

**Department of Microbiology**  
**School of Bioscience**  
**Periyar University**  
**Periyar Palkalai Nagar**  
**Salem - 636 011**



**M.Sc. Microbiology**  
**Syllabus**

**(For the students admitted  
from 2016 – 2017 onwards)**

# **PERIYAR UNIVERSITY**

## **M.Sc. MICROBIOLOGY**

### **CHOICE BASED CREDIT SYSTEM**

#### **REGULATIONS**

#### **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/ Animal Science/ Applied Animal Science and Animal Biotechnology/ Biochemistry/ Bioinformatics/ Biology/ Home Science/ Food Science & Nutrition/ BSMS/ BAMS/ BUMS/ Chemistry with Botany/ Zoology as Allied Subjects] of this university or an examination of any other university accepted by the syndicate as equivalent there to shall be eligible for admission to M.Sc. Degree Course in Microbiology.

Candidate shall be admitted to the examination only if he/she has taken the qualifying degree in Science/ Medical subjects as mentioned after having completed the prescribed courses consisting of twelve years of study and has passed the qualifying examination.

##### **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. The date, venue, and time of the entrance examination and interview will be notified to the applicants separately as soon as it is fixed.

#### **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 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	16MBC01	Core I - General Microbiology & Plant Biology	7	5	25	75	100
	16MBC02	Core II - Immunology	7	5	25	75	100
	16MBC03	Core III - Biochemistry & Pharmaceutical Microbiology	6	5	25	75	100
	16MBCE01	Elective - 1	4	4	25	75	100
	16MBCP01	Core Practical I - Microbiology & Immunology	6	4	40	60	100
Sem - II	16MBC04	Core IV - Medical Microbiology	4	5	25	75	100
	16MBC05	Core V - Economics of Botany	4	5	25	75	100
	16MBC06	Core VI - Bioresource Technology	3	5	25	75	100
	16MBCE02	Elective - 2	3	4	25	75	100
	16MBCS01	Supportive - 1	4	4	40	60	100
	16MBCP02	Core Practical II - Medical Microbiology	6	4	40	60	100
	16MBCP03	Core Practical III - Industrial Microbiology & Fermentation Technology	6	4	40	60	100
	16MBCI01	Internship	2 wks	-	40	60	100
Sem - III	16MBC07	Core VII - Molecular Biology and Applied Biotechnology	4	5	25	75	100
	16MBC08	Core VIII - Bio Nano-technology and Infectomics	4	5	25	75	100
	16MBC09	Core IX - Soil, Food, Dairy and Environmental Microbiology	4	5	25	75	100
	16MBCS02	Supportive - 2	4	4	25	75	100
	16MBCP04	Core Practical IV: Molecular Biology and Biotechnology	6	4	40	60	100
	16MBCP05	Core Practical V: Applied Microbiology	6	4	40	60	100
		Value Education	2	-	40	60	100
Sem - IV	16MBC10	Core X-Bioinstrumentation, Biostatistics & Bioinformatics	6	5	25	75	100
	16MBCPR01	Project	24	4	40	60	100
<b>Total</b>				<b>90</b>			<b>2200</b>

**Elective courses**

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

**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

**SCHEME OF EXAMINATIONS**

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

**Theory Paper External**

<b>Theory</b>	: 75 Marks [Part A: 25 Marks (5 Ques) + Part B: 50 Marks (5 Ques)]
<b>Internal</b>	: 25 Marks
<b>Total</b>	: 100 Marks
<b>Time</b>	: 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

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25 marks  
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**Practical : 40 Internal Marks**

Attendance	: 5 marks
Practical Test (Best 2 out of 3)	: 30 marks
Record	: 5 marks

**Project**

Internal Mark	: 20 marks
Presentation Viva	: 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 SUBSEQUENT SEMESTERS:**

- (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, practicals, 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)**

<b>GRADE</b>	<b>GRADE POINT</b>	<b>PERCENTAGE EQUIVALENT</b>
'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**

Part - A (200 words): Answer all 5 questions either or type 5 x 5 = 25 marks

Part - B (500 words): Answer all 5 questions either or type 5 x 10 = 50 marks

**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 be counted 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 into consideration. Candidate will be allowed to improve marks in the practicals, 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.

## **M.Sc. DEGREE COURSE IN MICROBIOLOGY - SYLLABUS**

### **CORE - I: GENERAL MICROBIOLOGY AND PLANT BIOLOGY (16MBC01)**

#### **UNIT - I**

Microbial taxonomy: Definition and systematics, Nomenclature rules and identification, Hierarchical organization and the position of microbes in the living world classification systems - Artificial and phylogenetic - Dendogram. Whittaker's five kingdom approach. Characterization of microorganisms - Morphological, physiological and metabolisms. Classification and salient features of bacteria according to Bergeys Manual of Determinative Bacteriology. Numerical taxonomy, Modern classification of fungi - Ascomycetes (*Aspergillus*), Deuteromycetes (*Candida*), Zygomycetes (*Mucor*), Basidiomycetes (*Agaricus*), Acrasiomycetes (*Dictyostelium*), oomycetes (*Saprolegnia*) and Myxomycetes (*Ceratiomyxa*).

#### **UNIT - II**

Morphological types - Gram negative and Gram positive, L-forms, Cyanobacteria, Archeobacteria 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). Brief account of protozoans. Thraustochytrids - Morphological features and its biotechnological potential.

#### **UNIT - III**

Microbial physiology: Aerobic and anaerobic respiration, electron transport chain, pigment distribution, photosynthesis, light and dark reactions, quorum sensing. Microbial ecology - Principles of microbial ecology, Metabolic diversity - Nutritional types of microorganisms. Microbial habitat and microbial ecosystems - Fresh water, soil, plant, hydrothermal vents, hot springs, volcano, marine water (Open oceans and Deep sea organisms), barophiles and space. Microbial interaction with plant and animals. Microbial communications.

#### **UNIT - IV**

Plant taxonomy: Angiosperms: Scope, aims and principles of taxonomy. Relative merits and demerits of major systems of classifications. Taxonomic structure: Taxonomic hierarchy, concept of taxa, concept of species, concept of genus and family. Taxonomic character. General features, distribution and classification of bryophytes, pteridophytes and gymnosperms.

