Annexure No.	**42 L**
SCAA Dated	**29.02.2008**

BHARATHIAR UNIVERSITY, COIMBATAORE

SCHOOL OF DISTANCE EDUCTION
Syllabus for PG Diploma in Microbial Biotechnology

DURATION: 1 year **Non semester pattern**

	Subject	University examination	
		Duration in Hrs.	Max. Marks
PAPER I	Fundamentals of microbiology	3	100
PAPER II	Genetic engineering	3	100
PAPER III	Bioprocess technology	3	100
PAPER IV	Clinical Microbiology	3	100
	Practical I	6	50
	Practical I	6	50

PAPER I FUNDAMENTALS OF MICROBIOLOGY

PREAMBLE

Scope

This paper deals with various types of classification of microbes. The paper also throws light on multifarious habitats of microbes and provides information about all the microbial cellular functions and various metabolic pathways in microbes.

Objective

To impart knowledge on classification of microbes. This paper is also designed to provide knowledge on metabolic function and biochemical reaction going on inside the microbial cell

Goal

This paper enables the students to identify any microorganisms. The students will be able to understand and predict the intermediate metabolism of any microbe used in Industrial production processes

CONTENTS

UNIT I

CLASSIFICATION AND MOLECULAR SYSTEMATICS: Taxonomy – Classification of viruses, bacteria and fungi. Molecular systematics – Classical, numerical, polyphasic and molecular (G+C analysis, DNA-DNA hybridization, 16s rRNA sequencing and construction of phylogenetic tree) taxonomy

UNIT II

MICROBIAL CELL BIOLOGY AND METABOLISM: General structural organization of bacteria, viruses, Actinomycetes. Molecular architecture of nucleus, mitochondria, chloroplast, cell wall, ribosome, cilia, flagella, vacuole and other microbodies. Metabolic pathways and bioenergetics. Aerobic and anaerobic growth – product formation and substrate utilization – endogenous and maintenance metabolism.

UNIT III

MICROBIAL GENOMICS AND REPLICATION: Fine structure of gene, genetic code; Genetic rearrangement – organization of coding sequences and repetitive sequences. Genetic system of bacteria – transformation, transduction, recombination; plasmids and transposons; Genetic systems of viruses – phage I, RNA viruses and retroviruses. Genetic system of fungi – Yeast and Neurospora. Genetic system of protozoa and mycoplasma. Multiplication of bacteriophages, bacteria and differentiating organisms such as yeast, fungi and actinomycetes. Sexual and asexual reproduction in bacteria and fungi.

UNIT IV

MICROBIAL ECOLOGY: Soil, aquatic and aerobiology; Influence of environment on microbial physiology – chemical factors; nutrients – water, C, H, O, N, P, S, growth factors-amino acids, purines, pyrimidines, nucleosides, nucleotides, vitamins, lipids, inorganic nutrients, antimicrobial compounds, metabolic inhibitors. Physical factors – radiations, temperature, pH and pressure. Response to environment – growth and reproduction; growth inhibition and death, movement, differentiation, modification to the environment – changes in chemical composition, changes in physical properties

UNIT V

MICROBIAL TECHNIQUES: Isolation of microbes from various sources, Serial dilution technique, pure culture techniques and culture preservation techniques. Microbial culture collection centres. Staining techniques – Gram, endospore, negative, flagellar and methylene blue staining. Inoculum development – Development of inocula for yeast, bacterial, mycelial and vegetative fungal processes; aseptic inoculation of the fermentor

Sterilization methods: Moist heat; dry heat, flame, filter, gas (ethylene oxide), Richards' rapid method - HTST (high temperature/short time) treatments – continuous sterilizers and pasteurizers - Sterility, asepsis, Uses of UV and non-ionizing radiation. Sterilization methods – medium sterilization, batch sterilization, contiuous sterilization, filter sterilization

Microbiological media: Types of media, composition of media – carbon sources, nitrogen sources, vitamins and growth factors, mineral, inducers, precursors and inhibitors. Selection and optimization of media

