Department of Microbiology

School of Biosciences

Periyar University

Salem - 636 011, Tamil Nadu

M.Sc. Microbiology

Syllabus

(For the students admitted

from 2018 – 2019 onwards)

M.Sc. Microbiology

Syllabus

PERIYAR UNIVERSITY

M.Sc. MICROBIOLOGY

CHOICE BASED CREDIT SYSTEM

[Students admitted from 2018 – 2019 onwards]

REGULATIONS

Programme Specific Outcome (PS0)-Microbiology

Students who Postgraduate with Masters of Science in Microbiology will :

- Gain an understanding and acquire thefundamental knowledge in to the bacterial, fungal, algal and viral morphology and physiology and competently be able to cultivate and characterize them.
- Understand the fundamental concepts of immunity and the contributions of various organs and cells to immunity.
- Understand the various applications in Pharmaceutical Induistries.
- Understand the various concepts and disease development prevention and treatment of microbes in animals, plants and human.

1. CONDITIONS FOR ADMISSION

A. ELIGIBILITY CONDITIONS FOR ADMISSION

Candidate who has passed the B.Sc. degree in any Life Sciences [Microbiology/ Applied Microbiology/ Industrial Microbiology/ Botany/ Plant Sciences and Plant Biotechnology/ Zoology/ Biochemistry/ Bioinformatics/ Biology/Chemistry with Botany/ Zoology as Allied Subjects] of this university or an examination of any other university accepted by the syndicate as equivalent thereto shall be eligible for admission to M.Sc. Degree Course in Microbiology.

B. METHOD OF SELECTION

Candidates have to appear for an entrance examination in the respective subjects to be conducted by the respective departments and thereafter an interview.

2. ELIGIBILITY FOR THE AWARD OF DEGREE

A candidate shall be eligible for the award of the degree only if he/she has undergone the prescribed course of study in a college affiliated to the University for a period of not less than two academic years, passed the examination of all the four semesters prescribed earning 90 credits (plus 2 credits for Human Rights and Mooc Course) and fulfilled such conditions as have been prescribed therefore.

3. DURATION OF THE COURSE

The duration of the course is for two academic years consisting of four semesters.

4. EXAMINATIONS

There shall be four semester examinations: first semester examinations at the middle of the first academic year and the second semester examination at the end of the first academic year. Similarly, the third and fourth semester examinations shall be held at the middle and end of the second academic year, respectively.

5. COURSE OF STUDY AND SCHEME OF EXAMINATIONS

Semester	Paper code	Course	Hrs/ week	Credits	Marks		
					CIA	EA	Total
Sem - I	18MBC01	Core I - Basics of Microbiology	5	5	25	75	100
	18MBC02	Core II - Immunology & Immunotechnology	5	5	25	75	100
	18MBC03	Core III - Pharmaceutical Biochemistry	5	5	25	75	100
	18MBCE01	Elective -1	5	4	25	75	100
	18MBCP01	Core Practical I - General Microbiology	5	4	40	60	100
	18MBCP02	Core Practical Il - Immunology & Pharmaceutical chemistry	5	4	40	60	100
Sem - II	18MBC04	Core IV - Medical Bacteriology and Parasitology	4	5	25	75	100
	18MBC05	Core V - Medical Mycology and Virology	4	5	25	75	100
	18MBC06	Core VI - Bioresource Technology	5	5	25	75	100

	18MBCE02	Elective - 2	4	4	25	75	100
	18MBCS01	Supportive – 1	3	3	40	60	100
	18MBCP03	Core Practical II - Medical Microbiology	5	4	40	60	100
	18MBCP04	Core Practical III - Industrial Microbiology	5	4	40	60	100
	18MBCI01	Internship	2 wks	-	40	60	100
		Swayam / Mooc Course		4	25	75	100

Elective courses

1. Biocontrol and Entomology
2. Entrepreneurship in Microbiology
3. Algal Biotechnology
4. Quality Control in Industries
5. IPR, Biosafety and Bioethics
6. Mushroom and SCP Technology

Supportive courses for other departments

1. Microbiology
2. Medical Laboratory Technology
3. Quality Control in Industries
4. Health Science Management

Details of the course

1. No. of courses

(Core paper + Practical's) : 16

2. Elective - Major : 2
3. Supportive -Non Major : 2
4. Internship : 1
5. Value Education : 1
6. Mooc / Swayam course : 2

SCHEME OF EXAMINATIONS

The scheme of examinations for different semesters shall be as follows:

Theory Paper

External : 75 Marks

Internal : 25 Marks

Total : 100 Marks

Time : 3 hours

The following procedure will be followed for Internal Marks:

Theory Papers Internal

Best two tests out of 3 : 10 marks

Attendance : 5 marks

Seminar : 5 marks

Assignment : 5 marks

---

25 marks

Practical : 40 Internal Marks

Attendance : 5 marks

Practical Test : 30 marks

(Best 2 out of 3)

Record : 5 marks

Project

Internal Mark : 20 marks

Viva - voce : 20 marks

Project Report : 60 marks

Break-up details for attendance

Below 60% : No Marks

60 to 75% : 3 Marks

76 to 90% : 4 Marks

91 to 100% : 5 Marks

6. REQUIREMENTS FOR PROCEEDING TO SUBSEQUENTSEMESTERS:

(i) Candidates shall register their names for the first semester examination after the admission in the PG courses.

(ii) Candidates shall be permitted to proceed from the first semester up to the final semester irrespective of their failure in any of the semester examination subject to the condition that the candidates should register for all the arrear subjects of earlier semesters along with current (subject) Semester subjects.

(iii) Candidates shall be eligible to proceed to the subsequent semester, only if they earn sufficient attendance as prescribed therefore by the Syndicate from time to time.

Provided in case of candidate earning less than 50% of attendance in any one of the semester due to any extraordinary circumstance such as medical grounds, such candidates who shall produce Medical Certificate issued by the Authorized Medical Attendant (AMA), duly certified by the Principal of the College, shall be permitted to proceed to the next semester and to complete the course of study. Such candidate shall have to repeat the missed semester by rejoining after completion of final semester of the course, after paying the fee for the break of study as prescribed by the University from time to time.

7. PASSING MINIMUM

(i) There shall be no passing minimum for internal.

(ii) For external examination, passing minimum shall be of 50%of the maximum marks prescribed for the paper.

(iii) In the aggregate (external + internal) the passing minimum shall be of 50% for each paper/practical/project and viva-voce.

(iv) Grading shall be based on overall marks obtained (internal + external).

8. CLASSIFICATION OF SUCCESSFUL CANDIDATES

Candidates who secured not less than 60% of aggregate marks (internal + external) in the whole examination shall be declared to have passed the examination in the first class.All other successful candidates shall be declared to have passed in second class. Candidates who obtain 75% of the marks in the aggregate (internal + external) shall be deemed to have passed the examination in

first class with distinction, provided they pass all the examinations (theory papers, practical's, project and viva-voce) prescribed for the course in the first appearance.

9. GRADING SYSTEM

The term grading system indicates a seven (7) point scale of evaluation of the performances of students in terms of marks obtained in the internal and external examination, grade points and letter grade.

SEVEN POINT SCALE (As per UGC notification 1998)

GRADE	GRADE POINT	PERCENTAGE EQUIVALENT
'O' = Outstanding	5.50 - 6.00	75 - 100
'A' = Very Good	4.50 - 5.49	65 - 74
'B' = Good	3.50 - 4.49	55 - 64
'C' = Average	3.00 - 3.49	50 - 54
'D' = Below Average	1.50 - 2.99	35 - 49
'E' = Poor	0.50 - 1.49	25 - 34
'F' = Fail	0.00 - 0.49	0 - 24

10. RANKING

Candidates who pass all the examinations prescribed for the course in the first appearance itself alone are eligible for Ranking / Distinction.

Provided in the case of candidates who pass all the examinations prescribed for the course with a break in the First Appearance due to the reasons as furnished in the Regulations under "Requirements for Proceeding to subsequent Semester" are only eligible for Classification.

11. PATTERN OF QUESTION PAPER

Theory Paper External (75 Marks**)**

[Part A: 20 x 1=20 Marks (Objective type Questions to be filled in the OMR sheet and submitted]

[Part B: Analytical Questions 5 x 3= 15Marks (Either or type, One question from each unit)

[Part C: 5×8= 40 Marks (Either or type Descriptive Questions]

12. APPEARANCE FOR IMPROVEMENT

Candidates who have passed in a theory paper/papers are allowed to appear again for theory paper/papers only once in order to improve his/her marks, by

paying the fee prescribed from time to time. Such candidates are allowed to improve within a maximum period of 10 semesters counting from his/her first semester of his/her admission. If candidate improve his marks, then his improved marks will be taken into consideration for the award of classification only.Such improved marks will not becounted for the award of prizes/medals, rank and distinction. If the candidate does not show improvement in the marks, his previous marks will be taken intoconsideration. Candidate will be allowed to improve marks in the practical's, project, Viva-Voce and field work.

