

10/10/19

NORTH MALABAR STATE UNIVERSITY
KALGAGON - 425 001

20/10/19

FOR

MR. J. K. S. S. S. S. S. S.

10/10/19

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COURSE STRUCTURE
M.Sc. BIOTECHNOLOGY SYLLABUS

Semester I

THEORY

COURSE NO.	COURSE TITLE	TOTAL LECTURE
BT 101A	BIOCHEMISTRY UNIT-I	25
BT 101B	BASIC MICROBIOLOGY	25
BT 102A	BIOPHYSICAL CHEMISTRY	25
BT 102B	STATISTICS	25
BT 103	CELL AND DEVELOPMENTAL BIOLOGY	50

PRACTICALS

BT 104	PRACTICAL COURSE - I (BIOCHEMISTRY & MICROBIOLOGY)	
BT 105	PRACTICAL COURSE - II (CELL AND DEVELOPMENTAL BIOLOGY & STATISTICS)	

SEMESTER II

THEORY

BT 201	BIOPHYSICAL AND BIOCHEMICAL TECHNIQUES	50
BT 202	MOLECULAR BIOLOGY AND GENETICS	50
BT 203A	BIO-MATHEMATICS	25
BT 203B	COMPUTER PROGRAMMING	25

PRACTICAL

BT 204	PRACTICAL COURSE - I (MICROBIOLOGY & BIOCHEMICAL TECHNIQUE)	
BT 205	PRACTICAL COURSE - II (BIOMATHEMATICS, AND COMPUTER PROGRAMMING)	

SEMESTER = III

THEORY

BT 301	:	FUNDAMENTALS OF TISSUE CULTURE A) PLANT TISSUE CULTURE TECHNIQUES B) ANIMAL CELL AND TISSUE CULTURE	50
BT 302A	:	RECOMBINANT DNA TECHNOLOGY.	25
BT 302B	:	RECENT ADVANCES IN MOLECULAR BIOLOGY.	25
BT 303A	:	BIO-ORGANIC CHEMISTRY	25
BT 303B	:	BIO-CHEMISTRY UNIT II	25

PRACTICALS

BT 304	:	PRACTICAL COURSE - I (RECOMBINANT & DNA TECHNOLOGY)	
BT 305	:	PRACTICAL COURSE - II (PLANT CELL TISSUE CULTURE & BIO-ORGANIC CHEMISTRY)	

SEMESTER = IV

THEORY

BT 401	:	MICROBIAL BIOTECHNOLOGY	50
BT 402A	:	PLANT PHYSIOLOGY AND PHYTOCHEMISTRY	25
BT 402B	:	APPLICATIONS OF TISSUE CULTURE IN AGRICULTURE AND BIOTECHNOLOGY.	25
BT 403	:	BIOCHEMICAL PROCESSES AND BIOTECHNOLOGY.	50

PRACTICALS

BT 404	:	PRACTICAL COURSE - I : DISSERTATION	
BT 405	:	PRACTICAL COURSE II	

BIOTECHNOLOGY SYLLABUS, SEMESTER I

BT 101A : BIOCHEMISTRY UNIT-I

Biomolecules : Chemistry and properties of aminoacids, Carbohydrate, lipide, and Vitamins.

Proteins : Primary, Secondary tertiary and quaternary structure, Methods for isolation and characterization.

Nucleic acid : Chemistry and structure.

Fat metabolism : β oxidation of fatty acids, synthesis of fatty acids (fatty acid synthesis complex system) Ketone bodies.

Carbohydrate metabolism : Glycolysis, glycogenolysis, glycogenesis and gluconeogenesis and their regulation, citric acid cycle.

Amino acid metabolism: Oxidative degradation and synthesis of amino acids

- Books :
- 1) A.L. Lehninger, Biochemistry (3rd Edition) Kalpana Publishers, Ludhiana.
 - 2) Biochemistry, Geoffrey Zubay Addison-Wesley Publishing Company, 1983.
 - 3) Biochemistry, Lubert Stryer, W.H. Freeman & Co., San Francisco, 1981.

BT 101B : BASIC MICROBIOLOGY

1. Characterization and classification of microorganisms
2. Cell wall structure of peptidoglycan and other cell wall components.
3. Cultivation of Bacteria, nutrition, physiology and growth of microbial cells.
4. Reproduction and growth, synchronous growth, continuous culture of microorganisms.
5. Pure cultures and cultural characteristics
6. Fundamentals of control of microbial growth, control by physical agents, control by chemical agents.
7. Production of mutants by chemical and physical agents and their characterizations.
8. Host Microbe interactions, endotoxins, exotoxins, capsular material, Enzymatic and other factors, tissue affinity, resistance and immunity.

