BHARATHIDASAN UNIVERSITY, TIRUCHIRAPPALLI – 620 024.

M.Sc. Microbiology Course Structure under CBCS

(For the candidates admitted from the academic year 2016-2017 onwards)

Sem	Course	Course Title	Ins. Hrs / Week	Credit	Exam Hrs	Marks		Total
						Int.	Ext.	
I	Core Course – I (CC)	Fundamentals of Biological Sciences	6	4	3	25	75	100
	Core Course – II (CC)	General Microbiology	6	4	3	25	75	100
	Core Course – III (CC)	Virology	5	4	3	25	75	100
	Core Course – IV (CC)	General Biochemistry	5	4	3	25	75	100
	Core Practical – I (CP)	Fundamentals of Biological Sciences, General Microbiology, Virology, General Biochemistry	8	4	3	40	60	100
		TOTAL	**30**	**20**				**500**
II	Core Course – V (CC)	Microbial Physiology	6	5	3	25	75	100
	Core Course – VI (CC)	Environmental and Agricultural Microbiology	6	5	3	25	75	100
	Core Practical – II (CP)	Microbial Physiology, Environmental and Agricultural Microbiology	8	4	3	40	60	100
	Elective Course – I (EC)	Any one from the list	5	5	3	25	75	100
	Elective Course – II (EC)	Any one from the list	5	5	3	25	75	100
		TOTAL	**30**	**24**				**500**
III	Core Course – VII (CC)	Molecular Biology and Microbial Genetics	6	5	3	25	75	100
	Core Course – VIII (CC)	Immunology	6	5	3	25	75	100
	Core Practical – III (CP)	Molecular Biology and Microbial Genetics, Immunology	8	4	3	40	60	100
	Elective Course – III (EC)	Any one from the list	5	5	3	25	75	100
	Elective Course – IV (EC)	Any one from the list	5	5	3	25	75	100
		TOTAL	**30**	**24**				**500**
IV	Core Course – IX (CC)	Medical Microbiology	5	5	3	25	75	100
	Core Course – X (CC)	Bioprocess Technology	5	5	3	25	75	100
	Core Practical - IV (CP)	Medical Microbiology and Bioprocess Technology	8	4	3	40	60	100
	Elective Course – V (EC)	Any one from the list	5	4	3	25	75	100
	Project		7	4	-	-	-	100
		TOTAL	**30**	**22**				**500**
		GRAND TOTAL	**120**	**90**				**2000**

Note:

Project : 100 Marks
Dissertation : 80 Marks
Viva Voice : 20 Marks

Core Papers - 10
Core Practical - 4
Elective Papers - 5
Project - 1

Note:

1. Theory	**Internal**	**25 marks**	**External**	**75 marks**
2. Practical	**”**	**40 marks**	**”**	**60 marks**

3. Separate passing minimum is prescribed for Internal and External

a) The passing minimum for CIA shall be 40% out of 25 marks (i.e. 10 marks)
b) The passing minimum for University Examinations shall be 40% out of 75 marks (i.e. 30 marks)
c) The passing minimum not less than 50% in the aggregate.

Reference/Text Books contain the following details:

I. Name of the Author
II. Title of the Book
III. Name of the Publisher
IV. Year

S.No	Semester	Elective papers (Any one from the list)
1.	II	Biological Techniques
2.	II	Food and Dairy Microbiology
3.	II	Molecular Taxonomy and Phylogeny
4.	II	Quality control and IPR
5.	III	Medical Laboratory Technology
6.	III	Marine Microbiology
7.	III	Bioinformatics and Biostatistics
8.	IV	Genetic Engineering
9.	IV	Microbial Biotechnology
10.	IV	Microbial Nanotechnology

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CORE COURSE I

FUNDAMENTALS OF BIOLOGICAL SCIENCES

OBJECTIVE

To enable the students to understand the basic knowledge in Biological Sciences

Unit I Algae and Fungi

Thallophytes: Algae-General characteristics- Economic importance- Types of life cycle- Outline of various classifications. Fungi: General characteristics- Classifications and Economic importance

Unit II Plant reproduction

General characteristics- Economic importance and outline of reproduction methods in Bryophytes, Pteridophytes and Gymnosperms.

Unit III Plants

Basics of plant cell – Monocot and dicot - Classification of plant diversity – Classes of plant kingdom- Morphology: Inflorescence types -Racemose, cymose, and Mixed –Special types, Cyathium, Hypanthodium, Verticillaster and Thyrsus. Technical description of flower and floral diagram- Microsporangium and structure of *Polygonum* type embryo sac- Taxonomy: Systems of classification, (Artificial, Phylogenetic and Natural). Outline of Bentham and Hooker's classification.

Unit IV Invertebrates

General characteristics and outline classification upto classes in Protozoa, Porifera, Coelenterata, Platyhelminthes and Ashelminthes; Economoic importance of invertebrates. Classification of Chordata – Characteristic features - protochordata class – Pisces and Amphibia up to orders - General characters - a brief study on Star fish.

Unit V Vertebrates and pests control

Salient features of Reptilia, Aves and Mammalia- Economic importance of Vertebrates. Bioluminescence. Insect pests of rice, sugarcane, coconut, cotton, vegetables, fruits and stored products (with an example of each). Principles of insect control: physical, mechanical, chemical, biological and integrated methods of pest control.

REFERENCES

1. Arumugam N. Invertebrate Zoology, Saras publication, Nagercoil.2002.
2. Ekambaranatha Iyar M and Ananthakrishnan TN. Manual of Zoology. Vol. I. part I and II, S. Visvanathan publication, Chennai.1994.
3. Ayyar EK and Ananthakrishnan. A Manual of Zoology, Vol. II (Chordata).1992.
4. Ekambaranatha Iyar M and Ananthakrishnan TN. Manual of Zoology Vol.II. S. Visvanathan publication, Chennai.1994.
5. Ranganathan TN.Chordata Zoology, Rainbow printers, Palayamkottai.1996.
6. Ekambaranatha Ayyar. Outlines of Zoology. Vols. I and II S. Viswanathan (Printers and Publishers) Pvt. Ltd., Chennai.1993.
7. Kotpal RL. Invertebrata, Rastogi Publication, Meerut.2000.
8. Jordan EL and Verma PS. Invertebrate Zoology, 12th Edition, S. Chand and Co.1995.
9. Mani MS. General Entomology, Oxford and IBH publishing Co., New Delhi. 1982.
10. Nayar KK, Ananthankrishnan TN and David M. General and applied Entomology, Tata McGraw Hill Pub. Co., Ltd., New York. 1995.
11. David BV. Pest Management and pesticides Indian Scenario, Namrutha Publications.1992.
12. Krishnan NT. Economic Entomology, J.J. Publications, Madurai. 1993.

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CORE COURSE II

GENERAL MICROBIOLOGY

OBJECTIVE

To enable the students to understand the basic knowledge in Microbiology

Unit I Ultra structure and function

Bacteria: Morphological types; cell wall – cell walls of Gram negative, Gram positive, halophiles. L-forms and Archaebacteria, Cell wall synthesis, cell membrane, capsule type's composition and function. Structure and function of flagella, fimbriae 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.

