

BHARATHIDASAN UNIVERSITY, TIRUCHIRAPPALLI – 620 024

M.Sc. MICROBIOLOGY – Course Structure under CBCS

(For the candidates admitted from the academic year 2005-2006 onwards)

Sem ester	Course	Course Title	Ins. Hrs / Week	Credit	Exam Hrs	Marks		Total
						Int.	Ext.	
I	Core Course – I (CC)	General Microbiology	6	4	3	25	75	100
	Core Course – II (CC)	Virology	6	4	3	25	75	100
	Core Course – III (CC)	General Biochemistry	6	4	3	25	75	100
	Core Course – IV (CC)	Practical I –Microbiology, Virology & Biochemistry	6	4	6	25	75	100
	Elective Course – I (EC)	---	6	4	3	25	75	100
II	Core Course – V (CC)	Microbial Physiology	6	4	3	25	75	100
	Core Course – VI (CC)	Environmental & Agricultural Microbiology	6	4	3	25	75	100
	Core Course – VII (CC)	Practical II – Physiology, Env. & Agri. Microbiology	6	4	6	25	75	100
	Elective Course – II (EC)	---	6	4	3	25	75	100
	Extra Disciplinary Course – I (EDC)	---	3	2	3	25	75	100
	Extra Disciplinary Course – II (EDC)	---	3	2	3	25	75	100
III	Core Course – VIII (CC)	Immunology & Medical Microbiology	6	4	3	25	75	100
	Core Course – IX (CC)	Molecular Genetics	6	4	3	25	75	100
	Core Course – X (CC)	Molecular Biology & Genetic Engineering	6	4	3	25	75	100
	Core Course – XI (CC)	Practical III Molecular Biology, Genetic Engineering, Immunology and Medical Microbiology	6	4	6	25	75	100
	Elective Course – III (EC)	---	6	4	3	25	75	100
IV	Core Course – XII (CC)	Bioprocess Technology	6	4	3	25	75	100
	Core Course – XIII (CC)	Biostatistics & Bioinformatics	6	4	3	25	75	100
	Project Viva Voce 25 marks Dissertation 75 marks	---	18	4	-	-	-	100
			120	72				

The Department of Microbiology will offer the following Elective Courses

1. Herbal Technology
2. Intellectual Property Rights
3. Biological Techniques

The Department of Microbiology will offer the following Extra Disciplinary Courses

1. Microbial Biotechnology
2. Bioinformatics

MSc. Microbiology Syllabus

Semester I

Core Course I (CC) - General Microbiology

Unit I – Ultra structure and function:

Bacteria: Morphological types; cell wall – cell walls of Gram negative, Gram positive, halophiles. L-forms and Archaeobacteria, Cell wall synthesis, capsule types composition and function. Cell membranes in eubacteria, archaeobacteria and cyanobacteria - membrane functions, periplasmic space. Structure and function of flagella, cilia and pili, gas vesicles, chlorosomes, carboxysomes, magnetosomes and phycobilisomes. Reserve food materials – polyhydroxybutyrate, polyphosphates, cyanophycin and sulphur inclusions. Nuclear material – bacterial chromosomes and bacterial plasmids. Endospore types, structure and functions.

Fungi: Cell wall – chemical composition and functions, membranes and their function; Fine structure of flagella and somatic nuclei.

Unit II – Classification:

Microbial Taxonomy - Definition and systematics, Nomenclatural rules and identification, Hierarchical organization and the position of microbes in the living world classification systems – artificial and phylogenetic – dendrogram. Haeckel's three kingdom classification, Whittaker's five kingdom approach.

Major characteristics used in taxonomy – morphological, physiological and metabolic, genetic and molecular. Numerical and chemotaxonomy of microorganisms. Classification and salient features of bacteria according to Bergey's Manual of Determinative Bacteriology (9th edition). Modern classification of fungi, mycoplasma, cyanobacteria, protozoa and prochlorales.

Unit III – Fungi

Structure and life cycle of fungi – Ascomycetes (*Aspergillus*), Deuteromycetes (*Candida*), Zygomycetes (*Mucor*), Basidiomycetes (*Agaricus*); Acrasiomycetes (*Dictyostelium*), Oomycetes (*Saprolegina*), Myxomycetes (*Ceratiomyxa*). Hyphae and non-motile unicells, motile cells, spores, dormancy, growth and colonies, effect of environment on growth, prevention of fungal growth. Fungi and ecosystem: saprophytes, substrate groups and nutritional strategies substrate successions, fungi. Parasitism, mutualism and symbiosis with plants and animals.

Unit IV – Algae and protozoans

Structure of algal cells – classification – reproduction and characteristics of Chlorophyta (Green algae), Chrysophyta (Golden-Brown and Yellow), Green Algae, Diatoms, Euglenophyta (Euglenoids). Rhodophyta (Red algae), Cyanophyta, Xanthophyta – Brief account of protozoans.

Unit V – Cultivation methods of microbes

Isolation of different types of bacteria - Fungi – Actinomycetes - Cyanobacteria - Protozoa. Preservation methods of microbes for storage and microscopy studies, culture collections. Physical, chemical methods for controlling microorganisms. A note on fossil microorganisms.

References:

- Bernard D. Davis. Renato Dulbecco. Herman N. Eisen. and Harold, S. Ginsberg. (1990). Microbiology (4th edition). J.B. Lippincott company, New York.
- Alexopoulos CJ and C W. Mims. (1993). Introductory Mycology (3rd edition). Wiley Eastern Ltd, New Delhi.
- Mara D. and Horan N. (2003). The Handbook of Water and waste water Microbiology. Academic Press-An imprint of Elsevier.
- Elizabeth Moore-Landecker. (1996). Fundamentals of the fungi. (4th edition). Prentice Hall International, Inc, London.
- Heritage, J. Evans E.G.V. and Killington, R.A. (1996). Introductory Microbiology. Cambridge University Press.
- Holt, J.S., Kreig, N.R., Sneath, P.H.A and Williams, S.T. Bergey's Manual of Determinative Bacteriology (9th Edition), Williams and Wilkins, Baltimore.
- John Webster (1993). Introduction to Fungi. (2nd edition). Cambridge University press, Cambridge.
- Prescott LM Harley JP and Klein DA (2003). Microbiology (5th edition) McGraw Hill, New York.
- Larry Mc Kane. and Judy Kandel (1996). Microbiology-Essentials and applications. (2nd edition). Mc Fraw Hill Inc, New York.
- Madigan MT Martinko. JM and Parker J Brock TD (1997). Biology of Microorganisms. (8th edition). Prentice Hall International Inc, London.
- Schaechter M and Leaderberg J (2004). The Desk encyclopedia of Microbiology. Elsevier Academic press, California.
- Nester, E.W., Roberts, C.V. and Nester, M.T. (1995). Microbiology, A human perspective. IWOA, U.S.A.
- Pelczar Jr, M.J. Chan, E.C.S. and Kreig, N.R. (1993). Microbiology, Mc. Graw Hill. Inc, New York.
- Salle, A.J. (1996). Fundamental principles of Bacteriology. (7th edition). Tata McGraw-Hill publishing company Ltd, New Delhi.