#### **UNIT - V**

Detailed study of the following families and their economic importance: Malvaceae, Fabaceae, Euphorbiaceae and Musaceae. Plant nutrition- Absorption of water and minerals. Transpiration - types, mechanism of stomatal movement. Factors affecting transpiration. Guttation. Role of macro and microelements. Stress physiology-Classification of stress-biotic abiotic stress, factors response of plants to salts, drought, freezing and heat.

## References

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3. Baveja, C.P. and Baveja, V. (2015) *APC Text Book of Microbiology*, 2<sup>nd</sup> Edition, Arya Publications, NewDelhi.
4. Johanne, M.W., Linda, M.S. and Christopher, J.W. (2014) *Prescott's Microbiology*, 9<sup>th</sup> 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. Meena Kumari, S. (2011) *Microbial Physiology*, 5<sup>th</sup> Edition, MJP publishers, Chennai.
7. Wheelis, M. (2008) *Principles of Modern Microbiology*, 4<sup>th</sup> Edition, Bartlett Publishers, UK.
8. Elizabeth, M.L. (1996). *Fundamentals of the Fungi*, 4<sup>th</sup> Edition, Prentice Hall International Inc, London.
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11. Dennis, W.W. (2009) *Contemporary Plant Systematics*, 4<sup>th</sup> Edition, Andrews Univ Press, USA.
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2. [www.microbiologyonline.org.uk](http://www.microbiologyonline.org.uk)
3. [www.csus.edu/indiv/t/telleena/biol440/](http://www.csus.edu/indiv/t/telleena/biol440/)
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## **CORE - II: IMMUNOLOGY (16MBC02)**

### **UNIT - I**

History and scope of immunology: Types of immunity - Innate and acquired, active and passive, Cell mediated immunity and Humoral immunity, Haematopoiesis. Ontogeny, origin, development and differentiation of immune cells. 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, immunoflourescence, haemagglutination, 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; Immunohaematology, Transplantation immunity - Organ transplantation and HLA tissue typing. Introduction to autoimmune disorders and immunology of infectious diseases.

### **UNIT - V**

Hypersensitivity reactions. Immunological tolerance. Immunosuppression. Immunotherapy. Hybridoma and monoclonals. Recombinant antibodies. DNA vaccines and edible vaccines. Immunotechniques - ELISA, Immunoelectrophoresis etc.

### **References**

1. Coico, R. and Sunshine, G. (2015) *Immunology: A Short Course*, 7<sup>th</sup> Edition, John Wiley & Sons, 432 pages.
2. William E. Paul (2012) *Fundamental Immunology*, 7<sup>th</sup> Edition, Willams and Wilkins Publishing.
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4. Abbas, A.K., Litchman, A.H., Pober. J.S. (2000) *Cellular and Molecular Immunology*, 2<sup>nd</sup> Edition, W.B.Saunders, USA.

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9. Peter Wood (2006) *Understanding Immunology University of Manchester*, 3<sup>rd</sup> Edition, Pearson Education Lts, Essex.
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#### **Websites**

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2. <http://bitesized.immunology.org/what-is-immunology/>
3. [http://onlinelibrary.wiley.com/journal/10.1111/\(ISSN\)1365-2567](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: BIOCHEMISTRY AND PHARMACEUTICAL MICROBIOLOGY (16MBC03)**

### **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 Henderson Hassel 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, Microbial spoilage, Infection risk and contamination control. Chemical disinfectants, antiseptics and preservatives. Pharmacopoea - US, Europea, British and Indian Standard Organization, Audit related to pharma. United States Federal Drug Administration Audits.

### **UNIT - V**

Growth promotion test, 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 pharmaceuticals, Biological indicators, Raw material samplings and sterility checking for finished products.

### **References**

1. Ambika Shanmugam (2012) *Fundamentals of Biochemistry for Medical Students*, 7<sup>th</sup> Edition. Lippincott Williams & Wilkins.
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8. Jayashree Ghosh (2010) *A Textbook of Pharmaceutical Chemistry*, 3<sup>rd</sup> Edition, S. Chand Publishing.
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### **Web References**

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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](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 & IMMUNOLOGY (16MBCP01)**

#### **General Microbiology: List of Experiments**

1. Gram Staining
2. Metachromatic granular Staining
3. Spore Staining
4. Capsule Staining
5. Flagella staining
6. Lactophenol Cotton Blue Staining
7. Micrometry
8. Motility Test
9. Fungal Slide Culture
10. Growth Curve- Growth rate and Generation Time
11. Effect of pH, temperature and osmotic pressure on growth of bacteria.
12. Isolation of cyanobacteria
13. Isolation of Arbuscular mycorrhizal (AM)
14. IMVIC tests
15. Carbohydrate fermentation
16. Starch hydrolysis Test
17. Cellulose hydrolysis Test
18. Gelatin Hydrolysis Test
19. Casein Hydrolysis Test
20. Catalase Test
21. Oxidase Test
22. Urease Test
23. Nitrate Test
24. Triple Sugar Ion Agar Test
25. Herbarium preparation.
26. Sectioning of plant parts (stem, root & leaves)

#### **Immunology : List of Experiments**

1. ABO Blood grouping - Rh typing and cross matching
2. WIDAL Test
3. RA
4. ASO
5. C- reactive Protein (CRP)
6. Beta-HCG
7. TPHA
8. RPR
9. Ouchterlony's Double Immuno-diffusion test

10. Counter Immunoelectrophoresis
11. Rocket Immunoelectrophoresis
12. VDRL
13. Isolation of Buffy coat

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2. Harley, J.P. 2013. *Laboratory Exercises in Microbiology*. 9<sup>th</sup> Edition, McGraw Hill Education; New York.
3. Alfred E. Brown (2010) *Benson's Microbiological Applications: Laboratory Manual in General Microbiology*, 11<sup>th</sup> Edition, McGraw-Hill Companies.
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## **CORE - IV: MEDICAL MICROBIOLOGY (16MBC04)**

### **UNIT - I**

Medical bacteriology: Medical terminologies. Collection and lab processing of clinical specimens - Urine, Sputum, CSF, Blood Pus and Stool. The epidemiology, pathogenesis, symptoms, diagnosis and treatment of infections caused by Gram positive bacterial organisms belonging to *Staphylococci*, *Streptococci*, *Enterococci*, *Corynebacterium*, *Mycobacterium*, *Bacillus* and *Clostridium*; Gram negative Enterobacterial and Non-enterobacterial organisms - Spirochaeta, Chlamydia and Rickettsia.