9. Viruses, bacterial, plant and animal cells, structure classification, life cycle, Mycoplasma and Prion.

REFERENCES BOOKS

1. Microbiology, M.S.Peterson, K.L. Tindal, K.L. Shan McGraw Hill (1986) New York.
2. General Microbiology (Fifth edition), W.Y. Starmer et al. Prentice Hall, (1988).
3. Biochemical Engineering, Asaba : A.E. Imhoff, Nancy E. Mills, University of Tokyo Press, (1978)
4. Introductory Microbiology, F.J. Ross, Charles Merrill Publication (1983).

BT 102A : BIOPHYSICAL CHEMISTRY

1. Macromolecular interactions - hydrogen bond, van der Waals interactions, ionic interactions.
2. Acid-base chemistry, aqueous solutions, equilibrium constants, acids and bases, buffers.
3. Hydrodynamic properties - viscosity, diffusion, D.W., osmotic pressure, surface tension, etc.
4. Biochemical energetics - energy yielding and energy requiring reactions. Calculations of equilibrium concentrations, oxidation and reduction, electron Metabolism and ATP yield. Photosynthetic phosphorylation, Active transport, enthalpy and entropy and activation analysis.
5. Spectrophotometry and other optical methods.
6. Isotopes and radioactive decay. Solution of radioactive compounds. Assays using radioactive substrates, double label analysis. Biological half-lives, turnover, radioactive tracer dilution analysis. Biological half-lives, turnover, Radioactive tracer dilution analysis. Radioactivity, counting errors.

BT - 102B STATISTICS

Statistical population, sample from population, random sample

Tabular and graphical presentation.
 Mean and standard deviation of grouped and ungrouped data.
 Probability, relative frequency, probability distribution, binomial, Poisson and normal distributions.

Test of significance, test for proportion, means and standard deviations, F and t test, chi-square test for goodness of fit. Theory of errors, errors and residuals, precision, measure of regression, probable error of function, rejection of observation. Methods of averages and least squares. Correlation and linear regression, associated test of significance. Analysis of variance for one and two way classification. Design of experiments, randomization, replication, local control, completely randomized and randomized block design.

BT 103 : CELL AND DEVELOPMENTAL BIOLOGY

- 1) Cell ultrastructure and chemical composition -recapitulation
- 2) Plasma Membrane and Cell surface
 - Structure : Models
 - Chemistry : Glycoproteins, lipids, enzymes
 - Receptors : Receptor function
 - Transport : Passive and active

Pinocytosis and Phagocytosis

Neurotransmission across the synapse

 - Cell Junctions : Types, ultrastructure, functions
 - Cell surface : Microvilli, glycocalyx
- 3) Mitochondria
- 4) Chloroplast : Structure & function, photosynthesis
- 5) Cytoplasmic vacuolar system :
 - Endoplasmic Reticulum : Rough, smooth, Sarcoplasmic structure function
 - Golgi complex : Structure, Chemistry, function & origin
 - Lysosomes : Polymorphism, function
 - Peroxisomes : Structure, function
 - Glyoxysomes : Structure, function
 - Cytoskeleton and Cell movement (2 lecturers)
- 6) Cell Division :
 - Mitosis : Mitotic apparatus, centrioles
 - Meiosis : Synaptonemal complex Crossing over and its modern interpretation
- 7) Cytoskeleton and Cell movement
- 8) Cell cycle
 - Methods of analysis and regulations during early development
- 9) Cell fusion and Somatic cell hybridization

- 10] Immune system
- 11] Structure and development of egg and sperm
- 12] Models of fertilization mechanism, Cleavage patterns & their control. Concept of morphogenesis and histogenesis, cell death
13. Concept of growth at sub-cellular, cellular & organ level in vitro and in vivo
14. Concept of cellular differentiation, stability of the differentiated state, metaplasia, neoplasia, transdifferentiation, Transdetermination, cell transformation, synthesis, transport and uptake of vitellogenin during oogenesis. Synthesis and storage of nucleic acids and proteins during early embryogenesis
15. Cell aging
16. Nucleo cytoplasmic interactions (Amoeba and acetabularia)
17. Cellular excitability
18. Ultrastructure, chemical composition and organization of interphase nucleus, nucleolus, nuclear infrastructure, nuclear membrane including nuclear pores
19. Mechanism of hormone action
20. Formation of seed, germination of seeds and development of plant from embryo, vegetative propagation, callus formation

References

- De Robertis, et al. Cell Biology 1980 or later edition. Alberts, et al. Molecular Biology of Cell, 1983.