Core Course II (CC) – Virology

Unit I – General Virology

Brief outline on discovery of viruses, nomenclature and classification of viruses; Distinctive properties of viruses; morphology & ultrastructure. Capsids and their arrangements - types of envelopes and their composition-viral genome, their types and structures. Virus related agents (viroids, prions).

Unit II – General Methods of Diagnosis and Serology

Cultivation of viruses in embryonated eggs, experimental animals, and cell cultures. Primary & secondary cell cultures and monolayer cell cultures; cell strains, cell lines and transgenic systems. Serological methods – haemagglutination & HAI; complement fixation; immunofluorescence methods, ELISA and radioimmunoassays.

Assay of viruses – physical and chemical methods (protein, nucleic acid, radioactivity tracers, electron microscopy). Infective assay (plaque method, end point method) – Infectivity assay of plant viruses.

Unit III – Bacterial Viruses

Bacteriophage - structural organization - life cycle - one step growth curve – transcription - DNA replication - eclipse phase - phage production - burst size; lysogenic cycle. Bacteriophage typing - application in bacterial genetics. Brief details on M13, Mu, T₃, T₄, Lambda and P1.

Unit IV – Plant Viruses

Classification and nomenclature; effects of viruses on plants; symptoms – histology - physiology and cytology of plants. Common virus diseases of plants; paddy, cotton, tomato and sugarcane. Viruses of cyanobacteria, algae, fungi and their life cycles.

Type species of plant viruses TMV, Cauliflower Mosaic Virus and Potato Virus X; transmission of plant viruses with vectors - insects, nematodes, fungi and without vectors (contact, seed and pollens). Diagnostic techniques; seed stocks and diseased plants - (seed morphology, seedling symptomatology, indicator plants, serological methods, histochemical test and fluorescent microscopy) – control measures - virus-free planting material; vector control.

Unit V – Animal Viruses

Classification and nomenclature of animal human viruses.

Epidemiology, lifecycle, pathogenicity, diagnosis, prevention and treatment of RNA Viruses - Picorna, Orthomyxo, Paramyxo, Toga and other arthropod viruses, Rhabdo, Rota, HIV - Oncogenic viruses. DNA viruses; Pox, Herpes, Adeno, SV 40; Hepatitis viruses. Viral vaccines (conventional vaccines, genetic recombinant vaccines used in national immunization programmes with examples, newer generation vaccines including DNA Vaccines with examples) interferons, and antiviral drugs.

Reference:

Alan J.Cann (1997). Principles of Molecular virology.(2nd edition).Academic press,California.

Ann Giudici Fettner (1990). The Science of Viruses.Quill William Marrow,Newyork.

Conrat HF, Kimball PC and Levy JA. (1988). Virology. II edition. Prentice Hall, Englewood Cliff, New Jersey.

Dimmock NJ, Primrose SB. (1994) Introduction to Modern Virology IV edition. Blackwell Scientific Publications, Oxford

Flint, S.J., Enquist, L.W., Krung, R. Racaniello, VR. and Skalka, A.M. (2000). Principles of Virology, Molecular Biology, pathogenesis and control, ASM Press, Washinton D.C.

Maloy, S.R, Cronan Jr. J.E, Freifelder, D. (1998). Microbial genetics. Jones and Bartlett publishers.

Nicklin,J.Greame-Cook.and Killington, R. (2003). Instant Notes in Microbiology.(2nd edition).Viva Books private limited,NewDelhi.

Robert I.Krasner (2002). The microbial challenge:Human Microbe Interactions.American society for Microbiology,Washington.

Roger Hull (2002). Mathews' Plant Virology.(4thEdition).Academic press-A Harcourt Science and technology company,Newyork.

Tom Parker, Leslie, M. and Collie, H. (1990). Topley & Wilson's Principles of Bacteriology, Virology and Immunity (VIII Edition).

Core Course III (CC) – General Biochemistry

Unit I – Cell and its function

Composition of living matter. Biochemistry of bacterial, animal and plant cell. Specialized components of microorganisms and their structure and function.

Unit II - Enzymes

Enzymes as biocatalysts, enzyme classification, specificity, active site, unit activity, isozymes. Enzyme kinetics: Michaelis – Menton equation for simple enzymes, determination of kinetic parameters, multistep reactions and rate limiting steps, enzyme inhibition. Allosterism, kinetic analysis of allosteric enzymes, principles of allosteric regulation.

Unit III – Types of macromolecules and their biosynthesis

Structural features and chemistry of macromolecules. Nucleic acid – properties, biosynthesis and degradation of purines and pyrimidines - Structure of DNA and RNA. Proteins – classification – aminoacids - primary-secondary-tertiary – quaternary and three dimensional structure of proteins. Carbohydrates - mono, di, oligo and polysaccharides, cellulose, chitin, starch, xylan. Lipids and biomolecules: Fatty acids, properties, β -oxidation - biosynthesis of cholesterol – A brief note on secondary metabolites.

Unit IV - Bioenergetics

Bioenergetics and strategy of metabolism - flow of energy through biosphere, strategy of energy production in the cell. Oxidation – reduction reactions, coupled reactions and group transfer. ATP production, structural features of biomembranes, transport, free energy and spontaneity of reaction, G , G° , G' and equilibrium. Basic concepts of acids, base, pH and buffers.

Unit V – Metabolism – basic Concepts

Cell metabolism - catabolic principles and break down of carbohydrates, lipids, proteins and nucleic acids - biosynthesis of macromolecules - vitamins and their role as coenzymes.

Reference:

Christopher K. Mathews and Van Holde, K.E. (1996). Biochemistry.(2nd edition).The Benjamin/Cummings publishing company,Inc.

David E. Metzler. And Carol M. Metzler (2001). Biochemistry-The chemical reactions of living cells-Vol1&2.(2nd edition).Harcourt/Academic press, Newyork.

Donald Voet and Judith G. Voet (1995). Biochemistry – Second Edition. John Willey and Sons, Inc.

Freifelder, D. (1996) Molecular Biology, II Edition, Narosa Publishing House, New Delhi.

Geofferey, L and Zubay (1998). Biochemsitry. (Fourth Edition) Wm. C. Brown Publishers.

Jeremy M.Berg. John L. Tymoczko and Lubert stryer (2002). Biochemistry.(5th edition).W.H.Freeman and company, Newyork.

Lubert Stryer.(1995). Biochemistry.(4th edition). W.H. Freeman and company, Newyork.

