure and reactions. **4 hrs**

4. Amino acids: Classification, structure and stereo chemistry, Zwitter ionic form, qualitative tests , color reactions of amino acids with ninhydrin, nitric acid, dansyl chloride, Phenylisothiocyanate and qualitative estimation, essential amino acids, unusual amino acids and non-protein amino acids, occurrence, and function. Chemical synthesis of a dipeptide **6 Hrs**.

5. Water: Its essentiality to life. Water as biological fluid, special properties of water, buffer and pH. **1hrs**

6. Acids and Bases: Review of Lewis acids, Lowry-Bronsted, weak acids and bases. Buffers: Preparation of buffer, buffer capacity, pKa, Henderson-Hassel Bach equation. **1 hrs**

UNIT III

7. **Lipids:** Classification and biological role, Iodine number, acid value and their significance. Fatty acids -nomenclature, physiochemical properties, essential fatty acids, rancidity, acylglycerols-saponification. Phosphoglycerates -occurrence, physiochemical properties and function, sphingolipids. Glycolipids - Occurrence, classification gangliosides and cerebrosides, alkyl &alkenyl lipids. Plant and animal waxes – their composition and roles. Soaps and detergents, cleaning action of soap. Cholesterol – occurrence, structure & role. **8hrs**

8. **Biologically active lipids:** Eicosanoids - prostaglandins, thromboxane, leukotrienes, structure, nomenclature, occurrence and role. Platelet activating factors, ceramide, sphingolipid derivatives - structures and function, Isoprostins and Lipoxins. **4hrs**

UNIT IV

9. **Nucleosides and Nucleotides:** Purines and pyrimidines - occurrence, structure and properties. Nucleosides and nucleotides found in nucleic acids. Nucleotide sugar, nucleotides that are not part of nucleic acids - occurrence and role. **4hrs**

10. **Vitamins:** Classification, structure & biological importance, coenzyme forms, provitamins, anti-vitamins, hyper and hypovitaminosis. **8hrs**

Practical - 1 Credit **32hrs**

1. Qualitative analysis of monosaccharides (Glucose/ fructose).
2. Qualitative analysis of disaccharides (Lactose/maltose/sucrose) and polysaccharide starch.
3. Qualitative analysis of Amino acids : color reactions
4. Quantitative estimation of proteins by Biuret Method.
5. Determination of acid value of lipids
6. Determination of saponification value of lipids
7. Determination of Iodine value of lipids
8. Estimation of Ascorbic acid in Biological source by DNPH Method.
9. Isolation and estimation of lactose from milk. (Qualitative Benedict's reagent)

References:

1. Conn E.E. and Strumpf P.K. Outlines of Bio-chemistry. Wiley Eastern Limited.
2. Voet D, Voet J.G. Biochemistry. Ed. John Wiley & Sons. New York.
3. Lehninger AL., Nelson JR., and Cox MM. 1993.Principles of Biochemistry. CBS Publishers, New Delhi.
4. White, Handier and Smith. Principles of Biochemistry Tata McGraw Hill.
5. Cantorow & Trumper. Clinical Biochemistry. Saunders.
6. Stryer L 1996. Biochemistry**.** WH Freeman &Company.
7. Plummer D. T. 1987. An introduction to practical Biochemistry. Tata Mc Graw Hill.

MBC130 - DEVELOPMENTAL BIOLOGY – THEORY - 4 Credits 64 hrs

SECTION- A- ZOOLOGY **32 Hrs**

UNIT I

1. Gametogenesis: Spermatogenesis and Oogenesis in mammals. Types of eggs based on quantity and distribution of yolk, egg membranes. **2 hrs**

2. Fertilization: i. Details of the process with reference to sea urchin - approach of gametes,fertilizin and antifertilizin,gamones and its role, activation, penetration, reaction of the eggand amphimixis. Monospermy and Polyspermy (physiological and pathological), significanceof fertilization. ii. Fertilization in mammals: molecular events in fertilization. **4 hrs**

3. Early Development:

Cleavage: Cytoskeletal mechanisms, patterns of embryonic cleavage - holoblastic,meroblastic, radial, spiral rotational and superficial types with examples.

Gastrulation: Gastrulation types, **Organiser phenomenon** - potencies of the dorsal lip of theblastopore of amphibian gastrula. **Brachet's**experiment, experiment of **Spemann** and**Mangold**.**Induction** -chemical nature of organizer -parts of organizer -theories of organizer phenomenon. Competence, determination and differentiation.Primary germ layers and their derivatives **10 hrs**

UNIT II

4.**Development in mammals:** Blastocyst implantation – types; placentation – types; embryonicstem cells and their significance. **6 hrs**

5.Post embryonic development: brief description of metamorphosis, regeneration and ageing **2 hrs**

6. Parthenogenesis and cloning: Cytology of natural parthenogenesis - arrhenotoky, thelytoky(amictic and apomictic) and cyclical parthenogenesis with examples. Artificialparthenogenesis -Loeb's and Batailon's experiments with principles of activation andregulation.Significance of parthenogenesis. **8 hrs**

SECTION-B: BOTANY **32hrs**

UNIT III

7. An introduction to reproductive biology of Angiosperms. **1hr**

8. Microsporangium, Microsporogenesis and Male gametophyte: Development and structureof the microsporangium, wall layers (special emphasis on the anther tapetum and its, functions); Microsporogenesis; development of male gametophyte/pollen; Concept of malegerm unit; pollen shedding; pollen morphological features; Palynology and its scope. **10 hrs**

9. Megasporangium, Megasporogenesis and Female gametophyte: Structure andmorphological types of ovules; Ovular structures; Megasporogenesis; development ofmonosporic, bi-sporic and tetrasporic types, structure, organization and nutrition of female gametophyte. **5 hrs**.

UNIT IV

10. Fertilization: Pollination in brief, types, contrivances for pollination, liver mechanism(pollination in ficus). A general account of pollen-pistil interaction; obturator; polyspermyandhetero-fertilization. **6 hrs**.

11. Endosperm: Developmental types; endosperm haustoria; ruminate and compositeendosperm.

12. Embryo: structure and development of Dicot and Monocot embryos; embryonal suspensor.

13. Polyembryony: Types, causes, experimental induction and significance. Structure ofmonocot and dicot seed. **7 hrs**

14. Gametophytic apomixis- A general account.

15. Embryology in relation to taxonomy with reference to the following taxa Loranthaceae,Gentianaceae, *Trapa*and *Exocarpus*.

16. Experimental embryology: Nature and scope. **3 hrs**

Practicals - 1 Credit **32hrs**

Section A– Botany: 16hrs

1. Ovule and its structure. Types of ovules and placentation
2. Megasporogenesis- Developmental stages of embryo sac development. Structure ofmatureembryosac
3. Microsporogenesis and structure of mature anther
4. Structure of Microspore. Mounting of Microspores and pollinia. Male gametophytedevelopment and structure of male gametophyte
5. Pollen viability test by hanging drop method
6. Endosperm - types of endosperms. Mounting of endosperm (*Cucumis*, Coconut)
7. Development of embryo- structure of mature embryo and mounting of mature embryo
8. Seed and its structure. Endospermic and non-endospermic seeds. Dicot embryo(*Cicer*) and Monocot seed(Maize)

Section B - Zoology: **16hrs**

1. Different types of eggs -insect egg. Frog's egg, Hen's egg and Graffian follicle.
2. Different types of sperms -of grass hopper, frog and a mammal, abnormal spermdetection.
3. Frog Development: Cleavage stages, blastula (section) gastrula (yolk plug stage) andneurula (section).
4. Chick embryo: 18 hrs, 24 hrs (W .M. and section), 36 hrs and 48 hrs (W.M.).
5. Study of development in Hen's egg: Window technique -demonstration.
6. Study of placenta of rat (gross and section) sheep and Human.

References:

1. Balinsky B.I. 1981. An Introduction to Embryology. W. B. Saunders Co.
2. Bodemer C. W. 1968. Modern Embryology. Holt Rinehart and Winston.
3. Huttener A. F. 1967. Fundamentals of Embryology of vertibrate. Macmillan Publishers.
4. Jangir O. P. 1996. a manual of developmental biology. Agro-botanical publications.
5. Bhojwani S. S. and Bhatnagar S. P. 1978. The embryology of angiosperms. Vikas PublishingHouse, Bangalore.
6. Raghavan V. 2000 Developmental Biology of Flowering Plants. Springer Verlag.

MBC140 - CELL BIOLOGY – THEORY - 3 CREDITS 48 hrs

UNIT I

1. An overview of cells and cell research. **2 hrs**

2. **The origin and evolution of cells:** From molecules to cell, from prokaryotes toEukaryotes, from single cells to multicellular organisms. **4 hrs**

3. **Tools of cell biology:** Microscopy - compound and light microscope, electronmicroscope (SEM, TEM), confocal microscopy, fluorescence microscopy, phasecontrast microscopy, use of flow cytometry for sorting cells, **6 hrs**

UNIT II

4. **Compartmentalization in cells:** overview and role of cell organelles- cytosol,endoplasmicreticulum, the golgi apparatus, lysosomes and Peroxisomes, ribosomes,vesicles, vacuoles, mitochondria, chloroplast, nucleus, nucleolus, nuclear membrane,centrioles and cell wall.
10 hrs

5. **Cell communication:** Plasmodesmeta, Jap junction, septate junction **2hrs**

UNIT III

6. **Composition and architecture of plasma membrane:** Membrane asymmetry-lipids proteins and carbohydrates. Membrane models- Gorter and Grendel model, Davson and Danielli model (sandwich), Robertson model (unit membrane), Green's protein crystal model, Singer and Nicholson's model (fluid mosaic). **4 hrs**

7. **Membrane transport:** Simple diffusion (small molecules), facilitated diffusion,active transport (primary and secondary), passive transport, symport, uniport andantiport. Exocytosis, endocytosis and pinocytosis. **2hrs**

8. **Cell cycle:** cell division types, phases of cell cycle, mitosis and meiosis, comparisonof cell division in prokaryotes and eukaryotes. **6hrs**

UNIT IV

9. **Chromatin organization:** Chromatin fiber structure, nucleosome, models of nucleosome, chromosome structure. Anatomy of eukaryotic chromosome – Centromere, Telomere, Nucleosome, Nucleomere, Kinetochore. **4 hrs**

10. **Extracellular matrix and cell adhesion molecules:** Proteoglycans, nonproteoglycans(hyaluronic acid), fibres (collagen, elastin), fibronectin. Integrins, selectins, cadherins, classification and role in maintaining cell integrity. **6 hrs**

11. **Cell culture:** Maintenance of cell culture, primary and established cell lines, cellgrowth kinetics plant and animal cell culture, culture media and application of cellculture. **2 hrs**

Practicals - 1 Credit 32Hrs

· Blood cell counting: RBC, WBC :Total and differential count.
· Temporary preparation of stained samples for Mitosis in onion root tips.
· Temporary preparation/observation of stained slides for Meiosis in flower buds (e.g, Onion/Chlorophytum)
· Separation of cell organelles by differential centrifugation/direct observation of cell organelles (Cell wall , Plasma membrane, Chloroplast and Nucleus)

· Cell viability assay by Trypan blue dye exclusion method.
· Isolation of DNA from coconut endosperm
· Preparation of permanent slides Staining –Plant tissues in stem/leaf/root/callus

References:

1. Lodish H. F. (Editor) Berk A., Matsudaira P., Kaiser C. A., Krieger M., Scott M. P., Zipursky S. L., Darnell J. Molecular Cell Biology. W. H. Freeman and Co., Publishers.
2. Pollard T. D., Earnshaw W. 2004. Cell Biology. Saunders- Elsevier.
3. Alberts B., Bray D., Lewis J., Raff M., Roberts K.,.Watson J.D. Moleucular Biology of the Cell. Garland Publishing, New York and London.
4. Cooper G. M. 2000. The Cell - a molecular approach. 2nd Edn. ASM Press. Washington.

MBC160 - COMPUTER APPLICATIONS – THEORY – 2 CREDITS 32 hours

UNIT -I

Introduction to computer system: Overview, software, hardware, firmware, functionalities of a computer, components of a computer,generations of computers, types of computers and Applications.

Input devices: keyboard, mouse, joystick, light pen, track ball, scanner, digitizer, Magnetic Ink Card Reader (MICR), Optical Character Reader (OCR), Bar Code Readers and its applications in molecular biology, Optical Mark Reader (OMR).

Output devices: Monitors, Printers- Impact Printers, Non-Impact Printers.

Memory - Types of primary memory/main memory and secondary Memory. **8 hrs**

UNIT –II

Number System: Binary, decimal, octal and hexa-decimal Number System, binary arithmetic, number conversion-decimal to other base system, other base system to decimal, other base system to non-decimal. **8 hrs**

UNIT –III

Network fundamentals: Basic Networking concepts, characteristics of a computer network, Local Area Networks(LAN), Metropolitan Area Networks(MAN), Wide Area Networks (WAN) and Applications.

Operating Systemfundamentals**:**Objectives of Operating System, Characteristics of Operating System, Types of operating system**.** **8 hrs**

UNIT –IV

Basics of Algorithms, Flowcharts, Programming Languages.
Fundamentals of Programming in C : Overview, program structure, basic syntax, data types, variables, constants, storage classes, operator, decision making and loops. 8 hrs

Practicals – 1 Credit **32hrs**

Windows desktop functions, All menu of MS Word, MS Excel: Using excel Formula. Calculating Mean, Median Mode, average, sum, min, max, Correlation, All types of Graphs, MS Access: Table, forms Querying, Internet, E Mail, Statistical Tools, Basic Linux shell programs and basic C programs.

References:

1. Textbook of Computer Applications And Biostatistics
   By Dr.S.B.Bhise, Dr.R.J.Dias, K.K.Mali and P.H.Ghanwat, Trinity Publishing House
2. Introduction to Information Technology by Rajaraman V
   Prentice Hall India Learning Private Limited; Second edition (2013)
3. Computer Number Systems and Arithmetic By Norman R. Scott
   Publisher: Pearson College Div (September 1, 1984)

SEMESTER –IV

MBD110 - ADVANCED ORGANIC CHEMISTRY - THEORY - 2 CREDITS 32 hrs

UNIT I

I. Reduction and Oxidation: Reduction: Catalytic hydrogenations (homogeneous and heterogeneous) and reduction of functional groups, catalytic transfer hydrogenation reaction, Wilkinson's catalyst, LiA1H$_4$, NaBH$_4$, Birch reduction, Meerwein-Pondrof- Varley reduction, Wolf-Kishner reduction, Clemenson reduction. Oxidation with chromium and manganese compounds ($K_2Cr_2O_7$, $KMnO_4$), Ozone, peracids, lead tetra acetate, osmium tetra oxide. Oppenauer oxidation. **8 hrs**

UNIT II

II. Heterocyclic compounds: Classification, nomenclature of heterocycles with examples. Preparation of furan from mucic acid, pyrrole, thiophene, pyridine from acetylene, pyrimidine from urea, Indole – Fischer method, quinoline – Skraup synthesis, synthesis of isoquinoline. **4 hrs**

III. Alkyl halides: Classification, Nucleophilic substitution reaction-SN1, SN2 with mechanism (ter-butylbromide and methyl bromide) Elimination reactions: Saytzeff rule, mechanism of ElandE2 reactions; (ter-butylbromide and ethyl bromide). Effect of solvent and structure on nucleophlic substitution reaction and elimination reaction. **4 hrs**

UNIT III

IV. Terpenes: Classification, isolation, general properties. Isoprene rule, structural formulae and biological importance of alpa-terpeneol, camphor, menthol and geraniol. **2 hrs**

V. Alkaloids : Occurrence, isolation, classification and detection, synthesis and structural elucidation of nicotine, structural formulae of quinine, atropine, piperine, cocaine and morphine. Physiological importance of alkaloids **4 hrs**

VI. Dyes: Colour and constitution, classification of dyes based on applications withexamples **2 hrs**

UNIT IV

VII. Drugs: Definition and types of drugs-antipyretics, antibacterial, antimalarial, sulphadrugs with examples. Synthesis and uses of paracetamol, sulphanilamide and sulphagunanidine. Chemotherapy, chemotherapeuitic agents. **4 hrs**

VIII. Insecticides and fungicides: Definition, structural formulae and their importance of aldrin, BHC, lindane, malathion. Mode of action of insecticides. Herbicides definition structural and importance of Diuren, 2, 4-D (2, 4 dichlorophenoxy acetic acid), mode of action of herbicides. Wood protectors -definition, importance of cresol oil, pentol and chlorophenols.