### **UNIT - II**

Superficial mycosis, Sub-cutaneous mycosis and systemic mycosis. Emerging fungal diseases. Ocular Mycology - Fungal keratitis, Endophthalmitis. Orbital fungal infections. Dental Mycology - Oropharyngeal candidiasis. Opportunistic mycosis. Nosocomial infections, control and related ethical committee. CLSI Guidelines, BSL Guidelines, Hospital waste management.

### **UNIT - III**

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 - IV**

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 - Rabbits, Yellow fever, Pappataci fever. Newly emerging viral diseases in Asia - SARS, Swine Flu, Hepatitis-C, Hepadna Pulmonary Syndrome, Dengue fever, Chicken kunya, Zika virus. Cultivation of viruses.

### **UNIT - V**

Parasitology - Introduction and classification. Epidemiology, life cycle, pathogenicity, diagnosis, prevention and treatment of protozoan infections - Amoebiasis, Giardiasis, Trichomoniasis, Leishmaniasis, Trypanosomiasis, Malaria, Toxoplasmosis. Helminthic infections - Taeniasis, Schistosomiasis, Fasciolopsiasis, Trichuriasis, Ascariasis, Filariasis, Trichinellosis.

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6. <http://microbiology.mtsinai.on.ca/manual/default.asp>
7. <http://www.biosci.ohio-state.edu/-zoology/parasite/home.html>

## **CORE - V: ECONOMICS OF BOTANY (16MBC05)**

### **UNIT - I**

Plant breeding - Methods of breeding, self and cross fertilized and vegetatively propagated plants. Breeding of plant for improving the yield, resistant to diseases and pest. Threatened and endangered plants. Plant conservation - Kew royal botanical garden, Medicinal plants - germplasm collection and conservation. Role of NBPGR in germ plasm conservation.

### **UNIT - II**

Medicinal plants- Scope and importance of medicinal plants. Indigenous Medicinal sciences. Ethnomedicinal plant gardens. Important medicinal plants and their uses. Cultivation and utilization of medicinal plants in India, Types of phytochemicals – Carbohydrate & derived products, Glycosides, Volatile oils, Alkaloids, flavanoids - Extraction methods, Preliminary screening, Assay of drugs- Biological assay, Application of phytochemicals - Industry, Health care, Biocides and Biopesticides.

### **UNIT - III**

General features, Classification of lichens, Distribution, Thallus organization, Vegetative organization, Vegetative and Sexual reproduction, Study of growth forms of lichens (Crustose, Foliose and Fruticose) on different substrates. Lichens and environment - Lichens as indicators of pollution, Economic importance of lichens.

### **UNIT - IV**

Mycorrhizae: Ectomycorrhizae & endomycorrhizae (phylograph) and their significance. Mycorrhizae in agriculture, Ectomycorrhizal association with pines, Arbuscular mycorrhizal association (AM) - *Glomus* sp., Mass production of mycorrhiza. Application of mycorrhiza as biofertilizers.

### **UNIT - V**

Economic botany: General account on economic botany - cultivation and utilization of selected crop plants - cereals (wheat and maize), pulses (gram, arhar and pea) vegetables (potato, tomato and onion) spices (coriander, ginger, turmeric and cloves), condiments (Cardamon and Cinnamon), commercial crops - fibre (Jute and Hemp), Timber (sandal wood and teak), and essential oils (olive and mustard). Brief account of ethnobotany.

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2. Philips, H. (2016) *Medicinal Plants: Biotechnology and Phytochemistry*, Syrawood Publishing House, USA.
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11. <http://www.boundless.com> › ... › Nutritional Adaptations of Plants

## **CORE - VI: BIORESOURCE TECHNOLOGY (16MBC06)**

### **UNIT - I**

Bioresource technology - Introduction - Biomass, Biological waste treatment, Bioenergy - Biofuels, Biotransformations and bioresource systems analysis. Bioproducts: Biocatalysis and fermentations.

### **UNIT - II**

Bioprocess technology - Introduction - Fermentation process - The range of fermentation process - Chronological development - Component parts of 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 fermentation processed upstream processing.

### **UNIT - III**

Fermentor types and design - Body construction, individual parts, heat production - gas liquid exchange - mass transfer - heat transfer - oxygen transfer - stirring and mixing - Newtonian, Non-Newtonian fluids - effect of viscosity. Scale up fermentation process. Control of temperature, pH, form pressure - Sterilization of bioreactors and nutrients. Computer application in fermentation technology. Fermentation types - Submerged and solid state fermentation.

### **UNIT - IV**

Downstream processing - Recovery of intracellular and extra cellular products - Biomass separation by centrifugation, filtration, flocculation and other recent developments. 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 and pesticides.

### **References**

1. Stanbury, P.F., Whittaker, A. and Hall, S.J. (1995) *Principles of fermentation technology*, 2<sup>nd</sup> edition, Pergamon press.
2. Crueger and Crueger, A. (1989) *Biotechnology: A text book of Industrial Microbiology*, 2<sup>nd</sup> edition, Sinavos association, Ino Sundeland.
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## PRACTICAL - II

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

### **CORE PRACTICAL - II: MEDICAL MICROBIOLOGY (16MBCP02)**

#### **List of Experiments**

1. Collection of specimens, microscopic methods (Simple stains, Gram stain & other differential stains).
2. Laboratory diagnosis of etiological agents from Pus, Sputum, throat/ear/nasal/wound swabs, CSF and other body fluids
3. Antibioqram for different clinical isolates and Epsilometer test (E-test)
4. Cultivation and identification of fungi (*Mucor*, *Rhizopus*, *Aspergillus*, *Penicillium*, *Candida*, *Trichophyton*, *Microsporium* and *Epidermophyton*)
5. Slide culture method - Germ tube method - Sugar assimilation/fermentation tests for yeast
6. Examination of parasites in clinical specimens - Ova/cysts in Faeces - Direct and concentration: methods.
7. Blood smear examination for malarial parasites. Thin smear by Leishman's stain
8. Isolation and characterization of bacteriophage from sewage.
9. Cultivation of virus in embryonated egg.
10. Spotters of viral inclusions and CPE - stained smears. Viral serology - HAI - ELISA kits, Western Blotting.