Reginald, H., Garret & Charles M. Grishm. (1998). Biochemistry (Second Edition) Saundars College Publishing.

Thomas M. Devlin. (2002). Textbook of Biochemistry with clinical correlations.(5th edition).A John Wiley and sons,Inc.,publication,Newyork.

Trudy McKee and James R. McKee. (1999). *Biochemistry-An Introduction*. (2nd edition). WCB McGraw-Hill, U.S.A

Core Course IV (CC) – Practical I: Microbiology, Virology & Biochemistry

Microbiology

Principles and methods of sterilization – (Wet, dry and cold sterilization). Direct microscopic observations of bacterial shape – cocci, rods, chains, fungal spores, mycelium, yeast budding. Preparation of Media: Nutrient broth, Nutrient agar, plates, slants, soft agar. Pure culture technique: Streak plate, spread plate and pour plate methods. measurement of size of microbes – micrometry method. Motility determination – Hanging drop method. Enumeration of bacterial / yeast cells-viable count (Plate count) Total count (Haemocytometer count)

Isolation methods – dilution series, spread plate method – agar-shake method, streak plate method, filter disc method, phototaxis. Isolation and purification of cyanobacteria, actinomycetes, fungi and protozoans. Staining methods: Simple, Negative, acid fast, Gram staining, spore, Capsule, Metachromatic granular staining, Lactophenol cotton blue staining - Fungal slide culture

Measurement of growth – Direct haemocytometer count, viable count – growth curve, Determinations of growth rate and generation time. Effect of pH, temperature and osmotic pressure on growth of bacteria. Biochemical tests: carbohydrate fermentation – acid-gas production; IMViC test; Hydrolysis of starch; cellulose; gelatin; casein; catalase test, oxidase, urease test, nitrate reduction – triple sugar iron test, ONPG test, amino acid decarboxylase.

Virology

Isolation and characterization of bacteriophage and cyanophage from natural resources. Phage titration – T₄ or Lambda or M₁₃. Determination of lysogeny using Lambda Phage or *Staphylococcal* indicator systems. Study of virus infected plant samples – animal tissue culture – chick embryo fibroblast culture preparation (Demonstration). Transmission methods – mechanical.

Biochemistry

Preparation of Buffer; (Tris, phosphate, acetate buffer). Acid-Base titration – pKa value determination – Determination of [H⁺] ion concentration. Verification of Beer-Lambert's law using coloured solution (CuSO₄). Preparation of standard graph for the following and estimating the concentration in a sample (i) glucose – anthrone method (ii) bovine serum albumin (Lowry's method) and (iii) Nucleic acid – DNA (diphenylamine method), RNA (Orcinol method). Separation of aminoacids by paper chromatography (ascending and descending) and identification of aminoacid. Extraction and separation of bacterial pigment through alumina / silica column. Separation of proteins by polyacrylamide gel electrophoresis and determination of molecular weight of unknown protein.

References:

Wilson, K. and Walker, J. (2000). *Practical Biochemistry*, 5th Edition, Cambridge University Press.

Cappuccino and James, G (1996) *Microbiology a laboratory manual*, Addison Wesley Publishing Company Inc. 4th edition, England, California.

David R. Brooke. *Bergey's Manual of Systematic Bacteriology* (Vol. I), Eastern Halz, Springer Publication.

Gerhardt, P., Murray, R.G., Wood, W.A. and Kreig, N.R. (1994) Methods of General and Molecular Bacteriology, Ed. American Society for Microbiology, Washington D.C.

James T. Stanley, Marvin P. Bryant. Bergey's Manual of Systematic Bacteriology (Vol. II), Nobert Pfeming Springer Publishers.

Wilson K. Walker (1995). Practical Biochemistry, Principles and Techniques, Cambridge University Press.

Gerhardt, P., Murray, R.G., Crood, W.A. and Kreig, N.R. (1994) Methods for general and molecular bacteriology, ASM, Washington D.C.

Jeanne Dejkstra, Ces.P.de Jager (1998) Practical plant virology, Springer Verlag, Lab Manual, Berlin, Heidel Berg, New York.

Miller, J.H. (1992) A short course in bacterial genetics, Cold Spring Harbor.

Elective course I (EC) Herbal Technology

Unit – I Pharmacognosy – Definition and history, Indian systems of medicine – Siddha, ayurvedha, and Unani systems. Taxmony of locally available medicinal plants, their chemical constituents and medicinal uses – Classification of Crude drugs – Chemistry of Drugs – Future of pharmacognosy.

Unit – II Classification of medicinal plants – Vernacular name and family – Geographical source, cultivation, collection, and processing for market and commerce in crude drugs. Morphological and histological studies, chemical constituents – Therapeutic and other pharmaceutical uses. Underground stem – ginger, Alpinia – Roots – Rauolfia – Belladona – Aerial parts – Bark – Cinchona.

Unit – III Leaves – Adathoda, Eucalyptus – Flower – Clove fruits seeds – Nux vomica Nutmegs, Gooseberry – unorganized drugs – Gum – *Acacia* – Resin – *Turpentine*, fixed oil – castor oil.

Unit – IV Herbal medicines for Human ailments – Drugs acting on cardiac diseases, cerebral diseases, Nasal, diseases – Blood pressure Drugs acting on Nervous system – Depressants. – stimulants – Respiration and Drugs – Urogenital system and drugs – Psychoactive plants.

Unit – V Propagation of medicinal plants – Micro and macro propagation conservation of rare medicinal plants Role of biotechnology in medicinal plants banks – cultivation of medicinal and aromatic plants – Drug adulteration- methods of Drug evaluation, Herbal food – Food processing – packaging – Herbal sale and Export of medicinal plants – marketing – Intellectual property rights – Export laws.

References

George Edward Trease and W.C. Evans - Pharmacognosy 12th edition, English Language Books Society, Baelliere Tindall.

Handa, S.S. and Kapoor, V.K. Pharamcognosy by 2nd Edition, Vallabh Prakashan Publishers, New Delhi.

Jain, S.K (1980) Indian Medicinal plants.

Kokate, C.K., Durohit, A.P. and Gokhale, S.R., Pharmacognosy by 12th edition – Nirali Prakasham Publishers, Pune.

Kumar N.C. (1993) An Introduction to Medical Botany and Pharmacognory.

Nadkarni (1981) Indian Materia Medica.

Shah, S.C. and Qudary (1990) A text book of Pharmacognosy.

Wallis, T.E, Text book of phamacognosy by 5th edition. CBS publishers and distributors, New Delhi.

Semester II

Core Course V (CC) -Microbial Physiology

Unit I – Cell structure and function

Biosynthesis of peptidoglycan - outer membrane, teichoic acid – Exopolysaccharides; cytoplasmic membrane, pili, fimbriae, S-layer. Transport mechanisms – active, passive, facilitated diffusions – uni, sym, antiports. Electron carries – artificial electron donors – inhibitors – uncouplers – energy bond – phosphorylation.