Strain improvement methods; Recombinant cell culture process – guidelines for choosing host, vector systems, plasmid sterility in recombinant cell culture, limits to over expression

REFERENCES

1. Microbiology by Pelczar, Reid and Chan, McGraw Hill Book Company.
2. Microbiology, Fundamental and Applications by R.A. Atlas, McMillan Publishers.
3. General Microbiology by Powar and Daginawala, Himalaya Publishing House.
4. Microbial genetics by David friefelder

PAPER II GENETIC ENGINEERING

PREAMBLE

Scope

The content throws light on genomic structure of microbe and various molecular tools used for genetic manipulation

Objective

This paper aims to improve the knowledge on genomic structure of microbes and applications of genetic engineering

Goal

The students will be able to utilize this knowledge for improving the products and production process in Industries.

CONTENTS

UNIT I

NUCLEIC ACID & PROTEIN SYNTHESIS AND REGULATION: Transcription, and translation; regulation of protein expression in prokaryotes

UNIT II

GENE CLONING VECTORS: Biology of vectors – plasmids, bacteriophages, single stranded DNA vectors, cosmids, phasmids, specialized vectors; Plant viral vectors and other plasmid vectors; Animal viral vectors

Cloning strategies: cloning of genomic DNA, cDNA cloning; screening strategies; differential cloning

UNIT III

RECOMBINANT TECHNIQUES: Blotting techniques – Southern, Northern and Western blotting; transformation of *E. coli*, PCR; probe construction, RFLP, AFLP, RAPD, SSCP and SNP. Construction of cDNA library, molecular mapping of genome – genetic and physical maps

UNIT IV

TRANSFORMATION TECHNIQUES: Cloning in Gram negative and Gram positive bacteria, streptomycetes and fungi including *Saccharomyces cerevisiae*; Cloning in plants and animals

UNIT V

RECOMBINANT PRODUCTS IN INDUSTRIES

BIOTECHNOLOGY AND ETHICS – biotechnology in agriculture and environment: benefits and risks – benefits and risks of genetic engineering – ethical aspects of genetic testing – ethical aspects relating to use of genetic information – genetic engineering and biowarfare.

REFERENCES:

1. “Principles of Gene manipulation” by R.W. Old and S.B. Primrose Third Edition. Blackwell Scientific Publication 1985.
2. “Genes VII” by Lewin
3. “Genes to clones” by L. Winnecker.

PAPER III BIOPROCESS TECHNOLOGY

PREAMBLE

Scope

This paper provides technical information on fermenter designing and kinetics involved in the fermentation processes. This paper adds information about the role of microorganisms in many industries both in production and treatment processes.

Objective

This paper aims to empower the students with various designs of fermenter. The growth kinetics and process kinetics of the fermentation process enable the students to manipulate for improvement. This also encodes the importance of the role of microorganisms in various industries.

Goal

The students will be able to design any fermentation production processes to improve the production on completion of the paper. The students will be able to also exploit the microbes for improved quality of products.

CONTENTS

UNIT I

DESIGN OF FERMENTER AND KINETICS: Types and modes of operation (Stirred tank, air-lift, bubble column, fluidized bed, packed-bed etc) – Design and construction of bioreactors for different products. Fundamentals of process control and monitoring – control and monitoring theory. On-line and off-line analysis – Sensors for physical, chemical and biological environments. Regulatory and feedback control. – PID controller – regulators and actuators. Computer aided control.

Microbial kinetics: Batch, fed-batch and continuous cultures – Phases of batch growth. Kinetics of cell growth – Kinetic models and methods of model parameter estimation – Yield concept and productivity.

