

॥ सा विद्या या विमुक्तये ॥



स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड
“ज्ञानतीर्थ” परिसर, विष्णुपुरी, नांदेड - ४३१६०६ (महाराष्ट्र)
SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY NANDED
“Dnyanteerth”, Vishnupuri, Nanded - 431606 Maharashtra State (INDIA)
Established on 17th September 1994 – Recognized by the UGC U/s 2(f) and 12(B), NAAC Re-accredited with ‘A’ Grade



ACADEMIC (1-BOARD OF STUDIES) SECTION

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प्रस्तुत विद्यापीठाच्या संकुलातील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील प्रथम वर्षाचे CBCS Pattern नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०१९-२० पासून लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, दिनांक ०८ जून २०१९ रोजी संपन्न झालेल्या ४४व्या मा. विद्या परिषद बैठकीतील ऐनवेळचा विषय क्र.११/४४-२०१९ च्या ठरावानुसार प्रस्तुत विद्यापीठाच्या प्रस्तुत विद्यापीठाच्या संकुलातील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील प्रथम वर्षाचे खालील विषयांचे C.B.C.S. (Choice Based Credit System) Pattern नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०१९-२० पासून लागू करण्यात येत आहेत.

1. Botany
2. Certificate Course in Industrial Safety, Health and Environmental Management (SHM)
3. Chemistry
4. Computer Application
5. Computer Network
6. Computer Science
7. Geophysics
8. Mathematics
9. M.C.A.
10. Microbiology
11. Physics
12. Zoology

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या www.srtmun.ac.in या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी.

‘ज्ञानतीर्थ’ परिसर,

विष्णुपुरी, नांदेड - ४३१ ६०६.

जा.क्र.: शैक्षणिक-१/परिपत्रक/संकुले/पदव्युत्तर-सीबीसीएस
अभ्यासक्रम/२०१९-२०/४६५

दिनांक : ११.०७.२०१९.

प्रत माहिती व पुढील कार्यवाहीस्तव :

- १) मा. कुलसचिव यांचे कार्यालय, प्रस्तुत विद्यापीठ.
- २) मा. संचालक, परीक्षा व मूल्यमापन मंडळ यांचे कार्यालय, प्रस्तुत विद्यापीठ.
- ३) मा. संचालक, सर्व संबंधित संकुले, विद्यापीठ परिसर, प्रस्तुत विद्यापीठ.
- ४) साहाय्यक कुलसचिव, पदव्युत्तर विभाग, प्रस्तुत विद्यापीठ.
- ५) उपकुलसचिव, पात्रता विभाग, प्रस्तुत विद्यापीठ.
- ६) सिस्टम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ.

स्वाक्षरित/—

उपकुलसचिव

शैक्षणिक (१-अभ्यासमंडळ) विभाग

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED
SCHOOL OF LIFE SCIENCES,
M. Sc. MICROBIOLOGY COURSE (TOTAL CREDITS: 100)
TOTAL MARKS : 2500
Program Structure – 2019 Onwards (CBCS Pattern)

Semester	Course Code	Title of the Course	No. of Instructional hr / week		Total Credits	Marks		Total Marks
						CIA	ESA	
First Semester	THEORY & PRACTICAL							
	MBT-101	Virology	04	CC	04	50	50	100
	MBT-102	Microbial physiology	04	CC	04	50	50	100
	MBT-103	Immunology	04	CC	04	50	50	100
	MBT-104	Elective I	04	DSC	02+02	50	50	100
	MBT 105	Communication skill/Teaching competency	02	SEC	02	25	25	50
	MBL-I	Lab Course – I	4	DSC	04	50	50	100
	MBL-II	Lab Course-II	4	DSC	04	50	50	100
				Total	26	325	325	650
Second Semester	MBT-201	Extremophiles and biodiversity	04	CC	04	50	50	100
	MBT-202	Microbial metabolism	04	CC	04	50	50	100
	MBT-203	Microbial Genetics	04	CC	04	50	50	100
	MBT-204	Elective II	04	DSC	02+02	50	50	100
	MBL-III	Lab Course –III	4	DSC	04	50	50	100
	MBL-IV	Lab Course –IV	4	DSC	04	50	50	100
				Total	24	300	300	600
Third Semester	MBT-301	Bioprocess Engineering and Technology	04	CC	04	50	50	100
	MBT-302	Food & Dairy Microbiology	04	CC	04	50	50	100
	MBT-303	Environmental Microbiology/Medical Microbiology	04	CC	04	50	50	100
	MBT 304	Computers in Biology/Foreign language	02	SEC	02	25	25	50
	MBT-305	Elective III (OPEN ELECTIVE)	04	OEC	04	50	50	100
	MBL-V	Lab Course – V	4	DSC	04	50	50	100
	MBL-VI	Lab Course-VI)	4	DSC	04	50	50	100
				Total	26	325	325	650
Fourth Semester	MBT-401	Genetic Engineering						
	MBT-402	Microbial Technology	04	CC	04	50	50	100
	MBT-403	Pharmaceutical Microbiology / Agricultural Microbiology	04	CC	04	50	50	100
	MBT-404	Elective (OPEN ELECTIVE)	04	OEC	04	50	50	100
	MBL-VII	Lab Course –VII	4	DSC	04	50	50	100
	MBD-VIII	Dissertation/Review Writing/Applied Microbiology lab course + Seminar based on MBD VIII OPTED BY STUDENT	3+1	DSC	04	50	50	100
					Total	24	300	300
				Total	100	1250	1250	2500

CC: Core Course, SEC Skill enhancement Course, EC: Elective Course, , CIA: Continuous Internal Assessment, ESA :End Semester Assessment. Credits of Theory of four semesters = 68.