Unit II – Microbial growth

Phases of growth curve – measurement of growth – calculations of growth rate – generation time – synchronous growth – induction of synchronous growth, synchrony index – factors affecting growth – pH, temperature, substrate and osmotic condition. Survival at extreme environments – starvation – adaptative mechanisms in thermophilic, alkalophilic, osmophilic and psychrophilic. Bioluminescence - mechanism – advantages.

Unit III – Microbial pigments and carbon assimilation

Autotrophs - cyanobacteria - photosynthetic bacteria and green algae – heterotrophs – bacteria, fungi, myxotrophs. Brief account of photosynthetic and accessory pigments – chlorophyll – fluorescences, phosphoroscences - bacteriochlorophyll – rhodpsin – carotenoids – phycobiliproteins; Carbohydrates – anabolism – autotrophy – oxygenic – anoxygenic photosynthesis – autotrophic generation of ATP; fixation of CO₂ – Calvin cycle – C₃ – C₄ pathways. Chemolithotrophy – sulphur – iron – hydrogen – nitrogen oxidations. Brief account of methanotrophs in relation to CO₂ fixation.

Unit IV – Microbial respiration and fermentative pathway

Respiratory metabolism – Embden Mayer Hoff pathway – Enter Doudroff pathway – glyoxalate pathway – Krebs cycle – oxidative and substrate level phosphorylation – reverse TCA cycle – gluconeogenesis – Pasteur effect. Fermentation of carbohydrates – homo and heterolactic fermentations. Cell division – endospore – structure – properties – germination.

Unit V – Spore structure - function

Cell division – endospore – structure – properties – germination. Microbial development, sporulation and morphogenesis. Hyphae vs yeast forms and their significance. Multicellular organization of selected microbes. Dormancy.

References:

- Caldwell, D.R. (1995). Microbial Physiology and metabolism, Wm. C. Brown Publishers, USA
- Lansing M. Prescott, John P. Harley and Donald A. Klein. (2003). Microbiology.(5th edition).McGraw-Hill company, Newyork.
- Larry McKane and Judy Kandel.(1996). Microbiology-Essentials and applications.(2nd edition).McGraw Hill, Inc., Newyork.
- Moat, A.G. and Foster, J.W. (1988). Microbial Physiology (Second Edition). John Wiley & Sons, New York.
- Pelczar Jr, M.J. Chan, E.C.S. and Kreig, N.R. (1993). Microbiology, Mc. Graw Hill. Inc, New York.
- Salle,A.J. (1996). Fundamental principles of Bacteriology(7th edition).Tata McGraw-Hill publishing company limited, NewDelhi.
- White, D. (1995). The physiology and biochemistry of Prokaryotes, Oxford University Press, Oxford, New York.

Core Course VI (CC) – Environmental and Agricultural Microbiology**Unit I – Biogeochemical cycles & Air microbiology**

Roles of microbes in biogeochemical cycles – carbon, nitrogen, phosphorus, sulphur. Soil microbes and fertility of soil. Air microbiology: a brief account.

Unit II – Aquatic microbiology and bioremediation

Microbes in marine and fresh water environment – eutrophication – quality testing of water – water borne pathogens. Biodegradation and bioaccumulation – bioremediation concepts, microbial and phytoremediation – composting strategy for bioremediation. Waste water treatment and methods. Pollution indicators – BOD and COD determinations.

Unit III – Soil microbiology

Microbial association – beneficial – nitrogen fixing organism – symbiosis, asymbiosis, associate symbiosis – bacteria, actinomycetes, cyanobacteria – mycorrhiza – ecto and endo mycorrhiza – phosphate solubilizers – application of biofertilizers in agriculture.

Unit IV – Plant diseases and its control

Plant pathogens – bacterial – viral – fungal pathogens. Morphological, physiological changes with reference to disease establishment in plants – plant protection – phenolics – phytoalexins and related compounds. Bioinsecticides – viral, bacterial and fungal – a brief note.

Unit V – Nitrogen fixation and plant tumor

Biology of nitrogen fixation – nitrogen fixation genes and their regulation in *Klebsiella* – *Rhizobium* – *Azospirillum* & *Azotobacter*. Agrobacterium and plant tumour – Ti plasmids Ri plasmids – Genetic regulation of tumorigenity in plants. Brief account of Ti, Ri plasmids in Biotechnology.

References:

- Atlas Ronald, M., Bartha, and Richard (1987). Microbial Ecology 2nd Edition. Benjamin/Cummings Publishing Company, California.
- Dirk, J. Elsas, V., Trevors, J.T., Wellington, E.M.H. (1997). Modern Soil Microbiology, Marcel Dekker INC, New York, HongKong.

Ec Eldowney S, Hardman DJ, Waite DJ, Waite S. (1993). Pollution: Ecology and Biotreatment – Longman Scientific Technical.

Grant W.D. and Long, P.L. (1981). Environmental Microbiology. Blackie Glasgow and London.

Mitchel, R. (1992). Environmental Microbiology. Wiley – John Wiley and Sons. Inc. Publications, New York.

Clescri, L.S., Greenberg, A.E. and Eaton, A.D. (1998). Standard Methods for Examination of Water and Waste Water, 20th Edition, American Public Health Association.

Gerhardt, P., Murray, R.G., Wood, W.A. and Kreig, N.R. (1994). Methods for General and Molecular Bacteriology, ASM Publications, Washington D.C.

Patricia Cuning (1995). Official Methods of Analysis, Vol. I and II, 16th Edition, Arlington, Virginia, USA, AOAL.

Richard G. Burus and Howard Slater (1982). Experimental Microbial Ecology, Blackwell Scientific Publishers.

Tuffery (1996). Laboratory Animal, an Introduction, II Edition, John Wiley and Sons, New York.

Core Course VII (CC) Practical II- Environmental, agricultural Microbiology

Isolation and enumeration of soil microorganisms (fungi, bacteria and actinomycetes). Isolation and staining of *vesicular arbuscular mycorrhizae* from plant. Isolation and culturing of *Rhizobium* from root nodules. Isolation and testing of antagonistic microorganisms from soil (*Pythium* versus *Trichoderma*). Isolation of microorganisms from Rhizosphere and Rhizoplane. Testing nodulation ability of *Rhizobium*. Seed inoculation with *Rhizobium* and testing of nodulation ability.

Estimation of foliar infection by Stoyer's method. Study of the following diseases: Tobacco mosaic; Bacterial blight of paddy; Downy mildew of bajra; Powdery mildew of cucurbits; Head smut of sorghum; Leaf rust of coffee; Leaf spot of mulberry, Red rot of sugar cane, Root knot of mulberry.