Unit II Microbial Classification

Microbial Taxonomy - Definition and systematics, Nomenclature and identification. Haeckel's three kingdom classification, Whittaker's five kingdom approach. Three domain classification; Taxon, species, strain, type culture; Major characteristics used in taxonomy – morphological, physiological, metabolic, serological and molecular. Phylogenetic relationships – Cladogram, Dendrogram; Classification and salient features of bacteria according to Bergey's Manual of Determinative Bacteriology (9^{th} edition).

Unit III Fungi and Viruses

Fungi: Classification of fungi based on Alexopoulos system. - characteristics of Fungi – Filamentous, non-filamentous and dimorphic fungi -Morphology, structure and life cycle of *Aspergillus niger* and *Saccharomyces cerevisiae.* Parasitism, mutualism and symbiosis with plants and animals. Industrial uses of yeast and moulds. Viruses: ICTV system of classification, General properties, Morphology and ultra-structure of virus - capsid and their arrangements, types of envelopes and their composition, viral genome (RNA, DNA); Viroids, Prions - structure and importance.

Unit IV Algae and Protozoans

Classification of Algae based on Fritsch system – General characters of Blue-green Algae (Cyanobacteria) Macroalgae - Biological and Economic importance of algae. Protozoa –structural characteristics, classification and reproduction.

Unit V Cultivation methods of microbes

Isolation of different types of bacteria - Fungi – Actinomycetes - Cyanobacteria - Protozoa. Physical and Chemical requirements for growth; Pure culture methods. Anaerobic culture techniques. Preservation methods of microbes. Type culture collections. Physical and chemical methods of controlling microorganisms.

REFERENCES

1. Alcamo E. Fundamentals of Microbiology. 6th Ed., Jones and Bartlett Publishers, New Delhi. 2001.
2. Alexopoulos CJ, Mims CW and Blackwell M. Introductory Mycology. Fifth edition John Wiley and Sons. Chichester. 2000.
3. Holt JS, Kreig NR, Sneath PHA and Williams ST. Bergey's Manual of Determinative Bacteriology (9th Edition), Williams and Wilkins, Baltimore.1994.
4. Dubey RC and Maheswari DK. A Text Book of Microbiology. S Chand, New Delhi. 2010.
5. Dube HC. Introduction to Fungi. Vikas publishing pvt. Ltd. New Delhi. 2009.
6. Johri RM, Snehlatha, Sandhya Shrama. A Textbook of Algae. Wisdom Press, New Delhi. 2010.
7. Kanika Sharma. Textbook of Microbiology – Tools and Techniques. 1st edition, Ane Books Pvt. Ltd., New Delhi. 2011.
8. Madigan MT, Martinko JM, Dunlap PV and Clark DP. Brock Biology of Microorganisms. 12th Ed. Pearson/ Prentice Hall.2008.
9. Pelczar TR, Chan ECS and Kreig NR .Microbiology. 5th Edition, Tata McGraw – Hill, New Delhi.2006.
10. Prescott LM, Harley JP and Klein DA. Microbiology. 7th edition, McGraw Hill, Newyork. 2008.
11. Salle AJ. Fundamental principles of Bacteriology.7th edition, Tata McGraw-Hill publishing company Ltd, New Delhi. 2001.
12. Schlegel HG. General Microbiology, Cambridge University Press, UK. 2008.

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CORE COURSE III

VIROLOGY

OBJECTIVE

The course is designed to develop the student with enough knowledge about general account of viruses, bacteriophages, plant, animal and human viral diseases. To train up the student in gaining knowledge about instrumentation relevant to virology

Unit I General Virology

Terminologies , Discovery, nomenclature, classification and properties of viruses, Morphology and ultra structure – capsid and their arrangement, envelope - types and their composition, viral genome – types and structure. Sub viral agents- viroids, prions, virusoids and satellite viruses.

Unit II General Methods of Diagnosis and Serology

Characterization and Cultivation of viruses- Embryonated eggs, Primary and secondary cell cultures, monolayer cell cultures- cell strains, cell lines and transgenic system. Serological methods- haemagglutination, haemagglutination inhibition, complement fixation, immunofluorescence, ELISA, RIA and assay of viruses.

Unit III Microbial Viruses

Bacteriophages- one step growth curve, Life cycle- Lytic and Lysogenic, Classification, Morphological groups - virulent dsDNA phage, ssDNA phage, phage lambda, Temperate and Transposable phage, Phage Mu, M13, T4, P1, Bacteriophage typing, Phage therapy (bacteriophage therapy), Cyanophages, Mycoviruses (Mycophages), Rhizobiophages.

Unit IV Animal and Human Viruses

Classification, Multiplication, Epidemiology, Pathogenesis, Diagnosis, Prevention and Treatment of animal viruses- DNA containing viruses- Papovavirus, Simian Virus – 40 (SV40), Adenoviruses, Herpes viruses, Pox viruses. RNA containing viruses- Picornavirus, Togaviruses (Arboviruses), Rhabdoviruses, Orthomyxoviruses, Reoviridae, Retroviridae, Human Immuno Deficiency virus (HIV), SARS, Influenza viruses and Emerging viruses. Viral Vaccines, Interferon and Antiviral drugs.

Unit V Plant Viruses

History, Classification and nomenclature of plant viruses, Transmission, Multiplication, symptoms and control of plant viral diseases- Tobamo virus group, Potex virus, Poty virus, Tymo virus, Tomato spotted wilt, Cauliflower mosaic virus, Potato leaf roll virus, Rice tungro virus, Mosaic disease of sugarcane.

REFERENCES

1. Alan J. Cann. Principles of Molecular Virology. 6th edition, Academic press, California. 2015.
2. Ann Giudici Fettner. The science of viruses. 2nd edition, Quill, William Marrow, New York. 1990.
3. Baishali C, Sumanta K Dutta, PatraLekha RC and Ranjita S. Topley and Wilson's: Principles of bacteriology, Virology and immunity. 11th edition, vol 4, Edward Arnold, London. 2005.
4. Dimmock NJ and Primerose SB. Introduction to modern virology. 6th edition. Blackwell scientific publication, Oxford, London. 2007.
5. Dimmock NJ, Easton AJ and Leppard K. Introduction to Modern Virology, Oxford: Blackwell Publishers, London. 2007.
6. James G Cappuccino and Natalie Sherman. Microbiology. 10th edition, The Benjamin/Cummings pub.co. California. 1996.
7. John Carter and Venetia Saunders. Virology: Principles and applications, 2nd Edition, John wiley and son's publishers, USA. 2013.
8. Kenneth M Smith. A text book of plant viral diseases, 3rd edition, Elsevier Inc, New York. 1972.
9. Morag C Timbury. Medical virology. 11th edition. Churchill Livingston, London. 1997.
10. Maureen A Harrison and Ian F Rae. General techniques of cell cultures, Cambridge University Press, England. 2010.
11. Nayudu MV. Plant viruses, Tata Mc Graw Hill education, US. 2008.
12. Nicklin J, Greame Cook and Killington, R. Instant notes in Microbiology, 2nd Edition, Viva Books private Limited, New Delhi. 2003.
13. Robert I Krasner. The Microbial challenge: Human Microbe Interaction, American Society for Microbiology, 2nd edition, Washington. 2002.
14. Roger Hull. Mathews' Plant Virology, 4th edition, Academic press- A Harcourt Science and technology company, New York. 2002.
15. Villarreal LP. Viruses and the Evolution of Life. ASM Press, Washington DC. 2005.