There will be four papers of practicals in first year and three papers of practicals and one dissertation/review writing/Lab course program in Applied Microbiology in second year. Each practical course and dissertation will be of 100 marks (04 credits).

Laboratory Course: First Year (1st & IInd Semester)

Credits of Laboratory Courses of four semesters = 32

- **Total Credits / year = 50**
- **Total Credits of All Four Semesters = 100**
- **Total Marks of All Four Semesters = 2500**
- **CIA Two test of 15 marks each will be conducted 10 marks for home assignment/tutorial and 10 for seminar/conference presentation/ The examinations for laboratory Courses (External) will be held at the end of 2nd & 4th Semesters.**

List of Discipline Specific Electives:

Elective-I (02 credit course)

- 1. Biostatistics**
- 2. Bioinstrumentation**
- 3. Mycology**
- 4. Protozoology**

Elective-II (02 credit course)

- 1. Enzymology**
- 2. Molecular Biology**
- 3. Proteomics**
- 4. Genomics**
- 5. Apiculture**
- 6. Sericulture**

Note: Students should opt any two electives from above list for each semester or equivalent course of similar title and same weightage /credits from NPTL , SWYAM or MOOCK

Details of Open Elective papers offered under CBCS at PG level:

Department of Microbiology:

Sr. No.	Open elective title of the paper	Credits assigned to the paper	Semester for which course is offered	Eligibility
01	Microbiological Analysis	04 credits	III semester	Any Science graduate
02	Environmental Microbiology	04 credits	III semester	Any graduate
03	Food and Dairy Microbiology	04 credits	III semester	Any graduate
04	Infectious Diseases	04 credits	IV semester	Any graduate
05	Medical Microbiology	04 credits	IV semester	Any Science graduate
06	Pharmaceutical Microbiology	04 credits	IV semester	Any Science graduate

MBT-101 Virology

Objectives:

Primary objectives of this course are to facilitate conceptual understanding of

Classification and cultivation of viruses Learning outcome

At the completion of course student will be able to illustrate morphology and replication strategy of viruses

UNIT- I

Brief outline on discovery and origin of viruses. Classification and general properties of major families of viruses morphology and ultra-structure of viruses, capsid and their arrangements, types of envelopes and their composition, measurement of viruses. Viral genome; their types and structure, viral related agents- viroids and prions.

UNIT-II

Cultivation of inhibition, neutralization test, complement fixation, ELISA, RIA. Purification of viruses: gradient centrifuge, electrophoresis, and chromatography viruses- in embryonated eggs, experimental animals and cell lines; primary and secondary cell lines, diploid cell culture. 2. Assay of viruses: physical and chemical methods, end point method. Serological methods

UNIT-III

Plant viruses: recent advance in classification of plant viruses. Structure and pathogenicity of TMV. 2. Transmission of plant viruses with vector (insect, nematodes and fungi) and without vector (contact, seed and pollens). Biochemical changes induced by virus in plant cell. 3. Animal viruses: nomenclature and classification of animal viruses. 4. General idea about Cyanophage, and Mycophage.

Unit-IV

Animal viruses: Structure, genomic organization, pathogenesis and control of Herpes virus, Polio virus, Influenza virus, Retrovirus, Adenovirus, Hepatitis virus, SV40 virus, Chikungunya and Bird Flu virus. Bacteriophage: classification, morphology and ultra structure. One step growth curve (latent period, eclipse period, and burst of size.) Life cycle: lytic and lysogenic life cycle of bacteriophages. . Brief account of M13, Mu, T4, Ø x174 and lambda phage.

Reference Books:

1. Virology; Renato Dulbecco and Harold S. Ginsberg, Fourth edition, J.B. Lippincott Company, USA
2. An Introduction to viruses, S. B. Biswas and Amita Biswas. Forth edition, Vikas Publishing House PVT LTD New Delhi.
3. Textbook of Microbiology by Ananthnarayanan and Paniker's, eighth edition, Universities Press .
4. Microbiology; Lansing M Prescott, John P. Harley, Donald A Klein, Sixth edition, Mc Graw Hill Higher education.

MBT 102 MICROBIAL PHYSIOLOGY

Objectives:

- To develop a sufficient background to students about the growth of Microbes.
- To acquire knowledge on basic aspects of bacterial respiration and photosynthesis.
- To acquire knowledge on microbial stress response.