UNIT II

DOWN STREAM PROCESSING: Characteristics of biotechnological products. Primary separation – removal of insoluble (centrifugation, filtration and sedimentation). Cell disruption (mechanical, enzymatic and chemical). Product isolation – Methods including solvent extraction, adsorption, aqueous two-phase system and precipitation. Purification techniques – Chromatography (ion exchange, gel permeation and affinity), membrane separation (micro-filtration, ultra-filtration and reverse phase electrophoresis). Product polishing (crystallization, drying and diafiltration)

UNIT III

FERMENTED FOOD PRODUCTS: Dairy products: Milk processing - Cheese - principles of cheese making. Production of distilled beverage alcohol, wine, brandy and beer.

FOOD ADDITIVES: Production of additives - organic acid (acetic acid, lactic acid and citric acid), amino acids (glutamic acid, lysine, threonine, arginine and histidine), food flavourants and pigments, nisin and bacteriocin.

UNIT IV

PHARMACEUTICAL PRODUCTS: Antibiotics (penicillin, streptomycin, tetracycline), vitamins, probiotics. Therapeutic proteins – Insulin, human growth hormone, clotting factors, interferons, interleukins, tissue plasminogen activators, erythropoietin, DNAseI, alginate lyase, muteins

UNIT V

WASTE MANAGEMENT: Water treatment processes: Primary treatment, screening, skimming with coagulants, flocculation, filteration, aeration and disinfection

Secondary treatment : Aerobic processes – activated sludge, oxidation ditches, trickling filter, towers, rotating discs, rotating drums, oxidation ponds. Anaerobic digestion, anaerobic filters, Up flow anaerobic sludge blanket reactors.

Tertiary treatment: Activated carbon treatment, reverse osmosis and electro dialysis.

Solid waste management: sewage sludge treatment and utilization, refuse disposal, excreta disposal in unsewered area; composting and vermiculture. Radio active product waste disposal.

REFERENCES;

1.Microbial Biotechnology-Fundamentals of applied Microbiology by A.N.Glazer and H.Nikaido. W.H Freeman and company

2.Principles of Fermentation Technology, P.F.stanbury & A. Whitaker, Pergamon Press.

3.Microbial Process Development by H.W Woelle, World Scientific

4.Biotechnology Text book of Industrial Microbiology by W.Creuger and A Creuger

5.Industrial Microbiology by Casida

6.Industrial Microbiology by Prescott

7.Biochemical Engineering Fundamentals (2^{nd} Ed) by J.E Bailey and D.Ollis, Mc Graw-Hill Book Company.

PAPER IV: CLINICAL MICROBIOLOGY

Unit I

Infection and Immunity: General principles of Infection, Antigens, Antibodies, Antigen-antibody reactions, complement system

Unit II

Immune system – structure and functions, immune response, immunodeficiency disease, hypersensitivity, autoimmunity, Immunology of transplantation and malignancy, immunohematology

Unit III

Pathogenic/parasitic organisms: Bacterial, viral and protozoal infections of the gastrointestinal system, nervous system, lung, liver and eye; Sexually transmitted diseases, skin infections, zoonoses, arthropod borne diseases. Transmission and spread of diseases – Disease epidemiology.

Unit IV

Control and prevention of infections – drugs and antibiotics – drug resistance,. Mycobacteria, leprosy and malarial parasite – importance, lifecycle, spread and control.

Biochemical changes due to infections – Blood test and tissue analysis. Isolation and identification of organisms from tissue samples. Disease detection – conventional and molecular techniques.

Unit V

Normal microbial flora of human body, Laboratory control of antimicrobial therapy, Immunoprophylaxis.

Vaccines – types and methods of action. Biotechnological approaches to disease control and vaccine production. Genetic disorders and Gene therapy. Control of vectors – Mosquito control - Biotechnological approaches.