SEMESTER - II

BT 201 : BIOPHYSICAL AND BIOCHEMICAL TECHNIQUES

1. Chromatography - adsorption, affinity, partition (gas-liquid-gas, HPLC, TLC, RPC, etc). Immobilized cells
2. Electrophoresis colloidal solutions of biopolymers and their electrochemical properties, different methods of electrophoresis for proteins, nucleic acids, small W.W. compounds immunoprecipitates etc. (4 L)
3. Peptide mapping and combination of electrofocussing and SDS-PAGE (O/Farrell).
4. Hydrodynamic properties: viscosity, diffusion etc. of biopolymers, M.W. determination, osmotic pressure, reverse osmosis, and Donnan effect. (4 L)
5. Structure of biomembranes and their electrochemical properties, membrane potential, action potential and propogation of impulses (3 L)
6. Introduction of curve smootings, derivative curves, numerical integration, fourier transformation (4 L)
7. Principles and application of a) Spectroscopic methods, (UV, VIS, IR, Photoacoustic, Flouresence, ORD, CD, Mossbauer) to biological systems (15 L)
8. Use of radioactive and stable isotopes and their detection in biological systems (1 L)
9. Principles and working of light and electron microscope, X-ray diffraction and neutron scattering (2 L)
10. Automatic analysers for amino acids, protein sequenator, peptide synthesizer, nucleic acid synthesizer (2L)
11. Theory of lyophilization and its appalications to biological systems (1 L)
12. Microcalorimetric methods (1L)
13. Manometric methods and their applications in biological systems (1 L)
14. Cell sorter and their applications (2 L)
15. Theory of centrifugation and application to biological systems. Rotors angle/ swing out/ vertical/ zonal continuous flow. Buoyant density centrifugation. (4 L)

BT 202 : MOLECULAR BIOLOGY AND GENETICS (50L)

Classification of bacteriophages and structure.
Ultrastructure, chemical composition and organization of interphase nucleus, nucleolus, nuclear infrastructure and nuclear membrane including nuclear pores. DNA structure and evidence that DNA is genetic material - genetic code. Structure of chromatin, organization of bacterial and eukaryotic genomes. Transcriptional units in eukaryotes and T7 bacteriophage. Structure and organization of genes for globin, IgG and rRNA Transcription and processing of rDNA and mRNA - transport DNA replication.

Ribosomes structure, composition and role in protein synthesis. Mechanism of protein synthesis, processing and transport.

Nuclear and cytoplasmic ribonucleoprotein - free and organel bound, structure and role of small RNAs
Transformation, conjugation, theories of crossing over.
Recombination between DNA duplexes - Molecular basis of recombination and repair - mutations and deletions
Bacterial operons - lactose, his - gal, complex gene clusters- induction/ repression/ and product inhibition.
Phase lambda ineffective pathways - phage morphogenesis.
Genetic systems of T-even and T-odd phages : single strand DNA phages / RNA phages : : Transduction

Chromosomal gene mapping, transposable element /Mu bacteriophage system, Plasmids episomes
Principles of recombinant DNA techniques.

BT. 203A : BIOMATHEMATICS

Differential and integral calculus

Derivative and its physical significance, basic rules for differentiation (without derivation) maxima and minima, their applications in chemistry, exact and inexact differentiation with specific emphasis on thermodynamic properties, partial differentiation. Curve sketching. Basic rules for integration (without derivations), definite and indefinite integrals, geometric meaning of integration, applications in the biology and chemistry. Solutions to quadratic and cubic equations.

Differential equations

Separable variable, homogeneous, exact and linear equation, equations of second order, applications of differential equations in chemistry.

Probability and theory of errors

Permutations and combinations probability and probability theorems. probability curves, errors and deviations. thermodynamic probability, distinguishable and indistinguishable particles, methods of averages and least squares.

Determinants evaluation of 3×3 determinants, matrices manipulations, simultaneous equations and inversion

Interpolation and polynomial fitting.

BT 203B : COMPUTER PROGRAMMING

Overview of computers, microcomputers, VDU and printer
What is programming? algorithms.

INPUT, PRINT and END statements, arithmetic expressions etc.

GOTO, DO UNTIL, ELSE etc.

Handling arrays, Procedures

Color, sound and graphics

Use of standard packages.