Outcomes

- Knowledge on growth of Microbes
- General Information about microbial respiration and photosynthesis
- Clear idea on physiological adaptations under stress conditions.

Unit-I

Structure and functions of prokaryotes, Appendages, Glycocalyx, cell wall, Periplasm, Cell membrane and cytoplasm. Microbial Nutrition- Nutritional requirement for growth (macronutrients, micronutrients and growth factors), nutritional types of microorganism.

Unit –II:

Measurement of growth, growth physiology, cell division, growth yields, growth kinetics, steady state growth and continuous growth. Solute transport: ABC transporters, phosphotransferase system, iron transport, chemotaxis and flagellar movement, protein export, liposomes and proteoliposomes.

Unit III

Oxidation reduction potential, components of electron transport chain free Oxidative phosphorylation and theories of ATP formation, inhibition of electron transport chain, Coupling sites, Q loops, Q cycles and proton pumps, patterns of electron flow in aerobic and anaerobic bacteria, ATP synthesis in heterotrophic and phototrophic bacteria. Phototrophic prokaryotes, photosynthetic pigments, reactions of photosynthetic apparatus, photosynthetic apparatus of cyanobacteria, photosynthesis in halobacteria,

Unit-IV

Introduction to two component system, regulatory systems during aerobic, anaerobic shifts: Arc, Enr, Nar, Fhl A regulon, response to phosphate supply: The pho regulon, Quorum sensing : A to C signalling system, sporulation in *Bacillus subtilis*, control of competence in *Bacillus subtilis*. Response to environmental stress and homeostasis: Heat shock responses, response to osmotic stress, PH homeostasis and osmotic homeostasis.

References:

1. Madigan, M.T., Martinka, M., Parker, J. and Brock, T.D. 2000. Twelfth Edition, Biology Microorganisms, Prentice Hall, New Jersey.
2. Moat, A.G. and Foster, W. 2002. Microbial Physiology, Fourth Edition, John Wiley and Sons, New York.
3. Postgate, J. 1998, Nitrogen Fixation, third edition, Cambridge University Press.
4. Salisbury, F.W. and W. Ross, 1992, Plant Physiology, fourth edition, Wardsworth Publishing Company, California.
5. Deb, A.C. 2006. Fundamentals of Biochemistry, New Central Book Agency Pvt. Ltd., Kolkata.
6. Donald Voet and Judith G. Voet, 2011. Biochemistry. Third Edition, John Wiley and Sons, Inc. New York.
7. Stryer, L. 2010. Biochemistry, Seventh Edition, W.H. Freeman and Company, New York.
8. Nelson, D.L. and Cox, M.M. 2012. Lehingers's Principles of Biochemistry, Sixth Edition, Mac Millan worth Publishers, New Delhi.
9. Srivastava, M.L. 2008. Microbial Biochemistry, Narosa Publishing House, New Delhi.

10. Satyanarayana, U. and Chakrapani, U. 2013. Biochemistry, Fourth Edition Book and Allied Pvt. Ltd., Kolkata.
11. Bacterial metabolism by Gerhard Gottschalk (second edition), (1986) Springer Verlag New York Inc.

MBT-103 Immunology

- **Primary objectives of this course are to facilitate conceptual understanding of**
- Components and functions of Immune system, Development of Immune response interdependence of HI and CMI. Disorders of Immune system
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- **Learning outcome**
- At the completion of course student will able to illustrate
-
- Anatomy and function of cells and organs of immune system, Antigen ,Antibody and their interactions. Autoimmunity, Hypersensitivity

UNIT-I

History of immunology,. Immune response: mechanism of innate and adaptive immune response. Haematopoiesis: . Anatomical organization of immune system: primary and secondary lymphoid organs: structure and function. Antigens- structure and properties, factors affecting the immunogenicity, properties of B and T- cell epitopes, haptens, mitogens, super antigen, adjuvant. Antibody: structure, properties, types and function of antibodies,. Antigen- antibody interaction: avidity and affinity measurements, detection of antigen- antibody interaction by precipitation, agglutination, RIA, and ELISA.

UNIT-II

Major histocompatibility complex: organization of MHC genes, types and function of MHC molecules, antigen presentation, MHC polymorphism, MHC related diseases. Complement system: components, activation pathways, regulation of activation pathways and role of complement system in immune response. Cytokines: types, structure and functions, cytokines receptors, cytokine regulation of immune receptors. Immune response to infectious diseases: viral infection, bacterial infection, protozoan diseases, helminthes related diseases.

UNIT-III

Hypersensitivity: type I, II, III and types IV hypersensitivity. Immunodeficiency diseases: primary and secondary immunodeficiency. Autoimmunity: organ specific autoimmune diseases, mechanism of autoimmune diseases and therapeutic approaches. Transplantation immunology: immunologic basis of graft rejection, clinical manifestation of graft rejection and clinical transplantation.

