

॥ अंतरी पेटवू ज्ञानज्योत ॥



**NORTH MAHARASHTRA UNIVERSITY,
JALGAON.**

Syllabus for M.Sc.(Part-I)

BIOCHEMISTRY.

(W.e.f. Acd.Yr. 2002 - 2003)

NORTH MAHARASHTRA UNIVERSITY, JALGAON.

Syllabus for M.Sc. (Part-I) BIOCHEMISTRY.

(W.e.f. Acad. Yr. 2002 - 2003)

STRUCTURE

Semester -- I

BC-101	:	Cell Biology and Bio-membranes
BC-102	:	Microbial Physiology
BC-103	:	Bioenergetics and Intermediary Metabolism
BC-104	:	Laboratory Course - I
BC-105	:	Laboratory Course - II

Semester -- II

BC-201	:	Advanced Enzymology
BC-202	:	Biotechniques
BC-203	:	Biostatistics and Plant Biochemistry
BC-204	:	Laboratory Course - I
BC-205	:	Laboratory Course - II

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BC-101 : Cell Biology and Biomembranes

Cell Biology :

- Cell classification : Cell variability (size, shape, complexity, functions).
- Structural organisation of prokaryotic and eukaryotic cells. Ultra structure of nucleus, mitochondria, endoplasmic reticulum (rough and smooth), Golgi apparatus, lysosomes and peroxisomes and their functions.
- The cytoskeleton -- microtubules and microfilaments.
- Types of tissues, epithelium - types, epithelial apices - glycocalyx, microvilli. The basement membrane - structural features and characteristics. The extra-cellular matrix-collagen, elastin, fibrillin, fibronectin, laminin and proteoglycans.
- Plant and animal cells : variation in structure and function.
- Cell differentiation - organogenesis, morphological, functional and biochemical maturation of tissues.
- Biochemistry of cancer - carcinogenesis, characteristics of cancer cell, agents promoting carcinogenesis.

Bio-membranes :

- Biological membranes and transport.
- Physicochemical properties of cell membranes, molecular constituents of membranes - up a molecular architecture of membranes - asymmetrical organisation of lipids and proteins.
- Solute transport across membranes : Fick's law, Types of transport - simple diffusion, passive - facilitated diffusion.
- Active transport - primary & secondary group translocation.
- Transport ATPases
- Molecular models of transport mechanism - Mobile carrier and pores mechanisms.
- Transport by vesicle formation : Endocytosis, exocytosis
- Intracellular communication through junctions : gap junction, tight junction, desmosome.

Books and References

1. Molecular Biology of the Cells (3rd edn 1994) -- Alberts *et al.*, Garland Publications Inc. NY and London.
2. Cell Biology (1993) -- E.S. Sadava, Jones and Bartlett Publishers Boston, London.
3. Cell and Molecular Biology (8th edn. 2001) - E.D.P. de Robertis & E.M.F. deRobertis (ed) Lippincott Williams & Wilkins, Philadelphia.
4. Principles of Cell Biology (1988) - Klein Smith and M. Kish, Harper-Collins Pub. Inc. New Delhi.
5. Biochemistry - Lubert Stryer, Freeman & Co., NY.
6. Principles of Biochemistry - Smith, Lehman, Lefkowitz, Hadler and Smith.
7. Lehninger's Principles of Biochemistry - D.L. Nelson and M.M. Cox, Macmillan/Worth Pub Inc., NY
8. Biochemistry of Plants - G. F. X. Dieckmann, Academic Press, New York, 1970.