BT 204 : PRACTICAL COURSE - I
(MICROBIOLOGY & BIOCHEMICAL TECHNIQUE)

BT 205 : PRACTICAL COURSE - II
(BIOMATHEMATICS, AND COMPUTER PROGRAMMING)

SEMESTER - III

BT-301 : FUNDAMENTALS OF TISSUE CULTURE

A) PLANT CELL TISSUE CULTURE TECHNIQUES

In vitro system

- a) in vitro condition - composition of nutrient media, role of ingredients, physical conditions, light quality, quality and duration, temperature and humidity.
- b) explant - structure, composition, function and physiological status at the time of isolation, effects of isolation, totipotency of plant cells, processing plant cells for inoculation.
- c) Incubation systems - advantages, limitations and applications of each system
- d) culture systems - organs, anther, tissue, cell, protoplast response of the explant vis-a-vis "in vitro" conditions
 1. growth and differentiation
 2. morphogenesis - organogenesis and embryogenesis
 3. metabolism and whole system hormonal control
 4. cellular, biochemical and molecular basis of growth and differentiation.

Assessment of growth and differentiation in vitro
- polyploidy, deletions, translocations, recombinations, transpositions, spontaneous mutations, somaclonal variations

BT- 301B ANIMAL CELL & ORGAN CULTURE

1. History and development of tissue culture
2. Tissue culture systems - Cell culture, tissue fragments, organ, embryo culture, their merits and limitations. Slide, tube & bottle cultures.
3. Cell and microenvironment
4. Effective use of Microscopy - compound, phase, interference, fluorescence.

5. Preparatory techniques: decontamination, washing, cleaning (alkalies acids soaps, detergents, ultrasonication), packing, labeling. Sterilization (hot air, steam under pressure). UV and gamma ray irradiation, gases etc. Quality control of glass-ware, water, plasticware, sterility and toxicity testing).
6. Work benches, utility, function, laminar flow systems.
7. Preparation of media, mixing, sterilization, testing and storage (B.S.S., synthetic, natural media, growth factors, selective media). Buffering methods, Development of synthetic media.
8. Methods of cell dissociation and preparation of primary cell culture.
9. Characterization of cells in vitro.
10. Short term cultures (Leukocytes)
11. Poikilotherm cells in culture.
12. Cell culture growth parameters (Quantitative studies on cells in vitro)
13. Design and organization of tissue culture laboratory, air handing - unit activities (washing, sterilization, storage, clean work, preparation room, cryopreservation, etc.)
14. Contamination in tissue culture, (detection, prevention, decontamination)

ET - 302A : RECOMBINANT DNA TECHNOLOGY

1. Bacterial phages, plasmids, cosmids, charron phages, chimeric plasmids.
2. Choice of vector/vehicle and host strains - E. coli, B. subtilis yeast, animal cells, etc.
3. Bacterial transformation with plasmids (R factor and F factor).
4. Chimeric plasmids

5. Enzymes in genetic engineering:
DNA polymerase, Polynucleotide ligase, Nick-translation system, Terminal deoxynucleotidyl transferase (end-addition), reverse transcriptase, restriction endonuclease of type I & II.
6. DNA extraction procedure for a) high M.W. DNA and b) plasmid DNA
7. DNA restriction fragment analysis
8. Shotgun procedure for genomic DNA cloning-gene libraries and re-cloning cloned fragments.
9. Shotgun procedure for cDNA libraries
10. Isolation of mRNA and synthesis of single stranded and double stranded cDNA.
11. Southern blotting, Northern blotting, Dot blots etc.
12. Western blots and immuno blots for detection of expression of cloned genes.
13. Fragments for specific gene functions and location of gene maps.
14. Colony hybridization, in-situ hybridization procedures
15. Site-specific mutagenesis

BT = 302B RECENT ADVANCES IN MOLECULAR BIOLOGY

Gene amplification during oogenesis

Localization and reiteration of 5 S RNA genes

Polytene chromosomes. DNA and RNA puffs. Independent control of DNA replication in polytene chromosomes. Lampbrush chromosomes organization

Structure and regulation of genes for globin, ovalbumin, IgG, vitelline, histones, silk fibroin, delta crystalline and HLA

Organization, structure and expression of SV 40 genome. SV 40 life cycle structure and composition. Organization and expression of adenovirus genome

Quantitative and qualitative changes in cytoplasmic mRNA populations - stability and turn-over

Role of cyclic AMP as the second messenger

DNA damage and mechanisms of repair - role in the conservation of genome integrity - relationship to the life span and ageing process. Synthesis and degradation of nucleosides and nucleotides.