#### **References**

1. Patrick Murray, R. and Ellen Jo Baron (2007) Manual of Clinical Microbiology, Vol 1. ASM Press, Washington.
2. James G. Cappuccino and Natalie Sherman (2004) *Microbiology A laboratory Manual*, 6<sup>th</sup> edition - Pearson Education.
3. Beister, L. (1996) *Microbiology in Practice*, 6<sup>th</sup> Ed, Adeland Wesley, Langman, New York.
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5. James, G.C. and Sharman, N. (1996) *Microbiology: A laboratory Manual*, 4<sup>th</sup> Edition, The Benjamin/ Cummings Publishing Company, International USA.
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4. <http://www.cdc.gov/dpdx/diagnosticprocedures/blood/specimenproc.html>
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## PRACTICAL - III

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

### **CORE PRACTICAL - III: INDUSTRIAL MICROBIOLOGY AND FERMENTATION TECHNOLOGY (16MBCP03)**

#### **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, gurgling 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.

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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
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**CORE - VII: MOLECULAR BIOLOGY AND APPLIED BIOTECHNOLOGY  
(16MBC07)**

**UNIT - I**

Molecular basis for life - DNA, various types of RNAs and peptide nucleic acid (PNA) - Watson and Crick model DNA structure - Various forms of DNA - DNA, Replication in bacteria - process and factors involved - post replication events. DNA damage and repair mechanisms - Direct repair, excision repair, mismatch repair, non-homologous end joining, SOS repairing, Mutagenesis - Physical and Chemical.

**UNIT - II**

Transcription - RNA polymerases, different sigma factors related to stress, viral infection etc. Transcription of mRNA, rRNA and tRNA - Initiation, elongation and termination. Regulatory elements of transcription. Operon models - *lac*, *trp*, *ara* operons.

**UNIT - III**

Translation process - Elucidation of genetic code - Wobble hypothesis - Suppression of missense - Nonsense - Frameshift mutations - Intragenic and extragenic suppression. Gene transfer in bacteria - transformation - conjugation - and transduction.

**UNIT - IV**

Enzymes in recombinant DNA technology, Gene cloning in bacteria, Genomic library - shotgun cloning. Construction of genomic and cDNA libraries in plasmid, Tiplasmids, SV40, Baculoviral system, Caulimo viral vectors, Phage, Cosmid, Transposons, BAC and YAC vectors. Biolistic transformation, Screening of recombinants - Phenotypic expression of characters - Hybridization techniques. DNA sequencing methods - strategies for genome sequencing.

**UNIT - V**

Applications of recombinant DNA technology - Production of recombinant products like insulin, interferon, tissue plasminogen activator, subunit vaccines. Genetically modified organisms (GMO's). Gene silencing - Gene knockouts and gene therapies, antisense technologies. Genetic engineering of plants for viruses, herbicide tolerance.

**References**

1. Brown, T.A. (2010) *Gene cloning and DNA analysis*, 6<sup>th</sup> Edition, Published by Wiley-Blackwell A John Wiley & Sons, Ltd.
2. Sandy B. Primrose, Richard M. Twyman and Robert W. Old (2006) *Principles of gene Manipulation*, 7<sup>th</sup> Edition, Published by Wiley-Blackwell.
3. Desmond, S.T. Nicholl (2008) *Introduction to Genetic Engineering*, Cambridge University Press.
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## **CORE - VIII: BIONANOTECHNOLOGY AND INFECTOMICS (16MBC08)**

### **UNIT - I**

The Journey of biotechnology to nanotechnology. Historical perspectives. Introduction and definition of nanoscience. Opportunities, challenges and principles of nanoscience. Types of nanomaterials. Generation of biomaterials. Top down and bottom up approaches. Microbial synthesis of nanomaterials - Silver, Gold, ZnO, Titania and etc.

### **UNIT - II**

Instrumentation for nanotechnology - Characterization: particle size analyser - X-ray diffraction (XRD) - Fourier transformer infrared spectroscopy (FTIR), Field Emission Scanning Electron Microscopy (FESEM) - High Resolution Transmission Electron Microscope (HRTEM) - Atomic force Microscopy (AFM)- Surface enhanced Raman spectroscopy (SERS) - X - ray Photoelectron Spectroscopy (XPS) - Auger electron spectroscopy (AES).

### **UNIT - III**

Application of semiconductor (metal) nanoparticles – Nanoscience in biomedical Application. Nanosensors in Diagnosis - Nanorobotics in Surgery - Nanotechnology in Food industry - Nanoscience in agriculture - fertilizers and pesticides. Nanoscience for water treatment and fermentation process. Nanotechnology in textiles and Cosmetics - Nanotechnology in energy conversion - Nanocatalysts - Nanotoxicology - Risks and Ethics. Nanoscience in India and abroad. Future of nanobiotechnology.

### **UNIT - IV**

Genomics: Introduction and concepts of microbial genomics. Methods of gene sequencing. Genome prediction. Types of genomics - Structural, functional, comparative and environmental genomics. SNPs, RAPD, RFLP. DNA microarray - Types and applications. Genomic databases, Future of genomics. Proteomics: Introduction and basic principles of proteomics. Relation between gene and protein. Approaches for study of proteomics. Types of proteomics - Expression proteomics, structural proteomics and functional proteomics. Protein sequences databases - SWISS-PROT, PDB, etc. Human Genome Project.