BC-102 : Microbial Physiology

- **Methods in Microbiology** : Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganism.
- **Microbial Systematics and Taxonomy** : New approaches to bacterial taxonomy classification including ribotyping; Ribosomal RNA sequencing; Characteristics of primary domains; Taxonomy, Nomenclature and Bergey's Manual.
- **Microbial Growth** : The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture; Growth as affected by environmental factors like temperature, acidity, alkalinity, water availability and oxygen; Culture collection and maintenance of cultures.
- **Prokaryotic Diversity** : a) Bacteria : Purple and green bacteria; Cyanobacteria; Homoacetogenic bacteria; Acetic acid bacteria; Budding and appendaged bacteria; Spirilla, Spirochetes; Gliding and sheathed bacteria; Pseudomonads; Lactic and propionic acid bacteria; Endospore forming rods and cocci; Mycobacteria; Rickettsias, Chlamydias and Mycoplasmas.
b) Archaea : Archaea as earliest Life forms; alophiles; Methanogens; Hyperthermophilic archaea; Thermoplasma.
c) Eukarya : Algae, Fungi, Slime molds and Protozoa.
d) Viruses : Bacterial, Plant, Animal and Tumor viruses; Discovery, classification and structure of viruses; Lysogeny; DNA viruses; Positive strand, Negative strand and double stranded RNA viruses; Replication; Examples of Herpes, Pox, Adenoviruses, Retroviruses, Viroids and Prions.
- **Microbial Diseases** : Disease reservoirs; Epidemiological terminologies; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (rabies, plague), insects and ticks (Rickettsias, Lyme disease, Malaria), Food and water borne disease; Public health and water quality; Pathogenic fungi; Emerging and resistant infectious diseases.
- **Host-Parasite Relationships** : Normal microflora of skin, oral cavity, Gastrointestinal tract; Entry of pathogens into the host; Colonization and factors predisposing to infections; Types of toxins (Exo-, Endo-, Entero-) and their structure; Mode of actions; Virulence and Pathogenesis.
- **Prokaryotic Cells** : Structure-function - Cell walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of Gram-negative bacteria; Flagella and motility; Cell inclusions like endospores, gas vesicles.
- **Chemotherapy/Antibiotics** : Antimicrobial agents; Sulfa drugs; antibiotics; Penicillins and Cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Books and References

1. General Microbiology, Stainer, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter, P.R. The MacMillan Press Ltd.
2. Bacteriology of Microorganisms, Madigan, M.T., Martinko, J.M. and Parker, J. Prentice-Hall.
3. Microbiology, Pelczar, M.J. Jr., Chan, E.C.S. and Kreig, N.R., Tata McGraw Hill.
4. Microbial Genetics, Maloy, S.R., Cronan, J.E., Jr. and Freifelder, D. Jones, Bartlett Publishers.
5. Basic Experimental Microbiology, Ronald M. Atlas, Alfred F. Brown, Kenneth W. Doornik, Leonard Miller, (1986) Prentice Hall.
6. General Microbiology, Robert F. Boyd (1984) Times Mirror/

BC-103 : Bioenergetics and Intermediary Metabolism

- **Bioenergetics** : Energy transformation, Laws of thermodynamics, entropy, enthalpy, Gibbs energy, free energy changes and redox potentials, Phosphate potential, Uniport, antiport and symport mechanisms, shuttle systems.
- **The mitochondrial respiratory chain**, order and organization of carriers, proton gradient, iron sulphur proteins, cytochromes and their characterization. The Q cycle and the stoichiometry of proton extrusion and uptake; P/O and H/P ratios. Reversed electron transfer, respiratory controls and oxidative phosphorylation, uncouplers and inhibitors of energy transfer. Fractionation and reconstitution of respiratory chain complexes.
- **ATP - Synthetase complex**, Microsomal electron transport, partial reduction of oxygen, super-oxides.
- **Intermediary metabolism** : Approaches for studying metabolism.
- **Carbohydrates** : Glycolysis, citric acid cycle its function in energy generation and biosynthesis of energy rich bonds, pentose phosphate pathway and its regulation. Alternate pathways of carbohydrate metabolism.
Gluconeogenesis, interconversions of sugars.
Biosynthesis of glycogen, starch and oligosaccharides.
Regulation of blood glucose homeostasis.
Hormonal regulation of carbohydrate metabolism.
- **Lipid** : Fatty acid biosynthesis : Acetyl CoA carboxylase, Fatty acid synthase, desaturase and elongase. Fatty acid oxidation : α , β , ω oxidation and lipoxidation. Lipid Biosynthesis : Biosynthesis of triacylglycerols, phosphoglycerides. Ketone bodies : Formation and utilization. Metabolism of circulating lipids : chylomicrons, LDL, HDL and VLDL. Free fatty acids. Lipid levels in pathological conditions.
- **Amino Acids** : Biosynthesis and degradation of amino acids and their regulation. Specific aspects of amino acid metabolism. Urea cycle and its regulation. Inborn errors of amino acid metabolism.
- **Nucleic Acids** : Biosynthesis of purines and pyrimidines, Regulation of purine and pyrimidine biosynthesis, Degradation of purines and pyrimidines, Structure and regulation of ribonucleotide reductase, Biosynthesis of ribonucleotides, deoxyribonucleotides and polynucleotides, Inhibitors of nucleic acid biosynthesis.