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CORE COURSE IV

GENERAL BIOCHEMISTRY

OBJECTIVES

To provide basic understanding of Cell and its function, chemical nature of biological macromolecules, metabolism and mechanism of molecular recognition including control.

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. Enzyme inhibition.

Unit III Types of macromolecules and their biosynthesis

Structural features and chemistry of macromolecules. Nucleic acid – properties, biosynthesis 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. Lipids and biomolecules: Fatty acids, properties, -oxidation - biosynthesis of cholesterol.

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 - vitamins and their role as coenzymes.

REFERENCES

1. Christopher K Mathews and Van Holde KE. Biochemistry. 2nd edition. The Benjamin/Cummings publishing company, Inc.1996.
2. David E Metzler and Carol M Metzler. Biochemistry -The chemical reactions of living cells- Vol1and2.2nd edition. Harcourt/Academic press, Newyork. 2001.
3. Donald Voet and Judith G. Voet. Biochemistry – Second Edition. John Willey and Sons, Inc.1995.
4. Freifelder D. Molecular Biology, II Edition, Narosa Publishing House, New Delhi.1996.
5. Geofferey L and Zubay. Biochemsitry. Fourth Edition.Wm. C. Brown Publishers.1998.
6. Jeremy M Berg, John L Tymoczko and Lubert stryer. Biochemistry.5th edition.W.H.Freeman and company, Newyork.2002.
7. Stryer L Berg JM and Tymoczko JL. Biochemistry. 5th edition. New York: W. H. Freeman. 2002.
8. Reginald H Garret and Charles M Grishm. Biochemistry (Second Edition) Saundars College Publishing.1998.
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12. Rafi MD. Textbook of Biochemistry for medical students, 2nd edition, Universities Press, (India) Pvt. Ltd, Hyderabad, India. 2014.

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CORE PRACTICAL I

FUNDAMENTALS OF BIOLOGICAL SCIENCES, GENERAL MICROBIOLOGY, VIROLOGY, GENERAL BIOCHEMISTRY (P)

Fundamentals of Biological Sciences

- Stem and root sections of a monocot and a dicot plant
- Demonstration of computer program- Vertebrate Dissection Guides: The Frog.

General Microbiology

- Principles and methods of sterilization
- Direct microscopic observations of bacterial shape- cocci, rods and chains; fungal spore- mycelium, yeast budding
- Preparation of media: Nutrient broth, Nutrient agar, plates, slants and soft agar
- Micrometry - counting and measurements
- Pure techniques - serial dilution - pour plate, spread plate, streak plate methods and stab culture techniques
- Bacterial Staining methods - simple, Gram's, acid fast, flagella, capsule and spore.
- Fungal Staining methods - Lacto-phenol cotton blue
- Motility of bacteria
- Enumeration of bacteria/ yeast cell; viable count (plate count) , total count (Haemocytometer)
- Isolation and purification of cyanobacteria, actinomycetes and fungi

Virology

- Isolation and characterization of bacteriophage and cyanophage from natural resources
- Phage titration – T4 phage
- Study of virus infected plant samples- animal tissue culture- chick embryo fibroblast culture preparation
- Transmission methods – mechanical

General Biochemistry

- Preparation of buffer (Tris, phosphate, acetate buffer)
- Determination of (H+)ion concentration
- Verification of Beer-Lambert's law using coloured solution
- Preparation of standard graph for the following and estimating the concentration in a microbial 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 and identification of aminoacid
- Separation of proteins by PAGE, SDS – PAGE – Demonstration.

REFERENCES

1. James G Cappuccino and Natalie Sherman. Microbiology. 10th edition, The Benjamin/Cummings pub.co. California. 1996.
2. David R Brooke. Bergey's Manual of systematic bacteriology (Vol 1), Eastern Halz, Springer publication, US. 2007.
3. Gunasekaran P. Laboratory Manual in Microbiology, New Age International Pvt. Ltd. Publishers, New Delhi. 2008.
4. Kanika Sharma. Manual of Microbiology – Tools and Techniques. 2nd Edition, Ane Books Pvt. Ltd., New Delhi. 2009.
5. Keith Wilson and John Walker. Principles and Techniques of Practical Biochemistry. 4th edition. Cambridge University press, Britain. 1995.
6. Nizhny Novgorod. Laboratory manual on Biochemistry: Publishing House of Nizhny Novgorod State medical academy. 2008.
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   Australia. 2000.
9. Wilson K and Walker J. Practical biochemistry, 5th edition, Cambridge University Press, London. 2000.
10. Mahatma Gandhi-Doerenkamp Centre (MGDC) for Alternatives to Use of Animals in Life Science Education. http://www.mgdcaua.org/

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CORE COURSE V

MICROBIAL PHYSIOLOGY

OBJECTIVES

To understand the growth, enzymology and physiological processes of microbes

Unit I Cell structure and function

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

Unit II Microbial growth

Bacterial 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.

Unit III Microbial pigments and photosynthesis

Autotrophs - cyanobacteria - photosynthetic bacteria and green algae – heterotrophs – bacteria, fungi, myxotrophs. Brief account of photosynthetic and accessory pigments – chlorophyll – fluorescence, phosphorescence - bacteriochlorophyll – rhodopsin – carotenoids – phycobiliproteins.

Unit IV Carbon assimilation

Carbohydrates – anabolism – autotrophy – oxygenic – anoxygenic photosynthesis – autotrophic generation of ATP; fixation of CO_2 – Calvin cycle (C3) – C4 pathways. Respiratory metabolism – Embden Mayer Hoff pathway – Entner Doudroff pathway – glyoxalate pathway – Krebs cycle – oxidative and substrate level phosphorylation – reverse TCA cycle – gluconeogenesis – Fermentation of carbohydrates – homo and heterolactic fermentations.

Unit V Spore structure and function

Cell division – endospore – structure – properties – germination. Microbial sporulation and morphogenesis – Bacteria including cyanobacteria and actinobacteria, fungi and algae.