### **UNIT - V**

Infectomics: Introduction and definitions of Infectomics. Infectomes. Genomics and proteomics of microbial infections - Structural and functional strategies. Types of infectomics - ecological, immuno and chemical infectomics. DNA and protein microarrays, cloning, PCR, gene knockout and knockin, antisense strategies. Pharmacomes - definition and functions. Future of Infectomics.

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1. Shah, M.A. and Tokeer Ahmad (2010) *Principles of Nanoscience and Nanotechnology*, Narosa Publishing House.
2. Subbiah Balaji (2010) *Nanobiotechnology*, MJP Publishers.

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## **CORE - IX: SOIL, FOOD, DAIRY AND ENVIRONMENTAL MICROBIOLOGY**

**(16MBC09)**

### **UNIT - I**

Food microbiology: Sources of contamination of microorganisms in foods, Factors influencing microbial growth in foods. Food borne diseases. Spoilage of fruits, vegetables, meat, poultry, fish and seafoods. Principles and methods of food preservation: Traditional techniques, physical and chemical methods. Applications of food microbiology: Beneficial uses of microorganisms in food, Intestinal beneficial bacteria, Concept of prebiotics and probiotics, Genetically modified foods, Biosensors in food industry.

### **UNIT - II**

Dairy microbiology: Micro flora of milk and milk products, Fermented milk and milk products: Sauerkraut, Buttermilk, Cream, Yogurt, Cheese, Kafir and kumiss. Microbes involved in fermentation: Starter lactic acid cultures. Sources of contamination, Spoilage of milk and milk products, Milk borne diseases, Preservation of milk and milk products. Food sanitation, food control agencies and their regulations.

### **UNIT - III**

Soil microbiology: Distribution of microorganisms in soil, Factors influencing the soil microflora, Biogeochemical cycles: Carbon, Nitrogen, Phosphorus and Sulfur, Interactions among microorganisms: Mutualism, commensalism, ammensalism, synergism, parasitism, predation and competition. Interaction of microbes with plants: Rhizosphere, phyllosphere, mycorrhizae. Nitrogen fixation: Symbiotic and asymbiotic. Microbial carbon sequestration.

### **UNIT - IV**

Microbiology of air and water: Composition of air, Number and types of microorganisms in air, Distribution and sources of air borne organisms, Aerosol, Airborne diseases, Assessment of air borne microbes, Air sanitation, Microbes and climatic change, Microbiology of water: Physico-chemical properties of water, Microbial assessment of water. Aquatic micro flora and fauna of lake, ponds, river, estuary, mangrove and sea. Extremophiles - Deep sea, Space, desert, hot spring, mountain, acidophilic, alkalophilic and halophilic microorganisms. Impact of environmental factors on the aquatic biota.

### **UNIT - V**

Environmental Microbiology: Microbes and environment, Waste treatment - Types and characterization of solid and liquid wastes. Treatment of solid wastes - composting, vermiform composting, silage, pyrolysis and saccharifications. Treatment of liquid wastes - Primary, secondary (anaerobic and aerobic) - trickling, activated sludge, oxidation pond and oxidation ditch-tertiary - disinfection. Xenobiotic compounds and their degradation: Crude oil, hydrocarbon, pesticides, paper, leather, wood, textile and paints. Bioaccumulation of heavy metals, Biofouling, Bioleaching, Biofilm and Bioremediation. Bioluminescence and microbes. Biodegradation of natural substances - Cellulose, xylan, hemicellulose, starch, fructose, mannan, pectin and lignin.

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## PRACTICAL - IV

**PRACTICAL EXAM: 7 HRS / DAY; 2 CONSECUTIVE DAYS**

### **CORE PRACTICAL - IV: MOLECULAR BIOLOGY AND BIOTECHNOLOGY (16MBCP04)**

#### **List of Experiments**

1. Isolation and quantification of DNA and RNA
2. Isolation of plasmid DNA from bacteria
3. Separation of DNA by agarose gel electrophoresis
4. Restriction digestion of plasmid
5. Determination of molecular weight
6. Cloning of fragment in plasmid
7. Preparation of competent *E.coli* cells
8. Transformation of plasmid DNA to the *E.coli* cells
9. Screening for transformants - Blue white selection
10. PCR amplification of DNA fragment
11. Screening for recombinant proteins by SDS - PAGE
12. Screening by TLC
13. Isolation of auxotrophic mutants
14. Isolation of antibiotic resistant bacteria.

#### **References**

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3. <https://www.dnalc.org/resources/animations/gelectrophoresis.html>

## PRACTICAL - V

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

### CORE PRACTICAL - V: APPLIED MICROBIOLOGY (16MBCP05)

#### List of Experiments

1. Detection of number of bacteria in milk by breed count.
2. Determination of quality of milk sample by methylene blue reductase test and resazurin method.
3. Detection of number of bacteria in milk by standard plate count.
4. Isolation of yeast and molds from spoiled nuts, fruits and vegetables.
5. Bacteriological examination of specific food (a) Curd (b) Raw meat (c) Fish (d) Ice cream.
6. Isolation and enumeration of soil microorganisms (bacteria, fungi and actinomycetes).
7. Isolation of phosphate solubilizers from soil.
8. Isolation of nitrogen fixers (a) *Rhizobium* from root nodule and (b) *Azotobacter* from rhizosphere and Cyanobacteria from surface water.
9. Evaluation of root nodule by cross section of legume roots.
10. Screening of antagonistic bacteria in soil by agar block overlay method.
11. Isolation of plant pathogens - Study of the following diseases: Tobacco mosaic, Bacterial blight of paddy, Red root of sugarcane, Citrus cancer, Downy mildew of bajra, Powdery mildew of cucurbits, Head smut of sorghum, Leaf rust of coffee, Leaf spot of mulberry, Red rot of sugarcane, Root knot of mulberry.
12. Physical, chemical and microbial assessment of water and potability test for water. Colour, pH, alkalinity, acidity, COD, BOD, TS, TDS and TSS.
13. Microbiological assessment - MPN index presumptive, confirmatory and completed tests.
14. Quantification of microorganisms in air: Solid and liquid impingement techniques.
15. Isolation of dye degrading microbes.
16. Isolation and screening of nitrate reducers.
17. Bacterial reduction of nitrate from ground waters.
18. Bacterial reduction of heavy metals in aqueous media.