Isolation and identification of air-borne bio-particles using Andersen sampler. Effects of high salt concentration on microbial growth. Oligodynamic action of heavy metals on bacteria. Microbial flora of polluted water/soil. Microbial flora of sewage. Determination of BOD of polluted/pond water. Determination of COD of polluted/pond water. Microbial degradation of cellulose (cotton) by *Trichoderma*

References:

Atlas Ronald, M., Bartha, and Richard (1987). Microbial Ecology 2nd Edition. Benjamin/Cummings Publishing Company, California.

Dirk, J. Elsas, V., Trevors, J.T., Wellington, E.M.H. (1997). Modern Soil Microbiology, Marcel Dekker INC, New York, HongKong.

Ec Eldowney S, Hardman DJ, Waite DJ, Waite S. (1993). Pollution: Ecology and Biotreatment – Longman Scientific Technical.

Grant W.D. and Long, P.L. (1981). Environmental Microbiology. Blackie Glasgow and London.

Mitchel, R. (1992). Environmental Microbiology. Wiley – John Wiley and Sons. Inc. Publications, New York.

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Gerhardt, P., Murray, R.G., Wood, W.A. and Kreig, N.R. (1994). Methods for General and Molecular Bacteriology, ASM Publications, Washington D.C.

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Richard G. Burus and Howard Slater (1982). Experimental Microbial Ecology, Blackwell Scientific Publishers.

Tuffery (1996). Laboratory Animal, an Introduction, II Edition, John Wiley and Sons, New York.

Elective Course – II (EC)

Intellectual Property Rights

UNIT I: Introduction-Invention and Creativity-Intellectual property(IP) -Importance-Protection of IPR-Basic types of property((i) Movable property (ii) Immovable property and (iii) Intellectual property)

UNIT II: IP-Patents-Copy rights and related rights- Trade Marks and rights arising from Trade mark registration-Definitions-Industrial Designs and Integrated circuits-Protection of Geographical Indications at national and International levels – Application procedures.

UNIT III: International convention relating to Intellectual property- Establishment of WIPO-Mission and Activities-History-General Agreement on Trade and Tariff (GATT).

UNIT IV: Indian position. Vs. WTO and Strategies-Indian IPR legislations-Commitments to WTO-Patent Ordinance and the Bill-Draft of a national Intellectual Property policy-Present against unfair competition.

UNIT V: Case studies on Patents -Basmati rice, Turmeric, Neem, etc.-Copy right and related rights-Trade Marks-Industrial Design and Integrated circuits- Geographic indications-Protection against unfair competition.

References:

Mittal, D.P. (1999) Indian Patents Law. Taxmann Allied Services (p) Ltd.

Subbaram N.R. “ Handbook of Indian Patent Law and Practice “; S. Viswanathan (Printers and Publishers) Pvt. Ltd., 1998.

Eli Whitney, United States Patent Number : 72X, Cotton Gin, March 14, 1794.

Intellectual Property Today : Volume 8, No. 5, May 2001, [www.iptoday.com].

Using the Internet for non-patent prior art searches, Derwent IP Matters, July 2000. [www.ipmatters.net/features/000707_gibbs.html.

Extra Disciplinary Course I (EDC) : Microbial Biotechnology

Unit I – Microbial Systems

Isolation of microorganisms - Principles of selective isolation – Pure and mixed cultures – The improvement of industrial microorganisms – Transcription and its control – Translation and its control – Aspect of protein synthesis in eukaryotes – protein secretion – regulation of enzyme activity – strain improvement – Mutation programmes.

Unit II – Growth and Fermentation Systems

Fermenter construction – Aeration and agitation – Sterilization of fermenters – Inoculation of fermenters – Accessory equipment – Air-lift fermenters – Continuous fermentation – Immobilized cell reactors.

Unit III – Enzyme Technology

Industrial enzymes – Immobilization of enzymes – Starch processing industry – Proteases – Other enzymes – Diagnostic enzymes – Enzyme analyzers and electrodes – Enzyme immunoassay – Therapeutic enzymes.

Unit IV –Foods and Beverages

Beer – Wine – Distilled spirits – Baker's yeast – Milk products – Organic acids – Single cell protein and oil – Amino acids – Vitamins – Flavorings.

Unit V – Fertilizers, fuels and fine chemicals

Fuel alcohol – Biogas – Enhanced oil recovery – Industrial chemicals – Acetone and butanol – Polysaccharides – Biofertilizers – Penicillin – Vaccines.

Reference:

Balasubramanian, D., Bryce, C., Dharmalingam, K., Green, J. and Jayaraman, K. (1999). Concepts in Biotechnology, University Press, India.

Colin Ratledge and Bjorn Kristiansen (2001). Basic Biotechnology, Cambridge University Press, UK.

Joshi, V.K., Ashok Pandey. (1999). Biotechnology, Food fermentation (Microbiology, Biochemistry and Technology) Vol. I & II Basic, Educational Publishers and Distributors, Ernakulam.

Whitaker Stanbury (1998). The principles of fermentation technology, Butterworth Heineman, U.K.

Vedpal's S. Malik, Padma Sridhar, Sharma, M.C. and Polasa, H. (1992). Industrial Biotechnology, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.

Extra Disciplinary Course II (EDC): BIOINFORMATICS

Unit I. Computer

Basics of computers – basic commands – file creation, copying, moving & deleting in Linux & Windows. Using email - Using browsers – search engines, - Pubmed.

Unit II – Databases

Biological resource databases – Examples and application – sequence Analysis – protein and nucleic acid.

Unit III – Genomics

Sequencing genomes – sequence assembly – genome on the web – annotating and analyzing genome sequences. – biochemical pathway databases.

Unit VI - Sequence analysis

Pair wise sequence comparison. protein data bank, Swiss-prot, Genebank – sequence queries against biological databases – BLAST and FASTA – multifunctional tools for sequence analysis. multiple sequence alignments, phylogenetic alignment – profiles and motifs.

Unit V. Proteomics

Proteomics: Protein structure prediction software. Profiles and motif. Statistical software available on the web and their use

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Baxevanis, A.D. & Ouellette, B.F.F. (2001). Bioinformatics: A practical guide to the analysis of genes and proteins – Wiley Interscience – New York

Cynthia Gibas & Per Jambeck (2001) Developing Bioinformatics Computer Skills: -Shroff Publishers & Distributors Pvt. Ltd (O'Reilly), Mumbai

Des Higgins & Willie Taylor (2000) Bioinformatics: Sequence, structure and databanks. Oxford University Press

HH Rashidi & LK Buehler (2002) Bioinformatics Basics: Applications in Biological Science and Medicine, CRC Press, London

Semester III

Core Course VIII (CC) – Immunology and Medical Microbiology

Unit I - Antigenes and Antibodies

History of Immunology - types of immunity – Innate and acquired - Passive and Active. Lymphoid organs – autoimmunity. Physiology of immune response – humoral and cell mediated immunity – immunohaematology Antigens – structure and properties – types – iso and allo – haptens; adjuvants – antigen specificity, vaccines and toxoids. Immunoglobulins – structure – heterogeneity – types and subtypes – properties (physico chemical and biological); Theories of antibody production. Complement – structure – components – properties and functions of complement components; complement pathways and biological consequences of complement activation.