13. TRANSITORY PROVISION

Candidates who have undergone the course of study prior to the academic year 2008-2009 will be permitted to appear for the examinations under those regulations for a period of three years i.e., up to and inclusive of April/May 2012 Examinations. Thereafter, they will be permitted to appear for the examination only under the regulations then in force.

Course Specific Outcome (CS0) - Microbiology

- Students will acquire and demonstrate competency in laboratory safety and develop specialized microbiological laboratory skills applicable to microbiological research or clinical methods, including accurately reporting, observations and analysis.
- Student will develop the ability to design, conduct experiments and analyze data in the field of Microbiology.
- Students will develop skills to become a good microbiologist and will have placements in various industries.

CORE - I: BASICS OF MICROBIOLOGY (18MBC01)

Course Objectives

The course contents are designed to gain knowledge about the different forms of bacteria, fungi, algae, protozoan's along with the basic principles of microbial taxonomy. The learner will understand about the microbial metabolism and microbes thriving in extreme environments.

Course Outcome

At the end of the course, the learner will be able to

1. Know about the important aspects of microbial taxonomy from species to kingdoms.
2. Learn the basics of various characteristics features of divisions used in the classification of fungi and algae.
3. Know the basics of Microbial physiology, microbial ecology with reference to extreme ecosystems.

UNIT – I

Introduction – Development of microbiology and the early discoveries - Isolation of different types of bacteria – fungi – actinobacteria – cyanobacteria. Preservation methods of microbes for storage and microscopy studies, culture collections. Sterilization and disinfection – physical and chemical methods for controlling microorganisms.

UNIT - II

Morphological types - Gram negative and Gram positive, Cyanobacteria, Archeabacteria and Eubacteria. Ultrastructure of prokaryotic and eukaryotic cells. Fungi: Cell wall - chemical composition and functions, membranes and their functions. Algae: Structure of algal cells, classification, reproduction and characteristics of Chlorophyta (green algae), Chrysophyta (golden-brown and yellow), Green algae, Diatoms, Euglenophyta (Euglenoids), Rhodophyta (Red algae), Cyanophyta, Xanthophyta, Phaeophyta (Brown algae).

UNIT - III

Microbial taxonomy: Definition, systematics, Nomenclature rules and identification, Hierarchical organization and the position of microbes in the living world, classification systems – Haeckel's three kingdom concept- Whittaker's five kingdom concept- three domain concept of Carl Woese. Characterization of

microorganisms - Morphological, physiological and metabolisms. Modern classification of fungi - Ascomycetes (*Aspergillus*), Deuteromycetes (Candida), Zygomycetes (Mucor), Basidiomycetes (Agaricus), Acrasiomycetes (Dictyostelium), oomycetes (Saproleina) and Myxomycetes (Ceratiomyxa).

UNIT – IV

Microbial respiration and fermentative pathway - respiratory metabolism - Embden Mayer Hoff pathway - ED pathway - Glyoxalate pathway - Kreb's cycle - ETC - oxidative and substrate level phosphorylation - TCA cycle - gluconeogenesis - Fermentation of carbohydrates - homo and hetero lactic fermentation. Bioenergetics, Cell division - endospore - structure and properties.

UNIT – V

Microbial Ecosystems - Principles of microbial ecology, Metabolic diversity - phototrophy, auxotrophy and lithotrophs. Microbial Habitat, Microbial ecosystems - Fresh water, soil, plant, hydrothermal vents, hot springs, volcano, Marine (Open oceans and Deep sea organisms), barophiles and space. Nutrient cycles - Nitrogen, Sulphur, Phosphorus and Iron, Animal - Microbial symbiosis, Plant - Microbial symbiosis - Microbial communications - Quorum sensing, Cell signaling, Biofilm.

References

1. Tortora, G.J., Funke, B.R. and Case, C.L. (2016) *Microbiology: An Introduction*, 11th Edition, Pearson Education, India
2. Madigan, T.M., Martinko, M.J., Bender, S.K., Buckley, H.D., Stahl, A.D. and Brock, T. (2017) *Brock Biology of Microorganisms*. 14th Edition, Licensing agency, UK.
3. Baveja, C.P. and Baveja, V. (2017) *APC Text Book of Microbiology*.4thEdition, Arya Publications, New Delhi.
4. Johanne, M.W., Linda, M.S. and Christopher, J.W. (2017) Willey Prescott's Microbiology 10E.10th Edition. McGraw Hill Education, India.
5. Dubey, R.C. and Maheshwari, D.K. (2013)*A Textbook of Microbiology*. Revised Edition, Chand and company, NewDelhi.
6. MeenaKumari, S. (2011) *Microbial Physiology*. 5th Edition, MJP publishers, Chennai.
7. Wheelis, M. (2008) *Principles of Modern Microbiology*. 4th Edition, Bartlett Publishers, UK.
8. Elizabeth, M.L. (1996). *Fundamentals of the Fungi*. 4th Edition, Prentice Hall International Inc, London.

9. Alexopoulus, C.J. and Mims, C.W. (1996) *Introductory Mycology*. 4TH Edition, Wiley Eastern Ltd. New Delhi.
10. Lincoln, T. and Eduardo, Z. (2010) *Plant Physiology*, International Edition, 5th Edition,Sinauer Associates, USA.

Web References

1. www.life.umd.edu/classroom/bsci424/BSCI223WebSiteFiles/LectureList.htm
2. www.microbiologyonline.org.uk
3. www.cambridge.org › Home › Academic › Life science › Microbiology and immunology
4. https://open.umn.edu/opentextbooks/BookDetail.aspx?bookId=404
5. https://www.boundless.com/microbiology
6. www.ebooks.cambridge.org/ebook.jsf?bid=CBO9781139170635
7. www.grsmu.by/files/file/university/cafedry/…/files/essential_microbiology.pdf
8. https://microbiologyinfo.com/top-and-best-microbiology-books/

CORE - II: IMMUNOLOGY AND IMMUNOTECHNOLOGY (18MBC02)

Course Objectives

The course contents are designed to provide students with knowledge on how the immune system works and to state the role of immune system, be able to compare and contrast humoral and cell mediated immune responses, to distinguish and characterize various immune cells, to understand the mechanism of antibody diversity, to understand the role of cytokines in immunity, to understand the significance of the major histocompatibility and to provide an overview of the interaction between the immune system and pathogens.

Course Outcome

At the end of the course, the learner will be able to

1. Describe the basic mechanism of innate and acquired immunity; humoraland cell mediated immunity.
2. Describe the cellular and molecular mechanism of lymphocyte production and activation.
3. Understand the cellular process involved in inflammation and immunity, hypersensitivity reactions.
4. Understand the mechanism of clonal selection, antibody diversity and various serological diagnostic techniques based on antigen – antibody interaction.

UNIT - I

History and scope of immunology: Types of immunity - Innate and acquired, active and passive, Cell mediated immunity and Humoral immunity, Haematopoeisis. Ontogeny, origin, development and differentiation of immune cells. Toll – like receptors Antigen presenting cells. T-helper and T-cytotoxic cells, Natural killer cells, Dendritic cells, Langerhan cells, Macrophages, Microphages.

UNIT - II

Lymphoid tissues and organs - Primary lymphoid organs - Thymus, Bone marrow: Secondary lymphoid organ - Lymph node, spleen, MALT and GALT. Phagocytosis process. Clonal selection theory. B-lymphocytes and their activation, mechanism of T-cell activation. Thymus derived lymphocytes, Major histocompatibility complex. Structure and functions of Class I and II molecules. Immunoglobulins - Structure, distribution and function. Generation of antibody diversity. Organisation and expression of immunoglobulin genes.

UNIT - III

Antigenicity: factors governing antigenicity. Antigen types, haptens, epitopes, adjuvants, carriers, bacterial, viral and tumour antigens, autoantigens, blood group antigens, T dependent, T independent antigens. Kinetics of antibody production - primary and secondary antibody response. Antigen antibody reactions-precipitation, agglutination, immunoflouroscence, haem agglutination, RIA, ELISA. Factors governing antigen-antibody interactions: Affinity, avidity, valency, cross reactivity.

UNIT - IV

The complement systems: Mode of activation, classical, alternate and lectin pathway; Immuno haematology, Transplantation immunity - Organ transplantation and HLA tissue typing. Introduction to autoimmune disorders and immunology of infectious diseases. Tumour Immunology-Immuno diagnosis and Immunotherapy of Cancer.