4 Hrs

Practicals - 1 Credit **32 hrs**

Organic estimation
1. Estimation of Amino acids by formal titration method
2. Estimation of Hydroxyl group by Acetylation method
3. Estimation of Flavonoids
4. Estimation of sucrose in cane juice.
5. Colorimetric estimation of plant phenols byfolin-ciocalteu method separationtechniques.
4. Thin layer chromatography -Separation of plant pigments
5. Paper Chromatography- identification of amino acids.
6. Column chromatography- Separation of mixture of ortho and Para- nitroaniline.
7. Isolation of Caffeine from Tea powder.
8. Isolation of Piperine from pepper.

References

1. Carey, F. A., and R. J. Sundberg. 2000. Advanced Organic Chemistry, Part A: Structure and Mechanisms. 4th ed. New York, NY: Springer.
2. Joule, J. A., and K. Mills. 2000. Heterocyclic Chemistry. 4th ed. Malden, MA: Blackwell Science.

MBD120– MICROBIOLOGY – THEORY - CREDITS – 3 48 hrs

UNIT I

A brief history: Discovery of microorganisms-contributions of Antony van Leeuwenhoek, Theory of spontaneous generation and biogenesis. Contributions of Edward Jenner, Louis Pasteur, Joseph Lister, Robert Koch, Metchnikoff, Beijerinck, Ivanowsky, Alexander Fleming, Selman Waksman. Recent developments in Microbiology. Branches of Microbiology, Microscopy, simple, compound and electron microscopy.

Sterilization:

Physical methods- dry heat-hot air oven, incineration, moist heat-autoclave, tyndallisation. Filtration- Types of filters. Laminar airflow. Radiation method- UV radiation

Chemical methods: Definition of disinfectants, antiseptics.

Microbicides- Bactericide, virucide, fungicide and sporicide; microbial static and fungistatic agents; use and mode of action of alcohols, aldehydes, halogens, phenols, heavy metals. **12hrs**

UNIT II

Staining: Types of stains, simple staining, negative staining, differential staining (Gram's staining and acid fast), endospore and flagella staining.

Cultivation of Microbes: Media types. Pure culture techniques: Serial dilution, pour plate, spread plate and streak plate, cultural characteristics. Preservation of pure cultures: subculturing, mineral oil overlay and lyophilisation. Microbial culture collection centers (ATCC, MTCC, ITCC).

Viruses: Classification Based on morphology. Nucleic acids and host, role of ICTV, structure of TMV and T_4 phage, Replication of T_4, Economic importance .**12hrs**

UNIT III

Bacteria: Classification (based on morphology and flagella); Bergey's manual (in brief), Structure: pili, capsule, cell wall (structure and chemical composition of gram+ve and gram-ve bacteria), plasma membrane (including mesosomes), cytoplasmic inclusions, nuclear material, Endospores. Reproduction; Vegetative, fission, budding. Genetic recombination- conjugation, transformation, transduction. Economic importance.

Cyanobacteria: Morphology/structure and economic importance -Type Study: *Spirulina, Anabaena*.

Mycoplasma: Importance and general characters, Ultrastructure and reproduction. Diseases caused by the Mycoplasma. **12hrs**

UNIT IV

Microbial nutrition: Major nutritional types of microorganism (Based on energy, electron and carbon sources); nutritional requirements (Macro and Micronutrients, growth factors); uptake of nutrients- passive, facilitated, active (Binding-protein type), group translocation (PTS system).

Microbial growth: Generation time, growth curve, factors affecting growth, measurement of growth (cell number-counting chambers e.g. Haemocytometer).

Strain improvement methods: recombination using mutagens, protoplast fusion, r-DNA technology, selection of improved strains: Enrichment technique. **12hrs**

Practicals - 2 Credit 64 hrs

1. **Study of microbiological tools** (inoculation loop, spreader, spatula, swabs), equipments (laminar airflow chamber, hot air oven, incubator, autoclave/ pressurecooker, filtration unit, colony counter) and microscopes.
2. **Staining**: Simple staining and negative staining, Differential (Gram's staining).

Observation of bacterial motility by hanging drop method. Study of theCyanobacteria: *Spirulina, Anabaena.*

3. **Preparation of media**-nutrient broth, nutrient agar, potato dextrose agar, Czapek doxagar, Mac Conkey's agar.
4. **Study of pure culture techniques**: serial dilution, pour plate, spread plate, streakplate, point inoculation to Petri plate and agar slant.
5. **Single Colony isolation, Maintaining pure culture**-preparation of glycerol stocks
6. **Study of plaque formation**
7. **Effect of temperature and pH** on the growth of microorganism

8. **Measurement of growth using** -Turbidometer/ photocolorimeter/ spectrometer andHaemocytometer (Yeast cells)
9. **Effect of disinfectants, antiseptics and antibiotics** on the growth ofmicroorganisms.
10. **Display of photographs** (Scientists)/charts (related to viruses, Mycoplasma etc.,) studied in the theory.

References:

1. Pelczar,M.J., Jr,.Reid R.D. and Chan, E.C.S. 1993. Microbiology. Mc-Graw Hill Inc. New Delhi.
2. Sullia, S.B. and Shantharam, S. 1998. General Microbiology. Crawford and MH Publishing Co. Pvt. Ltd., New Delhi.
3. Prescott, L.M., Harley, 1.P. and Klein, D.A. 1996. Microbiology. WMC Brown Publishers. New Delhi.

MBD130- PLANT PHYSIOLOGY – THEORY - 3 Credits 48 Hrs

UNIT I

Water and plant cell: Transport process, Absorption by roots, Transport of water through xylem – role of cavitation and embolism. Transpiration & SPAC (Soil–plant-Atmosphere-Continuum). **4 hrs**

Solute transport: Pinocytosis, exocytosis, endocytosis CURL (Compartment of Uncoupling of Receptors – Ligand) concept. Aquaporins and phytosiderophore. **2 hrs**

Transport in phloem: Pathways of translocation, source and sink relationship, Phloem sap and pressure flow model for phloem transport. Vein loading and unloading. Transport signaling molecules. **4 hrs**

Brief account of lipids, waxes & phytosteroles in plants **2 hrs**

UNIT II

Plant growth hormones: Definition, biochemistry, biosynthesis, storage and transport, Mechanism of action & Physiological roles of Auxins, Gibberlins, cytokinins, Ethylene and Polyamines. Brassinosteroids, effect on growth & development, Abscissic acid, Morphactins, Jasmonic acid and Expansins. Horticultural importance of growth hormones. **8 hrs**

Phytochrome: Discovery, structure and physiological function of phytochrome.Molecular mechanism of action of photoreceptors, **4 hrs**

UNIT III

Photosynthesis: Photochemistry, General concept, Historical background, photosynthetic pigments, Light harvesting complexes, Photo-oxidation of water, Mechanism of electron and proton transport. Carbon assimilation: Calvin cycle (C_3), C_4 cycle and CAM pathway. Photosynthetic efficiency of C_4 plants, Regulation of Calvin's cycle and RUBISCO. Photorespiration and its significance: Comment on absence of C2 pathway (Photorespiration) in C_4 plants, CO_2 and HCO_3 – pumps. **9 hrs**

Stress physiology: Water deficit and drought resistance, heat stress and heat shock,Chilling and freezing injury. Salinity and anaerobic stress. **3 hrs**

UNIT IV

Respiration: Glycolysis, TCA cycle: Amphibolic nature of TCA Cycle. TCA Cycle as a central metabolic cycle connecting carbohydrates, lipids and amino acid metabolism.

Chlorophyll and haem synthesis. Glyoxylate cycle and gluconeogenesis. Electron transport and Peter-Mitchelle theory of ATP synthesis (chemiosmotic hypothesis). Pentose phosphate pathway and cyanide insensitive respiration. Comparison of photosynthesis & respiration. **8 hrs**

Nitrogen fixation: Nitrogen cycle, Mechanism of biological nitrogen fixation, symbiotic and non-symbiotic, nitrogenase complex, nodule formation and nod factors, Role of leghaemoglobin, nif genes and hup genes. **4 hrs**

Practicals - 1 Credit **32 Hrs**

1. Determination of water potential of tissue by plasmolytic / gravimetric method.
2. Quantitative estimation of chlorophyll a, chlorophyll b, and total chlorophyll in plant tissues.
3. Determination of diurnal fluctuation acid content in CAM plants.
4. Determination of stomatal index, stomatal frequency and area of stomatal aperture.
5. Cobalt Chloride experiment to show the differential rate of transpiration
6. Demonstration of Hill's reaction.
7. Mohl's Half-leaf experiment
8. Estimation of leghaemoglobin in root nodules by pyredine method.
9. Estimation of proline in stressed and unstressed plant.
10. Photographs, charts, instruments related theory

References:

1. Buchanan B. B., Gruissem W. and Jones R. L. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Physiology, Maryland.
2. Conn E.E. and Stumf P.K. 1992. Outlines of Biochemistry. Wiley Eastern Pvt. Ltd.
3. Taiz L. and Zeiger E 1998. Plant Physiology. Sinauer Associates, Inc., Massachusetts.
4. Zimmermann, M.H. and Milburn J.A. Transport in Plants I Phloem transport (Encyclopedia of Plant Physiology, New Series, Vol. I, Springer Verlag, New York.

MBD140- ANIMAL PHYSIOLOGY –THEORY - CREDIT-3 48hrs

UNIT I

I. Introduction: Meaning and scope of Animal physiology **1hr**

II. **Digestion**: Digestion and absorption of Carbohydrates, proteins and fats. Role of gastro intestinal hormones in digestion. **3hrs**

III. **Excretion**: End products of nitrogen metabolism. Functional architecture of Kidney. Formation of urine. Mechanism of urine concentration. Hormonal control of urine formation. **4 hrs**

IV. **Respiration**: Types of respiration. Mechanism of pulmonary respiration in man. Transport of O2 and CO2. Respiratory pigments, respiratory quotient and oxygen toxicity. **3 hrs**

V. **Adaptation**: Adaptation to extreme environment - Desert, high altitude and salt tolerance. **2hrs**

UNIT II

VI. **Circulation**: Components of blood, Hemoglobin, Types of hemoglobin, clotting of blood - Mechanism and factors involved in clotting, Lymphatic system, Blood related disorders - Hemophelia, Sickle cell anemia, Thalassemia. Types of Criculation, structure of heart, conduction of heart beat, Blood pressure, Factors affecting blood pressure. **6 hrs**

VII. **Sensory Physiology**: Structure of a neuron, types of nerve cells, machanism of conduction of nerve impulse, synaptic transmission, neurotransmitters, neuromuscular transmission, Autonomic nervous system - distribution and functions. Mechanism of sensory transduction. **6 hrs**

UNIT III

VIII. **Endocrine System**: Endocrine System in Man, Structure of hypothalamus, hormones of hypothalamus - GRH, Somatostatin, TRH, CRH, GnRH. Pituitary structure, Hormones of anterior, posterior and median lobes and their actions. Propiomelanocortin. Brief structure, hormones and their actions of thyroid, parathyroid, Pineal and islets of langerhans. Pituitary target organ feedback. **6 hrs**

IX. **Muscle Contraction**: Types of muscle - striated, non-striated and cardiac. Structure of skeletal muscle, Mechanism of skeletal muscle contraction, Muscle fatigue. **5 hrs**

UNIT IV

X. **Thermoregulation**: Effect of Temperature on biological system. Temperature relations of Poikilotherms and homeotherms, acclimation and acclimatization to cold and heat. Neuronal basis of thermoregulation. **5 hrs**

XI. **Physiology of reproduction**: Hormonal control of testicular and ovarian functions. Estrous and menstrual cycle, implantation, gestation and partiurition.Modern trends in reproduction – Invitro fertilization, cloning, sperm bank, artificial insemination, test tube baby. **7 hrs**

Practicals - 1 Credit **32hrs**

1,2. Urine analysis: Normal constituents: Organic: Urea, uric acid, creatinine, amino acid; Inorganic: Cl, SO_4, P

3,4. Qualitative analysis of urine for abnormal constituents- Glucose, Albumin, Ketone bodies, Bile salt

5,6 Quantitative analysis – Titrable acidity, creatinine, urea, & Sulphate

7. Blood analysis: Blood glucose , Uric acid

8. Total count , Differential count, Hemoglobin

References:

1. Chatterjee C C. 1985.Human Physiology. 11th ed. A.K. Chatterjee Publisher

2. Murray R K Granner Darryl K Mayes Peter A Rodwell Victor W. 1999. Harper's Biochemistry McGraw-Hill Medical.

3. Purohit S.S. Mathur S.K 1996 Biotechnology : Fundamentals and Applications. Vedhams Publishers, Jodhpur.

MBD150- MACROMOLECULES – THEORY - 3 CREDITS 48 hrs

UNIT I

1. **Carbohydrates:** Overview of Structure and classification of carbohydrates. Polysaccharides -Homopolysaccharides and heteropolysaccharides - starch, cellulose, glycogen, hyaluronic acid, chondroitin sulphate, chitin, xylans, bacterial cell wall polysaccharides, blood group polysaccharides – structure elucidation-degradation, graded acid hydrolysis, periodate oxidation methylation. **8 hrs**

2. **Proteins:** Peptide Bond - Features of the peptide bond, naturally occurring peptides – glutathione, enkaphalins and endorphins, chemical synthesis of peptides - Khorana's solution phase synthesis. Merrifield's solid phase synthesis. **4 hrs**

UNIT II

3. **Determination of Amino Acid Composition**: Acid and base catalysed hydrolysis, separation and quantification, Determination of N and C terminal residues, determination of site of glycosylation and type of linkage (o-glycosyl and nglycosyl). **4 hrs**

4. **Determination of Primary structure:** sequencing strategies, N-terminal and Cterminal, sequencing methods. Automated sequenators. Determination of disulphide bond position. Secondary structure of protein - α, β sheet, β bend and β turn. Prediction of secondary structure of proteins. Chou and Fasman algorithm. Helix forming amino acids, Helix breakers. Tertiary and quaternary structures. Ramachandran Plot. **8 hrs**

UNIT III

5. 3D Structure of Myoglobin hemoglobin, Immunoglobulin, Collagen, chymotrypsin, Keratin . **4 hrs**

6. **Elucidation of Structure of Proteins:** Isolation of proteins - Overview of purification and criteria of purity. **2 hrs**

7. **Nucleic Acids:** Isolation of DNA and RNA from biological sources (microbes, plants and animals). Purification of nucleic acids, physiochemical properties of nucleic acids, Melting of DNA, Tm, factors affecting Tm, Cot curve, and classification of DNA based on Cot curve. Chargaffs rule, Chemical reactions of DNA and RNA. **6 hrs**

UNIT IV

8. **Factors Responsible for Protein folding:** Anfinsen's experiment. Weak forces of interaction. Denaturation and renaturation of protein - molten globule. **2 hrs**

9. **Secondary structure of DNA:** Watson and Crick model B and Z DNA, other models of DNA structure. Secondary structure of tRNA clover leaf model. Other secondary structural features in DNA - stem loop structure. Palindromic sequences - Cruciforms, DNA protein interaction - zinc finger, leucine zipper, helix - Turn - helix, and other motifs. DNA bending and Kinks. **10 hrs**

Practicals - 1 Credit **32 hrs**

1. Estimation of Reducing sugars by Hegedorn-Jensen's Method.
2. Estimation of Inorganic Phosphate by Fiske-Subbarow's Method.
3. Estimation of Protein by Lowry's Method.
4. Extraction of starch from potato and determination of purity by DNS method.
5. Isolation of DNA from spinach leaves.
6. Estimation of DNA by Diphenylamine Method.
7. Estimation of RNA by Orcinol Method.
8. Extraction and estimation of Casein from Milk

References:

1. Creighton T 1987 Protein Structure: A Practical Approach Oxford University Press.
2. Greenwood, C. T. (1970) in The Carbohydrates (Pigmon, W., & Horton, D., Eds.) Vol. IIB, pp 471-513, Academic Press.
4. Adams R.L.P., Knowles J.T., Leader D.P.,1992. The Biochemistry of the Nucleic Acids, 11th edition, Chapman &. Hall, London,
5. Stryer L 1996. Biochemistry. WH Freeman &Company,

6. Devlin T. M.(ed). Text Book of Biochemistry with Clinical Correlations. 4th Edition. - Wiley-Liss.
7. Voet D, Voet J G. Biochemistry. Ed. John Wiley & Sons. New York.
8. Lehninger AL., Nelson JR., and Cox MM., 1993.Principles of Biochemistry. CBS Publishers, New Delhi.
9 . Garrett. R.H. and Grisham. C.M. Biochemistry. 2ndEdition.. Saundes College Publication.
10. .Metzler. D.E. Biochemistry - The Chemical Reactions of Living Cells. 2nd Edition.Vo Harcourt - Acqoleric Press.
11. West and Todd. Text Book of Biochemistry. 1998. Macrillian.
12. Zuby G.L., 1988. Biochemistry. (second ed.). MacMillan, New York.
13. Mainwaring et al. Nucleic acid Biochemistry and Molecular Biology. Blackwell.
14. Smith et al. 1983.Principles of Biochemistry. General Aspects. Mc Graw Hill.