Unit II – MHC and Tumor Immunology

Structure and functions of MHC and the HLA system. Gene regulation and Ir-genes. HL-A and tissue transplantation – tissue typing methods for organ and tissue transplantations in humans; graft versus host reaction and rejection. Autoimmunity – theories - mechanism and disease with their diagnosis. Tumor immunology – tumor antigens – immune response to tumors - immunodiagnosis of tumors – detection of tumor markers – alphafoetal proteins, carcinoembryonic antigen *etc.*, Immunotherapy of malignancy. Autoimmune diseases – monoclonal antibody – production and their applications.

Unit III – Microbial pathogens

Early discovery of pathogenic microorganisms; development of bacteriology as scientific discipline; contributions made by eminent scientists. Classification of medically important microorganisms; Normal microbial flora or human body; role of the resident flora; normal flora and the human host. Classification of pathogenic bacteria: *Staphylococcus*, *Streptococcus*, *Pneumococcus*, *Neisseria*, *Corynebacterium bacillus*, *Clostridium*, Non sporing Anaerobes, Organisms belonging to *Enterobacteriaceae*, *Vibrios*, Non fermenting gram negative bacilli *Yersinia*; *Haemophilus*; *Bordetella*, *Bucella*; *Mycobacteria*, *Spirochaetes*, *Actinomycetes*, *Rickettsiae*, *Chlamdiae*.

Unit IV Clinical Microbiology

Diagnosis of the following diseases.

Disease	Pathogen
a. Pneumonia	<i>Streptococcus pneumoniae</i>
b. Whooping –cough	<i>Bordetella pertussis</i>
c. Meningitis	<i>Haemophilus influenzae</i>
d. Diphtheria	<i>Corynebacterium diphtheriae</i>
e. Pulmonary Tuberculosis	<i>Mycobacterium tuberculosis</i>
f. Leprosy	<i>Mycobacterium leprae</i> .
g. Typhoid	<i>Salmonella typhi</i>
h. Cholera	<i>Vibrio cholerae</i> .
i. Tetanus	<i>Clostridium tetani</i>
j. Syphilis	<i>Treponema pallidum</i>

k. Gonorrhoea	<i>Neisseria gonorrhoeae</i>
l. Dental caries	<i>Streptococcus mutans</i>
m. Dysentery	<i>Shigella dysenteriae</i>
n. Bacterial food poisoning	<i>Clostridium botulinum</i>
o. Gastroenteritis	<i>Escherichia coli</i>

Unit V – Viral, protozoan and helminth – Common diseases

Virus: Small pox, Influenza, Measles, Poliomyelitis, Common cold (Rhino virus), Hepatitis, *Encephalitis*, Rabies, AIDS. Protozoa: Amoebiasis – *Entamoeba histolytica*, Malaria – *Plasmodium vivax*, *P. malariae*. Helminths: Liverfluke – *Fasciola hepatica*, Filariasis – *Wuchereria bancrofti*. Hospital acquired infection: Hospital infections Principles of control committee – functions; Hospital waste disposal – Ethical committee – functions.

References:

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- Donald M. Weir, John Steward. (1993). Immunology VII edition. ELBS, London.
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- Ivan M. Roit. (1994) Essential Immunology – Blackwell Scientific Publications, Oxford.
- Paul (1998). Fundamental Immunology, II Edition, Raven Press, New York.
- Peter J. Delves, Ivan M. Roit (eds) (1998) Academic Press – Encyclopedia of Immunology – 2nd edition.
- Ridklad, M. Aycl (1995). Immunology, II Edition, Baltimore, HongKong, NMS Publication.
- Roit, J.M. Brostoff, J.J. and Male, D.K. (1996). Immunology (4th Edition) C.V. Mosby Publisher, St. Louis.
- Collee, J.G., Duguid, J.P., Fraser, A.G. and Marimoin, B.P. (1989). Mackie and Mc Cartney Practical Medical Microbiology, 13th edition. Churchill Livingstone.
- David Greenwood, Richard CD., Slack, John Forrest Peutherer. (1992). Medical Microbiology. 16th edition. ELBS with Churchill Livingstone.
- Joan Stokes, E., Ridgway GL and Wren MWD (1993). Clinical Microbiology, 7th edition, Edward Arnold. A division of Holder and Stoughton.
- Tom Parker, M., Leslie H. Collier (1990). Topley & Wilson's Principles of Bacteriology, Virology and Immunity (VIII Edition).

Core Course IX(CC) – Molecular Genetics

Unit I – Nucleic acid as genetic material and mutagenesis

Nucleic acids as genetic information carriers: experimental evidence. – concept of gene – allele, cistron, regilon – origin of mutation– mutagens – physical and chemical agents. Induced mutation types – mechanisms of mutation induction – suppression of mutations – Intergenic and intragenic suppression. Frame shift mutations – reversion – fine structure mapping – rII mutants of T4 – fluctuation test

Unit II – Transformation

Transformation – natural or artificial competence – transformation in *Bacillus*, *E. coli*, *Haemophilus* and *Streptococcus* – mechanism of recombination – genetic mapping.

Unit III - Conjugation

Bacterial conjugation – F plasmid – structure and functions. Origin of Conjugation – Hfr and F' strains. Interrupted and uninterrupted mating – time map and recombination map. Conjugation in *E. coli*, *Pseudomonas*, *Streptomyces*. Plasmids, F- factors description and their uses in genetic analysis. Colicins and col factors.

Unit IV – Transduction

Transduction – generalized and specialized transduction – λ phage and P1 phage – mechanism of gene transfer through lambda and P1 phages. HFT and LFT lysate. cotransduction – transduction mapping.

Unit V – Gene regulation

Regulation of bacterial gene expression – Operon model – lac, ara, trp and his operons, operon concept, catabolite repression, instability of bacterial RNA, positive and negative regulation, inducers and corepressors. Negative regulation – *E.coli lac* operon; positive regulation – *E. coli ara* operon; regulation by attenuation – *his* and *trp* operons; antitermination – N protein and nut sites in I. Induction and repression mechanism in operons.

References:

- Freidberg, E.C., Walker, G.C., Siede, W. (1995). DNA repair and Mutagenesis, ASM Press, Washington D.C.
- Lewin, B, (2000). Genes VII. Oxford University Press.
- Maloy, S.R., Cronan Jr. Je. Freifelder D (1998). Microbial genetics. Jones and Barlett Publishers.
- Malacinski, M. and Freifelder, D. (1998). Essential of Molecular Biology. III Edition. Jone and Barlett Publishers, Boston.
- Maloy, S.R., Cronan, J.R. Freifelder, D. (1994). Microbial Genetics, Jones and Bartlett Publishers.
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- Watson, J.D., Hopkins, N.H., Roberts, J.W., Steitz, J.A. and Weiner, A.M. (1998). Molecular biology of the gene, 4th edition, Benjamin/Cummings publishing company.