Books and References

1. Lehninger's Principles of Biochemistry (2000) Third Edition by D.L. Nelson and M.M. Cox, Macmillan Worth Pub. Inc. N.Y.
2. Biochemistry (1992) Fourth Edition by Lubert Stryer, W.H. Freeman and Co., N.Y.
3. Harper's Biochemistry, 25th Edition by R.K. Murray & Others, Appleton and Lange, Stanford.

BC-104 : Laboratory Course - I

- Microscopy : Bright field, Phase contrast.
- Microtony - taking a suitable example (Floral bud/animal tissue)
- Sub cellular fractionation.
- Histochemical techniques - (detection of protein, mucopolysaccharide, nucleic acid and lipids).
- Stages of Mitotic division by Squash method.
- Meiotic cell division (onion buds).
- Extraction of lipids from tissues and their estimation by TLC.
- Concept of buffers, pH, molarity and normality.
- Colorimetric determination of pKa.
- Titration of amino acid.
- Estimation of protein by Lowry's method.
- Estimation of inorganic phosphate.

Books and References

1. Experiments on Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation. (11th edn., 1996), Aneja, K.R. Wishwa Prakashan (New Age International (P) Ltd.)
2. An introduction to practical Biochemistry. Plummer, D., Tata McGraw Hill Publisher.
3. Laboratory manual in Biochemistry. Jayaraman, J., New Age International Publisher.
4. Staining methods - Histological and Histo-chemical. McManus & Moroy, R.W.
5. Guide to practical Histochemistry, Chayer, J., Eitensky, L., Butcher, R. & Poulter, J.A.

BC-105 : Laboratory Course - II

- Preparation of liquid media for growth of microorganisms.
- Preparation of solid media for growth of microorganisms.
- Isolation and maintenance of organisms by plating, streaking and serial dilution methods.
- Storage of microorganisms : Slants and stab cultures
- Isolation of pure cultures from soil and water.
- Growth : Growth curve; Measurement of bacterial population by turbidometry and serial dilution methods.
- Effect of temperature, pH and carbon and nitrogen sources on bacterial growth.
- Microscopic examination of bacteria, yeast and molds.
- Study of micro-organisms by Gram stain, Acid fast stain and staining for spores.
- Assay of antibiotics and demonstration of antibiotic resistance.
- Analysis of water for potability and determination of MPN.
- Biochemical characterization of selected microbes.

Books and References

1. Microbiology - a Laboratory Manual, Cappuccino, J.G. and Sherman, N. Addison Wesley
2. Microbiological Applications, (A Laboratory Manual in General Microbiology) Benson, H.J., WCB:Wm C. Brown Publishers.
3. Bacteriological Techniques, F.J. Baker
4. Introduction to Microbial techniques, Gnanasekaran.
5. Experiments on Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation. (Ind edn., 1996), Aneja, K.R. Vishwa Prakashan (New Age International (P) Ltd.).