SEMESTER V

MBE110 - METABOLISM- I - THEORY - 3 CREDITS 48 HRS

Tutorial: 01 Credit (32 hours)

UNIT I

1.**Introduction: Metabolism** - catabolic, anabolic and amphibolic pathways. Carbohydrates – Glycolysis- energetics regulation. Pathways of utilization of pyruvate-lactate, ethanol. Gluconeogenesis- regulation. Cori cycle, Citric acid cycle regulation, energetics, anapleurosis, Glyoxylate cycle. HMP shunt pathway, Entry of other carbohydrates (fructose, galactose, Maltose, Lactose) to glycolytic pathway. Biosynthesis of: sucrose, starch and glycogen. Inborn errors of carbohydrate metabolism (Glycogen storage disease, Galactosemia). **6 hrs**

2. **Mitochondrial Electron transport:** Entry of reducing equivalents for oxidation: Malate - Aspartate shuttle, Glycerol phosphate shuttle. Organization of respiratory chain complexes, structure and function of the components - Fe-S proteins, cytochromes, Q cycle, proton transfer, P/O ratio, respiratory control, oxidative phosphorylation, uncouplers and inhibitors, sequence of electron carriers based on redox potentials. ATP synthesis- ATP synthase complex, Binding change mechanism, Proton motive force, Mitchell's hypothesis. **6 hrs**

UNIT II

3. **Lipids:** Degradation of triacylglycerols and phospholipids -lipase, hormone sensitive lipase, phospholipases. Fatty acid degradation -b oxidation- Knoop's experiment; Oxidation of Saturated and unsaturated fatty acids. α and ω oxidation, Energetics of palmitic acid oxidation, Biosynthesis of fatty acids – Fatty acid synthetase complex, chain elongation and desaturation. Pathways in plants and animals - conversion of linoleate to arachidonante (scheme only).
10 hrs

4. **Biosynthesis of:** Prostaglandins, thromboxanes, leukotrienes, COX-1 v/s COX-2 **2 hrs**

UNIT III

5. **Phospholipid:** Biosynthesis-de novo pathway and interconversion; biosynthesis of sphingolipids, ether lipids and glycolipids. Degradation and biosynthesis of gangliosides and cerebrosides. Inborn errors: Taysach's disease, Niemann-Pick disease, Fabry's disease. **6 hrs**

6. **Cholesterol:** biosynthesis and degradation-regulation. Mechanism of Statin Action. Metabolism of circulating lipids - chylomicrons, HDL, LDL and VLDL. Reverse cholesterol transport by HDL. Oxidized lipids and their metabolism, Bile acids. **6 hrs**

UNIT IV

7. **Photosynthesis:** Overview of photosynthesis and photosynthetic apparatus of higher plants Light harvesting antennae complex, role of pigments in trapping light energy, Electron flow – cyclic & non-cyclic photo phosphorylation; oxygen evolution; Calvin cycle, C3 & C4 cycle, primary photochemical reaction – Hill reaction, regulation of photosynthesis, photo inhibition, photorespiration, bacterial photosynthesis, structure and function of RUBISCO. **10 hrs**

8. **Integration of:** carbohydrate and lipid metabolism, metabolomics glucose paradox **2 hrs**

References:

1. Principles of Biochemistry, D.L. Nelson and M.M. Cox (2008), 5th ed., W.H. Freeman & Co.
2. Biochemistry, D. Voet and J.G. Voet (2004), 3rd ed.. John Wiley and Sons Inc.
3. Biochemistry, J.M. Berg, J.L. Tymoczko and L. Stryer (2007), 7th ed., W.H. Freeman & Co.
4. Essentials of Glycobiology, E. Etzler et.al. (2009), Cold Spring Harbor Laboratory Press.
5. Plant Physiology, L. Taiz and E. Zeiger (2006), 4th ed., Sinauer Associates Inc.

Practicals - 1 Credits **32hrs**

1. Estimation of Cholesterol- in serum by Zak's Method.
2. Estimation of blood sugar by Folin-Wu's Method/glucose oxidase test
3. Estimation of calcium in serum by titrimetric method.
4. Estimation of phosphorous by ascorbic Molybdate method
5. Antioxidant assay using DPPH
6. Estimation of blood urea by DAMO method
7. Estimation of SOD Activity
8. Estimation of Glutathione Activity

MBE120 - BIOCHEMICAL TECHNIQUES – THEORY - 3 Credits 48 Hrs

UNIT I

1. Chromatographic Techniques: Concept of stationary and mobile phases, Principles and Applications of Paper, TLC, Column chromatography, theoretical plates, Ion exchange, Gel Filtration, Affinity, GLC-MS, Chromato focusing, HPLC,RPHPLC of proteins, peptides and organic compounds, FPLC, LC-MS. **12 hrs**

UNIT II

2. **Electrophoretic Techniques:** Polyacrylamide gel electrophoresis, SDS-PAGE, Agarose gel Electrophoresis, separation of proteins, Lipoporteins, Nucleic acids, Visualizing separated components - staining, Fluorescent techniques, isoelectric focusing, pulsed field electrophoresis, High voltage electrophoresis, Paper electrophoresis, Capillary Electrophoresis, Isotachophoresis. Blotting techniques: dot-blot, southern blot, northern, western blotting and their applications.

12 hrs

UNIT III

3. **Centrifugation:** Sub cellular fractionation using differential and Density gradient centrifugation and gradient formers, marker enzymes, construction of preparative and analytical ultracentrifuge, Svedberg's constant, sedimentation velocity and sedimentation equilibrium, schlerien optics. **10 hrs**.

4. **Fractionation Techniques:** Cell lysis, Isolation of Proteins, Salting in, Salting out, Dialysis, Ultra filtration. **2 hrs**

UNIT IV

5. **Radioisotope Techniques:** Heavy isotopes and radioisotopes theory and construction of mass spectrometer. Ionization, fragmentation, m/e. time of flight, MALDI, ESI, GM and Scintillation counters - Solid & liquid scintillation, Specific activity, Carrier free isotopes. Isotope dilution techniques, autoradiography, RIA, labeling of proteins, nucleic acid and synthesis of isotopically labeled glucose.

12 hrs

Practicals: 2 credits **64 hrs**

1. Extraction and salting out of proteins (ammonium sulphate saturations).
2. Polyacrylamide gel electrophoresis (PAGE) of proteins.
3. Thin Layer chromatography of lipids.
4. Electrophoresis of Glycoproteins and PAS staining.
5. Circular paper chromatography.
6. Determination of Isoelectric point of Amino acid.
7. Ascending paper chromatography.
8. Column chromatography- Gel permeation and Affinity Chromatography.
9. Agarose gel electrophoresis of DNA.

MBE130 - BIOPHYSICS – THEORY – 4 CREDITS 64 hrs

UNIT I

I. Introduction to Biophysics, Role of Biophysics in natural science, Scope and methods of Biophysics, **1 hr**

II. Spectroscopy: Spectral analysis of the structure of simple organic compounds & Biomolecules from: Vibration spectra – IR and Raman – Principles and applications. Infra-red absorption spectra of macromolecules, infrared dichroism: Absorption frequencies for functional groups in simple organic molecules, Ultraviolet and Visible spectra of macromolecules, Visible and UV dichroism, UV difference spectra. Polarized light – Plane and circularly polarized light. CD, Applications of CD. Optical Rotatory dispersion (ORD). **15 hrs**

UNIT II

III. Biomolecular studies by X-ray diffraction techniques: Protein crystals, Bragg's law, Unit cell, Isomorphous replacement, fiber pattern of DNA, Early work on proteins, Wet crystals, Shrinkage stages, Salt change, Studies on biopolymers, Crystallization of biomolecules, Growth conditions. Molecular analysis using Light Scattering Methods. Magnetic Resonance, NMR spectroscopy, chemical shift, spin-spin coupling, coupling constant, application to simple biomolecules , ESR - Principles and applications.

16 hrs

UNIT III

IV. Radiation Biophysics: Ionization radiation, Interaction of radiation with matter, Radiation dosimetry, Biological effects of radiation, Radiation protection and therapy. **6 hrs**

V. Neurobiophysics: General anatomy of brain, Central peripheral nervous system, Myelinated & unmyelinated nerve cells, Blood brain barrier generating nerve impulse, Synaptic transmission, Physicochemical basis of membrane potential, Resting and action potential, Propagation of action potential, Voltage clamp and patch-clamp techniques, Hadgkin-Huxley analysis, Motor and cortical control, Sleep and consciousness Neuromuscular junction, Excitation contraction coupling, Neuronal networks, Processing of information, Memory and Neuropeptides. **10 hrs**

UNIT IV

IV. Advanced Microscopy: Atomic Force Microscopy, Differential interference contrast Scanning Tunneling Microscopy, X-ray, Laser and infrared microscopy. **6 hrs**

Surface Plasmon Resonance. Spectroscopic techniques: Principle and instrumentation of Colorimetry, Spectrophotometry, fluorimetry. Beer-Lambert's law and its limitation,
extinction co-efficient and its application **4 hrs**

VI. Photobiological phenomenon: Photoactivation of biological systems, Photodynamic dyes and mechanism of photodynamic action on cells, Viruses, Proteins and nucleic acids, Concepts, Mechanism and Significance of photomorphogenesis, Photoperiodism, Phototaxis, Phototropism, Photosynthesis, Light acceptor, system, Photosystem as Photosynthetic reaction centre, Photophosphorylation, Bioluminescence. **6hrs**

Practicals: Biophysics - 1 Credits **32hrs**

1. Determination of λ max for a dye, verification of Beer's Law.
2 .Wave length scan of Nucleic acid and proteins (Comparison between Gelatin and BSA).
3. Determination of Tm of Nucleic acid.
4. Scintillation Counting
5. Determination of extinction coefficient
6. CD of Protein – a) HPLC b) Fluorescence excitation and emission maxima

References:

1. Bergethon P. R, 1998, **The Physical Basis of Biochemistry**, Springer- Verlag Publishers, New York.
2. Creighton T, 1987, **Protein Structure: A Practical Approach,** Oxford University Press.
3. Wilson K Walker J, 2005, **Biophysical Chemistry,** Cambridge University Press Cambridge, New York.
4. Upadhyay A and Upadhyay K, 2002, **Biophysical Chemistry: Principle and techniques,** Himalaya Publishing House, Bangalore.
5. Lehninger A L, Nelson J R and Cox M M, 1993, **Principles of Biochemistry,** CBS Publishers, New Delhi.

MBE140- PRINCIPLES OF GENETICS – THEORY – 3 CREDITS **48 hrs**
Tutorial 01 Credit (32 hours)

UNIT I

I) **Mendelism:** History and Mendel's experiments, Laws of inheritance-dominance and recessive concept, law of segregation, law of independent assortment,back cross and test cross, sex-linked inheritance, sex linked genes, sex limited genes and sex influenced genes, **6 hrs**

II) **Statistical testing of hybrid crosses:** Mean, Mode, median, Standard deviation and standard error, probability rules, calculation of genetic ratios, ratios for two or more segregating gene pairs, level of significance, degrees of freedom, chi square. **6 hrs**

UNIT II

III) **Extension of Mendelism:** incomplete dominance, codominance, multiple alleles, Pseudo alleles, Lethal alleles, Penetrance and expressivity, Interaction of genes- epistasis- dominance, recessive (atavism), complementary genes, supplementary genes, interaction of genes in comb pattern of fowls, polygenic inheritance, pleotropism **6 hrs**

IV) **Chromosomal aberrations: Structural** - Deletion, Duplication, Inversion, Translocation, Centric fusion and fission; Numerical variations – Aneuploidy, Euploidy,& Polyploidy; Chromosome syndromes- Causes & consequences of chromosomal aberrations; Karyotyping and chromosome banding. **6hrs**

UNIT III

V) **Extra Chromosomal inheritance:** Maternal effect – Pigmentation in *Ephistia*, inheritance of shell coiling in *Limnaea*, Infectious heredity of Paramecium, Cytoplasmic inheritance – Male sterility in maize and plastid inheritance in *Mirabilisjalapa.* **4 hrs**

VI) **Population genetics**: populations, gene pool, gene frequency, Law of Hardy- Weinberg equilibrium, assumptions of Hardy- Weinberg equilibrium, causes of changes in gene frequency (migration, selection, random genetic drift, inbreeding and mutations). Darwinism- concepts of variation,adaptation, struggle, survival of fittest and natural selection. **8 Hrs**

UNIT IV

VII) **Mutations**: **S**pontaneous, Induced mutation, Conditional lethal mutations – point mutation, Base substitution mutation, Mutation rates. Chemical mutagens, radiation induced mutation, reverse mutations and suppressor mutations - intergenic and intragenic suppression,, Missense, Nonsense and Silent mutations; and Detection of mutations induced by chemicals (Ames test), radiations (ClB technique) **10 hrs**

VIII) **Chromosomes:** Types of chromosomes, Chromosome theory of inheritance, Special chromosomes – B chromosome, Polytene & Lamp brush. **2 hrs**

Tutorials: stress should be given for solving problems related to the topics included in the theory.

Practicals - 1 Credit **32hrs**

1. Study of morphology and handling of *Drosophila melanogaster*.
2. Study of mutants of *Drosophila melanogaster*
3. Preparation of Salivary gland chromosomes of *Drosophila melanogaster*.
4. Demonstration of Mendel Monohybrid ratio.
5. Demonstration of Mendel Dihybrid ratio.
6. Demonstration of Sex linked inheritance.
7. Study of Karyotyping (normal and syndrome)
8. Study of inversion in *Drosophila.*

References:

1. Hartl D L Freifelder D Snyder L A 1988 Basic Genetics 1. Ed. Boston Portola Valley: Jones and Bartlett
2. Atherly A G, Girton, J R and Mc Donald J F, 1999. The Science of Genetics, Saunders College Publishing, Harcourt Brace College Publishers.
3. Brooker R.J. 1999. Genetics. Analysis and Principles. Ed. Benjamin Cummings. California
4. Gardner E J, Simmons M J, Snustad D P 1991. Principles of Genetics. John Wiley & Sons, Inc.
5. Griffith A J F, Miller J H, Suzuki D T, Lewontin R C, Gelbert W M.1996. An introduction to Genetic Analysis. W.H. Freeman and Co. New York
6. Strickberger, Monroe W. 1976. Genetics. Macmillan New York:
7. Watson, J. D., T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losick. 2004. Molecular Biology of the Gene. 5th Edition. Pearson Education Pte. Ltd., New Delhi, India.
8. Klug, W S, and M R Cummings. 1998. Essentials of Genetics, 3rd ed. Prentice Hall, Upper Saddle River, NJ.
9. Hartl, D L & Jones E W 2006. Essential genetics: a genomics perspective (4th Ed), Jones and Bartlett Publishers, Boston.
10. Robert H. Tamarin. 2002. Principles of Genetics Tata-McGraw Hill, Seventh Edition.
11. Lewin B., Gene IV, V, VI. Oxford University press, Oxford.
12. Gilham, N. W. 1994. Organelle genes and genomes. Oxford University Press, Oxford and New York
13. Goodenough, U. 1984. Genetics, Saunders College Publishing

14. Gardner, E.J. et al., 1996. Principles of Genetics, VII Edn. Jjohn Wiley land Sons, Inc., New York.
15. Winter, P.C. et al., 2000. Instant notes in Genetics. Viva Books Pvt. Ltd. New Delhi
16. Sambamurthy A V S, 1999 Genetics. Narosa Publishing House, New Delhi.