Core Course X (CC) – Molecular Biology and Genetic Engineering

Unit I – DNA structure, replication and repair

DNA structure: historical aspects and current concepts, melting of DNA. DNA replication: general principles, continuous and discontinuous synthesis, various modes of replication. Prokaryotic and eukaryotic DNA polymerases, structure and functions. Superhelicity in DNA, topological properties, mechanism of action of topoisomerases. Inhibitors of DNA replication (blocking precursor synthesis, nucleotide polymerization, altering DNA structure). DNA damage and repair: types of DNA damage (deamination, oxidative damage, alkylation, pyrimidine dimers). Repair pathways – methyl-directed mismatch repair, very short patch repair, nucleotide excision repair, base excision repair, recombination repair, SOS system.

Unit II – Transcription and regulation

DNA binding proteins, enhancer sequences and control of transcription. Identification of protein-binding sites on DNA. Structural features of RNA (rRNA, tRNA and mRNA) in relation to function. - Transcription: general principles - basic apparatus - types of RNA polymerases, Processing steps initiation, elongation and termination, inhibitors of RNA synthesis. Polycistronic and monocistronic RNAs. Regulation of transcription; RNA polymerases and promoter interaction, alternate sigma factors, controlled termination: attenuation and antitermination. Global regulatory responses - heat shock response - stringent response and regulation by small molecules such as ppGpp and cAMP, regulation of rRNA and tRNA synthesis. Maturation and processing of RNA: methylation, cutting and trimming of rRNA; capping, polyadenylation and splicing of mRNA ; cutting and modification of tRNA degradation system. Catalytic RNA, group I and group II intron splicing, RNase P.

Unit III – Genetic engineering Principle

Restriction and modification in bacteria *E. coli* K & B system; Restriction endonucleases type I, II, III - Ligases. Vectors – plasmids – phages, cosmids, phagemids, special vectors – broad host range, expression, integrating shuttle vectors – yeast vectors. Principles of gene cloning – □ complementation, genomic library & cDNA library – shot gun cloning – screening of recombinants – phenotypic expression of characters – colony hybridization – southern hybridization – use of antibody – Western blot – Physical mapping of the cloned gene.

Unit IV – PCR techniques

PCR technology – Gene amplification, PCR primer designing and optimization; variations in PCR (RT PCR, RACE) RAPD, RFLP and site directed mutagenesis – DNA sequencing – Manual and automated chromosome walking – DNA foot printing.

Unit V – Microbial products through genetic engineering

Cloning of human insulin, Interferon in *E. coli* – Human antibody production by rDNA technology – Vaccine production. Plant genetic engineering – Ti plasmid, CaMV vector – DNA delivery to plant protoplast – transgenic plants – cloning of endotoxins – *Cry* gene – Herbicidal resistance.

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- Brown, T.A. (199). Gene Cloning. 3rd edition. Chapman and Hall Publications, USA.
- Burrell, M.M. (1993). Enzymes of Molecular Biology, Humana Press.
- Chirikjian, J.G. (1995). Biotechnology – Theory and Techniques, Vol. II, Jones and Bartlett Publishers.
- Gerhardt, P. Murray, R.G., Wood, W.A., and Kreig, N.R. (1994). Methods for General and Molecular Bacteriology, ASM Press, Washington D.C.
- Glezk, B.R. and Pasternak, J.J. (1998) Molecular Biotechnology – Principles and Applications of Recombinant DNA, ASM Press, Washington D.C.
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Walsh, G. and Headon D. (1994). Protein Biotechnology, John Wiley and Sons, New York.

Winnacker, E.L. (1987). From genes to Clones: Introduction to Gene technology. VCH Publications, Federal Republic of Germany.

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Bruce Alberts, Dennis Brag, Julian Lewis, Martin Raff, Keith Roberts, James D. Watson. (1994). Molecular Biology of cell. Garland Publishing Inc.

George M. Malacinski, David Freifelder. (1998). Essentials of Molecular Biology. Jones and Bartlett Publishers.

Maloy, S.R., Cronan, J.R. Freifelder, D. (1994). Microbial Genetics, Jones and Bartlett Publishers.

Macinski, G.M. and Freifelder, D. (1998). Essentials of Molecular Biology, 3rd Edition, John and Bartlett Publishers.

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Core Course XI (CC) :

Practical III Molecular Biology Genetic Engineering, Immunology and Medical Microbiology

Isolation of antibiotic resistant/ auxotrophic mutants through physical and chemical agents induced mutagenesis. Transformation of *E. coli* Isolation of plasmid (pBR322/pBluescript) from *E. coli* – Separation by agarose gel electrophoresis. Restriction digestion of plasmid – single and double digestion – Determination of molecular weight – physical mapping. Cloning of fragment in pBR322/ pBluescript – insertional inactivation/blue white selection. Reisolation of plasmid from the recombinant clone, restriction digestion and agarose gel electrophoresis – confirmation of size of insert. IPTG induction of expression of cloned gene in *E. coli*. PCR amplification of DNA, RAPD, RFLP: gel electrophoresis – analysis of fragments.

Testing sensitivity of bacteria to antibiotics. Assessing minimum inhibitory concentration of antibiotics. Isolation and identification of certain pathogenic microbes from – wound, pus, faces, sputum, urine. Red blood cell counts. White blood cell – total count and differential count. Erythrocyte sedimentation rate (ESR). Haemoglobin content of blood. Serum analysis:- Sugar, cholesterol, serum glutamate oxalacetate transaminase (SGOT), serum glutamic pyruvic transaminase (SGPT). Urine analysis – Albumine, bile, sugars. Preparation of histopathological specimens.

Slide agglutination/precipitin tests. Demonstration of RIA/ELISA. Dissection and demonstration of major lymphoid organs and tissues in experimental animals. Preparation of bacterial parasite antigens (crude preparation) by homogenization sonication. Raising polyclonal antisera in experimental animals – Rabbits or Mouse. Agglutination & Haemagglutinin reaction: Latex Agglutination – RF, ASOL, CRP. Blood grouping. Rh-Typing/IHA/RPHA. Precipitation reactions in gels: single radial immunodiffusion, Double immunodiffusion, Immuno electrophoresis and staining of precipitation lines.

Reference:

Ausubel, F.M., Brent, R., Kingston, R.E., Moore, D.D., Seidman, J.G., Smith, J.A. and Struhl, K. (1994). Current Protocols in Molecular Biology.