REFERENCES

1. Caldwell DR. Microbial Physiology and metabolism, Wm. C. Brown Publishers, USA 1995.
2. Lansing M. Prescott, John P. Harley and Donald A. Klein. Microbiology.5th edition. McGraw-Hill Company, New York. 2003.
3. Moat AG, Foster JW and Spector MP. Microbial Physiology 4th edition. John Wiley and Sons, New York. 2002.
4. Pelczar Jr MJ, Chan ECS and Kreig NR. Microbiology, 5th edition. Mc. Graw Hill. Inc, New York. 2013.
5. Salle AJ. Fundamental principles of Bacteriology, 7th edition. Tata McGraw-Hill publishing company limited, New Delhi. 1996.
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7. Robert Poole K. Advances in Microbial Physiology, Volume 53, Elsevier Science and Technology. 2007.

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CORE COURSE VI

ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY

OBJECTIVES

To enable the students to get exposure on various aspects of environmental and agricultural microbiology

Unit I Air microbiology and Biogeochemical cycles

Aerobiology- Significance of air microflora - Microbial air pollution- sources, biological indicators and effects on plants and human beings. Enumeration of bacteria from air, Air sampling devices, Outline of Airborne diseases (Bacterial, Fungal and Viral), Air sanitation. Biogeochemical cycles -Nitrogen, Carbon, Phosphorous, Sulphur, Iron and their importance.

Unit II Aquatic microbiology

Microbes in marine and fresh water environment – eutrophication – Water pollution – sources and nature of pollutants in water – sewage – treatment of liquid waste – primary, secondary and tertiary treatment – water borne diseases – Assessment of water quality – BOD and COD. Solid waste treatment – saccarification and pyrolysis.

Unit III Recycling of Liquid and Solid wastes

Recycling of Liquid and Solid wastes-Composting-Biogas, Mushroom and SCP production from waste. Biodegradation of complex polymers (Cellulose, Hemicellulose, Lignin, Chitin and Pectin), Bioremediation (*In-situ, Ex-situ*, Intrinsic), Bioaugmentation and Biostimulation. Bioleaching (Copper and Uranium) -Xenobiotics degradation (Heavy metals). A brief note on panchakavya.

Unit IV Soil Microbiology

Microbial association with plants - Phyllosphere, Rhizosphere, Mycorrhizae, nitrogen fixing organism – symbiosis, asymbiosis, associate symbiosis – phosphate solubilizers – application of biofertilizers in agriculture. Biology of nitrogen fixation – genes and regulations in *Rhizobium.*

Unit V Plant diseases and its control

Bacterial, viral and fungal plant pathogens. Morphological, physiological changes with reference to disease establishment in plants – plant protection – phenolics – phytoalexins and related compounds. Disadvantages of chemical pesticides. Microbial pesticides- types, mechanisms, advantages and limitations.

REFERENCES

1. Atlas Ronald M, Bartha Richard. Microbial Ecology 2nd Edition. Benjamin/Cummings Publishing Company, California. 1987.
2. Baker WC and Herson DS. Bioremediation – McGraw Hill Inc., New York. 1994.
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12. Richard G Burus and Howard Slater. Experimental Microbial Ecology, Blackwell Scientific Publishers.1982.

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CORE PRACTICAL II

MICROBIAL PHYSIOLOGY, ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY (P)

Microbial Physiology

- Bacterial growth curve – Turbidity method
- Effect of temperature, pH and salinity on bacterial growth
- Starch, casein, gelatin and lipid hydrolysis tests
- Biochemical tests: IMViC, TSI, Urease, Catalase, Oxidase, Hydrogen sulphide, coagulase, nitrate reduction tests
- Carbohydrate fermentation test

Environmental and Agricultural Microbiology

- Enumeration of Microbial population from rhizosphere and Non-rhizosphere soil
- Localization of Arbuscular Mycorrhizae (AM)
- Isolation of *Azospirillum* and *Azotobacter* from soil
- Isolation of *Rhizobium* sp. from root nodules of legumes
- Isolation of phosphate solubilizing bacteria from soil
- Isolation of Cyanobacteria from agricultural soil and water
- Isolation of bacterial and fungal pathogens from plants
- Isolation and identification of air-borne microbes using Andersen sampler.
- Determination of BOD and COD of polluted and pond water.
- Assessment of water quality by MPN technique
- Demonstration of the plant diseases: a) Tobacco mosaic; b) Bacterial blight of paddy; c)Downy mildew of bajra; d) Powdery mildew of cucurbits; e) Head smut of sorghum; f)Red rot of sugar cane.

REFERENCES

1. Aneja KR. Experiments in Microbiology: Plant Pathology and Tissue Culture, Wishwa Prakashan, New Delhi. 1993.
2. Cappuccino JG and Sherman N. Microbiology – A Laboratory Manual. 7th Edition, Dorling Kindersley (India) Pvt. Ltd., New Delhi. 2012
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ELECTIVE COURSE

BIOLOGICAL TECHNIQUES

OBJECTIVES

To educate the students with the basic principles of biological techniques so as to develop their research aptitude and career prospects.

Unit I Microscopic techniques

Components of microscopes - Basic principles and methods of Bright field, Dark field, Phase contrast, Fluorescence, Polarization and confocal microscopes. Electron Microscopy – Principle, Techniques and applications of Transmission Electron microscope (TEM), Scanning Electron Microscope (SEM) and Atomic Force Microscope (AFM). Microtomy – Basic and Freezing microtome – specimen preparation.

Unit II Analytical Techniques Spectroscopic methods

UV- Visible, Atomic Absorption Spectrophotometer, Atomic Emission Spectroscopy. Centrifugation – Principle, types and applications. Electro-analytical methods- Potentiometric, Conductimetric, Coulometric and Voltametric analyses. Biosensors. Principles of radioactivity, GM and LS counter.

Unit III Chromatographic Techniques

Chromatography - Paper, Thin layer, Ion exchange, affinity and gel permeation - Principle, preparation of columns, adsorption and elution. GC, GC - MS and HPLC - principle and their applications.

Unit IV Electrophoresis and its Applications

Electrophoresis – Principle and applications of Agarose and Pulse field gel electrophoresis, counter current and rocket immuno electrophoresis, SDS-PAGE and 2D gel electrophoresis.

Unit V Molecular Techniques

Isolation and quantification of nucleic acid – DNA, RNA and Plasmids. Amplification of DNA - Polymerase chain reaction and Real time and reverse transcriptase PCR. Gene cloning techniques – Restriction digestion and phosphatase treatment of cloning vectors. Gene transfer mechanisms – chemical and electroporation. Method of detection of clones –colony hybridization, Blue - White selection and immunochemical detection

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ELECTIVE COURSE

FOOD AND DAIRY MICROBIOLOGY

OBJECTIVES

To make the students to learn about microbial illness in foods and importance of microbial fermented foods.

Unit I Food and microbes

Types of microorganisms in food – Bacteria, molds, yeast and protozoa. Source of contamination- Factors influencing microbial growth in food.

Unit II Food fermentation

Food fermentations: methods of fermentations and organisms used -Cheese, bread, wine, beer. Fermented vegetables. Food and enzymes from microorganisms - single cell protein and mushrooms. Prebiotics, Probiotics and synbiotics. Advantages of probiotics.

Unit III Fermented food products

Contamination, spoilage and preservation of cereals and cereals products, sugar and sugar products, vegetables, fruits, meat and meat products, Fish and other sea foods, egg and poultry, dairy and fermentative products (ice cream).