Elective-1 2 Credits 32 Hours

SEMESTER VI

MBF110 - MOLECULAR CELL BIOLOGY - THEORY - 3 CREDITS 48 hrs

Tutorials-1 Credit (32 hours)

UNIT I

1. **Plasma membrane:** Membrane biogenesis-lipids and proteins, membrane flow hypothesis, regulation of plasma membrane composition, membrane lipid and protein turnover, polarized cells Mechanism of protein sorting and targeting (ER, golgi, plasma membrane, mitochondria), signal peptide. **5 hrs**

2. **Special features of other organelles:** Golgi & ER – processing of glycoproteins, peroxisomes – lipid degradation and oxidative stress, vacuoles and their functions. **3 hrs**

3. **Membrane dynamics:** Lateral diffusion, FRAP, FRET, single particle tracking, transbilayer movement of lipids (flip-flop) (flippase, floppase, scramblase), microdomains caveolae, rafts. Membrane fusion eg: neurotransmitters release. **4 hrs**

UNIT II

4. **Membrane Transport:** Law of diffusion overview, glucose transporter, Na^+ K^+ ATPase, receptor mediated endocytosis, Ion channels (ligand gated and voltagegated), aquaporin channel, ionophores, and patch clamp technique. **4 hrs**

5. **Structural frame work of eukaryotic cell:** cytoskeleton, microfilaments, microtubules, and intermediate filaments. Composition, assembly and function. **4 hrs**

6. **Cell dynamics** – Flagella and cilia, structure and assembly, cell movement, diapedisis, and moment of vesicles (vesicular trafficking). **4 hrs**

UNIT III

7. **Cell cycle regulation:** cell cycle overview, cell cycle check points, cell cycle regulatory genes, cyclins (D, E, A, and B), cdk's role, phase transition regulation (G1- S, S-G2, G2-M), S phase replication initiation regulation by S-cdk's & MCM proteins, role of microtubule & kinesin, dynein in anaphase, anaphase promoting complex, and cytokinesis. **8 hrs**

8. **Protein degradation:** lysosomes (primary & secondary), lysosomal targeting of protein and degradation, non-lysosomal protein degradation- proteasome complex, ubiquitin mediated protein degradation. **4 hrs**

UNIT IV

9. **Cell death:** Apoptosis & necrosis role and mechanism, caspases and cathepsins. Cell death signals, survival factors, cell death genes. Cell death pathways, pro & anti apoptotic molecules.

Molecular markers for apoptosis: Membrane markers and DNA ladders. **6 hrs**

10. **Stem cells:** Origin of stem cells, differentiation, development, and applications. **2 hrs**

11. **Cancer cells:** Origin of cancer cells, oncogenes, malignant transformation, propertiesof cancer cells – e.g. metastasis, angiogenesis, detection & treatment. **4 hrs**

Practicals – 1- credit **32 hrs**

1. Kinetics of uptake of glucose by erythrocytes.
2. cAMP assay by ELISA.
3. Determination of membrane stability by erythrocyte lysis profile.
4. Catalase assay in peroxisomes.
5. Separation of RBCs and platelets.
6. Cytotoxicity Assay using EAT cells
7. Observation of cancer cells (cytology tests) by H & E staining.
8. Isolation of DNA and demonstration of apoptosis of DNA laddering.
9. Photographs related to molecular cell biology.

References:

1. Cooper Geoffrey M. 2000. The Cell - a molecular approach. 2nd Edn. ASM Press.
2. Washington.
3. Sharma A K & Sharma A. 1980. Chromosome techniques: Theory & Practice. Batterworth.
4. Bray A. D., Lewis J., Raff M., Roberts K. and Watson J.D. Moleucular Biology of the Cell. B. Garland Publishing, New York and London.
5. De Robertis E.D.P., De Robertis E.M.F. 2001. Cell and Molecular biology. Lippincott Williams & Wilkins. Bombay.
6. Freifelder D. 1990. Molecular biology. Narosa Publishing House, New Delhi
7. Gardner E J & D P Snustad 1996. Principles of genetics. John Willey, New York.
8. Sambamurthy, A.V.S.S. 1999. Genetics. Narosa Publishing House, New Delhi.
9. Sinnot E W., Dunn L.C ., Dobzhansky T. 1958. Principles of genetics. V Edn McGraw Hill, New York.
10. Stansfield W.D .1991. Theory & Problems in genetics III edn McGraw Hill, New York.
11. Strickberger M.W. 1996. Genetics III Edn. McMillan, New York.
12. Winchester A.M. 1967. Genetics Oxford & IBH. New Delhi.

MBF120- METABOLISM- II – THEORY - 3 CREDITS **48hrs**

Tutorials-1 Credit (32 hours)

UNIT I

1. **General Mechanisms of Amino Acid metabolisms:** Degradation of proteins, specificity of action of digestive enzymes, absorption of amino acids. Deamination, role of PLP in the following transamination, decarboxylation desulphuration; Degradation and biosynthesis of individual amino acids. Differences in the pathways in microorganisms, plants and animals. Ketogenic and glucogenic amino acids. Regulation of amino acid biosynthesis. **12 hrs**

UNIT II

2a. Regulation of amino acid biosynthesis; Transglutaminase cycle, Urea cycle; Inborn errors of amino acid metabolism - Phenylketonuria, Alkaptonuria, Maple syrup urine. **4 hrs**

3. **Protein Metabolism:** General mechanisms of degradation in cells, Degradation and biosynthesis of glycoproteins, proteoglycans and lipoproteins, errors in protein metaolism. **4 hrs**

4. Metabolism of Vitamins and Minerals: absorption and utilization in health and disease with any two examples each. Biosynthesis of NAD^+, FAD and coenzyme A. **4 hrs**

UNIT III

5. **Importance of nitrogen in biological systems:** Nitrogen cycle, Nitrogen fixation symbiotic and non-symbiotic, nitrogenase complex, energetic and regulation. Assimilation of ammonia.**4hrs**

6. **Nucleotide metabolism:** Pathways of degradation of nucleotides in cells, Catabolism of purines and pyrimidines; Uric acid formation & its inhibition. Salvage pathways, De novo biosynthetic pathways, Regulation of biosynthesis of nucleotides, conversion of ribonucleotides to deoxynuclotides. Mechanism of action of methotrexate, 5 fluorouracil, Azathymidine. **8 hrs**

UNIT IV

7. **Steroid hormone metabolism:** Introduction, biological importance, physiological action of cholesterol. Structural formulae of estradiol, progesterone and testosterone and their importance. Phytosterols, fungal sterols. **6 hrs**

8. **Metabolism of porphyrins and Peptides:** Heme, porphyrins, Biosynthesis ofcreatine, polyamines glutathione and gramicidine. **6 hrs**

Practicals - 1 Credits 32hrs

1. Estimation of Creatine and Creatinine in serum.
2. Estimation of Urea in serum.
3. Estimation of Uric acid in serum.
4. Estimation of Iron in Blood by Wong's method.
5. Estimation of Ketoacid by DNPH Method.
6. Estimation of Protein by Bradford's Method.

References:

1. Voet D., Voet J. G. Biochemistry. 2nd Ed. John Wiley & Sons. New York.
2. David J Rawn. Biochemistry, 1983. Harper and Row. New York.
3. Zuby G. L. 1988. Biochemistry 2nd Edn. McMillan. New York.
4. Lehninger AL., Nelson JR., and Cox MM., 1993.Principles of Biochemistry. CBS Publishers, New Delhi.
5. Stryer L 1996. Biochemistry**.** WH Freeman &Company.
6. Buchanan R. B. Gruissem W. Jones R. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiology, Maryland.

7. Goodwin and Mercer, Introduction to plant Biochemistry. IInd Ed. CBS Publication and distributors, New Delhi.
8. Dey, P.M., Harborne J.B, Plant Biochemistry Academic Press, New York.

MBF130– ENZYMOLOGY – THEORY - 3 CREDITS 48 hrs

Tutorials-1 Credit (32 hours)

UNIT I

I. **General Aspects** -Nature of enzymes, localization, isolation, purification and characterization of enzymes. Criteria of purity of enzymes. Units of enzyme activity, specificity and specific activity. Nomenclature and IUB classification of enzymes. Assay methods -coupled enzyme assays, continuous, end point and kinetic assay. **08 hrs**

II. **Enzyme Kinetics** -Rate of a reaction, order and molecularity. Michaelis Menten equation, initial velocity approach, steady state approach. Vmax Km and their significance. Linear transformation of Michaelis Menten equation -Lineweaver Burk plot, Eadie Hofstee, Haynes - Wolf and Comish-Bowden. Turnover number. **4 hrs**

UNIT II

III. I**nhibitio**n - Competitive, non-competitive, uncompetitive and product inhibition. Irreversible inhibition- suicide inhibition. Determination of Ki. **3 hrs**

IV. **Bisubstrate Reaction** - Cleland's notation with examples of ordered, pingpong, and random.General rate equation. Primary and secondary plots. **3 hrs**

V. **Mechnisms of Enzyme Catalysis** - Active site structure. Methods of determining active site structure - isolation of ES complex, affinity labeling, chemical modification studies. Active site structure investigation. **6 hrs**

UNIT III

VI. **Nature of Enzyme catalysis** - Transition state theory proximity and orientation, oribital steering, acid base catalysis, covalent catalysis, metal ion catalysis, nueleophilic and electrophilic catalysis, intramolecular catalyses, entropy effects. Effect of temperature and pH on enzyme catalysed reaction. **6 hrs**

VII. **Cooperativity** - Binding of ligands to macromolecules - Scatchard plot, cooperativitiy, positive and negetive cooperativity. Oxygen binding to hemoglobin. Hill equation homotropic and heterotropic effectors, aspartyl transcarbamylase as an allosteric enzyme. **6 hrs**

UNIT IV

VIII. **Mechanisms of Action of Specific Enzyme** - Chymotrypsin zymogen activation, acid – base catalysis, charge relay network. Lysozyme, Alcohol dehydrogenase, Ribonuclease, Carboxypeptidase A, RNA as enzyme, Coenzymic action of NAD+ FAD, TPP, PLP, Biotin, CoA, Folic acid, Lipoic acid. **5 hrs**

IX. **Multimolecular Forms** - Isozyzme, eg. LDH, Multifunctional enzyme (DNA polymerase) multi enzyme complex (PDC) **2 hrs**

X. **Metabolic regulation of Enzyme Activity** - Feedback regulation, fine control of enzyme activity **3 hrs**

XI**. Fast reactions** - Stopped flow, temperature jump method with examples of enzymes **2hr**

Practicals - 1 Credit 32hrs

1. Salivary amylase assay – Specific activity, pH, Temperature, Time Kinetics, Km & Vmax.
2. Effect of Activators and Inhibitors on Salivary amylase activity.
3. Acid phosphatase (Fiske Subbarow's Method).
4. Alkaline phosphatase.
5. Invertase assay from *Calotropis gigantean*

References:

1. Dixon, M Webb E C 1979 Enzymes, 3rd Ed Academic Press, New York
2. Alan F. Enzyme structure and mechanism. 2nd ed. 1985. Cornish-Bowden, Athel.
3. Lehninger AL., Nelson JR., and Cox MM., 1993.Principles of Biochemistry. CBS Publishers, New Delhi.
4. Smith et al., Principles of Biochemistry General Aspects 1983 . McGraw Hill.
5. Voet D, Voet JG. Biochemistry, 2a Ed.. New York: John Wiley & Sons.
6. Stryer L 1996. Biochemistry**.** WH Freeman &Company.
4. T. M. Devlin.Devlin T.M. 1986. Text Book of Biochemistry with clinical correlations (4th edition). John Wiley & Sons, New York.
5. West & Todd. Text of Biochemistry. 1908. MacMillian.
6. Zuby G.L., 1988. Biochemistry. (second ed.). MacMillan, New York.
7. Palmer T. 1985. Understanding Enzymes. John Wiley.

11. Price N. C., Stevens L. 1999.Fundamentals of Enzymology: The cell and molecular biology of catalytic proteins, 3rd edition. Oxford University Press.

12.Matzler D. E. Biochemistry chemical reactions of living cells. 2001.Vol.I Harcourt/ Academic Press. San Diego.

13 Mathews, C. K., van Holde, K. E. and Ahern, K. G. 1999. Biochemistry (3rd edn.), Addison Wesley Longman, San Francisco (Benjamin and cumming).

14. Palmer.Bonner T. L. and Bonner P. L. 2007. Enzymes; biochemistry, biotechnology and clinical chemistry, 2d ed. Horwood Publishing

MBF140- MOLECULAR GENETICS–THEORY– 3 CREDITS 48 hr

Tutorials-1 Credit (32 hours)

UNIT I

I. Central dogma of molecular biology, historical perspectives- Hammerling (Nuclear control), Griffith (DNA, the genetic material), Avery *et al. (*DNA as the genetic material*)*, Hershe & Chase (DNA as the genetic material in bacteriophage), Frankel Conrat (RNA as the genetic material in TMV) and Meselson and Stahl's experiment (DNA replication by Semi conservative mechanism), nearest base frequency (anti parallel nature) analysis. **8 hrs**

DNA replication- semi conservative method - role of helicases, topoisomerases, formation of replication fork, DNA polymerases, DNA ligases. **4 hrs**

UNIT II

Transcription- Colinearity of genes and proteins, eukaryotic and prokaryotic gene structure, transcription in prokaryotes- initiation, elongation, rho dependant and rho independent termination, capping, tailing and splicing (spliceosome mediated) in eukaryotic RNA. **6 hrs**

Translation- genetic code, experiments of Khorana and Nirenberg, feature of genetic code-triplet codon, degeneracy, wobble hypothesis, variation in codon usage, structure of ribosome(review), A, P, E sites of ribosomes, translation in prokaryotes- activation of amino acids, initiation: shine dalgarno complex, initiation factors, elongation: elongation factors, peptide bond formation, termination: release factors. **6 hrs**

UNIT III

II. Concept of gene: Fine structure of gene, Beadle and Tatum's One gene one enzyme concept, One gene one polypeptide concept, Complementation test, Intragenic complementation, Cistron, Recon and Muton, Split gene, Jumping gene, Overlapping gene & multiple genes. **6 hrs**

III.Sex Determination: Sex chromosomes, Chromosomal basis of sex determination- Lyon hypothesis, genic balance in *C.elegans*, *Drosophila*, Man and Plant Example: *Lychnis(Melandrium)*. Molecular basis of sex determination in *C.elegans*, *Drosophila* and Man.