#### References

1. Garg, N., Garg, K.L. and Mukerji, K.G. (2010) *Laboratory Manual of Food Microbiology*, I.K. International Publishing House Private LTD.
2. McLandsborough, L. (2004) *Food Microbiology Laboratory*, CRC Press, Taylor and Francis Group.
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5. <http://www.fao.org/docrep/018/aq359e/aq359e.pdf>
6. <https://core.ac.uk/download/files/79/61089.pdf>
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## **CORE - X: BIOINSTRUMENTATION, BIOSTATISTICS AND BIOINFORMATICS (16MBC10)**

### **UNIT - I**

Units of measurements (Mole, equivalents - Molarity-Molality and normality), dilutions and percentages - The International System of Units, Unit conversion between SI and US, Common laboratory calculations. Laboratory glassware and instruments: Laboratory calculations - Preparation of standard solutions of acid and base. Standard solutions - Classification of standard solutions - Primary standard solution and Secondary standard solutions - Buffer solutions. Cleaning of laboratory glasswares.

### **UNIT - II**

Laboratory Instruments - Balances - Centrifuges - Ovens - Water Bath - Incubator - Colorimeter (Photometer) - Flow cytometry - Automated analyzers. Bioinstrumentation - Principles and applications of pH meter, Centrifuge, UV-Vis spectrophotometer, Viscosity, Density and Flash point analyzer. Chromatography - Thin layer, Column, Gas and high performance liquid chromatography.

### **UNIT - III**

Principle, methodology and application FTIR, LC-MS, Nuclear Magnetic Resonance spectrometry (NMR), IR Spectroscopy, Gas chromatography - Mass spectrometry (GC-MS), Matrix Assisted Laser Desorption/Ionization - Time of Flight (MALDI-Tof). Principle, methodology and application of PCR, RT-PCR and QPCR techniques, RACE & RAGE, DNA and protein array, Types of sequence, Designing of Primers.

### **UNIT - IV**

Biostatistics - Introduction - Basic concepts, Measurement and measurement scales, Sampling and data collection, Data presentation, Descriptive Statistics - Measures of central tendency and Measures of dispersion, Population parameters, sample estimates and confidence intervals. Basic concepts of probability. Probability distributions, Z - scores, Student's t - test, Chi square test, Correlation, regression, ANOVA, RSM.

### **UNIT - V**

Bioinformatics - Biological databases - Database searching, Sequence analysis, Pair alignment, Visualizing protein structures, Predicting structure and function of protein using sequences, QSAR, computer based drug designing. Abbreviations and terms used in the industries. Volume Calculations. Using Microsoft Excel graphing utility. Submission of nucleotides in NCBI-FASTA, Construction of phylogenetic tree, protein docking methods.

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1. Keith Wilson and John Walker (2010) *Principles and Techniques of Biochemistry and Molecular Biology*, 7<sup>th</sup> Edition, Cambridge Univ., Press.
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5. <http://www.wwpdb.org/>
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## **ELECTIVE COURSES**

### **ELECTIVE PAPER - 1: BIOCONTROL AND ENTOMOLOGY**

#### **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. Cyanobacterial Biofertilizers: Nostoc, Anabaena, Gloeocaps and Scytonema. Symbiotic association with Azolla. Bacterial biofertilizers: Free living forms - Azatobacter, Azospirillum. Symbiotic forms: Rhizobium Legume Association, Nonlegume association. Isolation and screening of bacterial biofertilizers. Mass production of bacterial biofertilizers.

#### **UNIT - II**

Fungal biofertilizers: Types of fungal biofertilizers - Ecto, endo and ect-endo mycorrhiza, Ectomycorrhizal association with pines, Arbuscular mycorrhizal association (AM) *Glomus* sp., Isolation and field enrichment of mycorrhiza. Actinomycetes as biofertilizers: Actinorhiza, Actinorhizal associations in higher plants, *Frankia* sp. - History and biology.

#### **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 pathogenic nematodes, viruses, bacteria, fungi, protozoa etc., 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. Borkar, S.G. (2015) *Microbes as Bio-fertilizers and their Production Technology* (Woodhead Publishing India in Agriculture), WPI Publishing, ISBN: 9380308574.
2. Shagufta (2012) *Biofertilizer Technology*, 1<sup>st</sup> Edition, Published at Delhi.

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## **ELECTIVE PAPER - 2: ENTREPRENEURSHIP IN MICROBIOLOGY**

### **UNIT - I**

Evolution of the concept of entrepreneur - Entrepreneurship: Definitions - concept of Entrepreneurship, development - need - role of resource, talent and spirit - process of Entrepreneurship to socio-economic gains.

### **UNIT - II**

Institutions and schemes of government of India - Schemes and programmes, Department of science and technology schemes, Nationalized banks - other financial institutions etc - SIDBI - NSIC - NABARD - IDBI - IFCI - ICICI etc.

### **UNIT - III**

Skills for entrepreneurs - communication skills, problem solving skills. Business plan development. Market need - market research, SWOT analysis, identify your competition. Financial plan - obtain financing for your business, insure your business, Marketing - mix - product, distribution, price, promotion, and set marketing goals.

### **UNIT - IV**

Successful entrepreneur - Steps, Characteristics. Entrepreneurship opportunities - Composting from domestic waste, agricultural and industrial waste. Vermicomposting - SCP production - Mushroom cultivation.

### **UNIT - V**

Biofertilizers and biopesticides. Production of teaching kits (plasmid DNA isolation, serum electrophoresis) and diagnostic kits (WIDAL test kits, ABO blood grouping kits)

### **References**

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## **ELECTIVE PAPER - 3: ALGAL BIOTECHNOLOGY**

### **UNIT - I**

Classification, structure, reproduction and other characteristics of algal divisions, Distribution of algae, Characteristics of- blue green algae, dinoflagellates, Microalgae, thallus organization. Characteristics of various micro and macro algal morphology, Salient features of Protochlorophyta, Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta. Algal blooms.