Unit IV Food preservation method

Food preservations: principles- methods of preservations- Physical and chemical methods. Canning: classification of can, structure of cans, canning of food items, Thermal process time calculations for canned foods.

Unit V Food borne diseases and control

Food borne diseases and food poisoning. General principles underlying food spoilage and contamination – *Staphylococcus, Clostridium, Escherichia coli* and *Salmonella* infections, Hepatitis, Amoebiosis and Mycotoxins. Spoilage in canned foods. Food sanitation and control measures, HACCP, GMP, GLP.

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ELECTIVE COURSE

MOLECULAR TAXONOMY AND PHYLOGENY

OBJECTIVES

To gain knowledge about microbial taxonomy and molecular phylogeny

Unit I Microbial Taxonomy

Introduction to microbial taxonomy – morphological, biochemical and molecular taxonomy. Basic concepts of numerical taxonomy. Positive and negative aspects of each taxonomical methods. Morphological phylogeny.

UNIT II Biochemical and molecular taxonomy

Chemotaxonomy - fatty acid, protein finger printing, Isozyme typing, pigments andpolyamines. Biochemical phylogeny. Molecular taxonomy - G +C content, DNA –DNA hybridization, Plasmid profiles, RFLP, RAPD, STRR and LTRR, REP –PCR, rRNA based DNA finger printing methods

Unit III 16S rRNA based finger printing

Types of rRNA - 23s rRNA, 16S rRNA and 5S rRNA. Isolation of DNA, amplification of 16S rDNA using PCR technique. Sequencing of 23s rRNA, 16S rRNA and 5S rRNA. Importance of 16S rRNA in identification of prokaryotes. Methods of 16S rRNA / rDNA fingerprinting.

UNIT IV Sequence analysis

Submission of rDNA sequences in GenBank – Bankit and Sequin guidelines. NCBI, EMBL and DDBJ – retrieving sequences. RNA structure prediction, Restriction enzyme patterns. Ribosomal Database Project - Designing primers and probes. Sequence comparison, alignment and data base searching – ClastalW, FASTA and BLAST. DNA barcoding.

UNIT V Molecular phylogeny

Introduction to Molecular phylogeny – tree terminology, software programs for making phylogenetic trees – MEGA, Phylib, RAPDistance. Cladogram, additive trees and ultrametric trees, rooted, unrooted trees and tree shapes.

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ELECTIVE COURSE

QUALITY CONTROL AND IPR

OBJECTIVES

To gain knowledge about intellectual property rights, copyrights, trademarks and geographical limitation. Explain various concepts of biotechnological inventions and their commercialisation. Ethics of biological Goods manufacturing practice, usage of animals, plants and their biosafety assessment.

Unit I Bioethics

Legality, Morality and Ethics, the principles of bioethics, autonomy, human rights, beneficience, privacy, justice and equality.

Unit II Biosafety

Concept and issues, rational vs subjective, perceptions of risk and benefits of Biosafety. Biosafety concern levels – Individual, institution, society, region, country and world- Lab associated Infections.

Unit III Biosafety Assessment (BSA)

BSA of biotechnology and pharmaceutical products such as drugs, vaccines and biomolecules.

Unit IV Quality Control

Quality control in food process technology- WHO Standards- Quality Control in Dairy product technology- Quality control in portable water.

Unit V IPR

GATT and IPR, IPR in India, WTO Act, Convention on Biodiversity (CBD), patent cooperation treaty (PCT), forms of patents and patentability, process of patenting, Indian and international agencies involved in IPR and patenting, Global scenario of patents and India's position, patenting of biological material, GLP and GMP.

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CORE COURSE VII

MOLECULAR BIOLOGY AND MICROBIAL GENETICS

OBJECTIVES

In addition to the most essential fundamentals of the subject, the paper aims to impart the current updated knowledge on molecular genetics of prokaryotes. It also endeavours to provide the required fundamental details on eukaryotic molecular genetics.

Unit I Genetic material, DNA replication and repair

Identification of genetic material (Griffith, Avery and Hershey and Chase experiments). Organization of genetic material: Bacteria – Eukaryotes: nucleus and nucleosomes, lamp brush and giant chromosomes. DNA replication - Meselson – Stahl experiment, Molecular mechanisms of DNA Replication – bidirectional and rolling circle replication. Differences between prokaryotic and eukaryotic replication. Plasmids – types, structure and replication. Inhibitors of DNA replication - DNA repair – mechanism of excision repair, SOS repair and mismatch repair.

Unit II Transcription and translation

Process of transcription – initiation, elongation – termination. Synthesis of mRNA in prokaryotes and eukaryotes. RNA splicing. Synthesis of rRNA and tRNA. RNA processing – capping and polyadenylation. Inhibitors of transcription. Genetic code, process of translation – initiation, elongation and termination. Signal sequences and protein transport. Inhibitors of translation.

Unit III Regulation of gene expression

Organization of Genes in Prokaryotes and Eukaryotes - Introduction - Operon concept, *lac*, *trp,* arabinose operons, promoters and repressors. Regulation of gene expression – Transcriptional control – promoters, terminators, attenuators and anti terminators; Induction and repression; Translational control – ribosome binding, codon usage, antisense RNA; post-transcriptional gene silencing – RNAi.

Unit IV Gene transfer and genetic recombination mechanisms

Transformation – competence cells, regulation, general process; Transduction – general and specialized; Conjugation – Discovery, mechanism of F^+ *v/s* F^-, Hfr^+ *v/s* F^-, F' *v/s* F^-, triparental mating, self transmissible and mobilizable plasmids, pili. Linkage and genetic maps – genetic mapping of T4 phage. C-value paradox. Hardy Weinberg Equilibrium.

Unit V Mutation and transposable elements

Types and molecular basis of mutation– Agents of mutation - Importance of mutations in evolution of species. Discovery of insertion sequences, complex and compound transposons – T10, T5, and retroposon – Nomenclature-Insertion sequences – Mechanism – Transposons of *E. coli*, Bacteriophage and Yeast. Importance of transposable elements in horizontal transfer of genes and evolution.

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CORE COURSE VIII

IMMUNOLOGY

OBJECTIVES

The aim of the course is to teach the types of immunity, immune system, antigen, antigen - antibody reaction, T and B cell activation, lymphokines and cytokines, hyper sensitivity reaction, immune deficiency disorders, immunohematology and transplantation of immunity.

Unit I Immune system

History of Immunology, Types of immunity- innate and acquired. Humoral and cell mediated immunity. Central and peripheral lymphoid organs- Thymus, bone marrow, spleen, lymph nodes and other peripheral lymphoid tissues GALT. Haematopoiesis, Cells of the immune system- lymphocytes, mononuclear phagocytes- dendritic cells, granulocytes. NK cells and mast cells, cytokines.