Dosage compensation: Gene dose, Molecular basis of dosage compensation in *Drosophila* and man. **6 hrs**

UNIT IV

IV.Crossing over,Linkage and mapping in eukaryotes: Crossing over**;** Mitotic recombination (somatic crossing over), meiotic recombination (Holliday model, gene conversion e.g., *Neurospora),* Concept of linkage- Bateson and Punett's Experiment, Incomplete linkage in *Drosophila* and *Maize*, genetic distance, two point cross, three point cross, gene order and construction of genetic maps in *Drosophila* and maize, Interference and coincidence, haploid mapping(tetrad analysis), Problems related to linkage and mapping. **8 hrs**

V.Linkage and mapping in prokaryotes: sexual processes in bacteria and virusestransformation, transformation mapping, conjugation, F+ plasmids, Hfr cells, mapping of genes by interrupted mating, transduction and mapping with transduction. **4 hrs**

Practicals – 1 credit **32 hrs**

1. Induction of puff in salivary glands chromosomes of *Drosophila Melanogaster*
2. Study of linkage analysis in Drosophila
3. Interaction of genes
4. Study of bar body in Buccal smear
5. Study of imaginal disc in Drosophila
6. Demonstration of multiple alleles
7. Study of meiotic chromosomes in mice
8. Photographs and charts related to molecular genetics

References:

1. Atherly A G, Girton, J R and Mc Donald J F, 1999. The Science of Genetics, Saunders College Publishing, Harcourt Brace College Publishers.
2. Brooker R.J. 1999. Genetics. Analysis and Principles. Ed. Benjamin Cummings. California

3. Gardner E J, Simmons M J, Snustad D P 1991. Principles of Genetics. John Wiley & Sons, Inc.
4. Griffith A J F, Miller J H, Suzuki D T, Lewontin R C, Gelbert W M.1996. An introduction to Genetic Analysis. W.H. Freeman and Co. New York
5. Strickberger, M. W. 1976. Genetics. Macmillan New York:
6. Watson, J. D., Baker T. A., Bell S. P., Gann A., Levine M., Losick R. 2004. Molecular Biology of the Gene. 5th Edition. Pearson Education Pte. Ltd., New Delhi, India.
7. Klug, W S, and Cummings M. R. 1998. Essentials of Genetics, 3rd Ed. Prentice Hall, Upper Saddle River, NJ.
8. Hartl, D L & Jones E W 2006. Essential genetics: a genomics perspective (4th Ed), Jones and Bartlett Publishers, Boston.
9. Tamarin R. H. 2002. Principles of Genetics. Tata-McGraw Hill, Seventh Edition.
10. Lewin B., Gene IV, V, VI. Oxford University press, Oxford.

MBF150 ELECTIVE-2, 2 credits (32 hours)

SEMESTER VII

MBG110- IMMUNOLOGY – THEORY - 3 CREDITS 48 hrs

Tutorials-1 Credit (32 hours)

UNIT I

1. **Introduction:** Historical development and milestones in immunology – Contributions of Edward Jenner, Louis Pasteur, Emilvon Behring &Kitasato, Metchinkoff, Cells of Immune system, Primary and secondary lymphoid organs – Lymphatic system, Reticulo-endothelial system, Types of immunity, Innate & Acquired. **4hrs**

2. **Non-specific defenses in man:** Barriers to infection – skin, mucous membrane,Inflammation, phagocytosis. **2hrs**

3. **Complement system:** Classical, alternate and lectin binding pathway, Generation ofmembrane attach complex. Anaphylotoxins&Opsonins. **3 hrs**

– hematopoiesis;soluble molecules and membraneassociated receptors; Toll-like receptors; cell types of innate immunity (neutrophils and macrophages); signal transduction pathways. **3 hrs**

UNIT II

4. **Antigens and Antibodies:** Chemical nature & properties, Epitopes, Antigenecity, Immunogenecity, Valency of antigens, Haptens. Immunoglobulins - Structure, Classes and subclasses, Paratopes, Immunoglobulin variants – Isotypes, Allotypes&Idiotypes, Valency of antibody, Genetic basis of antibody diversity. **6hrs**

5. **Immune responses:** Primary and secondary, class switching, Immune responses toInfectious diseases caused by Bacteria, virus and fungi.

6. **MHC:** Structure & functions-MHC antigens in man Antigen processing & presentation

6 hrs

UNIT III

7. Vaccines: Vaccines and their preparations (traditional and recombinant vaccines)BCG, Polio, DPT, HBV, Adjuvants. **2hrs**

8. **Cellular basis of immunity:** Hematopoiesis, Biology of T-cells and B-Cells, Generation and activation. T-cell subsets. T-cell and B-Cell receptors. Antigen presenting cells and accessory cells (macrophages & dendritic cells), T-cell and BCell co-operation, NK cells-ADCC, Clonal selection, Cytokines – role in immunity. **6 hrs**

9. **Transplantation:** Tissue typing- Autograft, Isograft, Allograft &Xenograft. Graftversus host reactions (GVHI). Immunosuppression. **2hrs**

10. **Hypersensitivity:** Types of Hypersensitivity reactions. Types – I, II, III & IV Anaphylaxis. **2hrs**

Complement system - components, activation and biological functions.

UNIT IV

11. **Disorders of immune system:** Immunological tolerance, Organ-specific and Systemic Autoimmune disorders, Immunodeficiency disorders, SCID, AIDS, Erythroblastosisfoetalis. **5hrs**

12. **Tumor immunology:** Tumor associated antigens & Tumor specific antigens.Immune surveillance, TNF !& ", immunotherapy. **2hrs**

13. **Monoclonal antibodies**: Preparations, stabilization and applications. **1hr**

14. **Immunological techniques:** Preparations, agglutinations, Complement fixation, WIDAL Test, Coomb's Test, Immunoferritin technique, Immunodiffusion, Immuno-electrophoresis and variants, Immunofluroscence, RIA & ELISA, Western blotting. **4hrs**

References:

1. Roitt I M, Brostoff J and Male D K. Immunology. 3rd edn. 1993. Mosby – Yearbook Europe Ltd., London.
2. Roitt I M Delves P J. Essential Immunology 10th ed 2001 Blackwell Scientific Publications
3. Boyd W C Fundamentals of Immunology 1964 Toppan Co. Ltd., Tokyo.
4. Kimball J W Introduction To Immunology. 1983. Macmillan Publishing Co., Inc.New. York.
5. Otto S. View and others. Fundamentals of Immunology.
6. Wier D M. Experimental Immunology 1978 Blackwell Scientific Publications Oxford.
7. Kubay J. Immunology. 2001. Second Edition. W H Frecman & Company NewYork.
8. Abbas A K Lichtman A H Cellular and molecular immunology 3rd edition 2007 Oxford University Press, Oxford.

MBG120-MOLECULAR MECHANISM OF SIGNAL TRANSDUCTION 2 Credits 32 hrs

UNIT I and UNIT II

I. Concept of cell signaling - Endocrine, paracrine, merocrine, juxtacrine and autocrine signaling. **1 hrs**

II. Types of receptor systems

1) GPCR-camp and PKA pathway, IP3 and DAG pathway, G proteins (trimeric and monomeric) Sensory transduction in vision, olfaction and gestation

2) Receptor tyrosine kinases-general structure and activation of RTKs, ex: EGF signaling Insulin receptors, JAK-STAT pathway-erythropoietin, cytokines, growth hormone. TGF" signaling through receptor serine/threonine kinase.
3) Receptor guanylylcyclases
4) Gated ion channels
5) Steroid hormone signaling **15 hrs**

UNIT III

III. Second messengers-c AMP discovery, function and regulation by Cholera toxin and Pertusis toxin and calcium signaling. Lipid second messengers - DAG and ceramide. SH and PH motifs, PI3K, PLC, and SMase. Receptor upregulation, down regulation, desensitization, signal cross talk MAPK pathway, stress pathway, Transcription factors - NF KB-regulation. Other transcription factors. cytoplasmic receptors, signaling cross talk, Glucocorticoid and estrogen receptors and their mechanism of action, antihormones (Eg. RU 486) and hormone replacement therapy. **8 hrs**

UNIT IV

IV. Signaling in Bacteria - Quorum sensing in Bacteria, mechanism of chemokine signaling. Molecules and mechanisms.

V. Signaling in yeast- pheromone signaling and nutrient signaling

VI. Signaling in plant - Signaling by stress and light, ethylene signaling, Phytochrome system.
8 hrs

References:

1.Cooper G. M. 1996. The Cell A Molecular Approach, Sinauer Associates, Inc.,
2.Waterman. Introduction to Computational Biology: Maps, Sequences and Genomes, CRC Press.
3.Moleucular Biology of the Cell. B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Garland Publishing, New York and London.
4.Watson, J. D., Hopkins N. H., Roberts J. W., Steitz J. A., Weiner A. M. 1987. Molecular Biology of the Gene. Benjamin/Cummings.
5.Cooper G. M. 1996. The Cell A Molecular Approach, Sinauer Associates, Inc.,
6.Waterman. Introduction to Computational Biology: Maps, Sequences and Genomes, CRC Press.
7. Moleucular Biology of the Cell. B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Garland Publishing, New York and London.
8.Watson, J. D., Hopkins N. H., Roberts J. W., Steitz J. A., Weiner A. M. 1987. Molecular Biology of the Gene. Benjamin/Cummings.
9. Lodish H. F. (Editor) Berk A., Matsudaira P., Kaiser C. A., Krieger M., Scott M. P., Zipursky S. L., Darnell J. Molecular Cell Biology. W. H. Freeman and Co., Publishers.
10. Devline and Witham, 1986. Plant Physiology. CBS Publs. and Distributors, New Delhi.
11. Hopkins, W.G. 1995. Introduction to Plant Physiology, John Wiley & Sons. Inc., New York, USA.
12. Moore, T.C. 1989. Biochemistry and Physiology of Plant Hormones. Springer Verlag, New York, USA.

13. Singhal et al. 1999. Concepts in Photobiology, Photosynthesis and Phytomorphognesis, Narosa Pub. House, New Delhi.
14. Taiz and Zeiger, 1998. Plant Physiology. Sinauer Associates Inc., Publishers, Sunderland

MBG130 MOLECULAR MECHANISM OF GENE EXPRESSION- I, 3 Credits 48 hrs
Tutorials-1 Credit (32 hours)

UNIT I

Introduction: Historical perspective overview. 2 hrs

1. **Replication:** DNA polymerase I II and III, DNA ligases, DNA topoisomerases (review). Eukaryotic replication initiation, replication of double stranded DNA - direction of replication, discontinuous replication - Okazaki fragments. Role of SSB proteins and clamp protein in replication, fidelity of enzymes, procesivity of replication, and replication at the chromosomal end. Bidirectional replication (replication). Replication of mitochondrial DNA, replication in viruse-phiX174, M13 single stranded DNA, rolling circle model. **10hrs**

UNIT II

2**. Transcription:** Prokaryotic transcription (review). Eukaryotic transcription, general transcription factors, RNA polymerases, promoters, initiation, elongation, and termination. Post transcriptional modifications- capping, tailing, and splicing (spliceosome mediated, non spliceosomal mediated), self-splicing RNA, RNA editing. Nuclear mRNA export. Reverse transcriptase (RNA mediated RNA synthesis), RNA replicase in QB virus. Transcriptional inhibitors. **12hrs**

UNIT III

4. **Translation:** Prokaryotic and eukaryotic ribosomes (review). Structure and role of tRNA, tRNAsynthetase, Prokaryotic & eukaryotic initiation- initiation factors, shine dalgarno and kozak sequence for recognition, elongation- elongation factors, termination- termination factors, translational inhibitors. Viral translation (IRES). **12hrs**

UNIT IV

5. **DNA repair mechanism:** Types of damage (review), enzymes involved in repair, mismatch repair, base excision repair, nucleotide excision repair, single and double strand breaks, translesion synthesis, and transcription-coupled repair. Prokaryotic repair mechanism.

4 hrs

6. **Post translational modifications:** Signal peptide cleavage, O and N-glycosylation,disulphide bond formation, folding of nascent protein, role of chaperons, attachmentofglycosyl anchor, and other modifications. **8 hrs**

References

1. Kornberg A., Tania A B. DNA replication. University Science books.
2. Harvy F. Lodish (Editor) Arnold Berk, Paul Matsudaira, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, S. Lawrence Zipursky, James Darnell: Authors. Molecular Cell Biology. W. H. Freeman and Co., Publishers
3. Alberts, B., Bray, D., Lewis, J., Raff, M, Roberts, K, and Watson, J. D. 1983. Molecular biology of cell. Garland Publishing Inc., New York.

4. Freifelder D. Molecular Biology. A Comprehensive Introduction to Prokaryotes and Eukaryotes. Jones and Bartlett, USA.
5. Watson J.D., Tooze J., Kurtz D.T. Recombinant DNA: A Short Course. Scientific American Book, W.A.Preemon.
6. Green, M R. and Sambrook J. 2013. Molecular cloning: Laboratory Manual. 4th Edition., Cold Spring Harber Laboratory, New York.
7. Ayala A.J., Castra. W. 1984. Modern Genetics. 2nd Edition, Geom Helns, London.
8. Walker J., Ed., Castra W. 1992.Techniques in Molecular Biology. Geom Helns, London.
9. Schecleif R.F., Wensik. P.C. 1991. Practical Methods in Molecular Biology Springer Verlag.
10. Lewin B. 1994. Genes V. Oxford University Press.
11. Watson, J. D., T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losick. 2004. Molecular Biology of the Gene. 5th Edition. Pearson Education Pte. Ltd., New Delhi, India.
12. Voet D, Voet JG. Biochemistry. Ed. John Wiley & Sons. New York.

MBG140- GENETIC ENGINEERING- I & BIO-INFORMATICS , Theory 4 CREDITS, 64 Hrs

Tutorials-1 Credit (32 hours)

UNIT I

1. Enzyme as tools in Genetic Engineering:

a) Nucleases: DNases, RNases, exonucleases, endonucleases, restriction endonucleases, isoschizomers.

b) DNA polymerase, klenow fragment, reversetransriptase, ligases, S1 nuclease.

c) DNA modifying enzymes: polynucleotide kinase, terminal transferase, phosphorylase & phosphatase.Glycosylases,ribonuclease inhibitors, topoisomerases. **6hrs**

2. **Extraction:** Isolation and purification of DNA, RNA and plasmid from various Sources (review) **1hr**

3. **Vectors:** Types - cloning, transcripts and expression vectors and construction, plasmid, phages, cosmid, phagemid, shuttle vectors, YAC, BAC, PAC and their significance. Hosts: bacteria, yeast, drosophila, xenopus oocyte, plant cell, mammalian cell. **9 hrs**

UNIT II

4. **Recombinant DNA technology:** linkers, adapters, homopolymer tailing cloning, ligation (blunt and staggered), gene transfer methods. Transformation, transfection(stable and transient), lipsome mediated transfer, microinjection, calcium phosphate method, DEAE- dextran method, electroporation, polybrene, laser transfection, biolistic methods (gene gun, microparticle bombardment. **8 hrs**

5. **Library construction and screening methods:** genomic library, cDNA library, probe hybridization, plaque hybridization, colony hybridization, PCR screening. Direct screening**:** blue white screening, □□complementation, insertional inactivation, plaque phenotype. Indirect screening: hybrid arrest and hybrid select translation. **8hrs**

UNIT III

5. **Library construction and screening methods:** genomic library, cDNA library, probe hybridization, plaque hybridization, colony hybridization, PCR screening. Direct screening**:** blue

white screening, α-complementation, insertional inactivation, plaque phenotype. Indirect screening: hybrid arrest and hybrid select translation. **6hrs**

6. **Labelling methods:** end labelling, oligonucleotide labelling by nick translation,fluorescent labelling and other methods like streptavidin and biotin **2hrs**

7. **PCR concepts, methodology, types and applications:** PCR basics, inverse PCR, multiplex PCR, nested PCR, colony PCR, real time PCR, tail PCR, reverse transcriptase PCR, PCR primers and primer designing. **4 hrs**

8. **Genetic engineering in plants: Vector mediated (***Agrobacterium* mediated transformation: *rhizogenes* and *tumefaciens*,) Physical methods (Microprojectile, microinjection, Liposome fusion) **4 hrs**

UNIT IV

9. Bioinformatics- an overview, Definition and History, Applications of Bioinformatics. Introduction to Genomics, Introduction to Proteiomics. Sequence formats. Homology and similarity. Introduction to Data mining, NCBI, EBI, DDBJ, UNIPROT Database search software: ENTREZ, SRS, Expasy. **4 hrs**

10. Sequence Analysis, definition of sequence analysis, Nucleotide Sequence Analysis, Protein Sequence Analysis, Pair wise Alignment, global and local alignment, and significance of alignment, dot- plot.Goals and types of alignment, Tools of sequence alignment, Homology sequence search, Parameters of Blast, BLAST2., BlastN, BlastP, tBlastX, TblastN, BalstX, Interpreting Blast Results, FASTA3. **6 hrs**

11. Multiple sequence analysis, Parameters of CLUSTAL-W, interpretation of Clustal WOutput, DNA Sequence Alignment, Protein Sequence alignment. **2hrs**

References:

1. Sambrook J, Frisch E and Maniatis T Molecular Cloning: A Laboratory manual. 2000. Old Spring Harbor Laboratory Press New York,
2. Glover D M and Hames BD.DNA Cloning: a Practical Approach, IRL Press
3. Kaufman P B, Kim W.Wu.D and Cseke L J. Molecular and Cellular methods in Biology and Medicine, CRC Press, Boca Raton Florida.
4. Berger S L and Kimmel A P. Methods in Enzymology Vol. 152, Guide to Molecular Cloning Techniques.1998. Academic Press, Inc San Diego,
5. Methods in Enzymology Vol. 185, Gene Expression Technology, D V Goeddel,
6. Academic Press, Inc. San Diego, 1990
7. Mickloss D A and Freyer G A. DNA Science: A first Course in Recombinant Technology. 1990. Cold Spring Harbor Laboratory Press, New York
8. Primrose S B. Molecular Biotechnology. 2nd Edn. 1994. Blackwell Scientific Pub. Oxford.
9. Davies J A and Reznikoff W S. Milestones in Biotechnology: Classic papers on Genetic Engineering. 1992. Butterworth-Heinemann, Boston,
10. Walker M R and Rapley R. Route Maps in Gene Technology. 1997. Blackwell Science Ltd, Oxford.
11. Bernard R. Glick, Jack J. Pasternak Molecular Biotechnology: Principles and Applications of Recombinant DNA (3rd edition). 2003. Amer Society for Microbiology
12. Balasubramanian Et Al. Concepts in Biotechnology. 1996. Orient Longman Publisher.