REFERENCES

1. Immunology, Roitt, I.M., Brestoff and Male, D.K, 1996
2. Text book of Microbiology – C. K. J. Panicker
3. Molecular Biotechnology – Glick
4. Clininal microbiology - Ananthanarayanan

PRACTICAL I

1. Isolation of microorganisms - Media preparation – sterilization techniques
2. Pure culture techniques
3. Staining – gram, simple
4. Estimation of reducing sugar and protein
5. Western hybridization
6. Southern hybridization
7. Genomic DNA isolation
8. Plasmid DNA isolation
9. RNA isolation
10. Library construction (Restriction, digestion and transformation)
11. PCR-RFLP
12. PAGE
13. TLC and Paper chromatography
14. Effect substrate concentration of bacterial growth and estimation of monod parameters
15. Effect of pH and temperature on bacterial growth kinetics
16. Effect of inoculum, age and size of bacterial growth kinetics
17. Effect of substrate concentration on enzyme activity (Vmax and Km)
18. Effect of pH and temperature on enzyme activity
19. Solvent extraction of product from fermentation broth
20. Purification of a fermentation product by ion exchange, gel exclusion and affinity chromatography

PRACTICAL II

1. Callus induction and differentiation
2. Isolation, fusion and regeneration of protoplasts
3. Agrobacterium mediated gene transfer
4. Batch cultivation of bacteria in fermentor; Different phases of bacterial growth (Estimation of μM, K_s and $Y_{X/S}$)
5. Medium optimization for bacterial growth by statistical method
6. Immobilization of bacteria and enzyme by calcium alginate method
7. Production of alcohol from molasses
8. Production of citric acid
9. Production of amylase
10. Estimation of oxygen transfer coefficient (KLa)
11. Analysis of pH, turbidity, color, total solids, suspended solids, dissolved solids
12. Estimation of COD, BOD
13. Estimation of Iron and chromium
14. MPN test
15. IMViC test
16. Calculation of bond length, bond angles and tension angles
17. Comparison of 3D structures of protein/nucleic acids
18. Searches of MEDLINE, CD_ROM and bibliographics data bases

MODEL QUESTION PAPERS

PAPER I - FUNDAMENTALS OF MICROBIOLOGY

Time: 3 hrs Marks: 100

Answer any five questions out of eight given below: 5 x 2 = 100

1. Describe the classification of viruses.
2. Explain the structure of mitochondria and its function.
3. What are retroviruses? Elaborate on various types of retroviruses.
4. Discuss in detail about aquatic microbiology.
5. What are the various components of media used for microbial growth?
6. Elaborate on various sterilization techniques.
7. What is transduction? Explain the process of transduction and its uses.
8. Describe the structural organization of bacteria.

PAPER II – GENETIC ENGINEERING

Time: 3 hrs Marks: 100

Answer any five questions out of eight given below: 5 x 2 = 100

1. Describe the molecular mechanism of replication.
2. Elaborate on the various types of vectors used for cloning.
3. Describe how the cDNA library is constructed.
4. Describe the cloning process in gram negative bacteria.
5. What are the ethical aspects relating to genetic engineering?
6. Explain how the transcription pathway is regulated.
7. What are transgenic plants? Explain with an example .
8. What is PCR? Elaborate on PCR amplification and its uses.

PAPER III – BIOPROCESS TECHNOLOGY

Time: 3 hrs Marks: 100

Answer any five questions out of eight given below: 5 x 2 = 100

1. What are the different modes of fed batch culture used in fermentation process.
2. Elaborate on the various types of chromatographic techniques.
3. Describe the production of amino acids.
4. Describe the production process of any two antibiotics.
5. What are the aerobic methods used for waste water treatment?
6. Explain how the beverages are produced.
7. What are controlling and monitoring devices of temperature and pressure in fermentation process?
8. Explain the kinetics of batch process.

PAPER IV – CLINICAL MICROBIOLOGY

Time: 3 hrs Marks: 100

Answer any five questions out of eight given below: 5 x 2 = 100

1. How are biological samples collected for microbial analysis?
2. Elaborate on the Monoclonal antibodies and hybridoma technology.
3. Describe the types and structure of Immunoglobulins.
4. Describe the life cycle of malarial parasite and its prevention strategy.
5. Describe the molecular structure of AIDS virus and its prevention.
6. Explain cell mediated immunity.
7. What are the different types of vaccine and its production?
8. Explain gene therapy with an example.