Unit II T and B cell, Antigen –antibody reactions

T and B-cell receptors, Antigen recognition- processing and presentation to T-cells. Interaction of T and B cells. Antigen and antibody – properties, types and functions. Antigen –antibody reactions - Precipitation, agglutination, complement fixation, RIA, ELISA, Western blotting and immunofluorescence.

Unit III T and B cell activation

B cell receptor complex, B cell maturation, antibody diversity, understanding self – non self discrimination, T_H cell subpopulation, organization of T cell receptor, cell mediated effectors responses. Complement system: Basics of complement protein - different pathways of complement activation - classical and alternative.

Unit IV MHC, Cytokines and Lymphokines

Structure of MHC molecules- Human Leucocyte Antigen- Functions of MHC. Cytokine and lymphokines structure and their receptors. Hypersensitivity reaction and their types. Auto immune disorders, transplantation and cancer immunology.

Unit V Immunotechnology and its applications

Production of polyclonal, monoclonal antibodies and phage display - techniques and applications. Immunization practices- active and passive

immunization. Vaccines- killed and attenuated, recombinant vaccines, DNA and peptide vaccines. Applications of immunotechniques – Flow cytometry, Immunoelectron microscopy, Immunohistochemistry and Bioplex array.

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CORE PRACTICAL III

MOLECULAR BIOLOGY AND MICROBIAL GENETICS, IMMUNOLOGY (P)

Microbial Genetics and Molecular Biology

- Isolation of antibiotic resistant microbes
- Isolation of mutants by spontaneous mutation – Gradient plate technique
- Isolation of auxotrophic and antibiotic resistant mutants by physical and chemical mutagens
- Competent cell preparation and Bacterial transformation
- Generalized transduction in *E. coli*.
- Isolation of microbial genomic DNA
- Isolation of plasmids from *E.coli* (mini preparation).
- Characterization of plasmid DNA by agarose gel electrophoresis.
- Restriction digestion and Ligation of DNA
- Polymerase Chain Reaction
- Blotting techniques (Southern, Northern, Western and Dot blottings)

Immunology

- Collection of venous blood from human and separation, preservation and storage of serum/plasma
- Identification and enumeration of RBC, WBC and total cell count.
- Estimation of Haemoglobulin content
- Agglutination reactions - blood grouping and WIDAL (slide and tube tests)
- Immunoelectrophoresis – Graber and William's technique.
- Counter- current immuno electrophoresis
- Précipitation reaction – Ouchterlony's Double Immuno Diffusion technique.
- Serum electrophoresis
- Enzyme Linked Immunosorbent Assay (ELISA)
- Handling of Laboratory animals and raising antibodies.
- Dissection of primary and secondary lymphoid organs in a selected laboratory animal

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ELECTIVE COURSE

MEDICAL LABORATORY TECHNOLOGY

OBJECTIVES

- To train students to work as laboratory technicians and assist pathologist.
- To encourage and prepare the graduates to improve their standard in medical sectors.

UNIT I Laboratory

Professional conduct, code of behaviour, staff health, safety and immunization, Reception, Labeling and Disposal of specimen and culture. Laboratory hazards and safety, First aid, Quality control in laboratory works.

UNIT II Clinical pathology

Urine analysis: Physical, chemical and microscopic examination, specific gravity, Test for albumin, acetone, bile salt and pigments, phosphate, urobilinogen, occult blood and urine deposits. Stool and Sputum analysis: Physical, chemical and microscopic examination (protozoa, helminthes). Examination of body fluids-CS, acidic and plural, hydatid fluids.

UNIT III Hematology

Anaemia - definition, types and investigation. Enumeration and investigation of RBCs, WBCs and Platelets. Blood coagulation and disorder, ESR determination.

UNIT IV Blood banking and Serology

Blood and Rh grouping, blood and plasma collection, screening and storage, safe transfusion of blood cross matching, Quality control, blood donation program, donor motivation and screening. Serology - WIDAL, RPR and ELISA tests.

UNIT V Clinical Microbiology and Biochemistry

Isolation and identification of microbes from clinical specimens - typhoid and bacillary dysentery, Antibiotic sensitivity test. Estimation of sugar from blood and urine. GCT. Estimation of Proteins and Cholesterol from blood.

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ELECTIVE COURSE

MARINE MICROBIOLOGY

OBJECTIVES

This subject aims to introduce the students to understand microbial diversity, significance, dynamics of marine environment, Marine food borne pathogens, and marine microbial products.

Unit I Marine Microbial Habitats and Diversity

Marine environment–properties of seawater , chemical and physical factors of marine environment-Ecology of coastal, shallow and deep sea microorganism **-** significance of marine microflora. Diversity of microorganism - Archaea**,** bacteria, actinobacteria, cyanobacteria, algae, fungi, viruses and protozoa in the mangroves and coral environments - Microbial endosymbionts – epiphytes - coral-microbial association, sponge-microbial association.

Unit II Cultivation of Marine microbes and Nutrient cycling.

Methods of studying marine microorganisms- sample collection- isolation and identification: Cultural, Morphological, physiological, biochemical and Molecular characteristics- Preservation methods of marine microbes. Role of microorganisms in carbon, nitrogen, phosphorous and sulphur cycles in the sea under different environments and mangroves.

Unit III Marine extremophiles and Bioremediation

Survival at extreme environments – starvation – adaptive mechanisms in thermophilic, alkalophilic, osmophilic and barophilic, psychrophilic microorganisms – hyperthermophiles, halophiles and their importance. Microbial consortia and genetically engineered microbes in bioremediation of polluted marine sites - heavy metals and crude oil. Biofouling and their control.

Unit IV Seafood microbiology

Pathogenic microorganisms, distribution, indicator organisms, prevention and control of water pollution, quality standards, International and National standards. Microbiology of processed finfish and shellfish products. Rapid diagnosis of contamination in seafoods and aquaculture products.

Unit V Marine microbial products

Marine microbial products – Carrageenan, agar-agar, sea weed fertilizers – Astaxanthin, β carotene – enzyme – antibiotics – antitumour agents-

polysaccharide – biosurfactants and pigments. Preservation methods of sea foods. Quality control and regulations for microbial quality of fishes, shellfish and Marine living resources used for food and drugs

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ELECTIVE COURSE

BIOINFORMATICS AND BIOSTATISTICS

OBJECTIVE

- To gain insight about computer based technology for the study of biological molecules.
- To equip statistical skills to solve biological problems.

Unit I Biology and computer

Basics of computers –types, servers, operating systems, UNIX, Linux. Finding scientific articles - Pubmed.

Unit II Genomics

Biological databases NCBI, EMBL, DDBJ – sequencing genomes - pairwise sequence comparison - BLAST and FASTA. Multiple sequence alignments, Phylogenetic alignment - Phylip.

Unit III Proteomics

Protein Data Bank, Swiss- prot – PIR, SCOP, CATH - secondary structure prediction – Chou Fassman, GOR method -predicting 3 D structure - protein modeling, abinitio - visualization tool RASMOL.