13. Primrose S B Richard M. Principles of Gene Manipulation Blackwell Publishing.
14. Brown T.A. Gene Cloning and DNA Analysis. (4th ed.). 2001. Blackwell Publishing.
15. Rastogi , S.C. , Mendiratta N., Rastogi P., Bioinformatics-concepts, skills Applications.
16. Andredas D., Baxevanis, B.F. Ouellette F. 1998. Bioinformatics: A Practical Guide to the analysis of Genes and Protiens-John Wiley and Sons, New York.
17. Bishop M.J. ,Rawling C.J.(Eds). 1997. DNA and proteins sequence analysis. A Practical approach. IRL Press, Oxford.
18. Mani K., Vijayaraj N- Bioinformatics-A Practical approach. Aparna Publications.

MBG150- MOLECULAR BIOLOGY LAB-1 , 4 CREDITS

32x4=128 hrs

(Immunology, Molecular Mechanism of Signal Transduction, Molecular mechanism of gene expression-1, Genetic engineering-1)

- Ouchterlony's Double diffusion.
- Single Radial Immuno diffusion (SRID).
- Immunoelectrophoresis.
- ELISA.
- Slide agglutination.
- Isolation of IgG form human serum.
- Purification of IgG by affinity chromatography.
- Isolation of lymphocytes from venous blood sample.
- Complement assay.
- Determination of Genotoxicity by comet assay.
- Isolation of DNA from liver.
- Isolation of RNA from yeast.
- Plasmid Isolation.
- Phospholipase C assay.
- Phosphoprotein assay.
- Estimation of Mucopolysaccharides..
- Western blotting of proteins.
- IPTG induction of β-Galactosidase.
- β -Galactosidase assay using ONPG.
- Apyrase assay using transgenic *E.coli*.
- Photographs and charts related to signal transduction mechanisms.
- Bacterial transformation.
- Restriction Digestion of λ-DNA and plasmids.
- Ligation of restricted fragments.

MBG160 Elective-3, 2 Credits 32 hours

SEMESTER VIII

MBH110- MOLECULAR PATHOLOGY – THEORY - 3 CREDITS

Tutorials-1 Credit (32 hours)

UNIT I

Pathology of Prokaryotes- Examples of Diseases of viruses, bacteria, fungi in plants, animals. Mechanism of pathogen entry, virulence, spreading and mechanism of diseases (in brief). Endo and exo toxins, animal toxins e.g.venoms.

Plant pathology- Some diseases of economically important plants: Downy mildew of bazra, Fruit rot of areca, powdery mildew of mulberry, rust of coffee, Helminthosporium blight and blast diseseses of rice, Fusarium wilt disease, Bacterial blight of paddy, Sandal spike, bunchy top of Banana **12 hrs**

UNIT II

Physiological and Molecular Plant Pathology- Altered metabolism of plants under biotic and abiotic stresses. Molecular mechanisms of pathogenesis: recognition phenomenon, penetration, invasion. Enzymes and toxins in relation to plant disease. Mechanisms of resistance: Genetics of Resistance, Host Pathogen interaction, Phytoalexins. PR proteins, HR, SAR, and active oxygen radicals. Role of Jasmonic acid and Salicylic acid in plant defense. , Management of Plant diseases: Disease diagnosis, Treatment: Biological control, through satellite, antisense - RNA. Ribozymes, coat protein, hypovirulence cross protection/useful genes. Tissue culture-meristem culture **12 hrs**

UNIT III

Infectious Diseases of human- mechanism of pathogen entry, virulence, spreading and mechanism of diseases**.**

a) Mycobacterial Diseases: Tuberculosis and Leprosy

b) Bacterial diseases: Pyogenic, Typhoid, Diphtheria, Gram negative infection, Bacillary dysentery, Syphilis.

c) Viral: Polio, Rabies, Measles; emerging viral diseases

d) Fungal diseases: Candidiasis

e) Parasitic Diseases: Filaria, Amoebiasis

f) AIDS: Aetiology, modes of transmission, diagnostic procedures and handling of infected material and health education. **12 hrs**

UNIT IV

Molecular mechanism of human diseases: Nutritional deficiency diseases –vitamin, mineral and protein-calorie. Symptoms, diagnosis and treatment. Classes of gene mutations in humans, Human mitochondrial diseases, loss of function and gain of functional mutations in humans, Agammaglobinemia, Diseases of collagens.

Genetic factor in common diseases- Genetic susceptibility to common diseases. Types and mechanisms of susceptibility. Genetic approaches to common diseases. Diabetes mellitus, Hypertension, Coronary artery diseases, Schizophrenia, Alzheimer's disease, congenital abnormalities. **12hrs**

References:

1. Agrios. G. N. 1997. Plant Pathology. Academic press, London.
2. Manners, J.G.1982. Principles of Plant Pathology. Cambridge University Press.
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15. Burtis CA, Ashwood EA, Bruns DE. Tietz Textbook of Clinical Chemistry and Molecular Diagnostics, 4th Ed. St. Louis, MO: Saunders, 2006.
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17. Gardner RJM, Sutherland GR. Chromosome Abnormalities and Genetic Counseling, 2nd Ed. New York: Oxford University Press, 1996.
18. Geren S, Keagle M. The Principles of Clinical Cytogenetics. Totowa, NJ: Humana Press, 1998.
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20. Killeen AA. Principles of Molecular Pathology. Totowa, NJ:, Humana Press, 2004.
21. Leonard DGB. Diagnostic Molecular Pathology. Philadelphia: WB Saunders, 2003.
22. Persing DH, Tenover FC, Versalovic J, Tang Y-W, Unger ER, Relman DA, White TJ, Eds. Molecular Microbiology: Diagnostic Principles and Practice. Washington: ASM Press, 2003.
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24. Scriver CR, Sly WS, Childs B, Beaudet AL, Valle D, Kinzler KW, Vogelstein B. The Metabolic and Molecular Bases of Inherited Disease, 8th Ed. New York: McGraw-Hill, 2000.
25. Sen F, Vega F, Medeiros LJ. Molecular genetic methods in the diagnosis of hematologic neoplasms. Semin Diagn Pathol 2002;19:72–93.
26. Shaffer LG, Tommerup N, Eds. ISCN 2005: An International System for Human Cytogenetic Nomenclature. Basel, Switzerland: S Karger, 2005.
27. Strachan T, Read AP. Human Molecular Genetics, 3rd Ed. London: Garland Press, 2004.
28. Therman E, Susman M. Human Chromosomes, 4th Ed. New York: Springer-Verlag, 2001.
29. Thompson MW, Mc Innes RR, Willard HF, Eds. Thompson & Thompson: Genetics in Medicine, 5th Ed. Philadelphia: WB Saunders, 2002.

MBH120 - BIOSTATISTICS AND RESEARCH METHODOLOGY THEORY 2 CREDITS 32 HOURS

UNIT I

1. Introduction: Why Statistics? Types of data: nominal, ordinal, discrete, continuous, Collection, classification and tabulation of data. Exploratory data analysis- histogram, stem and leaf diagram, frequency curves,

2. Descriptive analysis of statistical data. Measures of central tendency (mean, median and mode and quartiles), Measures of dispersion (Range and standard deviation, coefficient of variation, quartile deviation) **8hrs**

UNIT II

Basic models of probability. Definitions and properties. Random variables-discrete and continuous. Concepts of mathematical expectation and variance, Binomial, Poisson, Normal distributions (Definition and applications)

Regression and correlation:

Parametric Statistical inference: Estimators, confidence intervals, t-test, z-test, chi-square test. ANOVA- (One way and two way), DMRT.

Non parametric tests: Sign test, Median test **8hrs**

UNIT III

PART-B: RESEARCH METHODOLOGY

Introduction: Scope and significance of research methodology, Good laboratory practices, Quality control.

Review of literature, identifying the gaps and formulating the hypothesis.

Research material: Use of taxonomic keys, Samples: Collection, transport, handling and preservation of microorganisms, planktons, insects, animals from natural and lab bred population. Water and air samples. Relevance of sample size. Culture and maintenance of samples. Safe disposal of used and rejected samples and materials. **8hrs**

UNIT IV

Types of research studies: Collection of data – sources; methods –questionnaires, records, archives; scaling – Likert and Guteman scaling.

Design of experiments: Cohort studies, Double blind, placebo control, crossover. Eg., UKPDS, CUPS, Farmington), Clinical studies, toxicity studies.

Selection methods: Reviewing, standardization of the methods, modification and experimental design collection, analysis, statistical inference, presentation of the data. **8hrs**

Tutorials 1 credit 32 hours

Review of research articles (To be done by students. Each student can select one paper review and present it).

Demonstration of writing a research proposal

Research proposal: The student will identify a topic for research and prepare a document with the following information – Back ground of research problems, Objectives, strategies for experimental work, Expected results, preparation of rough draft and bibliography. The student will also present and defend the research proposal, Evaluation of research proposal

.

Practicals – 1 Credit **32hrs**

Section B: Biostatistics

1. Exploratory data analysis
2. Measures of central tendency
3. Measures of dispersion
4. Measures of skewness
5. Correlation and regression
6. Simple problems on probability and probability distributions
7. z and t-test
8. Chi-square test
9. ANOVA and DMRT
10. Non parametric test
11. Analysis using Minitab and excel- (two practicals)

References:

1. Michael R.Chernick, Robert H.Friis (2003) – Introductory Biostatistics for the Health Sciences, Wiley – Interscience.
2. Bhattacharya, G.K. and Johnson, R.A. (1977) – Statistical Concepts and Methods, John Wiley.
3. Freedman, D., Pisani, R., Purves, R., Adhikari, A. (1991) Statistics, W.W.Norton and Company.
4. Agarwal, B.L. (2001) – Basic Statistics, New Age International Publishers.
5. Chap T.Lee (2003) – Introductory Biostatistics, John Wiley.
6. Heejung Bang, Xi Kathy Zhou, Heather L. van Epps, Madhu Mazumdar - Statistical Methods in Molecular Biology, Publisher: Humana Press

MBH130- GENOMICS AND PHYLOGENETICS – THEORY + Tutorials 3 CREDITS 48 hours

Unit I

Concepts of genomics :History of genomics; Prokaryotic and Eukaryotic Genome: structure and organization. Genome annotation. Completed genome projects of model organisms; human genome structure and comparative genomics. Genomic elements, SNPs and genome-wide association studies. **6hrs**

Overview of metagenomics: Principles, applications and limitations of metagenomics, differences between metagenomics and single-cell genomics. Definition and principle of population genomics, difference between metagenomics and population genomics, applications of population genomics. **4hrs**

Genome sequencing technology: Principles and output from Sanger's dideoxy method versus NGS; shotgun sequencing method and library preparations, comparative study of standard NGS methods. Basics of Next Generation Sequence data analysis, fragment assembly, genome assembly, Human genome project – aims, goals and achievements. General Principles of Gene therapy. **6hrs**

Unit II

Gene Expression Profiling : Aligning Whole genome alignment (WGA), Prediction of Coding regions – genes structure- conserved motifs, Comparitive genomics, methods of gene discovery-prediction of gene function – methods – annotation, coding and non-coding genes and RNA. Expression profiling - Northern, qPCR, DDRT-PCR, EST Library, cDNA AFLP and SAGE

Transcriptome: General Account; DNA microarray: understanding of microarray data and correlation of gene expression data to biological processes. Gene regulatory networks and models **8hrs**

UNIT III

Bioinformatics databases - Nucleotide sequence databases, Primary nucleotide sequence databases-EMBL, GeneBank, DDBJ; Secondary nucleotide sequence databases; **4hrs**

Pharmacogenetics : Historical aspects of pharmacogenetics – Pharmacogenomics – biomarkers and promise of personalized medicine. Genetic polymorphism and evolution.

4hrs

Unit IV

Sequence Analysis: Basic concepts, Alignment of pairs of sequence:- Homologous, Analogue, Orhtologous, paralogous, Xenologous (Need for sequence alignment, Local and Global alignment, Scoring matrices- PAM and BLOSUM matrices

Pairwise sequence alignments: BLAST, Multiple sequence alignments (MSA) BLAST:- Nucleotide BLAST, Protein BLAST, PSI-BLAST, Analysis of BLAST results, E Value, sensitivity and specificity of BLAST, FASTA Structure analysis tools and softwares

Collecting and storing sequences: Various file formats for bio-molecular sequences: Genbank, FASTA, GCG, MSF, NBRF-PIR etc. **8hrs**

Phylogenetic analysis:Phylogenetics data analysis, Tree building methods, Rooted tree, un rooted tree, Distance method, UPGMA, NJ, Fitch-Margoliash, Minimum Evolution, Character based methods - Maximum Likelihood and Maximum Parsimony. Advantages and disadvantages of various sequence analysis methods. **8hrs**

Practicals – 1 Credits 32 hours

1. Downloading DNA sequence from NCBI database and interpretation.
2. Analyzing the DNA sequence in EMBOSS/ GENE TOOL/ DSGENE,
3. Analyzing the DNA sequence Fasta, Blast, Clustal W.
4. Analyzing the sequence against EST and genome database
5. Use of Mega
6. Use of other related softwares (Specify during the practicals)

References:
1. Hartwell L. H., 2004. Genetics, McGraw HILL higher education.
2. David W mount, 2002. Bioinformatics: Sequence and genome analysis, Cold Spring Harbor Laboratory Press.
3. Higgins and Taylor, 2000. Bioinformatics Sequence, Structure and databanks, Oxford University Press.
4. Starkey M. P. Edit. 2001Genomics protocols, Methods of Molecular Biology, VOL. 175, Humana Press.
5. Lesk A. 2007. Introduction to Genomics, Oxford University Press, USA; 1 edition.
6. Campbell A. M., Heyer L. J., 2006. Discovering Genomics, Proteomics and Bioinformatics, Benjamin Cummings; 2 edition.
7. Gibson G., Muse S. V., 2004. A Primer of Genome Science, Sinauer Associates, 2nd Edition
8. Cristianini N., Hahn M. W., 2007. Introduction to Computational Genomics: A Case Studies Approach, Cambridge University Press.
9. Pagel M., Pomiankowski A., 2007. Evolutionary Genomics and Proteomics, Sinauer Associates Inc.,U.S.; 1 edition
10. Pevsner J., 2003. Bioinformatics and Functional Genomics, Wiley-Liss; 1 edition
11. Felsenstein J., 2003. Inferring Phylogenies, Sinauer Associates; 2 edition
12. Hall B. G., 2007. Phylogenetic Trees Made Easy: A How-to Manual, inauer Associates, Inc.; 3 edition
13. Nei M., 2000. Molecular Evolution and Phylogenetics, Oxford University Press, USA; 1 edition
14. Graur D., 2000. Fundamentals of Molecular Evolution, Sinauer Associates; 2 Sub edition.
15. Salemi M., 2003. The Phylogenetic Handbook: A Practical Approach to DNA and Protein Phylogeny, Cambridge University Press; 1 edition.