UNIT-IV

Cancer immunology: tumor antigen, immune response to tumor, oncogene and induction, cancer immunotherapy Vaccines: Active and passive immunization, vaccine schedule, whole organism vaccine, subunit vaccine, vaccine, DNA vaccine, recombinant vaccine, subunit vaccines and anti-idiotypic vaccine. Hybridoma technology:

Reference Books:

1. Kuby Immunology by Kindt TJ, Goldsby RA, Osborne BA, Kuby J: 6th edition. New York. WH Freeman; 2006.
2. Cellular and Molecular Immunology by Abbas AK, Lichtman AH, Pillai S: Saunders Elsevier; 2007.
3. Immunobiology: The immune system in health and disease by Janeway CA, Travers P, Walport M, Shlomchik MJ: 6th edition. New York. Garland Science Publishing; 2005.
4. Medical Microbiology and Immunology by Levinson W, Jawetz E: Lange publication; 2001.
5. Roitt's Essential Immunology by Delves PJ, Martin SJ, Burton DR, Roitt IM; 11th edition. Blackwell

Elective-I Bio-statistics

Objectives

- To learn how to effectively collect data, describe and use data to make inferences
- Demonstrate understanding of hypothesis testing and Choose and apply appropriate statistical methods for analyzing variables.

Outcomes

- General Information about collection and analysis of data.
- Knowledge on use of statistical method in analysis and interpretation of biological data.

UNIT-I

Introduction to biostatistics, collection of data, sampling methods, processing and presentation of data. Measures of central tendency and dispersion (mean, median, mode, range, standard deviation, mean deviation, variance)

UNIT-II

Correlation, calculation of Karl Pearson's coefficient of correlation, Regression Analysis, linear regression, regression equation, Hypothesis testing: Types of hypothesis testing: t-test, χ^2 -test, and F- test., ANOVA. Software used in biostatistics- SPSS.

References:

1. Statistics in biology, Vol. 1 by Bliss, C.I.K. (1967) Mc Graw Hill, NewYork.
2. Practical Statistics for experimental biologist by Wardlaw, A.C. (1985).
3. Statistical Methods in Biology - 2000 by Bailey, N.T. J. English Univ. Press.
4. Biostatistics - 7th Edition by Daniel
5. Practical Statistics for experimental biologist by Wardlaw, A.C. (1985).
6. Fundamental of Biostatistics by Khan
7. Biostatistics by P Rama Kkrishna, Saras Publication, 1995.
8. Biostatistical Methods by Lachin

Elective-I Bio-instrumentation

Objectives

- To learn the principle, working and applications of basic bio-molecular techniques
- To acquire knowledge on advanced instrumentation techniques.

Outcomes

- General Information about basic bio-molecular techniques
- Knowledge on advanced instrumentation techniques.

Unit I- Basic techniques

Chromatography & Centrifugation: Principle, Working & Applications of chromatography (paper, thin layer, gel filtration, ion exchange, affinity, gas chromatography, HPLC, HPTLC) and centrifugation (preparative, analytical, ultracentrifugation, differential and density gradient methods). Electrophoretic Techniques: Basic principles, working and applications of paper, agarose gel electrophoresis, native and denaturing PAGE and two dimensional electrophoresis.

Unit II – Spectroscopy and radio isotopic techniques:

Principle, working and applications of UV, visible, IR, NMR, Fluorescence, Atomic Absorption, Mass and Raman Spectroscopy. Use of radioisotopes in biological sciences, principle and application of tracer techniques, Geiger- Muller and Scintillation counters, autoradiography and its applications

REFERENCES:

1. *Biochemistry*. 6th Edition by Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Freeman, New York.
2. *Biophysics: An Introduction* by Cotterill, R. M. J. (2002). John Wiley & Sons, England.
3. *Principles of protein X-ray crystallography* by Drenth, J. (2007). 3rd Ed. Springer, Germany.
4. *Biochemistry*. 3rd edition by Garrett, R. H. and Grisham, C. M. (2004). Brooks/Cole, Publishing Company, California.
5. *Understanding NMR Spectroscopy* by Keeler, J. (2002). John Wiley & Sons, England.
6. *Bioinformatics: sequence and genome analysis* by Mount, D. W. (2001). Cold Spring Harbor Laboratory Press, New York.
7. *Methods in Modern Biophysics*. Second Edition by Nölting, B. (2006). Springer, Germany.
8. *Biophysics* by Patabhi, V. and Gautham, N. (2002). Kluwer Academic Publishers, New York and Narosa Publishing House, Delhi.
9. *Principles and Techniques of Biochemistry and Molecular Biology* by Wilson Keith and Walker John (2005), 6th Ed. Cambridge University Press, New York.
10. *Proteins NMR Spectroscopy: Principles and Practice* by Cavanagh John *et.al.* (1995), Academic Press
11. *Molecular Biophysics: Structures in Motion* by Daune M. and W. J. Duffin (1999), Oxford University Press.
12. *Methods in Modern Biophysics* by Nalting B. and B. Nalting (2003) Springer Verlag
13. *Computational Analysis of Biochemical Systems* by Voit E. O. (2000) Cambridge University Press.
14. *Physical Biochemistry: Applications to Biochemistry and Molecular Biology* by Freilder, D. Freeman, San. Francisco, 1976
15. *Biochemical Techniques: Theory and Practice* by Robyt, John F.; White, Bernard J. Waveland Press, Inc., U.S.A. Published: 1990.