Unit IV Biostatistics I

Introduction – Population and sample – Variables – Collection and presentation of data – Descriptive statistics - Measures of Central tendency – Mean (arithmetic, harmonic and geometric) Median and Mode – Measures of dispersion – range, mean deviation, variance and standard deviation.

Unit V Biostatistics II

Inferential statistics – Probability and distributions – Poisson, Binomial and Normal distribution – Chi-square test – Hypothesis test - Student's t-test – Correlation and Regression – ANOVA.

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CORE COURSE IX

MEDICAL MICROBIOLOGY

OBJECTIVES

To impart and explain the students with the advanced knowledge on the characteristics of medically important human microbial pathogens with focus on the diseases caused by them, disease pathogenesis, lab diagnosis, prophylaxis, control etc.

UNIT I Introduction to Medical Microbiology

Significance of Microbiology in Medicine, Classification of medically important microbes, Normal microbial flora of the human body: normal flora of skin, eye, throat, gastrointestinal tract and urogenital tract - Infections- Sources, types – opportunistic, nosocomial and community acquired infections - Mode of transmission, carriers and their types – investigation of epidemic diseases.

Unit II Medical Bacteriology

Morphological, cultural and biochemical characteristics of and epidemiology, mechanism of bacterial pathogenesis, lab diagnosis, prophylaxis and control of medically important diseases caused by*: Staphylococcus aureus,* Group A Streptococci, *Corynebacterium diphtheriae, Clostridium tetani, Bacillus anthracis, Leptospira interrogans, Treponema pallidum, Mycobacterium tuberculosis, Escherichia coli, Vibrio cholerae, Niesserriae, Haemophilus influenza, Helicobacter pylori, Pseudomonas* and *Salmonella.* Brief note on Chlamydia, Rickettsia Mycoplasama, anaerobic bacterial infections, Atypical Mycobacterium, Zoonotic bacterial pathogens, Antibiotic susceptibility test: Kirby – Bauer disk diffusion method.

Unit III Medical Mycology

Morphological and cultural characteristics of and epidemiology, mechanism of fungal pathogenesis, lab diagnosis and treatment of medically important diseases caused by*:* Superficial mycosis – *Tinea versicolor*. Cutaneous mycoses: *Microsporum*, *Trichophyton*, *Epidermophyton*. Subcutaneous mycoses: Sporotrichosis, Chromoblastomycosis, Zygomycosis. Systemic Mycoses – *Histoplasma capsulatum*, *Blastomyces dermatitidis*, *Cryptococcus neoformans*, *Coccidioides immitis*, *Paracoccidioides brasiliensis*. Opportunistic mycoses: Candidiasis, Cryptococcosis and Aspergillosis. Antifungal susceptibility testing.

Unit IV Medical Virology

General properties of and epidemiology, pathogenesis, lab diagnosis and treatment of medically important viral diseases caused by: Influenza viruses, Measles, Mumps, Rubella, Chicken Pox, Hepatitis A,B,C, Dand E, Poliomyelitis, HIV, Human Papilloma Virus, Rabies, Yellow fever, Dengue and Japanese Encephalitis viruses. Brief note on oncogenic viruses.

Unit V Medical Parasitology and emergence of antibiotic resistant pathogens

Morphology of, and pathogenesis, laboratory diagnosis and treatment of medically important protozoan diseases caused by: *Entomoeba histolytica, Giardia lamblia, Trichmonas vaginalis, Plasmodium vivax*, *Leishmania donovani*, *Taenia solium, Ascaris lumbricoides, Ancyclostoma duodenale* and *Wuchereria bancrofti.* Brief note on the emergence of MDR bacterial, fungal pathogens, extremely drug resistant (XDR) pathogens and superbugs.

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CORE COURSE X

BIOPROCESS TECHNOLOGY

OBJECTIVES

To learn the process involved in the industrial production of microbial products. Understand the strategies of strain selection and improvement. Understand the process of fermentation. Familiarize with types of fermentors and downstream processing. To learn the role of microbes in food preparation, preservation and spoilage. To understand the quality of food and products.

Unit I Industrially important microbes and their improvement

Screening methods for industrial microbes – detection and assay of fermentation products– classification of fermentation types – strain selection and improvement. Mutation and recombinant DNA techniques for strain improvement. Preservation of cultures after strain improvement.

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. Photobioreactors.

Unit III Fermentation process

Growth of cultures in the fermenter. Importance of media in fermentation, media formulation and modification. Kinetics of growth in batch and continuous culture, specific growth rate, steady state in a chemostat, fed-batch fermentation, yield of biomass, product, calculation for productivity, substrate utilization kinetics. Fermentation process: Inoculum development. Storage of cultures for repeated fermentations, scaling up of process from shake flask to industrial fermentation.

Unit IV Food microbiology

Microbiology of fermented milk – starter cultures, butter milk, cream, yoghurt, kafir, kumiss, acidophilus milk and cheese. Microbes as sources of food (*Spirulina*, *Saccharomyces cerviceae*, *Rhizopus* sp.). Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins; Food infections: *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, Salmonellosis, Shigellosis and *Campylobacter jejuni* – spoilage of canned foods – Detection of

spoilage and characterization. Food sanitation in food manufacture and in the retail trade; Food control agencies and their regulations.

Unit V Legal protection and IPR

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

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CORE PRACTICAL IV

MEDICAL MICROBIOLOGY AND BIOPROCESS TECHNOLOGY (P)

MEDICAL MICROBIOLOGY

- Collection, coding and transport of clinical specimens for microbiological examinations
- Isolation and identification of upper respiratory tract bacterial pathogen – *Streptococcus pyogenes*
- Isolation and identification of *Staphylococcus aureus* from clinical specimen
- Isolation and identification of lower respiratory tract bacterial pathogen – *Pseudomonas aeuroginosa*
- Isolation and identification of gastrointestinal bacterial pathogens – *Salmonella, Shigella* and *Vibrio*
- Isolation and identification of urinary tract pathogens – *E. coli and Klebsiella pnemoniae*
- Isolation and identification of bacterial pathogen causing enteric fever – *Salmonella typhi, S. paratyphi* A and B
- Isolation and identification of clinically important yeast and molds - *Candida albicans, Cryptococcus neoformans, Fusarium spp. and Aspergillus spp.*
- Antibiotic susceptibility test – Disc diffusion method (Kirby –Bauer)
- Determination of MIC of any one antibiotic against any one bacterial species.
- Examination of blood smears for *Plasmodium spp.*
- Examination of faeces for parasites

BIOPROCESS TECHNOLOGY

Production, quantification, extraction and characterization of the following

- Alcohol - Wine
- Organic acid – Citric acid – Solid state and submerged fermentation.
- Amino acid– Glutamic acid.
- Extra cellular enzymes – Protease by submerged fermentation and Cellulase by solid state fermentation.

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ELECTIVE COURSE

GENETIC ENGINEERING

OBJECTIVES

To impart the learners with the advanced knowledge and growing significance of genetic and protein engineering/ DNA cloning. To educate the students with the advanced tools, techniques and methods employed in DNA/ gene cloning and expression as well as in protein engineering strategies.