BC -201 : Advanced Enzymology

- Review of unisubstrate enzyme kinetics and factors affecting the rates of enzyme catalyzed reactions. Michaelis pH functions and their significance.
- Classification of multisubstrate reactions with examples of each class. Kinetics of multisubstrate reactions. Derivation of the rate of expression for Ping Pong and ordered Bi Bi reaction mechanism. Use of initial velocity, inhibition and exchange studies to differentiate between multisubstrate reaction mechanisms.
- Methods of examining enzyme-substrate complexes.
- Methods for measuring kinetic and rate constants of enzymic reactions and their magnitudes.
- Enzymes Turnover and methods employed to measure Turnover of enzymes. Significance of Enzymes Turnover.
- Allosteric enzymes, Sigmoidal kinetics and their physiological significance. Symmetric and sequential modes for action of allosteric enzymes and their significance.
- Immobilized enzymes and their industrial application.
- Multienzyme system : Occurrence, isolation and their properties. Polygenic nature of multienzyme systems. Mechanism of action and regulation of pyruvate dehydrogenase and fatty acid synthetase complexes. Immobilized Multienzyme Systems and their applications.
- Co-enzymes and cofactors : Water soluble vitamins and their coenzymes. Metallo enzymes.
- Detailed Mechanisms of Catalysis of serine protease; Ribonuclease Chymotrypsin.
- Enzyme regulation : General mechanisms of enzyme regulation : Feed Back Inhibition and Feed forward stimulation; Enzyme repression, induction and degradation, control of enzymic activity by products and substrates; Reversible and irreversible covalent modifications of enzymes; Mono-cyclic and multi-cyclic cascade systems with specific examples.

Books and References

1. Enzymes. Dixon, M., Webb, E.C., Throne, C.J.R. and Tipton, K.F. Academic Press, New York.
2. Fundamentals of Enzymology. Nicholas, C., Price and Stevens, L. Oxford University Press, New York.
3. Lehningers' Principles of Biochemistry (2000) 10th Edition by D.L. Nelson and M.M. Cox. Macmillan Worth Pub. Inc. N.Y.
4. Biochemistry (1992) 4th Edition by Lubert Stryer, W.H. Freeman and Co., N.Y.

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BC - 202 : Biotechniques

- Principles of buffer and pH metry (calculation of molarity).
- Chromatographs : adsorption, paper (PC), thin layer (TLC), ion exchange, high pressure (HPLC), gas liquid (GLC) and affinity chromatography.
- Application of each chromatography technique in Biological Sciences
- Principles (Beer's law), methodology and applications of UV and visible spectroscopy (colorimetry and spectrophotometry).
- Colorimetry with respect to determination of reducing sugars, proteins and phosphate.
- Dialysis and electro dialysis, filtration and ultrafiltration. factors governing the choice of membranes.
- Electrophoresis, principles, types, parameters affecting electrophoretic separation, gradient electrophoresis and iso-electrofocussing, peptide mapping.
- Principles of microscopy, transmission electron microscopy (TEM), scanning electron microscopy (SEM).
- Principles and applications of lyophilization and Laminar air flow benches.
- Principles and applications of centrifugation to biological systems. basket centrifugation, density gradient centrifugation.
- Principles and Applications of IR, NMR, atomic absorption spectroscopy, X-ray diffraction techniques.

Books and References

1. Physical Biochemistry (11th edn 1983), D. Friefolder, WH Freeman & Co., USA.
2. Analytical Biochemistry, D. Holmes and H. Peck.
3. Physical Biochemistry (11th edn. 1985), VanHolds K.E., Prentice Hall Inc., New Jersey.
4. Biophysical Chemistry, Upadhye, Upadhye and Nath, Himalaya Publishers, Nagpur.
5. A Biologists' Guide to Principles and Techniques of Practical Biochemistry. Wilson, K. and Gouling K.H., ELBS edition.

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BC - 203 : Biostatistics and Plant Biochemistry

A : Biostatistics

- Principles and practices of statistical methods in biological research.
- Samples and population.
- Basic statistics - averages, statistics of dispersion, coefficient of variation.
- Standard error.
- Confidence limits.
- Probability distributions (Binomial, Poisson and Normal).
- Tests of statistical significance.
- Simple correlation of regression.
- Analysis of variance.
- Examples of the above for clarity of concepts.

Books and References

1. S. C. Gupta : Fundamentals of Statistics, Himalaya Publishing House, New Delhi.
2. Khan : Biostatistics, Tata McGraw Hill Publishers.
3. Daniel W.W. (7th edn, 1999). Biostatistics - A foundation for analysis in the health. John Wiley and Sons Inc., New York.