UNIT - V

Hypersensitivity reactions. Immunological tolerance. Immunosuppression. Immunotherapy. Hybridoma and monoclonals. Recombinant antibodies. DNA vaccines and edible vaccines. Immunotechniques - ELISA, Immuno electrophoresis,Flow cytometry-Fluorescent activated cell sorter- Applications in immunology.

References

1. Coico, R. and Sunshine, G. (2015) *Immunology: A Short Course*, 7th Edition, John Wiley & Sons, 432 pages.
2. William E. Paul (2018) *Fundamental Immunology*, 8th Edition, Willams and Wilkins Publishing.
3. Cruse, J., Lewis, R. and Wang, H. (2004) *Immunology Guidebook*, Academic Press.
4. Abbas, A.K., Litchman, A.H., Pober. J.S. (2017) *Cellular and Molecular Immunology*, 9th Edition, W.B.Saunders, USA.

5. Golds, R.A., Kindt T.J., Osborne B.A. (2005) *Immunology,* 5th Edition, Freeman and Company, New York.
6. Ivan M. Roitt and Peter J. Delves (2016) *Essential Immunology*, 13th Edition, Blackwell Science Ltd. Oxford.
7. Janeway, C.A., Travers, P., Walport, M. and Shlomchik, M.J. (2001) *Immunobiology: The Immune System in Health and Disease*, 5th Edition, Garland Publishing, USA.
8. Joshi, K.R., Osama, N.O. (2012) *Immunology*, 5th Edition, Agrobios Ltd, India.
9. Peter Wood (2006) *Understanding Immunology University of Manchester*, 2nd Edition, Pearson Education Lts, Essex.
10. Rao, C.V. (2012) *An Introduction to Immunology*. 2nd Edition, Narosa Publishing House, India.
11. Stefan H.E. Kaufmann, Sher, A., Ahmed, R. (2002) *Immunology of Infectious diseases*, ASM Press, USA.
12. Richard M. Hyde (1995) Immunology, 3rd Edition, Willams and Wilkins Publishing.

Web References

1. http://www.hhmi.org/biointeractive/immunology/lectures.html/
2. http://bitesized.immunology.org/what-is-immunology/
3. http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1365-2567
4. http://www.helmberg.at/immunology.pdf
5. http://www.mednotes.net/notes/immunology/

CORE - III: PHARMACEUTICAL BIOCHEMISTRY (18MBC03)

Course objectives

The course contents are designed with the basic science knowledge in Chemistry, Microbiology and Pharmaceutical science as prerequisites, to cover basic chemistry knowledge needed to understand cell biological functions. The learners will understand the atomic chemistry and role of macromolecules involved in cell activities.

Course outcome

At the end of the course, learners will be able to

1. Gain knowledge about the drug biotransformation reactions and drug interactions in living systems.

2. Acquire knowledge of GLP providing guidelines and better control for maintenance of instruments, environment control, preservation of test records.
3. Gain well-rounded knowledge and are fully prepared for employment within the pharmaceutical and biomedical sciences industries.
4. Understand the methodologies of making certain the finished pharmaceutical products sterile.

UNIT - I

Basic concepts **-** Standard periodic table of the chemical elements - Atomic structure: Atom - Atomic orbital - Molecular orbital - Chemical element - Valence - Atomic nucleus - Isotope. Bonding: Chemical bond - Ionic bond - Covalent bond - Metallic bond - Hydrogen bond - Intermolecular force - Dipole - Electron pair - Unpaired electron. Chemical formula - Structural formula - Mole - Stoichiometry - Chemical composition of cells.

UNIT - II

Macromolecular components of the cell - Structural conformation and biological functions of macromolecules. Carbohydrates - Monomers, oligomers, polymers, isomers. Lipids - simple lipids, compound lipids and derived lipids. Lipid beta oxidation. Proteins - Primary, secondary, tertiary and quaternary structures. Enzyme - Classification, nomenclature, properties and mechanisms of enzyme action. Classification and uses of vitamins.

UNIT - III

Pharmacokinetics and pharmacodynamics **-** Routes of drug administration-volume of distribution - biotransformation - Phase I and Phase II reactions - bioavailability - excretion of drugs and their metabolites as defined by Hendersson Hassle Batch equation. Drug physical and chemical actions - drug interactions - therapeutic applications of beneficial interactions. Adverse drug reactions. Principles of toxicity, evaluation and determination of LD50, ED50 and therapeutic Index.

UNIT - IV

Current good manufacturing practices, Good laboratory practices, Good documentation practices, Standard operating procedures, Instrumentation operating procedures, Calibration of equipment's, HACCP, ISO Standards,Laboratory information management system (LIMS).Microbial spoilage, Infection risk and contamination control. Chemical disinfectants, antiseptics, antibiotics, anti-infectives, endocrine and human growth hormone and preservatives. Pharmacopaea–Pharmacopaea updates, US, Europea, British and Indian Standard Organization, Audit related to pharma. United States Federal Drug Administration Audits.

UNIT - V

Growth promotion test(GPT), Disinfectant efficacy study for different types of Disinfectants, Container Closure Integrity test(CCIT),Preservative efficacy study (PET), Qualitative and quantitative methods of environmental monitoring samples, Gowning qualifications, Isolation and identification of isolates - VITEK - Biochemical method, Trend analysis, Results and Discussions reporting (OOS & OOT), Out of specifications and Out of trend. Bacterial endotoxin test (BET), Bio-burden analysis, Water analysis in pharmaceutics, Biological indicators, Raw material samplings and sterility checking for finished products. Cosmetic microbiology-testing methods and preservation

References

1 ArviRauk (2000) Orbital Interaction Theory of Organic Chemistry 2nd Edition editionPublisher: Wiley-Blackwell. 360 Pages

2 David E. Golan MD. (2016). Principles of Pharmacology: The Pathophysiologic Basis of Drug Therapy. Publisher: LWW; Fourth, North American edition. 1024 Pages

3 David L. Nelson, Michael Cox. **(**2017**).** Lehninger Principles of Biochemistry.7th ed. International Edition. Publisher: WH Freeman, 1328 Pages

4 Denise Guinn (2014). Essentials of General, Organic, and Biochemistry (2nd Edition). Publisher: WH Freeman, Pages: 700

5 John E. McMurry (2015). The Organic Chemistry of Biological Pathways (2nd Edition). Publisher: WH Freeman and Company. 576 Pages

6 John L. Tymoczko, Jeremy M. Berg, LubertStryer. (2015). Biochemistry: A Short Course. Third Edition**.** Publisher. WH Freeman. 896 Pages

7 Ochoa, Pamella S., Vega, Jose A. (2015). Concepts in sterile preparations and aseptic technique, Publisher. Burlington, MA Jones & Bartlett Learning. 404 Pages.

8 Robert T. Morrison, Robert N. Boyd (2016). Organic Chemistry. Sixth edition Publisher: Pearson India, 1364 pages

9 RS Satoskar NirmalaRege SD Bhandarkar (2015). Pharmacology and Pharmacotherapeutics24th Edition. 1170 Pages

10 Sara E. Rosenbaum (Editor) 2016. Basic Pharmacokinetics and Pharmacodynamics: An Integrated Textbook and Computer Simulations, 2nd Edition.576 pages

11 Wilson/Walker (2010). Principles and Techniques of Biochemistry and Molecular Biology Cambridge University Press. 744 Pages

Web References

1. http://listpdf.com/ph/pharmaceutical-chemistry-lecture-notes-pdf.html
2. https://sites.google.com/site/microbiologyacu2/home/fall/pharmaceutical-microbiology
3. http://jonspharmacy.weebly.com/uploads/2/1/9/2/21923694/hugo_and_russells_pharmaceutical_microbiology.pdf
4. http://fda.gov/downloads/ScienceResearch/FieldScience/UCM397228.pdf

PRACTICAL - I

PRACTICAL EXAM: 7 HRS. / DAY: 2 CONSECUTIVE DAYS

CORE PRACTICAL I: GENERAL MICROBIOLOGY, (18MBCP01)

Course Objectives

The learners will be able to gain adequate knowledge and acquire adequate skill to perform different staining techniques, growth rate of bacteria and biochemical test.To impart thorough knowledge and understanding of practical skills in immunology and means of applying these principles in diagnostic and therapeutic techniques and research.

Course Outcome

At the end of the course, learners will be able to:

1. Perform the various staining techniques of bacteria and study the growth rateof bacteria.
2. Competently cultivate algae in different types of media.
3. Demonstrate knowledge and understanding of immunology and the means of applying in the diagnostic and therapeutic techniques and research.
4. Understand the safe working practice in an immunology laboratory.
5. Develop skills to design diagnostic kits.