UNIT I Introduction to gene cloning strategies

Gene cloning: Steps - Isolation and purification of nucleic acids (genomic DNA, RNA and Plasmids) – Methods of handling and quantification of DNA and RNA. Analyses of DNA/ RNA and proteins: Agarose Gel and SDS – PAGE - Blotting – types of blotting – Southern, Northern and Western Blotting. Chromosome walking.

UNIT II Tools and methods in gene cloning

Restriction endonucleases – nomenclature, classification and characteristics - DNA methylases – DNA polymerases - Ligases – Adapters, Linkers and Homopolymer tailing – Gene transfer techniques: electroporation, microinjection, protoplast fusion and microparticle bombardment – Screening for recombinants: Direct: Insertional inactivation, plaque phenotype and indirect methods: Immunochemical detection, nucleic acid hybridization, Dot and Colony Blotting. Methods of DNA cloning. Construction and applications of Genomic DNA and cDNA libraries.

UNIT III Gene cloning vectors for prokaryotes and eukaryotes

Cloning Vectors – properties - types of vectors – plasmids – host range and incompatibility – plasmids vectors for cloning in *E. coli* (pBR322 and derivatives, pUC vectors and pGEM3Z) - Vectors constructed based on bacteriophages (M13 and Lambda), cosmids, phasmids, phagemids and BACs - Eukaryotic vectors - Yeast vectors – animal and plant vectors – expression vectors: *E. coli lac* and T7 phage promoter based vectors - shuttle vectors - Expression of foreign genes in bacteria, animal, plant, algae and fungi – merits and demerits.

UNIT IV Techniques in genetic engineering

Characterization of cloned DNA: Restriction mapping - restriction fragment length polymorphism (RFLP) - Polymerase chain reaction (PCR) – Principles,

types and their applications. DNA sequencing: Primer walking, Chemical method: Maxam and Gilbert method, Sanger's method: traditional (dideoxy) and automated sequencing methods. Pyrosequencing – DNA chips and micro array.

UNIT V Protein engineering and techniques

Site directed mutagenesis – methods - Design and construction of novel proteins and enzymes, Basic concepts in enzyme engineering, engineering for kinetic properties of enzymes. protein folding, protein sequencing, protein crystallization. Data analysis - Mass spectrometry based methods for protein identification, MALDI-TOF, 2D gel electrophoresis – Applications of protein engineering: Examples of engineered proteins.

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ELECTIVE COURSE

MICROBIAL BIOTECHNOLOGY

OBJECTIVES

To impart the potential applications of microbial and molecular biotechnology in medicine, agriculture and various other current industrial processes.

UNIT I Microbial production of therapeutic agents and vaccines

History – Microbial vs molecular biotechnology and Commercialization – concerns and consequences - Pharmaceuticals - interferons and growth hormones, enzymes: DNase I and alginate lyase, Monoclonal antibodies - HIV therapeutic agents. Subunit vaccines: Herpes simplex virus, Foot and mouth disease virus, TB, Peptide vaccines – genetic immunization – vector vaccines.

UNIT II Microbial production of commercial products

Microbial production of restriction endonucleases: *Pst*I, Dye: Indigo, Antibiotics: Synthesis of Novel antibiotics. Biopolymers: Xanthan gum and PHA. Microbial production of alcohol, lactic acid, streptomycin, L- glutamic acid, lipase and riboflavin.

UNIT III Production of PGPR, biofertilizers and biocontrol agents

Plant growth promoting bacteria (PGPR) – genetic engineering of nitrogenase gene cluster, hydrogenase and Nodulation. Mass cultivation of microbial biofertilizers: Cyanobacteria (*Sprirulina*), *Azolla* and other nitrogen fixers (*Rhizobia, Azospirillum, Azotobacter* and VAM) Biocontrol of pathogens: Siderophores, antibiotics and enzymes. Release of genetically engineered organisms - Ice nucleation and anti-freeze proteins. Microbial herbicides. Microbial insecticides (*Pseudomonas* and *Bacillus thrungiensis*): - genetic engineering of Bt strains – Bt cotton – viral insecticides – entomopathogenic fungi.

UNIT IV Plant and algal biotechnology and bioremediation

Ti plasmid derived vector systems - Development of insect, virus and herbicide resistant plants, stress and senescence tolerant plants, modification of flower nutritional content, sweetening by genetic engineering. Plant as bioreactors. Production of food, colourant and fuel from microalgae.

UNIT V Animal biotechnology and IPR

Transgenic animals: methods of creating transgenic mice, cattle and sheep. Human gene therapy – *in vivo* and *ex vivo* gene therapy. Molecular diagnostics for genetic diseases. Biosafety and Bioethics. Intellectual Property Rights: Patents - copy right and neighboring rights, patents for invention, - Drafting and filing a patent application, exploitation of patented invention. Indian patent laws.

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ELECTIVE COURSE

MICROBIAL NANOTECHNOLOGY

OBJECTIVE

To make the students realized the role of microbes and other eukaryotic systems in the synthesis of nanoparticles. To provide the knowledge of advanced methods of synthesis and designing of nano particles as well as to educate them the potential applications of nano particles/ materials in a variety of areas.

Unit I Introduction to bionanotechnology

Milestones in History – bionanotechnology – concept and future prospects – application in Life Sciences. Terminologies – nanotechnology, bionanotechnology, nanobiomaterials, biocompatibility, nanomedicine, nanowires, quantum Dots, nanocomposite, nanoparticles, nanosensors. Biotechnology to bionanotechnology, natural bionanomachines. Current status of bionanotechnology.

Unit II Synthesis of nanoparticles

Molecular nanotechnology – nanomachines – collagen. Uses of nanoparticles – cancer therapy – manipulation of cell and biomolecules. Cytoskeleton and cell organelles. Types of nanoparticles production – physical, chemical and biological. Microbial synthesis (bacteria, fungi and yeast) of nanoparticles – mechanism of synthesis.

Unit III Types of nanoparticles and methods of characterization

Nanoparticles – types, functions – Silver, Gold and Titanium. Physical and chemical properties of nanoparticles. Characterization of nanoparticles – UV-Vis spectroscopy, particle size analyzer, Electron Microscopy – HRTEM, SEM, AFM, EDS, XRD. Other tools and techniques required for bionanotechnology: rDNA technology, site directed mutagenesis, fusion proteins, X- Ray crystallography, NMR. Bioinformatics: molecular modeling, docking, computer assisted molecular design.

Unit IV Applications of bionanotechnology

Drug and gene delivery – protein mediated and nanoparticle mediated. Uses of nanoparticles in MRI, DNA and Protein Microarrays. Nanotechnology in health sectors. Nanomedicines, Antibacterial activities of nanoparticles. Nanotechnology in agriculture. Toxicology in nanoparticles – Dosimetry.

Unit V Merits and demerits of nanoparticles

Advantages of nanoparticles – drug targeting, protein detection, MRI, development of green chemistry – commercial viability of nanoparticles. Disadvantages – pollution and health risks associated with nanoparticles.

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