Control of cellular proliferation. Molecular basis of oncogenesis.

BT - 303A BIO-ORGANIC CHEMISTRY

1. Probiotic and early evolution of life
2. Biochemical reactions and their mechanisms (nucleophilic, electrophilic, addition and elimination reactions)
3. Stereochemistry of sugars, steroids, porphyrins, antibiotics, terpanes, drugs etc.
4. Use of enzymes for isolation of optically active isomers.
5. Organic synthetic methods for amino acids, lipids, nucleotides, peptides, and nucleic acids.
6. Contribution of synthetic organic chemistry to drugs, antibiotics, insecticides, hormones (plant and animal), vitamins etc.

BT - 303B - Enzymes:

Kinetics of enzymes catalysed reaction. (single substrate and bisubstrate reactions), factors effects enzymes reactions, activators, inhibitors, co-enzymes, metaloenzyme, isoenzyme, active site determination, enzyme mechanism, multienzyme complex, regulatory enzyme, covalent modification, zymogen activation, allosteric regulation and kinetics, induction zymogen kinetics, induction and repression of enzyme.

Mitochondria: structure of mitochondria, organization of respiratory chain, oxidative phosphorylation and its inhibitors.

SEMESTER - IV

BT - 401 MICROBIAL BIOTECHNOLOGY

1. Principles of fermentation technology screening, strain improvement & maintenance fermentor.
2. Antibiotic fermentations - Penicillin, streptomycin
3. Production of vitamins & organic acids by fermentation - Vit B₂, citric acid
4. Production of ethanol wine, Beer
5. Energy from microorganisms - ethanol, Biogas, H₂.
6. Microbial productions of food - SCP Algal biotechnology
7. Mining & metal biotechnology
8. Immobilization of enzymes & whole cells methods & applications.

BT - 402A PLANT PHYSIOLOGY & PHYTOCHEMISTRY (50 L)

1. Plant growth:
 - a. Concept - definition
 - b. Patterns of growth
 - c. Growth kinetics
 - d. Growth of plant organs
 - e. Factors controlling growth
2. Differential - Directional Growth - Tropism:
 - a. Phototropism
 - b. Gravitropism
 - c. Thigmotropism
3. Photomorphogenesis:
 - a. Concept - definition
 - b. Phytochrome - discovery: physical and chemical properties; distribution; role in seed germination, seedling establishment and vegetative growth.
4. Photoperiodism:
 - a. General principles
 - b. Short day plants, long day plants & day neutral plants
 - c. Role of dark period and phytochrome
 - d. Florigen concept - flowering hormones
 - e. Reproductive growth

5. Plant Growth Regulators:

- a. Biosynthesis - degradation - disposal
- b. Mechanism of action
- c. Hormonal control of whole plant development

6. Biosynthesis, chemical properties, distribution, classification and function(s) of:

- a. Carbohydrates
- b. Lipids
- c. Organic acids
- d. Glycosides
- e. Alkaloids
- f. Terpenoids
- g. Phenolics
- h. Unusual amino acids.

BT - 402B APPLICATIONS OF PLANT CELL TISSUE CULTURE

Plant propagation through tissue culture

- a. Agricultural crops
- b. fruit crops
- c. forest trees
- d. ornamental plants
- e. medicinal plants
- f. endangered/rare plant species

Germplasm preservation, synthetic seeds

- a. Objectives, methods and limitations
- b. selection of semi clonal variants
- c. induction and selection of mutants
- d. somatic hybridization, cybridization - intraspecific, intergeneric.
- e. gene transfer- direct through vector, through liposomes through protoplast, by microinjection and electroporation.
- f. improvements in cereals, legumes, vegetables, and tuber crops
- g. haploids, endosperm and embryo culture

Disease elimination

Application in basic research

- a. in vitro system for bioassay
- b. in vitro system for studying metabolism
- c. in vitro system for studying growth and development.

BT - 403 BIOCHEM PROCESSES & BIOTECHNOLOGY

1. Large scale process analysis for :
 - a. blood products (fractionation of plasma proteins and their therapeutic use)
 - b. recombinant DNA technology
 - c. virus based products
 - d. monoclonal antibodies
 - e. antibiotics & chemotherapeutic agents
 - f. enzymes
 - g. fine chemicals
 - f. biotransformation
 - g. food products
 - h. vaccines

Downstream processing - flocculation, sedimentation, filtration
centrifugation, floatation
-microbial cell disruption
-membrane separation
-liquid-liquid solvent extractions
-Novel downstream processing

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