General Microbiology

1. Microscopy- Phase contrast, Dark Field, Fluorescent Microscopy- Principle and Functions.
2. Gram Staining
3. Metachromatic granular Staining
4. Spore Staining
5. Capsule Staining
6. Flagella staining
7. Lactophenol Cotton Blue Staining
8. Micrometry
9. Motility Test
10. Fungal Slide Culture
11. Growth Curve- Growth rate and Generation Time
12. Effect of pH, temperature and osmotic pressure on growth of bacteria.
13. Isolation and cultivation of Algae
14. Isolation of Arbuscular mycorrizae (AM)
15. IMVIC tests
16. Carbohydrate fermentation

17. Starch hydrolysis Test
18. Cellulose hydrolysis Test
19. Gelatin Hydrolysis Test
20. Casein Hydrolysis Test
21. Catalase Test
22. Oxidase Test
23. Urease Test
24. Nitrate Test
25. Triple Sugar Ion Agar Test
26. Preparation of Millique water
27. Fumigation technique.

References

1. Kocher, G.S. (2013) *Practical Manual Series Vol III: Practical Teaching in Microbiology HB*, NPH Publishers and Distributors.
2. Harley, J.P. 2013. *Laboratory Exercises in Microbiology*.9thEdition, McGraw Hill Education; New York.
3. Alfred E. Brown (2010) *Benson's Microbiological Applications: Laboratory Manual in General Microbiology*, 11th Edition, McGraw-Hill Companies.
4. Emanuel Goldman and Lorrence H. Green (2015) *Practical Hand Book of Microbiology*, 3rdEdition, CRC Press. Taylor and Francis Group.
5. Cappuccino, J and Sherman, N. (2014) *Microbiology. A Laboratory Manual*. 10th Edition. Pearson Education Publication, New Delhi

Web References

1. http://www.microbiologyonline.org.uk/media/…/sgm_basic_practical_microbiology_2.pdf
2. http:/www.faculty.washington.edukorshin/Class486/MicrobiolTechniques.pdf
3. http://www.pdfsdocuments.com/cp-baveja-microbiology.pdf
4. http://www.cmu.edu.cn/jc_sys1/upl_files/200858184159474.pdf
5. http:// www vlab.amrita.edu/?sub=3&brch=69&sim=192&cnt=1
6. http:// www homepage.usask.ca/~jrg426/manualtoc.html
7. http:// www.asmscience.org/content/book/10.1128/9781555815905
8. http://www.pleasanton.k12.ca.us/avhsweb/thiel/apbio/labs/Lab_Topic19.pdf

CORE PRACTICAL II

7 Hrs/ day. Two Consecutive days

IMMUNOLOGY & PHARMACEUTICAL CHEMISTRY, (18MBCP02)

Course Objectives

The students will be able to gain adequate knowledge and understanding of practical skills in immunology and means of applying these principles in diagnostic and therapeutic techniques and research.

Course Outcome

At the end of the course, learners will be able to:

1. .Demonstrate knowledge and understanding of immunology and the means of applying in the diagnostic and therapeutic techniques and research.
2. Understand the safe working practice in an immunology laboratory.
3. Develop skills to design diagnostic kits.

Immunology& Pharmaceutical Microbiology

1. Collection of human peripheral blood
2. Separation of serum and plasma from human blood
3. Blood grouping
4. Isolation of Buffy coat
5. Antibody titration of human blood group antigen
6. Ouchterlony's Double Immuno-diffusion test
7. Counter Immuno electrophoresis
8. Quantification of Ig
   a) Radial immunodiffusion
   b) Rocket immune electrophoresis
9. Serotyping
   a) Antistreptolycin-O
   b) C-Reactive protein
   c) Rheumatoid Factor
   d) Beta-HCG
   e) TPHA
10. Bacterial agglutination – WIDAL
11. Serum bactericidal Activity

12. Isolation & Separation of T-cell & B Lymphocytes
13. Dead/fresh cell counting using Tryphan blue dye
14. ELISA
15. Fluorescent Microscopy(Demonstration)
16. Sterility Testing (Tablet, Needle and Syringes, Parentral's)
17. Phenol co-efficient Testing

References

1. Celis, J.E. (1998) *Cell Biology: A Laboratory Handbook*, 2nd Edition, Immunocytochemistry, San Diego: Academic Press, pp 457-494
2. Weir, D.M. (1986) *Hand Book of Experimental Immunology*Vol I & II by Blackwell Scientific Company, Publication, Chicago.
3. Talwar, G.P. (1983) *A Hand Book of Practical Immunology*, Vikas Publishing House, India
4. Arthi, N. and Archana, A. (2008**)** Lab Manual in Biochemistry, Immunology and Biotechnology, McGraw-Hill Education

Web Reference

1. http:// www homepage.usask.ca/~jrg426/manualtoc.html
2. http:// www.asmscience.org/content/book/10.1128/9781555815905
3. http:/www.pleasanton.k12.ca.us/avhsweb/thiel/apbio/labs /Lab_Topic_19.pdf

SEMESTER - II

Core IV – MEDICAL BACTERIOLOGY AND PARASITOLOGY(18MBC04)

Course Objectives

The students will gain knowledge about the different types of bacteria and protozoan. Collection and processing of specimens for microbiological analysis. Virulence factors of bacterial and protozoan pathogens. The mechanism of Pathogenesis, laboratory diagnosis and treatment of bacterial and protozoan infections.

Course Outcome

At the end of the course, learners will be able to:

1. Learn the methods of collection, transport and processing of clinical specimens.
2. Know the morphological, biochemical, cultural properties of medically important bacteria and protozoan.
3. Get complete information on pathogenesis of bacterial and protozoan diseases.
4. Comprehend the diagnosis of bacteria and protozoan infections and preventionmethods.
5. Gain knowledge on nosocomial infections and ethical committee.

UNIT - I

Microscopic appearance and Colony characteristics of different bacteria. Various Synthetic and Non – synthetic media for bacterial cultivation. Applications

of basal, Differential, Enriched and Selective media in bacterial growth. Maintenance and preservation techniques – Refrigeration, Freeze drying, Oil overlaying, Periodic transfers. Indigenous normal microbial flora of human system and their importance. Virulence factors of pathogenic bacteria.

UNIT – II

Collection and lab processing of clinical specimens – Urine, Sputum, CSF, Blood Pus and Stool. Gram positive bacteria – The epidemiology, pathogenesis, diagnosis and treatment of infections caused by pathogenic species of bacteria belonging to the genus – *Staphylococci*, *Streptococci*, *Enterococci*, *Corynebacterium*,*Treponemapallidum*,*Mycobacterium*, and *Clostridium*. Hospital waste disposal – Nosocomial infections – Functions of Hospital Infection control and related ethical committee.

UNIT - III

Gram Negative bacteria - The epidemiology, pathogenesis, symptoms, diagnosis and treatment of infections caused by medically important pathogenic species of bacteria belonging to the genus – *Escherichia, Klebsiella, Proteus*, *Salmonella, Shigella, Vibrio, Pseudomonas*, *Neisseria* and Zoonotic infections.

UNIT – IV

Parasitology- introduction and classification. Sarco Mastigophora – Sarcodina - Intestinal amoeba – *Entamaeba histolytica*. Free living amoebae – *Naegleria fowleri*, *Acanthamoeba* spp. Mastigophora – Intestinal and genital flagellates – Giardia, Trichomonas. Blood and tissue flagellates – *Leishmania donovani, Trypanosoma cruzi* and *T. brucei* complex. Apicomplexa – Haemosporina – Malarial Plasmodium, Ciliates – *Balantidium coli*.

UNIT – V

Helminthology – Cestodes – *Taenia solium, Taenia saginata.* Trematodes – *Schistosoma haematobium, Faciola hepatica, Faciola buski*. Nematodes – *Trichuris trichura*, Intestinal nematode-*Enterobius vermicularis, Ascaris lumbricoides*. Filarial nematode - *Wucheriria bancrofti*. Extra intestinal nematodes –*Trichinella spiralis*.

References

1. Patricia Tille (2013) *Bailey & Scott's Diagnostic Microbiology,* 13th Edition. Elsevier Health Sciences Division.
2. Abigail Salyers, A. and Dixie Whitt, D. (2002) *Bacterial Pathogenesis,* 2nd Edition. ASM Press, Washington.
3. Ananthanarayan, Paniker and ArtiKapil (2013) *Textbook of Microbiology,* 9th Edition. Universities Press.