Gerhardt, P., Murray, R.G., Wood, W.A. and Kreig, N.R. (1994). Methods for General and Molecular Bacteriology.

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Ronald M. Atlas, Lawrence C. Papis (1993) Hand book of Microbiological Media. Ed. LC. CRC Press, London.

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Lorian, V. (1991) Antibiotics in laboratory medicine, 3rd edition, Williams and Wilkins, Baltimore.

Elective Course III (EC) – Biological Techniques

Unit I Microscopy and Related Techniques

Light Microscopy : Microscopic optics, components of microscopes. Basic principles and method of Bright field, Dark field, Phase contrast. Fluorescence, Polarization and confocal microscopes.

Applications of various types of microscopy such as immunofluorescence – *In situ* hybridization.

Electron Microscopy – Principle, Techniques and applications of Transmission Electron microscope (TEM) and Scanning Electron Microscope (SEM), Atomic Force Microscope (AFM).

Photomicrography and Video micrography
Developing and printing of microphotographs

Unit II Analytical Techniques

Spectroscopic methods – UV-Visible, Atomic Absorption Spectrophotometer, Atomic Emission Spectroscopy.

Centrifugation – Principles, various types including centrifugation Electroanalytical methods – electrolytic all 4 galvanic cell – Potentiometric, conductimetric, coulometric & voltametric analysis. Biosensors.

Radioactive Analysis : Principles of radioactivity, GM counter & LS counter.

Unit III Principles & Applications of Chromatographic Techniques :

Adsorption – Ion exchange and gel permeation – affinity chromatography for separation of compounds including GC and HPLC.

Unit IV - Electrophoresis Techniques

Electrophoretic techniques – protein – nucleic acid – immuno – two dimensional electrophoresis.

Unit V Molecular Biological Techniques

- a) Microbiological techniques – purification, storage, measurement of microbial growth rate.
- b) Isolation and amplification of nucleic acid – Plasmid isolation, chromosomal DNA isolation. Polymerase chain reaction.
- c) Gene cloning techniques – Restriction digestion and Phosphatase treatment of cloning vectors. Cloning technique, separation and staining of DNA, qualification of DNA, gene transfer mechanisms – chemical and electroporation.
- d) Methods of detection of clones – Nucleic acid transfer by blotting, Hybridization plaque, colony hybridization, histochemical detection of β -galactosidase, antibody screening including colour development reaction.

Reference:

Cynthia Gibas & Per Jambek (2001). Developing Bioinformatics Computer Skills, Shroff Publishers & Distributors Pvt. Ltd., O'reilly) Mumbai.

Demain, A.L. and Davies, J.E. (1999). Manual of Industrial Microbiology & Biotechnology, ASM Press.

Glick, B.R. and Pasternak, J.J. (1994). Molecular Biotechnology, ASM Press.

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Sambrook, J. and Russell, D.W. (2001) Molecular Cloning – A Laboratory Manual (3rd edition, Vol. 1,2,3) Cold Spring Laboratory Press, New York.

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Semester IV

Core Course XII (CC) - Bio process Technology

Unit I – Industrially important microbes and their development

Screening methods for industrial microbes – detection and assay of fermentation products – classification of fermentation types – genetic control of fermentation – strain selection and improvement. Mutation and recombinant DNA techniques for strain development.

Unit II – Fermenter – types and function

Fermenters – Basic functions, design and components – asepsis and containment requirements – body construction and temperature control – aeration and agitation systems – sterilization of fermenter, air supply, and medium; aseptic inoculation methods – sampling methods, valve systems – a brief idea on monitoring and control devices and types of fermenters.

Continuous culture: System, productivity, product formation. Aeration and agitation, power requirement oxygen transfer kinetics, concepts of Newtonian and Non-Newtonian fluids, plastic fluids apparent viscosity, foam and antifoam. Scale-up, instrumentation control, physical and chemical environment sensors, downstream process.

Unit III – Food microbiology

Microbiology of fermented milk – starter cultures, butter milk, cream, yoghurt, kafil, kumiss, acidophilus milk and cheese. Microbes as sources of food (*Spirulina*, *Saccharomyces cerevisiae*, *Rhizopus* sp.). Food and water borne infections and food microbial poisoning. Food sanitation in food manufacture and in the retail trade; Food control agencies and its regulations.

Unit IV – Large scale fermentation

Fermentation in batch culture: Microbial growth kinetics, measurement of growth (cell number, direct and indirect methods) growth and nutrient, growth and product formation, heat evolution, effect of environment (temperature, pH, high nutrient concentration) media formulation. Sterilization, kinetics of thermal death of micro-organisms, batch and continuous sterilization. (All in relation to fermentation).

Unit V - Legal protection and IPR

GATT and IPR, forms of IPR, IPR in India, WTO ACT, Convention on Biodiversity (CBD), Patent Co-operation Treaty (PCT), forms of patents and patentability, process of patenting, Indian and international agencies involved in IPR & patenting, Global scenario of patents and India's position, patenting of biological materials.

Reference:

- Demain, A.L. and Davies, J.E. (1999). Manual of Industrial Microbiology and Biotechnology. ASM Press.
- Glick, B.R. and Pasternak, J.J. (1994). Molecular Biotechnology, ASM Press.
- Stanbury, P.F., Whitaker, A. and Hall, S.J. Principles of Fermentation Technology, Pergamon Press.
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- Venkataraman, L.V. (1983). A monograph on *Spirulina platensis*, CFTRI, Mysore.

Core Course XIII (CC) – Biostatistics and Bioinformatics

Unit I – Definitions

Scope of biostatistics, probability analysis – variables in biology, collection, classification and tabulation of data – graphical and diagrammatic representation – scale diagrams – histograms –

frequency polygon – frequency curves. Measures of central tendency – arithmetic mean, median and mode – calculation of mean, median, mode in series of individual observations, discrete series, continuous open – end classes. Measure of dispersion – standard deviation and standard curves. Measures of central tendency on variance.

Unit II – Correlation and regression

Simple correlation – correlation coefficient – regression simple linear regression. Basic ideas of significance test – Hypothesis testing level of significance – Test based on student 't' 'chi' square and goodness of fit. 'F' test - ANOVA.

Unit III – Databases

Biological resource databases – Examples and application – sequence Analysis – protein and nucleic acid.

Unit IV – Genomics and proteomics

Sequencing genomes – sequence assembly – genome on the web – annotating and analyzing genome sequences. proteomics – biochemical pathway databases.

Unit V - Sequence analysis

Pair wise sequence comparison. protein data bank, Swiss-prot, Genebank – sequence queries against biological databases – BLAST and FASTA – multifunctional tools for sequence analysis. multiple sequence alignments, phylogenetic alignment – profiles and motifs.

Reference:

Arora PN & Malhon PK, (1996) Biostatistics. Imalaya Publishing House, Mumbai.

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Semester IV

Core Course XIV Project work