MBH140 MOLECULAR BASIS OF DEVELOPMENT AND DIFFERENTIATION-
3 CREDITS-48 Hrs
UNIT I

An overview of gametogenesis and fertilization.Molecular basis of early development and differentiation:

Caenorhabditis elegans: Anterior- posterior axis formation, formation of the dorsal – ventral and right- left axes, control of blastomere identity. Differentiation of pharynx.

Drosophila: Primary axis formation during oogenesis. Generating dorsal – ventral pattern in embryo. Segmentation and the anterior – posterior body plan, segmentation genes, homeotic selector genes.

Mammals: Anterior–posterior axis formation, the dorsal–ventral and right–left axes in mice.

12hrs

UNIT II

Molecular basis of later development:
Differentiation of neural tubes and neurons. Myogenesis, osteogenesis, heart and angiogenesis. Differentiation of pancreas.

Reproductive biotechnology: Collection and cryopreservation of gametes – human and animals, superovulation and collection of eggs, *in vitro*- fertilisation (test tube baby), surrogate mothers. **12hrs**

UNIT III

Development in plants:
Embryogenesis: Pattern formation, establishment of symmetry, Cell lineages – positional control

Vegetative development: Embryonal axis – meristems, Meristems as dynamic centers of cell regeneration, Shoot, Leaf and Root Development– Organization of shoot apical meristem (SAM); Control of cell division and cell to cell communication; Molecular analysis of SAM; Leaf development and differentiation, Development of dorsal and ventral symmetry in leaves; Organization of root apical meristem (RAM); Root hair and trichome development; Cell fate and lineages. **12hrs**

UNIT IV

Transition to flowering: Vegetative meristems to inflorescence and floral meristems. Overview of Photoperiodism and its significance, Vernalization and hormonal control.

Floral development: Formation of four whorls, stamen and carpel development, gametogenesis. Genetic regulation of floral development. The ABC model for floral organ specification in *Arabidopsis thaliana*, *Antirrhinum majus* ABCDE model , Model for *Oryza sativa*, development of asymmetry in flowers.

Fruit and seed development: maturation and germination of seeds

Parthenogenesis: Developmental routes to Parthenogenesis, Parthenocarpy, Apomixis. **12hrs**

References:

1. Gilbert S. F. 2006. Developmental biology 8th edn., Sinaeur Associates, Massachusetts.
2. Bhojwani S.S. and Soh W.Y. (2001). Current Trends in Embryology of Angiosperms, Kluwer Academic Publishers.
3. Srivastava, L. M. 2003. Plant growth and development. Oxford University Press.
4. Lyndon R.F. (1990) Plant Development The Cellular Basis. Unwin Hyman
5. Raghavan V. (2000) Developmental Biology of Flowering Plants.Springer Verlag.
6. Buchanan B. B., Gruissem W. and Jones R. L. (2000) Biochemistry and Molecular Biology of Plants. Americal Society of Plant Physiology, Maryland.
7. Weiss P., Willier B. H., Hamburger V. 1955. Analysis of Development. Saunders, Philadelphia.

MBH 150 Molecular Biology Lab-2 - 4 Credits 16x8= 128 hrs

(Molecular Pathology, Molecular Basis of Development and Differentiation)

- Determination SGOT and SGPT assay.
- LDH assay by Wrobleski-Ladue's method.
- Determination of A/G ratio in serum.
- Observation of cancer cells by H & E staining.
- Studies of charts displaying transmission cycle of malaria, kala azar, tuberculosis, leprosy, Influenza.
- Study of Plant diseases: Symptoms, Causal agents– fungal - Downy mildew of bazra, Fruit rot of areca, rust of coffee, tikka disease of groundnut, fusarium wilt of tobacco.
- Study of plant diseases – bacterial –Bacterial blight of paddy, mycoplasmal – sandal spike; viral – bunchy top of banana.
- Isolation of any one fungal and one bacterial pathogens and pure culturing them
- Control of Plant Pathogens : Biocontrol (*Fusarium oxysporum versus Trichoderma harzianum/T. Viride*), Demonstrations of some biocontrol formulations
- Comparison of phenylalanine ammonia lyase in healthy and diseased plants.
- Pectic enzyme assay in plant pathogens by viscometry and disc diffusion method.
- Comparision of peroxidase in healthy and diseased plants.
- Comparision of superoxide dismutase in healthy and diseased plants.
- Genetic variation of fungal pathogens using Molecular markers.
- Study of embryo development in plants through Microtomy.
- Study of developmental stages of trichomes and Root.
- Study of floral whorls- ABC model of flower development.
- Study of homeotic mutants of *Arabidopsis thaliana/ Antirrhinum majus*
- Study of homeotic mutants in *Drosophila*
- Live observation of *Drosophila* embryo development

Elective-4 / Minor Research Project- Theory 2 Credits 32 hours

SEMESTER IX

MBI110- GENETIC ENGINEERING II – THEORY – 3 CREDITS -48 hrs

Tutorials 1 Credit 32 hours

UNIT I

I. GENETIC ENGINEERING OF LIVING ORGANISMS-

Prokaryotic expression systems: Expression and purification of recombinant proteins in *E.coli,*

Eukaryotic expression systems - expression vectors in yeast (*S. cerevisiae*– YES, and P. pastoris– pPICZ); gene expression in animal cells - pcDNA3.1/His and pSecTag2/Hygro; viral vectors – adenoviral and retroviral (pLenti expression system).

Insect expression system - baculovirus system

Mammalian Expression system: knock-out mice by targeted disruption by homologous recombination in ES cells; conditional knock-out by site specific recombination (Cre/loxP system); advanced transgenic technology – inducible expression system – tet on/off system
Transgenic plants: **6 hrs**

II Cell Culture:

Plant Cell Culture: Micropropagation callus culture, haploid production, somatic embryogenesis, somatic hybridization and cybridization, somaclonal variation.

Animal Cell Culture: Culture techniques, media, preparation of primary culture, chick embryo, HUVEC, cell lines, characterization of cultures ploidy, cell doubling time. Amplified cultures continuous cultures, applications. **6hrs**

UNIT II

III. Techniques: Sequencing techniques (**Maxam and Gilbert, Sanger and Coulson,** shot gun, nanopore) methods (NGS), cyclic reversible termination (CRT), singlenucleotide addition (SNA) and real-time sequencing, Sequencing by ligation (SBL), pyrosequencing. DNA finger printing, DNA foot printing, nuclease protection assay (EMSA), band shift assay, genome walking, RACE **6hrs**

VI. RNA interference and Antisense RNA: RNA induced gene silencing (miRNA, siRNA, shRNA) Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation.

VII. Ribozymes: Ribozyme biochemistry, hammerhead, hairpin and other ribozymes, strategies for designing ribozymes, application of antisense and ribozyme technologies. **6hrs**

UNIT III

VIII. Biomarkers - Morphological, biochemical and molecular markers; Importance of molecular markers; Molecular and protein polymorphism; Naturally occurring polymorphism in DNA sequences – Base pair deletion, substitution, additions or patterns; Application – germplasm characterization, genetic diagnosis, characterization of transformants, study of genome organization and phylogenetic analysis. Molecular markers for genome analysis: kinds of molecular markers - (RFLP, RAPD, STS, SSR, AFLP, SNPs) protein markers – merits and demerits and their applications in different fields of molecular biology; isozyme marker – merits and demerits, their application in molecular biology. **8hrs**

Molecular breeding: Marker-Assisted-Selection (MAS). Marker-Assisted Backcrossing (MABC). Case studies of MAS and MABC in rice. **2hrs**

Applications of recombinant DNA technology- Vaccine production, disease diagnosis, for disease prevention & treatment and production of transgenic plants and animals, Humanised antibody. **2hrs**

UNIT IV

Applications of recombinant DNA technology- Vaccine production, disease diagnosis, for disease prevention & treatment and production of transgenic plants and animals. **2hrs**

Gene therapy, types of gene therapy (somatic cell gene therapy, germ line gene therapy, enhancement genetic engineering, eugenic engineering), applications in agriculture medicine, industry **3hrs**

GM bio safety: GM foods, terminator gene technology and its negative impact. Laboratory methodologies, Handling of GMO's, Testing, Evaluation, Toxicity, Allergenic & Animal ethical issues, Disposal methodologies, role of IBSC, RCGM, GEAC **3 hrs**

IPR Issues: Forms of IPR, IPR legislation in India, implication of IPR legislation on India and other developing countries, WIPO, WTO, GATT, Trips Agreement,Introduction to patenting and patenting process. Biodiversity board. **4hrs**

References:

1. Sateesh M. K. 2008. Bioethics and Biosafety. I. K. International, Bangalore.
2. Sambrook J., Ffrisch E., Maniatis T., 2000. Molecular Cloning: A Laboratory manual, Old Spring Harbor Laboratory Press New York,
3. Glover D.M., Hames B. D., DNA Cloning : a Practical Approach, IRL Press.
4. Kaufman P.B., Kim W.W.D., Cseke L.J., Molecular and Cellular methods in Biology and Medicine. CRC Press..
5. Berger S.L., Kimmel A.P. 1998. Methods in Enzymology Vol. 152, Guide to Molecular Cloning Techniques, Academic Press, Inc San Diego.
6. Goeddel D.V., 1990. Methods in Enzymology Vol. 185, Gene Expression Technology, Academic Press, Inc. San Diego,
7. Mickloss D.A. and Freyer G.A., DNA Science. 1990. A first Course in Recombinant Technology, Cold Spring Harbor Laboratory Press, New York
8. Primrose S.B., 1994. Molecular Biotechnology (2nd Edn) Blackwell Scietific Pub. Oxford,
9. Davies J.A., Reznikoff W.S., 1992. Milestones in Biotechnology. Classic papers on Genetic Engineering. Butterworth-Heinemann, Boston.
10. Walker M.R., Rapley R. 1997. Route Maps in Gene Technology, Blackwell Science Ltd, Oxford.
11. Glick B. R., Jack J. Pasternak 2003.Molecular Biotechnology: Principles and Applications of Recombinant DNA (3rd edition). American Society for Microbiology.
12. Balasubramanian Et Al. 1996. Concepts in Biotechnology. Orient Longman Publisher.
13. Primrose S B Richard M. Principles of Gene Manipulation. Blackwell Publishing.
14. Draper J., Scott R., Armitage P., Walden R. 1988. Plant Genetic Transformation and Gene expression: A Laboratory Manual. Scientific Publication Oxford, London, Edinburgh

MBI120- PROTEOMICS AND DRUG DESIGNING – THEORY – 2 CREDITS 32 hrs

Tutorials 2 credits (32 hours)

Unit I and Unit II

Principles of Protein Structure and Classification: Properties of amino acids and peptide bonds, Ramachandran plot, Secondary structures, motifs and folds. Protein Structure Visualization; tools and analysis of protein structures. Concepts of B-factor and R-factor. Protein Structural

Alignment and Superposition. Protein Fold Classification, CATH, SCOP and FSSP Databases. **4hrs**

Proteomics- Need, Scope and challenge of proteomics, how proteomics is applied in real life scientific research, protein structures. Protein expression profiling, Protein secondary structure analysis. **2hrs**

Proteomics Proteome profiling methods, 2-D electrophoresis image comparisons; yeast two-hybrid system, protein arrays, mass spectrometry data processing and analysis; pathway analysis and identifying protein-protein interactions with mass scale expression data. **4 hrs.**

Biopolymer modeling building, editing and visualizing biopolymer structures and their complexes. Rendering, mutations, calculation of geometric parameters (bond distance, bond angle, dihedral angle). Overview of Protein databases- UniProt, Protein Data Bank (PDB) and NDB databases. Identifying inter-molecular interactions from crystal structures; protein…protein, protein…nucleic acids, protein…ligand/water, nucleic acids… ligand/water, protein… carbohydrate interactions. **6hrs**

Unit III

Protein structure/fold prediction Concepts and algorithms related to homology modeling, loop modeling, sequence-structure alignment (1D-3D), protein threading, Protein 3D structure prediction using Threading approach, secondary structure prediction, predicting cellular localization; structure refinement methods like energy minimization, MD simulation; structure validation methods such as RMSD and intra/inter-molecular interaction. Simulation study of protein, Force field concepts. **8hrs**

Unit IV

Rational drug design Identifying active site/drug binding pockets. Docking algorithms Virtual screening method in identifying potential lead molecules. Solvent accessible surfaces/properties of proteins; creating electrostatic potential surface diagram protein-ligand docking. Molecular Docking. Drug target identification and Drug design. **8hrs**

Practicals: 1 credit - 32hrs

1) Protein sequence from Uniprot database.
2) Analyzing the protein sequence in EMBOSS,
3) Analyzing the protein sequence Fasta, Blast, Clustal W.
4) Analysing the sequence against Prosite and Prodom database
5) Use of Expasy, SWISS-model
6) Use of Rasmol, DS wewer
8) Autodock, Online Docking software

9) Other rlevant softwares (specify during practicals)

References

1. Cohen N. C. 1996. Guidebook on Molecular Modeling in Drug. Design. Academic Press.
2. Brandon C., ToozeJ. 1998. Introduction toProtein Structur**e.** Garland Science Publishing.
3. Creighton T EProteins. 1983.Structures and Molecular Properties. Freeman, New York

MBI130 - Cancer biology – 2 Credits 32 hrs

UNIT I

Cancer Biology: The Basics

Introduction, historical perspective, classification, Carcinogenesis, cancer initiation, promotion and progression, Cancer cell cycles, Genomic instability, Apoptosis, Genes and proteins as players in apoptosis, DNA viruses/ cell immortalization.

Assays to detect Apoptosis; TUNEL assay(DNA fragmentation),

UNIT II

Cancer Genes I: Oncogenes and signal transduction

Cellular proto-oncogenes, oncogene activation, Growth factors, growth factor receptors, signal transduction , Transcription, Transcription factors and cancer, Retroviral oncogenes, Tumor suppressor, Tumor suppressor gene pathways, DNA methylation, epigenetic silencing of suppressor genes.

UNIT III

Understanding Cancer as a Disease: natural history of cancer development

Free radicals, antioxidants and Metabolic oxidative stress and cancer, Epidemiology of selected cancers, Gene rearrangements, detecting oncogene abnormalities in clinical specimens, Cell: cell interactions, cell adhesion, angiogenesis, invasion and metastasis, Antiangiogenic therapy of cancer.

UNIT IV

Current concepts in cancer therapy

Strategies of anticancer chemotherapy, Strategies of anticancer gene therapy/translating therapies from the laboratory to the clinic, Gene discovery in cancer research, cancer genome anatomy project , Cancer immunity and strategies of anticancer immunotherapy, stem cells and their applications in cancer therapy.

Strategies of anticancer chemotherapy, Strategies of anticancer gene therapy/translating therapies from the laboratory to the clinic, Gene discovery in cancer research, cancer genome anatomy project , Cancer immunity and strategies of anticancer immunotherapy, stem cells and their applications in cancer therapy.

References:

Weinberg,RobertA. 2014. The Biology of Cancer, Second Edition.NewYork: Garland Science,.

MBI140- MOLECULAR MECHANISM OF GENE EXPRESSION-II
- THEORY-3 CREDITS -48 Hrs

Tutorials 1 Credit – 32 hours

UNIT 1 and II

Fine structure of the prokaryotic and eukaryotic gene overview **2 hrs**

Regulation of Gene Expression in Prokaryotic: Operon model- Lac operon, structure and regulation (operator 1, 2, 3, and CAP protein). Galactose Operon –Role of two promoters, Arabinose operon –Positive –control, tryptophan operon –attenuation control. **8 hrs**

Regulation of gene expression at the level of DNA structure: Super coiling, DNA methylation, role of nucleosome structure of eukaryotic DNA in gene expression –e.g. Glucocorticoid gene, DNA kinking, bending and gene regulation. **8 hrs**

Regulation at the Level of Transcription: Transcription factors, TF II, NFkB, Regulation of NFkB and its activation. Formation of initiation complex, role of cis acting regulatory sequence-enhancer, mediators, activators & silencers in regulation. Regulation at chromatin level (acetylation & phosphorylation), **Histone code hypothesis,** SWI/SNF. Role of HAT and HDAC, regulation of transcription by non-coding RNA (gene silencing).