Elective-I Mycology

Primary objectives of this course are to facilitate conceptual understanding of fungal pathogens, applications of fungi

Learning outcome

At the completion of course student will be able to illustrate diagnosis, spread, prevention and treatment for fungal pathogens, application of fungi

Unit I

Medical Mycology, Introduction to fungi, Plant fungal pathogens and human fungal pathogens diagnosis, spread, prevention and treatment Tinea pedis or athlete's foot, *Candida albicans*. Infection, Ring worm, Aspergillosis

Unit II

Applied Mycology: Role of fungi in biotechnology, Application of fungi in food industry. (Flavour & texture, Fermentation, Baking, Organic acids, Enzymes, Secondary metabolites (Pharmaceutical preparations); Agriculture (Biofertilizers); Mycotoxins; Biological control (Mycofungicides, Mycoherbicides, Mycoinsecticides, Myconematicides);

References

Introductory Mycology, 4ed Paperback – 2007 by C.J. Alexopoulos (Author), C.W. Mims (Author), M. Blackwell (Author)

Textbook of Medical Mycology Hardcover – 2018 by [Jagdish Chander](#) (Author)

Elective-I Protozoology

Objectives:

This course is designed to teach students-

1. The basic concept of systematic protozoology
2. To study systematic of subkingdom protozoa
3. To study biological importance of free living protozoa
4. To study methodology of collection and identification of free living protozoa
5. To study culture methods of free living protozoa

Unit I:

1. Classification of protozoa upto order level
2. Factors affecting growth of protozoa: Balanced growth and non-balanced growth
3. Ecology of free living protozoa
 - i) Marine protozoa
 - ii) Planktonic protozoa
 - iii) Soil protozoa
 - iv) Protozoan blooms
 - v)

Unit II:

1. Nutrition in protozoa
 - i) Methods of feeding: Filter feeding, Raptorial feeding, diffusion feeding
 - ii) Digestion
 - iii) Nutritional requirements

References:

1. Aikawa and Sterling- Intracellular Parasitic Protozoa
2. Baker- Parasitic Protozoa
3. Chandler and Read- An introduction to Parasitology
4. Chattergy- Parasitology
5. Thomas C Cheng- General Parasitology
6. Hall- Protozoology
7. Kudo-Protozoology
8. Tayler and Baker- Cultivation of Parasites in vitro

MBT 201 EXTREMOPHILES AND BIODIVERSITY

Primary objectives of this course are to facilitate conceptual understanding of Extremophiles and their types, Adaptive strategies in typical extremophiles, systematic and occurrence of Archaea, Mycorrhiza

Learning outcome

At the completion of course student will able to illustrate Extreme habitats , Applications of extremophiles, culture dependent and independent methods of identification, Application of mycorrhiza

Unit-I

Microbial life at extreme temperature : prokaryotes and eukaryotes, habitats and ecological aspects, mechanism and molecular basis of thermophily and psychrophily commercial aspects of thermophiles and psychrophiles, application of thermozyms.

Microbial life at extreme P^H : Classification, habitats, soda lakes and deserts, calcium alkalophily, acidotolerance, mechanism of adaptation (external and internal PH, cell surface and membrane), applications.

Unit-II

Halophily and Oligotrophy : Classification, dead sea, cell wall and membrane, purple membrane, compatible solutes, osmoadaptation / halotolerance. Applications of halophiles, mechanism and regulation of oligotrophy. **Life under high irradiation:** Ionizing and non ionizing radiation, radiation sensitivity and nature of damage, mechanism of protection in radiation resistant strains.

Unit-III

Archaea : Systematics and occurrence, diversity, characteristic features, significance and potential applications (e.g. biochips, methane generation, ultra filtration membranes, production of PHB and PHA, desulfurization of coal and crude oil, bioleaching of metals, enzymes and compatible solutes) of different groups of archaeobacteria (Crenarchaeota, Euarchaeota, Korarchaeota and Nanoarchaeota.)

Bacteria : Conventional and molecular systematic, occurrence, diversity, characteristic features, significance and applications of various bacterial groups according to Bergey's Manual of Systematic Bacteriology.

Unit-IV

Fungal systematic and diversity : Implications of molecular and biochemical methods including r-DNA analysis, RFLP, RAPD and other fingerprinting techniques, fatty acids, polysaccharides and lipids, role of secondary metabolites in systematics, endophytic fungi and their adaptations, endophytes as biocontrol agents. **Mycorrhizal fungi** : Diversity of endo and ecto mycorrhizal fungi, biology of arbuscular mycorrhizal fungi, signalling, penetration and colonization inside roots, application and recent developments in the field of mycorrhiza. **Algal diversity** : Importance of algae in production of algal pigments, biofuels, hydrogen production, important bioactive molecules, role of algae in sustainable environment.