4. Gerhardt, P., Murray, R.G., Wood, W.A. and Kreig, N.R. (Eds) (1994) *Methods for General and Molecular Bacteriology,* ASM Press, Washington, DC.
5. Finegold, S.M. (2000) *Diagnostic Microbiology, 10th Edition*. C.V. Mosby Company, St. Louis.
6. Greenwood, D., Slack, R.B. and Peutherer, J.F. (2002) *Medical Microbiology, 16th Edition.* Churchill Livingstone, London.
7. Karyakarte, R.P. and Damle, A.S. (2012) *Medical Parasitology*, 3rdEdition,Books and Allied (P) Ltd., Kolkatta.
8. Sougata,G (2013)*Paniker's Textbook of Medical Parasitology, 7th Edition.* JAYPEE brothers, Medical Publishers (P) Ltd, New Delhi.
9. Subhash Chandra Parija (2013) *Text book of Medical Parasitology - Protozoology and Helminthology, 4th Edition*, Medical book publisher, New Delhi.
10. Ichpujani, R.L. and Rajesh Bhatia (2003) *Medical Parasitology, 3rd Edition.* JAYPEE brothers, Medical publishers (P) Ltd, New Delhi.
11. Amita Sarkar (2008) *A Textbook of Parasitology.*Sonali Publication, New Delhi.

Web References

1. http://www.mednotes.net/notes/microbiology/
2. https://books.google.co.in/books?id=qM83b0e9yUMC&source=gbs_navlinks_s&redir_es
3. http:// www.virology.net/garryfavwebaids.html
4. http:// www.bact.wise.edu/microtextbook/
5. http://dmoz.org/Science/Biology/Microbiology/
6. http://microbiology.mtsinai.on.ca/manual/default.asp
7. http://www.biosci.ohio-state.edu/-zoology/parasite/home.html

Core V - MEDICAL MYCOLOGY AND VIROLOGY (18MBC05)

Course Objectives

The course contents are designed to understand the basic information about the fungi, viruses and their associated diseases based on the signs and symptoms.

Course Outcome

At the end of the course, learners will be able to:

1. Gain knowledge on various types of fungi and viruses their cultural characteristics, growth conditions, diseases caused and therapy.
2. Know about different classes of anti-fungals and antiviral drugs, their mode of actions, treatment strategies and detection of resistant forms of fungi.

UNIT - I

Medical Mycology- Introduction-Historical Perspectives and Miles stones in Mycology, Fungal Taxonomy- Binomial nomenclature,fungal repository and databases, Classification of medically important fungi, Immunity to fungal diseases-cellular and humoral Immunity. Collection and Transport of fungal specimens.

UNIT – II

Antifungal therapy- Historical Perspectives and Current scenario, Classification of Antifungals-Polyene, Synthetic and Miscellaneous antifungals, Antifungal Susceptibility testing-CLSI guidelines, Diagnosis of Fungal infections-Conventional and non-conventional methods, Current techniques in fungal diagnosis.

UNIT - III

Superficial mycosis - Tinea, Piedra, Cutaneous mycosis - Dermatophytosis. Subcutaneous mycosis - Sporotrichosis, Mycetoma, Systemic mycosis-Blastomycosis and Histoplasmosis. Opportunistic mycosis - Candidiasis, Aspergillosis and Mucoromycosis,Miscelleneous mycosis- oculomycosis, Emerging fungal diaseases.

UNIT – IV

Discovery, nomenclature and classification of virus. Life cycle of Bacteriophage - Lytic and Lysogenic cycles. Definitions - Lysogen, Prophage, Temperate phage, Viroids, Virusoids, Satellite RNAs, Prions. Morphology and distinctive properties of phages - T4, Lambda, M13 and PI. Bacteriophage typing and its applications. Comparison of multiplication of bacteriophages and animal viruses. Grouping of animal viruses based on Baltimore system of classification

UNIT – V

Clinical virology - Epidemiology, life cycle, pathogenicity, diagnosis, prevention and treatment of human viral infections caused by animal viruses - Pox virus, Parvo virus, Reo virus, Retro virus, Hepadna virus. Zoonotic viral infections - Rabbies, Yellow fever, Pappataci fever. Newly emerging viral diseases in Asia - SARS, Swine Flu, Hepatitis-C, Dengue fever, Chicken kunya, Zika virus, Nipah virus. Cultivation of viruses.

References

1. Errol Reiss, Jean Shadomy, H. and Marshall Lyon, G. (2011) *Fundamental Medical Mycology.* 1st Edition,Wiley Blackwell.
2. Mehrotra, R.S. and Aneja, K.R. (2015) *An introduction to Mycology*. 2nd Edition, New Age International (P) Ltd, New Delhi.
3. JegadishChander (2018)*A Text Book of Medical Mycology*. 4th Edition, Jaypee Brothers Medical Publishers,Interprint, New Delhi.

4. Alexpoulos, C.J., Mims, C.W. and Blackwell, M. (2014) *Introductory Mycology.*4th Edition, John Wiley & sons, New Delhi.

5. Flint, S.J., Enquist L.W., Racaniello, V.R. and Skalka, A.M. (2009) *Principles ofVirology-1-Molecular Biology,* 3rd Edition. ASM Press, Washington.

6. Dimmock, N.J., Easton, A.J. and Lappard, K.N. (2009) *Introduction to ModernVirology*. Wiley Blackwell.

7. Topley and Wilson (1995) *Principles of Bacteriology Virology and Immunity, 9thEdition*. Edward Arnold, London.

8. Morag, C. and Timbury, M.C. (1994) *Medical Virology, 10th Edition*. Churchill Livingston, London.

9. Conrat, H.F., Kimball, P.C. and Levy, J.A. (1994) *Virology*, *3rd Edition*. Prentice Hall, New Jersey.

Web References

1. http://www.mednotes.net/notes/microbiology/

2 http:// www.virology.net/garryfavwebaids.html

3 http:// www.bact.wise.edu/microtextbook/

4. http://dmoz.org/Science/Biology/Microbiology/

5. http://microbiology.mtsinai.on.ca/manual/default.asp

6. http://www.biosci.ohio-state.edu/-zoology/parasite/home.

CORE - VI: BIORESOURCE TECHNOLOGY (18MBC06)

Course Objectives

The aim of Bioresource Technology course is to know current bio-resources and their exploitations on the production of microbial products. The content of the precise course include nature of the bio-resources, industrially important microorganisms, up and down stream process, functions of the fermentors, primary and secondary metabolites and production of recombinant products. It also covers production of steroids, sterols and non-steroid compounds through microbial transformations.

Course Outcome

1. By the end of the course, the students will be able to know about the nature and current status of the bio-resources.
2. The students will clearly get in-depth information about utilization of natural resources on the production of microbial products like enzymes, organic acids, antibiotic, vitamins, alcoholic beverages, steroid and non-steroid components.
3. The course will also provide meticulous ideas on different types of fermentors and their functions.
4. After the study, the course contents will give several opportunities for the students to develop bio-entrepreneur for the production of microbial products by utilizing natural wastes.

UNIT - I

Bioresource technology - Introduction - Biomass, Biological wastes from domestic, agriculture and industries. Biological waste treatment, Bioenergy – Biofuels-Production of Biofuels, Acetone-butanol production, Biotransformations and bioresource systems analysis. Bioproducts: Biocatalysis and fermentations.

UNIT - II

Bioprocess technology - Fermentation process - The range of fermentation process -Chronological development –Component parts of a fermentation process - Fermentation economics. Industrially important microorganisms - Isolation, preservation and improvement of strains -Handling, media for industrial fermentation -Formulation and sterilization, development of inoculum for various upstream process.

UNIT - III

Fermentor types and design –Parts of a fermentor, body construction, heat production - gas liquid exchange - mass transfer - heat transfer - oxygen transfer - stirring and mixing. Scale up and scale down fermentation process. Control of temperature, pH, form pressure - Sterilization of bioreactors and nutrients. Computer application in fermentation technology.Fermentation types –Submerged, solid state, batch and continuous fermentation.

UNIT - IV

Downstream processing - Recovery of intracellular and extra cellular products - Biomass separation by centrifugation, filtration, chemical and Electro flocculation. Cell disintegration - physical, chemical and enzymatic methods. Extraction - solvent, two phase, liquid extraction, whole broth, aqueous multiphase extraction. Purification by different methods, Concentration by precipitation, ultrafiltration, reverse osmosis. Drying and crystallization.

UNIT - V

Microbial Products - Organic acids - Amino acids, Antibiotics, Enzymes, Vitamins, Alcoholic beverages - wine and beer, Fermented foods - bread, cheese and soy sauce. Recombinant Products - insulin, interferon and growth hormone, Fermentation products from natural wastes - molasses, starch wastes and cellulosic wastes. Microbial transformations - steroids and sterols. Non-steroid compounds –Antibiotics.