B : Plant Biochemistry

- Photosynthesis - structure of organelles involved in photosynthesis in plants and bacteria. Proton gradients and electron transfer in chloroplasts of plants and in purple bacteria - differences from mitochondria. Light receptors - chlorophyll, light harvesting complexes, bacteriorhodopsin, rhodopsin as ion pump.
- Photosystems I and II, their location, mechanism of quantum capture and energy transfer between photosystems - ferredoxin, plastocyanin, plastoquinone, carotenoids.
- The Hill reaction, photophosphorylation and reduction of CO₂.
- C₃, C₄ and CAM metabolism, light and dark reactions. Light activation of enzymes, regulation of photosynthesis. Photorespiration.
- Nitrogen cycle, nitrogenase and nitrate reductase, symbiotic and nonsymbiotic nitrogen fixation.
- Plant hormones - Growth regulating substances and their mode of action. Molecular effects of auxin in regulation of cell extension and of gibberellin, abscisic acids and cytokinins in the regulation of seed dormancy, germination, growth and development, and embryogenesis.
- Secondary metabolites - Types (Phenolic acids, tannins, lignin, terpenes, terpenoids, alkaloids & flavonoids), physiological function and applications.
- Fertilizers and biofertilizers. Role of phosphate solubilizing microbes and mycorrhizae.

Books and References

1. Mohamud Pe Sarakle (ed.), Handbook of Photosynthesis, Marcel Dekkar, Inc. NY, Basel, Hong Kong 1997.
2. Goodwin, T.W. and Mercer, E.I. (1983). Introduction to plant biochemistry. Pergamon Press, Oxford, NY, Toronto, Sydney, Paris, Frankfurt.
3. Blackie Dennis D.T. (1987). Biochemistry of energy utilization in plants. Glasgow and London.
4. Dey, P.M. and Hartorne, J.B. Plant Biochemistry. Harcourt Asia PTE Ltd., Singapore.
5. Tandon, K.L. Fertilizers.
6. Varma, A. and Bock, H. Mycorrhizae.
7. Devlin and Wadham. Plant Physiology. CBS New Delhi.

BC - 204 : Laboratory Course - I

- Purification of a typical enzyme (β amylase)
- Effect of pH, temperature, activators and inhibitors on enzyme activity.
- Determination of specific activity and turn over number of salivary amylase.
- Determination of K_m and V_{max} of amylase by double reciprocal plot.
- Immobilization of a typical enzyme.
- Stabilization of an enzyme as a function of temperature and storage duration.
- Estimation of nitrogen by Kjeldahl method.
- Spectral characteristics and estimation of chlorophylls.
- Determination of PS II activity.
- Bioefficacy of biofertilizer

Books and References

1. Phimmer, D. An introduction to practical biochemistry. Tata McGraw Hill Publishers.
2. Jayaraman, J. A laboratory manual in biochemistry. New Age International Publishers.
3. Sasivan, S. and Manikam, K. Methods in agricultural biochemistry. Wiley Eastern Ltd., New Delhi.

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BC - 205 : Laboratory Course-II

A : Biotechniques

- Separation of amino acids by paper chromatography.
- Paper electrophoresis.
- Agarose gel electrophoresis.
- Polyacrylamide gel electrophoresis.
- Separation of blue dextran by gel filtration.
- Verification of Beers law and determination of λ -max. Absorption spectra.
- Demonstration - Lyophilizer/GC/HPLC/AA3.
- Carbohydrate separation by TLC.

B : Computer Applications

- Computer peripherals & hardware description : Computer system design, Recognition and spectrum of different components of a computer system and their respective usage I/O and storage devices.
- Operating systems : System and application software, CUI & GUI, DOS, Latest available window, multitasking.
- Introduction of digital computers : Organization, low level and high level languages, binary number system.
- Flow charts and programming techniques.
- Introduction to programming in Turbo Basic ; and C, writing few programmes in basic & C.
- Introduction to data structures and database concepts, introduction to Internet and its applications.
- Introduction to MS-Office software, covering words processing, spreadsheets and presentation software.
- Introduction to sequence analysis software.

Books and References

1. Fielding, A. Computing for biologists.
2. Wood, E.I. Microcomputers in Biochemical Education.
3. Jayaraman, J. A laboratory manual in Biochemistry, New Age International Publishers, New Delhi.
4. Sadashivan, S. and Marikam, K. Methods in Agricultural Biochemistry, Wiley Eastern Ltd., New Delhi.

Note: Each theory course is to be completed in 50 lectures of 60 min duration each in one semester.

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