References:

1. **Biology of Extremophiles.** Microbiology of Extreme Environments edited by C. ... Environments, Academic Press. 5 **Kushner**, D.J., ed. (1978) Microbial Life.

2 **Recent Advances on Mycorrhizal Fungi (Fungal Biology)** by Marcela C. Pagano (Editor)

3. **Brock Biology of Microorganisms Hardcover – Import, 17 Dec 2010** by Michael T. Madigan (Author), John M. Martinko (Author), David A. Stahl

MBT-202: Microbial Metabolism

Objectives

- To learn the characteristics of enzymes
- To acquire knowledge on metabolism of bio - molecules.

Outcomes

- General Information about enzymes
- Knowledge on metabolism of bio - molecules

Unit-I

1. General characteristics of enzymes, activation energy, coupled reactions, active site and its importance, forms and derivation of M.M Equation, Significance of V_{max} and K_m, types of enzyme inhibition.
2. Regulation of enzyme synthesis: Induction, catabolite repression, end product repression and attenuation, Allosteric enzymes and allosteric control, covalent modification of enzymes Nitrogen fixing organisms, biochemistry of nitrogen fixation, regulation of nitrogenase.

Unit-II

1. Growth of E. coli on glucose and substrates other than glucose, PPP, ED pathway, citric acid cycle-Reversed TCA cycle, anapleurtotic reactions, glyoxylate cycle, Calvin cycle.
2. Assimilation of nitrate and sulfate, Dissimilation of nitrate and sulfate, ammonia oxidizing bacteria, nitrite oxidizing bacteria, sulfur and iron oxidizing bacteria, Metabolism of hydrocarbons and lipids.

Unit-III

1. Biosynthesis of amino acids- oxaloacetate and pyruvate family, phosphoglycerate family, α -oxoglutarate family and aromatic amino acids.
2. Biosynthesis of fatty acids, phosphatidic acids, phospholipids and macromolecules (Glycogen, cell wall, outer membrane layer, Levan and dextran synthesis), Biosynthesis of purines and pyrimidines.

Unit- IV

1. Alcohol fermentation, Lactate fermentation, Butyrate and acetone –butanol fermentation, Propionate and succinate fermentation.
2. Methane fermentation, Sulfide fermentation, Anaerobic food chain, Fermentation of single amino acids, Stickland reaction and heterocyclic compounds.

References:

1. Bacterial metabolism by Gerhard Gottschalk (second edition), (1986) Springer Verlag New York Inc.
2. Bacterial metabolism by H. W. Doelle (Second edition), (2005), Academic press, Inc.
3. Biochemistry by A. L. Lehninger,
4. Biochemistry, Seventh Edition by Jeremy M. Berg, John L. Tymoczko and Lubert Stryer (Dec 24, 2010), W.H. Freeman & Company.
5. Chemolithoautotrophic bacteria: Biochemistry and environmental biology by Tateo Yamanaka, (Jan. 2008). Springer.
6. Lehninger: Principles of Biochemistry by Albert L. Lehninger, Michael Cox and David L. Nelson (4 May 2004), W. H. Freeman.
7. Microbial Biochemistry (Second Edition) by G.N. Cohen, (2011) Springer Dordrecht Heidelberg London New York.
8. Principles of Biochemistry (Lehninger Principles of Biochemistry) by Albert L. Lehninger, Michael M. Cox and David L. Nelson (February 2008), W. H. Freeman.

MBT-203: MBT – 203 Microbial Genetics

Course objectives: objectives of this paper are to take students through basics of microbial genome organization, mutation, DNA repair, recombination and regulation. On covering all these concepts students will be exposed to concept of microbial genetics, genome organization in microorganisms, recombination and gene transfer mechanism and regulation.

Students learning outcomes: on successful completion of this course students will be able;

- Describe fundamental principles of microbial genetics.
- Understand mechanism of DNA damage, mutation and repair.
- Describe mechanism of gene transfer between and within the bacterial cells.
- Understand how gene expression is regulated.

Unit – I.

Brief historical evidences of genetic material in bacteria and viruses, features of genome organizations in viruses, prokaryotes, archaea and eukaryotes. plasmids; bacteria and yeast. concept of operon, interrupted genes, gene families, structure of chromatin and chromosome. unique and repetitive DNA, heterochromatin, eucromatin, Allele, transposons.

Unit – II.

DNA Damage and Repair.

Mutation; spontaneous and induced, molecular mechanism of mutation, mutation rate, mutation priority, effect of mutation on gene product, significance of mutants, reversion of mutation, intragenic and intergenic mutation, suppressor mutation and complementation.

DNA protection and Repair: Role of restriction modification system in DNA protection and repair.

Unit – III.