### **UNIT - II**

Algal production systems: Isolation method, Screening methods, Plating methods, Strain selection, Algal growth curve, Culture media, Measurement of algal growth. Nutritional requirements, reproduction, evaporation and uniform dispersal of nutrients, Harvesting of algae, drying methods.

### **UNIT - III**

Estimation studies: Lipid, protein, carbohydrates, chlorophyll, biomass, medium selection, optimization of medium, pH, temperature, light sources, CO<sub>2</sub> supplements. Types of bioreactors. Extraction methods - lipid, pigments, Carbohydrate.

### **UNIT - IV**

Commercial utility of algae: Algae as a source of food and pigments. Role of algae in agriculture - Blue-green algal bio-fertilizer: Method of preparation, application and its advantages over inorganic fertilizers bio-fertilizers. Liquid seaweed fertilizer: Method of preparation and application, algae for pollution control and other novel applications.

### **UNIT - V**

Biotechnological approaches for production of important algae, pigments, biofuels, hydrogen production, important bioactive molecule. Aqua, cattle feed and bio-fertilizer conversion methods. Biodiesel separation and conversion methods, Transesterification methods.

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3. Richmond, A. and Hu, Q. (2013) *Handbook of Microalgal Culture: Applied Phycology and Biotechnology*, 2<sup>nd</sup> Edition, Wiley-Blackwell, UK.
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10. <https://www.uni-bielefeld.de/biologie/Zellbiologie/publik/paper/2007tpj.pdf>

## **ELECTIVE PAPER - 4: QUALITY CONTROL IN INDUSTRIES**

### **UNIT - I**

Introduction to laboratory safety: Good Laboratory Practice (GLP), Personal hygiene practice, regulatory agencies, safety of working lab, emergency response. Handling of hazardous materials, Operational qualification and performance Qualification of facilities. Applications of computers in quality control laboratory

### **UNIT - II**

Quality control in food industries: Quality of raw materials, finished product Release: Food quality evaluation - nutritional, functional, microbial, shelf life and physicochemical analysis. Rapid test for food quality and safety, Quality review, Quality audits, Batch release, Document warehousing - Good ware housing practices materials management.

### **UNIT - III**

Quality control in pharmaceutical industries: Qualitative and quantitative analysis of tablets, capsules, ointments, suppositories, creams, modified release products (controlled release, sustained release products and etc), parenteral, ophthalmic and surgical products. WHO guidelines for impurity and related substances in the drugs. Quality management in the pharmaceutical industry.

### **UNIT - IV**

Quality control in clinical laboratories: Role of laboratory in human health and diseases, Designing of laboratory sections, Anticipating demand and ensuring availability of adequate medical and diagnostic supplies (Contents of all diagnostic and medical kits), Internal and external quality control programmes. Universal safety precautions

### **UNIT - V**

Laboratory and industrial calculations: Abbreviations and terms used in the industries, The international system of units, Unit conversion between SI and US, common laboratory calculations - Units of measures (Mole, equivalents and normality) dilutions and percentages; Volume calculations. Using Microsoft Excel's graphing utility.

### **References**

1. Schedule, M. (2012) *Good manufacturing practices and requirements of premises, plant and equipment for pharmaceutical products*.
2. Abdul Malik, Zerrin Erginkaya, Saghir Ahmad, Hüseyin Erten (2014) *Food Processing: Strategies for Quality Assessment*, Springer.
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4. <http://www.ncbi.nlm.nih.gov/pubmed/6357609>
5. <http://as.wiley.com/wileycda/wileytitle/productcd-0471966754.html>
6. [http://www.cdsc.nic.in/html/GMP/ScheduleM\(GMP\).pdf](http://www.cdsc.nic.in/html/GMP/ScheduleM(GMP).pdf)

## **ELECTIVE PAPER - 5:**

### **INTELLECTUAL PROPERTY RIGHTS (IPR), BIO-SAFETY AND BIOETHICS**

#### **UNIT – I**

Introduction to Intellectual Property: IPR - Definition - Types of IP. Patents, Trademarks, Copyright & Related rights, Industrial design, Traditional knowledge, Geographical indications, IP as a factor in R & D. WTO - Definition - Functions and forms of IPR protection.

#### **UNIT – II**

Agreements and treaties: History of GATT and TRIPS agreement, Madrid agreement, Hague agreement, WIPO treaties, Budapest treaty, PCT, Indian Patent Act 1970 and recent amendments.

#### **UNIT – III**

Basics of patents and concept of prior art: Introduction to patents, Types of patent applications - Ordinary, PCT, Conventional, Divisional and Patent of addition. Specifications: Provisional and complete, Forms and fees invention in context of “prior art”, Patent databases, Searching international databases, Country-wise patent searches (UNESCO, USPTO, EPO, PATENT Scope (WIPO), IPO and etc). National & PCT filing procedure, Time frame and cost, Status of the patent applications filed, 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.

#### **UNIT – IV**

Biosafety: Introduction, Historical background, Introduction to biological safety cabinets, Primary containment for biohazards, Biosafety levels, Biosafety levels of specific microorganisms. Biosafety guidelines - Government of India, Definition of GMOs & LMOs, Roles 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.

#### **UNIT – V**

Bioethics: Definition, Principles, Ethics committees, Animal ethics, Norms in India, Licensing of animal house, Ethical clearance norms for conducting studies on human subjects. Ethics in nanosciences and animal studies.

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1. Deepa Goel, Shomini Parashar (2013). *IPR, Biosafety and Bioethics*, Pearson Education India.
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12. <http://nguyenthanhmy.com/courses/2013/IP-Bioethics-WIPO.pdf>
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## **SUPPORTIVE COURSES**

### **SUPPORTIVE - 1: MICROBIOLOGY**

#### **UNIT - I**

History and discovery of microorganisms - Microscopical appearance and Staining techniques - Simple staining, Differential staining, Special staining, Capsular staining, Albert staining and Fungal stainings. Colony characteristics of different bacteria. Microbial cellular morphology : Cell wall composition of Gram negative and Gram positive bacteria. Cellular structures - Capsule, Cell, Periplasmic space, Spores, Flagella, Cilia, Pili and other cellular inclusions.