References

1. Kumar, Sachin, Sani, and Rajesh K (eds) (2018) *Biorefining of Biomass to Biofuels*, Springer Publisher, ISBN: 978-3-319-67678-4.
2. MejdiJeguirim and Lionel Limousy (Eds.) (2018) *Biomass Chars: Elaboration, Characterization and Applications*, MDPI Books Publisher, ISBN: 978-3-03842-690-5.
3. Stanbury, P.F., Whittaker, A. and Hall, S.J. (1995) *Principles of fermentation technology*, 2nd edition, Pergamon press.
4. Crueger and Crueger, A. (1989) *Biotechnology: A text book of Industrial Microbiology*, 2nd edition, Sinavos association, InoSundeland.
5. Cassida, J.E. (1968). *Industrial Microbiology*, Willy Eastern.
6. Presscott and Dunn, S. (1940) Industrial Microbiology. New York, London.
7. Peppler, H.J. and Pearlman, D. (1979) *Microbial Technology*, Vol 1, Academic press.
8. Demain, A.L. and Soloman INA (1986) Mammal of Industrial Microbiology and Biotechnology, American society for Microbiology, Washington DC.
9. Chand and Subhash (2001) *Fermentation Biotechnology*: *Industrial Perspective*, New Delhi : All India Biotech Association, Delhi.
10. Belter, P.A., Cussler, E.L. and Hu, W.S. (1988) Bioseparation: Down stream processing for Biotechnology, John Wiley and Sons, N.Y.
11. Chisti, Y. (1999) *Fermentation, Biocatalysis and Bioseparation*, Encyclopedia of Bioprocess Technology, Vol. 5, John Wiley and Sons, N, Y.

Web References

1. http://site.iugaza.edu.ps/mwhindi/files/ebooksclub.org__Principles_of_Fermentation_Technology.pdf

2. http://www.cigr.org/documents/CIGRHandbookVol5.pdf
3. https://www.southeastern.edu/acad_research/depts/biol/pdf/industrial_microbiol.pdf
4. http://site.iugaza.edu.ps/mwhindi/files/Modern-Industrial-MicrobiologyBiotechnology.pdf

PRACTICAL - III

PRACTICAL EXAM: 7 HRS. / DAY: 2 CONSECUTIVE DAYS

CORE PRACTICAL - III: MEDICAL MICROBIOLOGY (18MBCP03)

Course Objectives

The course contents are designed to gain adequate hand on knowledge and acquire adequate skill to identifybacteria, fungi and parasites from clinical samples,cultivate viruses in embryonated eggs and identify the various pathogenic bacteria, fungi and parasites based on morphology, cultural and biochemical characteristics.

Course Outcome

At the end of the course, learners will be able to:

1. Gain knowledge on identification of bacteria and parasites from clinical specimens.
2. Analyze the clinical specimensandunderstand the different methods to cultivate fungi.
3. Understand the methods to collect and transport of clinical specimens.
4. Gain knowledge on examination of parasites from clinical specimens.
5. Understand the various methods to cultivate viruses

List of Experiments

1. Collection and transport of clinical specimens for microbiological examinations.
2. Cultivation of Microbes- Basal, Differential and Selective media.
3. Isolation and identification of bacterial pathogens from clinical specimens viz. Throat swab, pus, urine, sputum and stool.
4. Antimicrobial sensitivity testing by disc-diffusion technique and determination of MIC.
5. Examination of parasites in clinical specimens- Floatation and sedimentation techniques of stool examination.
6. Blood smear examination for malarial parasites.

7. Cultivation and Identification of fungi by Lactophenol cotton blue (LPCB) mount of *Mucor, Rhizopus, Aspergillus, Penicillium, Fusarium, Curvularia, Bipolaris&Trichophyton*).
8. Identification of Non sporulating fungi- Slide culture method, Cornmeal/Tapwater agar.
9. Identification of *Candida* species- Germ tube method,Sugar assimilation/ fermentation test, species differentiation on Hichrome agar.
10. Isolation and characterization of bacteriophage from natural sources.
11. Animal tissue culture – Egg inoculation methods of virus.
12. Spotters of viral inclusions.

References

1. Patrick Murray, R. and Ellen Jo Baron (2007) Manual of Clinical Microbiology, 9th Edition,Vol 1. ASM Press, Washington.
2. James G. Cappuccino and Natalie Sherman (2014) Microbiology A laboratory Manual, 10th edition - Pearson Education.
3. Benson, J.H. (1996) *Microbiological Applications*: *A Laboratory Manual in General Microbiology 7th* edition, Wn. C. Brown Publication IOWK, USA.
4. James, G.C. and Sharman, N. (1997) *Microbiology: A laboratory Manual,* 4thEdition, The Benjamin/ Cummings Publishing Company, International USA.
5. Patrick R. Murray, Ken S. Rosenthal, Micheal A. Pfaller (2005) *Medical Microbiology*, 5th Edition, Elsevier/Mosby, Philadelphia.
6. Holt, J.S., Krieg, N.R., Sneath, P.H.A. and Williams, S.S.T. (1994) Bergey'sManual of Determinative Bacteriology, 9thEdn. Williams & Wilkins, Baltimore.
7. Finegold, S.M. (2000) *Diagnostic Microbiology*, 10th Edition, C.V. MosbyCompany,St. Louis.

Web References

1.http://cid.oxfordjournals.org/content/22/5/766.full.pdf

2. http://www.yourarticlelibrary.com/experiments/experiment-to-cultivate-and identify-a-fungi-with-figure-micro-biology/26696/

3.http://www.dnatube.com/video/30156/Germ-Test-Tube--Identifying-Yeast

4.http://www.cdc.gov/dpdx/diagnosticprocedures/blood/specimenproc.html

5.http://www.microbelibrary.org/library/laboratory-test/3107-egg-inoculation- for virus-cultivation

PRACTICAL - IV

PRACTICAL EXAM: 7 HRS. / DAY: 2 CONSECUTIVE DAYS

CORE PRACTICAL - III: INDUSTRIAL MICROBIOLOGY

(18MBCP04)

Course Objectives

The aim of this course is to know various methods adopting to isolate, screen the industrially important microorganism and apply for the production of microbial products like enzyme, antibiotic, alcohol and biosurfactants. It also covers purification and characterization of the products by appropriate methods.

Course Outcome

1. By the end of the course, the students will able to know about the techniques to isolate and screen the significant microorganisms capable to produce products.
2. The course will also provide meticulous ideas for the production of ethanol from natural and industrial wastes.
3. From this course, the students will get an idea to isolate and characterize the microbial products for further applications.
4. After the study, the course contents will give several opportunities for the students to develop bio-entrepreneur for the production of microbial products by utilizing natural wastes.

List of Experiments

1. Screening of antibiotic producing microorganisms from soil.
2. Screening of enzyme producing organisms (e.g. Amylase and Cellulase).
3. Production of industrially important enzymes by Submerged fermentation (Any one enzyme).
4. Production of industrially important enzymes by solid state fermentation (Any one enzyme).
5. Assay of extracellular enzymes produced by bacteria: a) Amylase, b) Protease and c) Lipase.
6. Purification of enzymes by filtration method/chemical method by ammonium sulphate.
7. Production of wine.
8. Production of alcohol from agricultural wastes (sugarcane molasses and beetroot).
9. Characterization of alcohol: Nutritive value, Colour, Haze, Viscosity, foam Characteristics, gurting flavor
10. Microbial production of citric acid by using *Aspergillus*.
11. Production of extracellular metabolites from actinomycetes.
12. Production and extraction of biosurfactant.
13. Quantification and characterization of biosurfactant.
14. Synthesis and separation of bioactive compounds - TLC or Column Chromatography.
15. Immobilization of cells and enzymes.
16. Antibiotic sensitivity test: a) Kirby Bauer's method and b) MIC determination by filter paper assay and broth dilution assay.
17. Biofuel Production- Alcohol & Hydrogen

References

1. Basanta Kumar Rai and Dil Kumar Subba (2016) *Basic Practical Manual on Industrial Microbiology*, Dharan Multiple Campus, Nepal.
2. Kulandaivel and Janarthanan, S. (2012) *Practical Manual on Fermentation Technology*, ISBN: 9789381141809.
3. Mathur, N. and Singh, A. (2007) *Industrial Microbiology: A Laboratory Manual*, Pointer publishers.

4. Arnold L. Demain, Julian E. Davies, Ronald M. Atlas, Gerald Cohen, Charles L. Hershberger, Wei-Shou Hu, David H. Sherman, Richard C. Willson and David Wu, J.H. (1999) *Manual of Industrial Microbiology and Biotechnology*, 2nd Edition.
5. Dharmalingam, K. (1986) *Experiments with M13*. Macmilan India Ltd. Chennai.
6. Lorian, V. (1991) *Antibiotics in Laboratory Medicine*. Williams and Wilkins.
7. Willett, J.E. (1991) *Gas Chromatography*, John Wiley and Sons.
8. Sadasivam, S. and Manickam, A. (1996) *Biochemical Methods*. New Age International (P) Limited, Publishers.