DNA Binding Protein Motifs: Zinc finger, Leucine Zipper, Helix-Turn- Helix and helix- loop-helix and other motifs. **12 hrs**

Regulation at the level of RNA processingand export: RNA export arid RNA stability. Regulation at level of processing (splicing). Factors affecting RNA stability and RNA degradation. **4hrs**

Regulation at the Level of Translation: Secondary structure in the 5' and 3' untranslated region –e.g. Regulation of Feretin and Transferin mRNA. Role of upstream AUG codons. (Eg. GCN 4 gene regulation), transplicing and translational introns (inteins), protein splicing. **8 hrs**

Role of aminoacyl tRNA synthetase in the regulation of accuracy of translation –proof reading mechanism. Ribosomal optimization of translation. Regulation at the level of ribosome assembly. **6hrs**

References

1. Kornberg A., Tania A B. DNA replication. University Science books.

2. Harvy F. Lodish (Editor) Arnold Berk, Paul Matsudaira, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, S. Lawrence Zipursky, James Darnell: Authors. Molecular Cell Biology. W. H. Freeman and Co., Publishers

3. Alberts, B., Bray, D., Lewis, J., Raff, M, Roberts, K, and Watson, J. D. 1983. Molecular biology of cell. Garland Publishing Inc., New York.

4. Freifelder D. Molecular Biology. A Comprehensive Introduction to Prokaryotes and Eukaryotes. Jones and Bartlett, USA.

5. Watson J.D., Tooze J., Kurtz D.T. Recombinant DNA: A Short Course. Scientific American Book, W.A.Preemon.

6. Maniatis, Fritsch E.F., Sambrook J. 1982. Molecular cloning: Laboratory Manual. Cold Spring Harber Laboratory, New York.

7. Ayala A.J., Castra. W. 1984. Modern Genetics. 2nd Edition, Geom Helns, London.
8. Walker J., Ed., Castra W. 1992.Techniques in Molecular Biology. Geom Helns, London.
9. Schecleif R.F., Wensik. P.C. 1991. Practical Methods in Molecular Biology
Springer Verlag.
10. Lewin B. 1994. Genes V. Oxford University Press.
11. Watson, J. D., T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losick. 2004. Molecular Biology of the Gene. 5th Edition. Pearson Education Pte. Ltd., New Delhi, India.
12. Voet D, Voet JG. Biochemistry. Ed. John Wiley & Sons. New York.

MBI150– MOLECULAR BIOLOGY LAB – 3 - 6 Credits 16x12= 192 hrs

- Southern blotting.
- Western blotting.
- PCR amplification of DNA.
- Isolation of RNA from various sources.
- Electrophoretic separation of RNA on denaturing gel.
- Recovery of DNA from agarose gel.
- Bacterial and yeast transformation.
- Cloning of amplified gene into expression vector
- Expression of His-tagged protein in *E.coli* BL-21.
- Purification of His-tagged protein by Ni-Affinity chromatography.
- Band shift assay.
- Detection of Genetically engineered plants.
- Immunological measurement of Growth factors in normal and tumor cells.
- Counting microvessel density in tumor tissues.
- Staining of normal and tumor cells for tumor suppersor gene p53.
- Methods to study apoptosis. Bcl to Bax ratio.
- Angiogenesis and antiangiogenesis assays.
- Plant tissue culture Media preperation.
- Callus culture.
- Somatic embryogenesis and synthetic seeds.
- Suspension culture.
- Meristem culture.
- Isolation of *Agrobacterium* and *Agrobacterium* mediated plant transformation.
- Hairy root culture

MBI 160 Elective -5 , Theory 2 Credits 32 hours

SEMESTER X

MBJ 110 Elective 6 (Self study) 02 Credits

MBJ 120 Project work 08 credits

Total Credits for 10 semesters is 200

Syllabus for Elective Papers

ELECTIVE PAPERS (One paper per semester from 5th Semester onwards) - 2 credits (32 hours of teaching)

Industrial Biotechnology I
Industrial biotechnology II
Cell and tissue culture technology
Human nutrition
Evolution and behaviour
Ethology
Clinical Biochemistry

INDUSTRIAL BIOTECHNOLOGY-I

Biotechnology of Fermentation, Biotransformation and Bioprocess Engineering

UNIT I

(a) Screening, detection and assay of fermentation products (physical, chemical and biological assay) and inoculation; stock culture.
(b)Strain development: mutant selection, recombination, metabolic regulation, gene technology and genetic methods.
(c) Use of substrate as C-source and N-source.
(d) Methods and types of fermentation; dual/multiple fermentation; continuous fermentation and late nutrient addition.
(e) Growth kinetics of microorganisms.

UNIT II

(a) Fermenter systems, Construction of fermentor and fermentation.
(b) Stirring and mixing (Reynolds number and Power number kinetics).
(c) Oxygen concentration and oxygen transfer, Scale up processes through power consumption/volume and O2 transfer rate.
(d) Methods of gas and nutrient sterilization, instrumentation, Monitoring.

(e) Product recovery and unit operations in product recovery yields, kinetics of product yield; Commercial and economic considerations and evaluations.
(f) Fermentation economics, market potential, fermentation and recovery costs.

UNIT III

(a) Organic feed stock production by fermentations; general methodology.
(b) Ethanol, acetone/ Butanol and glycerol fermentations.
(c) Vitamin production, B12, Riboflavin and L-carotene: occurrence, economic significance, biosynthesis, production process.
(d) Alkaloid fermentation, Ergot production through fermentation and regulation.
(e) Fermentation processes in dairy and other food products.
(f) Biotechnology of food and feed: fermented food products– toffu, kaffir, cheese, buttermilk, yogurt, sour cream etc.
(g) Feed production, SCP, fats, amino acid, food additives, dyes and colourants.

UNIT IV

Regulating the use of Biotechnology.
- Food and Feed Ingredients.
- Release of GMOs
- Human Gene Therapy – Concerns, Policy and Future.
- Patenting Biotechnological inventions. Patents, patenting procedures for Technology, Microbes, Multicellular Organisms and Fundamental research.

INDUSTRIAL BIOTECHNOLOGY-II

UNIT I

Organisms, Cultures, Procedures of Fermentation Penicillins, β Lactams, Cyclosporine and their derivatives, Streptomycin, Erythromycin, Gentamycin, Tetracyclines.
Biotechnology of Antibiotic production:-
Cloning of Antibiotic- Biosynthesis genes by Complementation and other methods.
Synthesis of Novel Antibiotics. Improving Antibiotic productions.
Organic acids- Acetic acid, Lactic acid, Gluconic acid and Citric acid. Amino acid: Glutamic acid, Tryptophan, Phenylalanine

UNIT II

Biotechnological advances in Organic and Amino acid production (via recombinant DNA technology especially L-ascorbic acid (Vit. C) Glutamic acid and Tryptophan.
Bacterial and Fungal Cellulase, Amylases, Lipases, Proteases, Lysozyme, L-lactamases.
Biotechnological advance in production of Cellulase, Amylases, Lipases and Proteases. Engineered enzymes (Adding and reducing disulfide bonds, changing sour amino acids, Asparagine, Glutamine) to other Amino acids, increasing Enzyme Activity modifying enzyme specificity

UNIT III

Alcohols and Alcoholic beverages- Microbes and Biotechnology of Alcoholic Fermentation.

UNIT IV

Immobilization of Enzymes and Cells, Techniques and Applications with special reference to Matrices and Methods of Immobilization.

Transformation - Steroids, Alkaloids and Polysaccharides. Recent advances – in Biotransformation (Indigo, Xanthan, Melanin, Adhesive protein Biopolymer (Byssal adhesive, Rubber polymerase).

CELL AND TISSUE CULTURE TECHNOLOGY

UNIT I

Part A: Plant Cell and tissue culture Technology

Plant Cell and tissue culture Technology Landmarks, history and Developments in Plant Cell culture and different areas of Applications in Plant tissue culture.

Laboratory organization and culture techniques, general requirements, aseptic conditions, media preperation, culture media Role of hormones in growth and development of plants, tissue-specific hormones, sterlization, pre-treatment of ex-plants. Problems and solutions associated with tissue culture.

Principles of Tissue culture: callus culture- definition of callus, initiation, maintenance, subculture and organogenesis.

Organ culture: culture protocols and importance of root, meristem, ovary and ovule culture, factors affecting organogenesis. Cytodifferentiation, dedifferentiation and factors affecting them.

UNIT II

Micropropagation: methods, micropropagation from pre-existing meristem, shoot apical meristem, shoot and node culture, micropropagation stages and applications, somaclonal variation for disease resistance and desired agronomic traits.

Somatic embryogenesis: Embryoid and embryogenesis Induction and development, synthetic seeds. Applications of somatic embryogenesis.

Haploid Production: Techniques and methods of haploid culture, Factors affecting anther and microspore cultures, factors affecting androgenesis, applications and limitations

Protoplast Technology: Isolation, purification and culture of protoplasts, protoplast fusion and somatic hybridization, regeneration of plants. Applications of somatic hybrids/cybrids.

Secondary metabolite production: Induction of secondary metabolites by plant cell culture, technology of plant cell culture for production of chemicals, biotransformation using plant cell culture. Bioreactor systems and models for mass cultivation of plant cells.

UNIT III

Part B: Animal Cell Culture Technology

Tissue culture laboratory: Advantages and limitations of tissue culture, types of tissue culture, equipment, aseptic and sterile handling, general safety, choice of culture vessel, media, preparation and sterilization of media, facilities required, serum free media.

- Primary culture: Isolation of mouse and chick embryos, human biopsies, methods for primary culture, nomenclature of cell lines, sub culture and propagation, immortalization of cell lines, cell line designation, selection of cell line and routine maintenance cell lines, cloning and selection, contamination management, cryopreservation, quantitation of cells, cytotoxicity assays.
- Specialized Cells: different cell types used, development of cell lines,selective culture, specific tumor types.
- Cloning and Selection: Cloning protocol, stimulation of plating efficiency, suspension cloning, isolation of clones, isolation of genetic variants, interaction with substrate, selective inhibitors.

I. Cell separation and characterization: Density based, antibody based, magnetic and fluorescence based cell sorting. Characterization of cells based in morphology, chromosome analysis, DNA content, RNA and protein, enzyme activity, antigenic markers, cytotoxicity assays, cell quantitation, cell culture contamination: monitoring and eradication, cryopreservation.

Culturing of specialized cells: Epithelial, mesenchymal, neuro ectodermal, hematopoietic gonad and tumor cells, Lympocyte preparation, culture of amniocytes, fish cells, confocal microscopy. Stem cell culture and its applications

Organ and embryo culture: Choice of models, organ culture, histotypic culture, filter-well inserts, neuronal aggregates whole embryo culture eggs, chick and mammalian embryos.

Cell and Tissue engineering: Growth factors for in situ tissue regeneration, biomaterials in tissue engineering, approaches for tissue engineering of skin, bone grafts, nerve grafts. Haemoglobin-based blood substitutes, bio artificial or biohybrid organs. Limitations and possibilities of tissue engineering.

HUMAN NUTRITION

UNIT I

Introduction to Nutrition: Nutrition, Foods and Health

Food Groups: Fruits & vegetables, legumes, grains and nuts & seeds, meat, poultry, eggs, dairy products, sea foods.

Carbohydrates, Lipids and Proteins: Classification, Functions, dietary sources, digestion and absorption and deficiency diseases, role of omega fatty acids, trans-fats

UNIT II

Dietary fibres: types, sources, and their role in human healthglycemic response and glycemic index of Foods

Water metabolism: Factors affecting water metabolism, distribution of water, Hormonal influence on water metabolism.

Functional foods: Pre and Probiotics in health promotion and disease prevention

UNIT III

Minerals: Classification, sources, dietary requirements, biological availability,storage in human body, deficiency diseases, mineral toxicity, functions, Brief introduction on symptoms of obesity, cardiovascular diseases and diabetes

Public Health: Prevention of obesity: lifestyle modification, diet and physical activity

UNIT IV

Nutrition Recommendations (NR): Food guide pyramids,NR for the general population, NR for Subjects with Cardiovascular Disease, Medical Nutrition Therapy in the Treatment of Type 1 and Type 2 Diabetes

Vitamins: Types, functions, Dietary sources and deficiency diseases, Nutritional supplements.

EVOLUTION AND BEHAVIOUR

UNIT I

Emergence of evolutionary thoughts:

Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; Spontaneity of mutations; The evolutionary synthesis.

Origin of cells and unicellular evolution:

Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiement of Miller (1953); The first cell;Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism.

UNIT II

Paleontology and Evolutionary History:

The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multi cellular organisms; Major groups of plants and animals; Stages in primate evolution including *Homo sapiens*

UNIT III

Molecular Evolution:

Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; origin of new genes and proteins; Gene duplication and divergence.

UNIT IV

Brain, Behavior and Evolution:

Approaches and methods in study of behavior; Proximate and ultimate causation; Altruism and evolution- Group selection, Kin selection, Reciprocal altruism; Neural basis of learning, memory, cognition, sleep and arousal; Biological clocks; Development of behavior; Social communication; Social dominance; Use of space and territoriality; Mating systems, Parental investment and Reproductive success; Parental care; Aggressive behavior; Habitat selection and optimality in foraging; Migration, orientation and navigation; Domestication and behavioral changes.

ETHOLOGY

UNIT I

Introduction-historical background. Approaches to the study of behaviour, patterns ofbehaviour - Ethogram.

Reflex and complex behaviors; latency, after discharge, summation, warm up, fatigue, inhibition, feedback regulation.

Instinctive behavior: Fixed action pattern, sign stimuli and releasers as triggers.

Types of sign stimuli. Biochemical basis of instinctive behavior.

UNIT II

Learning: Definition, categories of learning, habituation, classical conditioning, latent learning, insight learning, learning sets, social learning, play.

Development of behavior: Causes of behavioural changes during development. Role of genes and environment in the development of bird song. Concept of critical period. Filial imprinting. Sexual imprinting in birds. Imprinting-like process in mammal.

UNIT III

Memory: sensory memory (short term memory), long term memory, loss of memory,drugsand memory.

Foraging: feeding strategies (herbivory, carnivory). Modes of hunting, food selection,anti-predatory behavior.

Biological communications: nature and function. Forms of signals -vision, audition,chemical. Pheromones in insects and mammals (Lee Boot effect, Whitten effect, Bruce effect, Coolidge effect, Castro Vandenbergh effect). Electro receptors.

UNIT IV

Sexual behaviour-, seasonality, courtship signals, physiological status, courtship as conflict behaviour. Hormones and sexual behaviour. Selected examples of courtship and mating. Social organization- advantages. Social organization with special reference to sub human primates and honey bees. Altruism. Biological clocks types of rhythms advantages and examples.

CLINICAL BIOCHEMISTRYUNIT I and II

UNIT I

Concept of health & diseases. Communicable, non-communicable diseases. Metabolic diseases & deficiency 2 hrs

Enzymes in clinical diagnosis 2 hrs

Diabetes - Etiology, classification, diagnosis, treatment strategies. Complications, Role of diet, life style in development and control of diabetes, Role of exercise, obesity and role of fat. 6 hrs

Cardiovascular diseases: Types, etiology, risk factors, causative mechanism,diagnosis, lipid profile, cholesterol, atherosclerosis. Management, obesity, diet 6 hrs

UNIT II

Inflammation : Mechanism, mediators, anti-inflammatory drugs, Diabetes, Arthritis, CVD and Cancer as inflammatory diseases**.** 5 hrs

Obesity: Problems, Causes & Consequences BMI, treatment and strategies. 2 hrs

Jaundice: Types, Prehepatic, hepatic and post hepatic gaundice. Laboratory diagnosis, liver function tests 6 hrs

Disease management: Inborn errors: Carbohydrate, Protein and Lipid; molecular diseases; possible course of treatment and management. 3 hrs