#### **UNIT - II**

Sterilization and culturing techniques - Physical and chemical methods for controlling microorganisms. Types of culture media and their preparation for bacterial cultivation. Applications of basal, differential, enriched and selective media in bacterial growth. Different forms of media and their use - Broth tubes, slants, stabs and plate media. Pure culture techniques. Anaerobic culturing techniques. Maintenance and preservation techniques - Refrigeration, freeze drying, oil overlaying, periodic transfers.

#### **UNIT - III**

Microbial physiology - Aerobic and anaerobic respiration in microbes. Nuclear material - bacterial chromosomes and bacterial plasmids. Bacterial DNA replication. 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, plague, meningitis, syphilis, pneumonia, tuberculosis, leprosy. 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.

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1. Prescott, L.M., Harley, J.P. and Klein, D.A. (2003) *Microbiology*, 5<sup>th</sup> Edition, McGraw Hill, New York.
2. Madigan, M.T., Martinko, J.M., Parker, J. and Brock, T.D. (1997) *Biology of Microorganisms*, 8<sup>th</sup> edition. Prentice Hall International Inc. London.
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7. <http://www.kensbiorefs.com/Microbio.html>
8. <http://www.microbeworld.org/>

## **SUPPORTIVE - 2: MEDICAL LABORATORY TECHNOLOGY**

### **UNIT - I**

Units of measurements, laboratory glassware and instruments - Laboratory calculations - Preparation of standard solutions of acid and base. Standard solutions - Classification of standard solutions - Primary standard solution - Secondary standard solutions - Buffer solutions. Cleaning of glasswares. Laboratory instruments - Balances - Centrifuges - Ovens - Water Bath - Incubator - Colorimeter (Photometer) - Flow cytometry - Automated analyzers.

### **UNIT - II**

Medical laboratory rules, ethics and professional code of conduct: Infrastructure of a medical laboratory - Rules of medical laboratory - Medical laboratory request form - Maintenance of laboratory records - Delivery of laboratory results - Professional code of conduct and ethics - Laboratory policies, General precautions for avoidance of laboratory accidents. Biomedical wastes - Introduction, categories of waste, standard protocol of waste disposal.

### **UNIT - III**

Specimen collection, processing, transport, staining and culture: General considerations. Types of specimens - Specimen collection and processing in hematology. Biochemical analysis, Pathological analysis, Microbiological analysis, Preservation and transport. Staining techniques and culture on various media for the differential diagnosis of pathogens.

### **UNIT - IV**

Immunohaematology - Introduction to hematology, collection of blood sample and anticoagulants, red cell count, haemocytometer and procedure for RBC count, white cell count, absolute eosinophil count, ESR, PCV, 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 (2005) *District Laboratory Practice in Tropical Countries Part 1 & 2*, Cambridge University Press.
2. 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.
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## **SUPPORTIVE PAPER - 3: QUALITY CONTROL IN INDUSTRIES**

### **UNIT - I**

Introduction to laboratory safety: Good Laboratory Practice (GLP), Personal hygiene practice, regulatory agencies, safety of working lab, emergency response. Handling of hazardous materials, Operational qualification and performance Qualification of facilities. Applications of computers in quality control laboratory

### **UNIT - II**

Quality control in food industries: Quality of raw materials, finished product Release: Food quality evaluation - nutritional, functional, microbial, shelf life and physicochemical analysis. Rapid test for food quality and safety, Quality review, Quality audits, Batch release, Document warehousing - Good ware housing practices materials management.

### **UNIT - III**

Quality control in pharmaceutical industries: Qualitative and quantitative analysis of tablets, capsules, ointments, suppositories, creams, modified release products (controlled release, sustained release products and etc), parenteral, ophthalmic and surgical products. WHO guidelines for impurity and related substances in the drugs. Quality management in the pharmaceutical industry.

### **UNIT - IV**

Quality control in clinical laboratories: Role of laboratory in human health and diseases, Designing of laboratory sections, Anticipating demand and ensuring availability of adequate medical and diagnostic supplies (Contents of all diagnostic and medical kits), Internal and external quality control programmes. Universal safety precautions

### **UNIT - V**

Laboratory and industrial calculations: Abbreviations and terms used in the industries, The international system of units, Unit conversion between SI and US, common laboratory calculations - Units of measures (Mole, equivalents and normality) dilutions and percentages; Volume calculations. Using Microsoft Excel's graphing utility.

### **References**

1. Schedule, M. (2012) *Good manufacturing practices and requirements of premises, plant and equipment for pharmaceutical products*.
2. Abdul Malik, Zerrin Erginkaya, Saghir Ahmad, Hüseyin Erten (2014) *Food Processing: Strategies for Quality Assessment*, Springer.
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## **SUPPORTIVE - 4: HEALTH SCIENCE MANAGEMENT**

### **UNIT - I**

General aspects of disease transmission - Source of contamination, Host parasite relationships, Defence mechanisms in human. Importance of effective health information system. Understanding relationship between food, nutrition and health.

### **UNIT - II**

Common deficiency diseases, clinical manifestation of deficiency and excess of micro and macronutrients, adult chronic diseases - diabetes, obesity, hypertension, heart diseases. Factors contributing to lifestyle disorders, prevention, control and management of nutrition related diseases.

### **UNIT - III**

Principles of meal planning - Fermented foods - Probiotics. Food Management - factors affecting eating behaviours, food, energy and nutrient requirements, physical activity levels, food needs at different stages of the life cycle, balance between energy intake and energy expenditure, reliable sources for nutrient information,

### **UNIT - IV**

Functions of food - Physiological, psychological and social - Concept of balanced diet, Food groups, Food pyramid, Nutrition improvement of foods - Nutrient losses in cooking and enhancing the nutritional quality of foods.

### **UNIT - V**

Modern concept of health managements - Health management information system, planning, organizing, staffing, motivating, leading, co-ordination and regulating. Trends in technology in decision making.

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1. Manay, S. and Shadaksharaswami, M. (2004) *Foods: Facts and Principles*, New Age Publishers, New Delhi, India.
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3. Meyer (2004) *Food Chemistry*, New Age Publishers, New Delhi, India..
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