Web References

1. http://www.asmscience.org/content/book/10.1128/9781555816827.fm04?crawler=true&mimetype=application/pdf
2. http://krishikosh.egranth.ac.in/bitstream/1/59781/1/NDRI-77.pdf
3. http://www.uvi.edu/files/documents/Research_and_Public_Service/WRRI/Introduction_to_Environmental_Microbiology.PDF
4. http://www.wdcm.org/workshop2014/student_three_one.pdf
5. https://www.bd.com/ds/technicalCenter/misc/difcobblmanual_2nded_lowres.pdf

ELECTIVE COURSES

ELECTIVE PAPER - 1: BIOCONTROL AND ENTOMOLOGY (18MBCE01)

Course Objectives

The aim of Biocontrol and Entomology course is to introduce necessary and application relevance of biofertilizers and biocontrol agents for the students who are in more attentiveness in the development of sustainable agriculture. The content of rigorous course includes significance of microbial lbiofertilizers namely, bacteria, fungi, cyanobacteria and actinorhiza. It also covers various methods applications of biocontrol agents and biomanures for the current agriculture.

Course Outcome

1. By the end of the course, the students will be able to know about the importance and applications of the biofertilizers for the sustainable agriculture.
2. The students will clearly learn in-depth knowledge in order to foster biofertilizers to overcome the applications of chemical fertilizers in the modern farming's.
3. The course will also provide opportunities for the students to develop bio-entrepreneur for the production of bioferilizers, biocontrol agents and biomanure.

UNIT - I

History, importance and present status of different types of fertilizers and their application to crop plants. Importance of macro and micro nutrients - Nutritional deficiency in plants. Biological fixation of nitrogen. CyanobacterialBiofertilizers: *Nostoc*, *Anabaena*, *Gloeocapsa* and *Scytonema*. Symbiotic association with *Azolla*, Lichens, Bryophytes and Higher plants. Bacterial biofertilizers: Free living forms - *Azatobacter*, *Azospirillum*. Symbiotic forms: Rhizobium-Legume association. Isolation and screening and mass production of bacterial biofertilizers.

UNIT - II

Fungal biofertilizers: Types of fungal biofertilizers - Ecto, endo and ect-endomycorrhiza, Ectomycorrhizal association with pines, Arbuscularmycorrizal association (AM) *Glomusspp.*,Nutrient uptake and exchange.Isolation and field enrichment of mycorrhiza. Actinomycetes as biofertilizers: History and biology of actinorhiza, Actinorhizal associations in higher plants, *Frankia spp*.

UNIT - III

Biomanures technology: A general account of manures - Moulds, Composts Farm yard manure, Oil seed cakes - Castor and neem, Green leaf manures - Gyricidia, Sesbania and Crotalaria, Agro-industrial wastes - Poultry manure and saw-dust, Vermi Compost, Microbial compost - pure culture and consortium as an inoculums. Application of biofertilizers and manures - A combination of biofertilizer and manure applications with reference to soil, seed and leaf sprays.

UNIT - IV

History, principles and scope of biological control. Important groups of parasitoids, predators and pathogens. Principles of classical biological control-importation, augmentation and conservation. Biology, adaptation, host seeking behaviour of predatory and parasitic groups of insects. Role of insect

Entomopathogenic nematodes, viruses, bacteria, fungi and protozoa in biocontrol and their mode of action.

UNIT - V

Biocontrol agents: Definition and importance of biological pests and bio-pesticides in agriculture. Brief conception of Integrated Pest Management (IPM), Integrated Pest and Disease Management (IDPM). Biopesticides - Advantages of bio-pesticides over chemical pesticides, Types of bio-pesticides, *Bacillus thuringiensis* and its importance. Mass production of quality biocontrol agents - techniques, formulations, economics, field release/application and evaluation.

References

1. Goyal, M.R. (2018) *Sustainable Biological System for Agriculture*, APP Apple Academic Press, ISBN: 978-1-77188-614-7.
2. Borkar, S.G. (2015) *Microbes as Bio-fertilizers and their Production Technology* (Woodhead Publishing India in Agriculture), WPI Publishing, ISBN: 9380308574.
3. Shagufta (2012) *Biofertilizer Technology*, 1st Edition, Published at Delhi.
4. Trivedi, P.C. (2008) *Biofertilizers*, Neha Publishers & Distributors. ISBN: 8171325424
5. Burns, R.C. and Hardy, R.W.F. (1975) *Nitrogen fixation in bacteria and higher plants*, Springer - Verlag, Bertin.
6. VarmaAjit (1998) *Mycorrhiza Manual*, Springer Publications.
7. Mark Coyne (1999) *Introduction to Soil Microbiology (Laboratory Manual)*, 99th Edition, Delmar Publications.
8. Subba Rao, N.S. (1995) *Soil Microorganisms and plant growth*, Oxford and IBH, New york.
9. Tilak, K.V.B.R. (1990) *Bacterial Biofertilizers*, IARI Publications, New Delhi.
10. Tirdale, Nelson, S.L., Werver, L. and Becton, J.D. (1985) *Soil fertility and fertilizers*, Macmillan Publishing Co., New York.
11. Totawat, K.L., Somani, L.L., Sharma, R.A. and Maloo, S.R. (2004)*Biofertilizer Technology*, Agrotech Publishing Academy. Udaipur, Rajasthan.
12. Subba Rao, N.S. (1995) *Biofertilizer in agriculture and forestry*, Oxford and IBH, New york.
13. Mathur, R. (2013) *A text book of Entomology*, Neha Publishers & Distributors. ISBN: 8187815648.

Web References

1. https://www.bio-fit.eu/upload/Bio-Fit-Book/EN/Bio-FIT_Book_EN.pdf
2. http://www.amm-mcrc.org/publications/Biofertilizers.pdf
3. http://www.fnca.mext.go.jp/bf/bfm/pdf/Biofertilizer_Manual.pdf

4. http://www.niir.org/books/book_pdf/115/niir-complete-technology-book-on-biofertilizer-organic-farming-2nd-revised-edition.pdf
5. https://www.k-state.edu/fungi/Greeting/Publications_files/2006%20Handbook.pdf
6. http://www.normevents.fr/frd-9/biofertilizer-frankia.pdf
7. http://plantpath.osu.edu/sites/plantpath/files/imce/images/McSpadden-Gardener/OEFFA%202014%20Biofertilizer.pdf
8. https://www.wpi.edu/Pubs/E-project/Available/E-project-030311-115831/unrestricted/English_Biofertilizers_Brochure.pdf
9. http://www.arvin-agri.com/Maghalat/GiyahPezeshki/Ipm/biopesticide.pdf
10. http://www.jbiopest.com/users/lw8/efiles/suman_gupta_v31.pdf
11. http://www.eolss.net/sample-chapters/c17/e6-58-05-08.pdf
12. http://krishikosh.egranth.ac.in/bitstream/1/2037478/1/16355.pdf

ELECTIVE PAPER – 2: INTELLECTUAL PROPERTY RIGHTS (IPR), BIO-SAFETY AND BIOETHICS (18MBCE02)

Course Objectives

This part of the curriculum helps students to have an ability to understand and conduct research to meet desired needs within the legal, social, ethical, safety & sustainability aspects in biology and the biocontainment.

Course Outcome

Students can know rules on how to protect patents, copyrights, trademarks, and other forms of IPRs have become a standard component of international trade agreements. He / she may become patent attorney, who has the specialized qualifications necessary for representing clients in obtaining patents and acting in all matters and procedures relating to patent law and practice, such as filing an opposition. So to become such expert in that patent and IPR, in addition to PG degree, Diploma in Law may be necessary.

UNIT - I

Introduction to Intellectual Property: IPR - Definition - Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Plant varieties, Trade Secrets, Geographical Indications, IP as a factor in R&D; IPs of relevance to Microbiology / Biotechnology and few Case Studies.WTO - Definition - Functions - Forms of IPR Protection.

UNIT - II

Agreements and Treaties: History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments. Paris Convention.

UNIT - III

Basics of Patents and Concept of Prior Art: Introduction to Patents; Concept related to patents novelty, non-obviousness, utility, anticipation, etc. Types of patent applications: Ordinary, Patent Co-operation treaty (PCT), Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; Forms and fees Invention in context of "prior art"; Patent databases; Searching InternationalpatentDatabases; Country-wise patent searches (USPTO, esp@cenet (EPO), Patents scope (WIPO), IPO, EPO, etc.).National & Patent Cooperation treaty(PCT) filing procedure; Time frame and cost; Status of the patent applications filed; Revocation of patent, Precautions while patenting – disclosure/non-

disclosure; Financial assistance for patenting - introduction to existing schemes Patent licensing and agreement Patent infringement- meaning, scope, litigation, case studies – Neem, Turmeric and Pasmati rice , Commercialization and Licensing.