Recombination and methods of gene transfer in bacteria; Homologous recombination, site-specific recombination, illegitimate recombination.

Conjugation: F-plasmid; structure and function, origin of conjugation, Hfr and F strain, interrupted and un-interrupted mating, time map and recombination, conjugation in E. coli, F-factor and their use in genetic mapping.

Transformation: Natural and artificial, competence, transformation in Bacillus, Himophillus and Streptococcus, mechanism of recombination, genetic mapping.

Transduction: Generalized and specialized transduction, λ -phage and P1-phage, HFT and LFT lysate, co-transduction and transduction mapping.

Transposons: Discovery of transposition, classes of bacterial transposons, analysis of transposition, transposon mutagenesis and Mu-transposon.

Unit – IV:

Gene regulation: control of gene expression, co-ordinated control of structural genes, stringent response, catabolite repression, instability of bacterial RNA, positive regulation in *E. coli* (arabinose operon) and negative regulation in *E. coli* (lac operon), inducers and repressors, trp operon- regulation by attenuation, gal, tol operon and regulons with recent advances.

References:

1. Fundamental Bacterial Genetics by Nancy Trun and Jenanine Trumphy (2003), Publisher: Blackwell Publishers.
2. Genetics a conceptual approach (5th Ed.) by Benjamin A. Pierce (2008) Publisher: W.H. Freeman and Company
3. Genetics A Molecular Approach (2nd / 3rd Ed.) by Peter J Russell (2006)
4. Modern Microbial Genetics (2nd Ed.) by Uldis N. Streips, Ronald Yasbin. Publisher: Wiley-Liss, Inc.
5. Microbial Genetics by Maloy et.al. 1994. Jones and Bartlett Publishers.
6. Molecular Genetics of Bacteria by J.W.Dale 1994 John Wiley and Sons.
7. Gene XII by Lewin Oxford University press. 2017
8. Organization of Prokaryotic genome. 1999 by Robert L Charlebois, ASM Publications.
9. Recombinant DNA by Watson J.D.

Elective-II (A): Enzymology

Objectives

- To learn the enzyme modification and recent developments in enzymes
- To acquire knowledge on applicability of enzymes.

Outcomes

- General Information about enzyme modifications.
- Knowledge on applications of enzymes

Unit I

1. **Enzyme engineering:** Introduction to enzyme engineering and their application, genetic and chemical modification, methods of enzyme immobilization, homology modeling, biosensors, enzyme sensors for clinical processes and environmental analysis, abzymes, ribozymes, synzymes and recent developments, enzyme carriers, enzyme probe.
2. **Enzymes in genetic recombination:** Restriction endonucleases, SI nucleases, BAL 31 nucleases, DNA ligase, DNA polymerase, polynucleotide kinases, phosphatases and reverse transcriptase

Unit II

1. **Enzymes in medical diagnosis and therapy:** Lactate dehydrogenase, malate dehydrogenase, Fructose 6 biphosphatase, acid and alkaline phosphatase, Glucose 6 phosphate dehydrogenase, Enzyme in cancer therapy, genetic diseases, clotting disorders, Neonatal jaundice, surgery, toxicity.
2. **Industrial applications of enzymes** - catalysts in the manufacturing and other conversion processes as analytical tools (enzyme electrode).

References:

1. *Advances in Enzymology* by Alton Meister (1996), Interscience Publishers.
2. *Allosteric enzymes – kinetic Behaviour* by B.I Kurganov (1982) John Wiley and son Inc., New York.
3. *Biology enzymes in biotechnology* by H.J.Rehm and G. Reed Verlag (1983) VCH Publishers. New York.
4. *Enzymes as Drugs* by John S. Hoilenberg and Joseph Roberts (2001). John Wiley and Sons New York.
5. *Enzymes* by Dixon, M., and E. C. Webb, 3rd edition, (1980), Academic Press. New York.
6. *Enzymology by palmer*
7. *Hand Book of Enzyme Biotechnology* by Wiseman (1985), Ellis Horwood.
8. *Methods in Enzymology* by W. A. Wood (1980) Academic Press New York.
9. *Methods in Enzymology. Volume 22- Enzyme purification and related techniques* by William B. Jakoby. Academic press, New York.
10. *Methods of Enzymatic Analysis* by Hans Ulrich. Bergmeyer (1974) Verlag Chemie.
11. *Topics in enzymes and fermentation biotechnology* by L.N.Weiseman, John wiley andSons.

Lab Course I

A Agglutination test:-

1Widal test ,

2VDRL/RPR TEST,

3RA TEST,

4 Detection of blood group antigens

B Precipitation

5Radial immunodiffusion ,

6oucherson assay .