UNIT - IV

Biosafety: Introduction: Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Biosafety guidelines and regulations (International); Biosafety guidelines –National ; Definition of GMOs & LMOs; Bioresponse of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Biosafety in relation to transgenic research and applications. Biopiracy.

UNIT - V

Bioethics: Definition - Ethical implications of cloning: Reproductive cloning, therapeutic cloning; Ethical, legal and socioeconomic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research. Animal ethics - Norms in India - Licensing of animal house - Ethical clearance norms for conducting studies on human subjects. Ethical implications of human genome project. Bioethics committees – IAEC, CPCSEA, OECD, etc.

References

1. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co.Pvt. Ltd., 2007.
2. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, ManupatraInformation Solution Pvt. Ltd., 2007.
3. Gurumani, N. Research Methodology,; For Biological Sciences . MJP Publishers,Chennai 2006.
4. Jose B. Cibelli, Robert P. Lanza, Keith H. S. Campbell, Michael D.West. 2002.Principles of Cloning, Academic Press, SanDiego, Gurdon.
5. Senthil Kumar Sadhasivam and Mohammed, Jaabir. 2008. IPR, Biosafety and Biotechnology Management. Jasen Publications, India.
6. Singh K. Intellectual Property Rights on Biotechnology, BCIL, and Newdelhi-1993.
7. Shaleesha A. Stanley, Bioethics, Wisdom educational service-2010

Web References:

1. http://www.w3.org/IPR/
2. http://www.wipo.int/portal/index.html.en
3. http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html

4. www.patentoffice.nic.in

5. www.iprlawindia.org/

6. http://www.cbd.int/biosafety/background.shtml

7. http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm

8. http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html

SUPPORTIVE COURSES

SUPPORTIVE-I: MEDICAL LABORATORY TECHNOLOGY (18MBCS01)

Course Objectives

The course contents are designed to gain a general insight in to the basic aspects of medical laboratory, measurements, equipment's used, the various microbiological and biochemical procedures and the safety aspects in a Medical laboratory.

Course Outcome

At the end of the course, learners will be able to:

1. Learn the handling of instruments and various measurements used in the laboratory.
2. Learn about the basics of laboratory techniques its significance in diagnostic evaluation.
3. Identify and differentiate the different types of bacteria and fungi in clinical samples.
4. Learn the differential diagnosis by the help of different serological techniques.
5. Learn the various methods used in Sterilization.

UNIT - I

General Laboratory Techniques and procedures: Chemicals and related substance, concept of solute and solvent, buffer solutions and their actions, safety measures in a Laboratory. Cleaning of glassware's. Laboratory instruments - Balance - Centrifuge - Ovens - Water Bath - Incubator – Laminar Airflow-Calorimeter-Working and applications.

UNIT - II

Medical laboratory rules, ethics and professional code of conduct: Rules of medical laboratory - Medical laboratory request form - Maintenance of laboratory records - Delivery of laboratory results. General precautions for avoidance of

laboratory accidents. Biomedical wastes – Introduction, categories of waste, standard protocol of waste disposal.

UNIT - III

Methods ofCollection, transport and processing of clinical specimens - Blood, Urine, Sputum, CSF, Pus &Faeces for microbiological examination.Types of media- Semi synthetic, Synthetic, Enriched, Selective and Differential media.Staining techniques-Simple and differential- Gram's. Lactophenolcotton blue (LPCB).

UNIT - IV

Hematology - Introduction to hematology, collection of blood sample and anticoagulants, Specimen collection and processing in hematology, haemocytometer and procedure for RBC,WBC, ESR count, haemoglobin estimation, bleeding time, whole blood coagulation time, platelet count, normal values and interpretation

UNIT - V

Biochemical analysis - Urine analysis, physical, chemical, microscopic, routine test viz., sugar, albumin and phosphates, other tests - bile salt, bile pigment, urobilin ketone bodies, chyle, specific gravity, total protein.

References

1. Monica Cheesbrough (2006) *District Laboratory Practice in Tropical Countries Part 1 & 2*, 2nd Edition, Cambridge University Press.
2. Tortora, G.J., Funke, B.R. and Case, C.L. (2016) *Microbiology: An Introduction*, 11th Edition, Pearson Education, India
3. Madigan, T.M., Martinko, M.J., Bender, S.K., Buckley, H.D., Stahl, A.D. and Brock, T. (2017) *Brock Biology of Microorganisms*. 14th Edition, Licensing agency, UK.
4. Baveja, C.P. and Baveja, V. (2017) *APC Text Book of Microbiology*, 4thEdition, Arya Publications, NewDelhi.
5. Johanne, M.W., Linda, M.S. and Christopher, J.W. (2017) Willey Prescott's Microbiology 10E,10th Edition. McGraw Hill Education, India.
6. Dubey, R.C. and Maheshwari, D.K. (2013)*A Textbook of Microbiology*, Revised Edition, Chand and company, NewDelhi.
7. Duerden, B.I., Reid, T.M.S., Jewsbury, J.M. and Turk, D.C. (1987) *A New short Text Book of Microbial & Parasitic Infections,* Hodder & Stoughton, London.

8. Ramnick, Sood (2006). *Textbook of Medical Laboratory Technology*Jaypee Brothers Publishers.
9. Naigankar, A.V. and Burande, M.D. (2007) *A manual of Medical Laboratory Technology,* 5th Edition Pragati Books Pvt. Ltd.
10. Mukherjee, K.L. (2010) *Medical Laboratory Technology,* Vol. I, II & III - Manual of Histopathological Techniques &their Diagnostic application, Churchill Levingston.

Web references

1. http://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/med_lab_tech_students/MedicalLabTechnology.pdf
2. http://www.cartercenter.org/health/ephti/learning_materials/lecture_notes/medical_lab_technology_students.html
3. http://apps.who.int/iris/bitstream/10665/37042/1/WHO_OFFSET_21.pdf
4. http://www.sciencedirect.com/science/book/97814831679.

SUPPORTIVE - II: MICROBIOLOGY

UNIT - I

History and discovery of microorganisms - Microscopical appearance and Staining techniques -. Colony characteristics of different bacteria. Microbial cellular morphology : Cellular structures - Capsule, Cell, Periplasmic space, Spores, Flagella, Cilia, Pili and other cellular inclusions.

UNIT - II

Sterilization and culturing techniques - Types of culture media and their preparation for bacterial cultivation. - Broth tubes, slants, stabs and plate media. Pure culture techniques. Anaerobic culturing techniques. Maintenance and preservation techniques -

UNIT - III

Microbial physiology - Aerobic and anaerobic respiration in microbes. Biochemical test characteristics - carbohydrate fermentation, IMVIC tests, starch hydrolysis, cellulose, gelatin, casein, catalase test, oxidase test, urease test, nitrate reduction, TSI and antibiogram.

UNIT - IV

Medical microbiology - Epidemiology, pathogenicity, diagnosis and treatments of bacterial diseases - diarrhea, typhoid, cholera, leptospirosis, tuberculosis, Fungal diseases - Athlete's foot, aspergillosis and dermatitis. Parasite diseases - amoebiasis, malaria and taeniasis.

UNIT - V

Microbial biotechnology - Microbial metabolites - Production and use of enzymes, organic solvents, single cell proteins, beverages (beer and wine), baker's yeast and milk products. Production of microbes as biofertilizers and biopesticides. Production of genetically engineered microbial products.

References

1. Prescott, L.M., Harley, J.P. and Klein, D.A. (2003) *Microbiology,* 5th Edition, McGraw Hill, New York.
2. Madian, M.T., Martinko, J.M., Parker, J. and Brock, T.D. (1997) *Biology of Microorganisms, 8th edition*. Prentice Hall International Inc. London.
3. Elizabeth Moore Landecker (1996) *Fundamentals of the Fungi,* 4th edition, Prentice Hall International Inc, London.
4. Holt, J.S., Kreig, N.R., Sneath, P.H.A. and Williams, S.T. (1994) *Bergeys Manual of Determinative Bacteriology,* 9th edition. Williams and Wilkins, Baltimore.
5. Pelczar, J.R., Chan, M.J. and Krei, N.R. (1993) *Microbiology*. McGraw Hill, New York.
6. Alexopoulus, C.J. and Mims, C.W. (1993) *Introductory Mycology,* 3rd edition. Wiley Eastern Ltd, New Delhi.