7 ELISA TEST: - online assay and quiz.

8 DLC (differential leucocyte count)

9 Isolation and enumeration of bacteriophage.

10 Growth phase of phage and burst size.

11Turbidometric assay

12 Study of plant viruses

13 collection of infected plant material

14 Study of morphology of lesions on infected plant

Lab Course II

1. Preparation of microbiological media: autotrophic media, minimal media, basic media, enrichment media, enriched media and differential media.
2. Culturing techniques of microbes: Slant and stab, tube culture, flask culture and shake flask culture.
3. Anaerobic jar and its uses.
4. Studies on bacterial growth curve
5. Effect of pH, temperature, salt concentration on bacterial growth.
6. Microbial growth experiments: viable count of culture and generation time determination
7. Glucose uptake by *E. coli* or *Saccharomyces cerevisiae*
8. Isolation of photosynthetic bacteria.
9. Estimation of calcium ion in sporulating bacteria (AAS/ Colorimeter/ EDTA)
10. Measurement of growth rate and generation time by turbidometry method.
11. Studies on pH titration curves of amino acids/acetic acid and determination of pKa values and Handerson-Hasselbach equation.
12. Paper chromatography- separation of amino acids and sugars.
13. Thin layer chromatography - separation of amino acid.
14. Spectrophotometric estimation of biomolecules (carbohydrates, proteins, lipids and nucleic acids)
15. Absorption maxima of proteins, nucleic acid, aromatic amino acid, riboflavin and photosynthetic pigments.
16. Representation of Statistical data by
 - a) Histograms
 - b) Ogive Curves
 - c) Pie diagrams
17. Determination of Statistical averages/ central tendencies.
 - a) Arithmetic mean
 - b) Median
 - c) Mode
18. Determination of measures of Dispersion
 - a) Mean deviation
 - b) Standard deviation and coefficient of variation
 - c) Quartile deviation
19. Tests of Significance-Application of following
 - a) Chi- Square test
 - b) t- test
 - c) Standard error

Lab course III:

- 1 Studies on halophiles from sea water (pigmentation and salt tolerance).
- 2 Studies on alkalophiles isolated from lonar water (at least one enzyme).
- 3 Isolation of acidophiles from metal sulphides or acid mine water.
- 4 Demonstration of iron oxidation rate of Thiobacillus thiooxidans isolated
- 5)Physico chemical analysis of water sample ph, DO, phosphate,BOD,and COD.
- 6)Study of VAM fungi.
- 7)Demonstration of sewage treatment .
- 8) Enrichment and isolation of thermophiles from hot water spring (at least one enzyme).
- .
- 9 Isolation of fungal endophytes.
- 10 Studies on biocontrol activities of endophytes .
- 11 Isolation and identification of cyanobacteria.
- 12 Isolation and purification of degradative plasmid of microbes growing in polluted environments .
- 13 Utilization of microbial consortium for the treatment of solid waste.
- 14 Recovery of toxic metal ions an industrial effluent by immobilized cells .

Lab Course IV:

- 1) Isolation and identification of Reserve food material (Glycogen / Polyphosphate/ PHB) of *B. megaterium* and *Azotobacter sp.*
- 2) Demonstration of endogenous metabolism in *B. megaterium* or *E. coli* and their survival under saturation condition.
- 3) Quantitative estimation of amino acid by Rosen's method.
- 4) Quantitative estimation of sugar by Sumners method.
- 5) Quantitative estimation of protein by Folin Lowry /Biuret method.
- 6) Preparation and analysis of polar lipids from *S. aureus* and *E. coli*.
- 7) Isolation of autotrophs.
- 8) Isolation of hydrocarbon degraders
- 9) Isolation and characterization of nitrogen fixers.
- 10) Isolation and characterization of chemolithotrophic microorganisms.
- 11) Isolation of cellulose, pectin, xylan and chitin degraders and estimation of their activities.
- 12) Nitrification and denitrification by soil isolates
- 13) Qualitative study of photosynthesis in photosynthetic bacteria and Cyanobacteria.
- 14) Isolation of iron and sulfur oxidizing bacteria.
- 15) Effect of UV, gamma radiations pH, disinfectants, chemicals and heavy metal ions on spore germination of *Bacillus SP.*
- 16) Determination of Iron Oxidation Rate of *Thiobacillus ferrooxidans*.
- 17) Determination of Sulfur Oxidation Rate of *Thiobacillus thiooxidans*.
- 18) Microbial degradation, decolorization and adsorption of organic dyes
- 19) Detection of enzyme activity of lipase, Urease, invertase, protease, Tween 80 hydrolysis.
- 20) Determination of kinetic constant of amylase:-Amylase activity, V_{max} . K_m .
- 21) Effect of pH and temperature on amylase activity.
- 22) Effect of inhibitors on amylase activity.
- 23) An Enzyme Purification theme
 - (a) Preparation of cell-free lysates & Ammonium Sulfate precipitation
 - (b) Enzyme Kinetic Parameters: K_m , V_{max} and K_{cat} .
 - (c) Column Chromatography/ Ion-exchange Chromatography/ Gel Filtration/ Affinity Chromatography/ Generating a purification Table
 - (d) Assessing purity by SDS-PAGE Gel Electrophoresis.
- 24) Determination of Molecular weight of Protein by Column chromatography
- 25) Determination of Surface Tension by Stalagmometer.