

**GONDWANA UNIVERSITY**

**GADCHIROLI**



**FACULTY OF SCIENCE AND  
TECHNOLOGY**

**Syllabus for the T.Y.B.Sc.**

**Semester V & VI**

**Program: B.Sc.**

**Course: Microbiology**

**Choice Based Credit System with Effect from the Academic Year**

**2019–2020**

# GONDWANA UNIVERSITY, GADCHIROL I

## CHOICE BASED CREDIT SYSTEM

### T.Y. B.Sc.

### MICROBIOLOGY

### (SEMESTER V)

(With effect from academic session 2019-20)

- There shall be two semesters in B.Sc. Part III. Each semester comprise of two theory papers, practical and internal assessment.
- The syllabus is based on six theory periods and six practical periods per week.
- Each theory paper divided into four units.
- **Scheme of examination:** The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment (college assessment) in the first part & by conducting the Semester End Examinations (conducted by university) in the second part.
- **Internal Assessment:** It is defined as the assessment of the learners on the basis of continuous evaluation as envisaged in the Credit based system by way of participation of learners in various academic and correlated activities in the given semester of the program.
- **Semester End Assessment:** It is defined as the assessment of the learners on the basis of Performance in the semester end Theory/ written/ Practical examination.
- The internal assessment marks assigned to each theory paper shall be awarded on the basis of Attendance/Assignment / Class test / Project assignment / Seminar / Case studies/ Quizzes/ Viva, any other innovative practice / activity.
- **The Semester End Examination for MICROBIOLOGY course will be as follows:**
  - External assessment- University examination : 50 marks each for DSE- I, DSE- II, DSE- III, DSE- IV (Any Two): Total 100 marks
  - Internal assessment- College Assessment : 10 marks each for DSE- I, DSE- II, DSE- III, DSE- IV (Any Two): Total 20 marks  
(External assessment+ Internal assessment= Total - 120 Marks for theory)
  - One practical course: 30 marks(For any two selected from DSE)
  - The practical course will be concerning with the DSE theory papers.
- Duration of examination for each theory paper will be 3 hours.
- The practical examination shall be of 6 hours duration.
- Practical examination for odd semester will be at college level and for even semester at university level with external examiner.
- **Skill Enhancement Course (SEC):** The students have to choose one Skill Enhancement Course from a pool of courses designed to provide value-based and/or skill-based knowledge.
- Marks distribution for SEC: Theory- 15 marks, Exercise/Practical-35 Marks
- Assessment of skill Enhancement Course shall be done at college level.
- The B.Sc. students of Microbiology shall pay at least one visit to any Industry, Microbiological Research Institute as a study tour during three year (six semesters) degree course.
- The marks will be given for all examinations and they will be converted into grade points. The final grade card will have marks, credits, grades, grade points, SGPA & CGPA.

**SCHEME OF TEACHING AND EXAMINATION: B.Sc. Semester V (MICROBIOLOGY)**

Semester	Paper No.	DSE T/P	Paper code	Title of Paper: Discipline Specific Elective (Any Two)	Periods / week	Max Marks		Total Marks	Credits	Total: Th+ Pract	
						External (U.A.)	Internal(C.A.)				
V	IX	DSE-I	USMBT-09	Medical Microbiology	6	50	10	60	2	150	
	X	DSE-II	USMBT-10	Bioinstrumentation	6	50	10	60	2		
	XI	DSE-III	USMBT-11	Virology	6	50	10	60	2		
	XII	DSE-IV	USMBT-12	Pharmaceutical Microbiology	6	50	10	60	2		
		Practical	USMBP-05	DSE Practical (Concerning with selected DSE theory papers). <u>Any two Practical</u> courses from USMB P-05,USMBP-06,USMBP-07,USMBP-08	6	30	-	30	2		
			USMBP-06								
			USMBP-07								
			USMBP-08								
		<b>paper No.</b>	<b>SEC</b>	<b>Paper code</b>	<b>Skill Enhancement Course (Any one) (College level)</b>	<b>Credit</b>	<b>Theory</b>	<b>Exercise</b>	<b>Total</b>	<b>Credits</b>	<b>Total Marks</b>
		I	SEC I	USMBSEC-01	Microbial Diagnosis in Health Clinics	2	15	35	50	2	50
	II	SEC II	USMBSEC-02	Fermented Food and Microbial Quality Control in Food	2	15	35	50	2		

**Internal Assessment for DSE Theory Paper:**

S.No	Type of Evaluation	Marks	
		Paper I	Paper II
1	Minimum Two Class Test	04	04
2	Attendance, Active participation in routine class activities/seminars etc.	03	03
3	One assignment	03	03
	Total	10	10

**Distribution of Marks in DSE Practical Examination:**

S.No	External assessment	Marks
1	Experimental work	20
2	Practical record	05
3	Viva-voce	05
	Total	30

## QUESTION PAPER PATTERN

- a. Question paper will consist of five questions and each question will be of 10 marks.
- b. All questions will be compulsory and with internal choice.
- c. The first four questions will be from the four units separately.
- d. Fifth question will be compulsory with questions from each of the four units having equal weight age and there will be no internal choice.

### T.Y. B.Sc. Semester V (CBCS) MICROBIOLOGY

**Time: 3 Hours**

**Max. Marks: 50**

**Note: A) All questions are compulsory and carry equal marks  
B) Draw well labeled diagrams wherever necessary**

- Q 1. Long answer type question from Unit I 10 Marks  
OR  
a) Short answer type question from Unit I 2½ Marks each  
b) Short answer type question from Unit I  
c) Short answer type question from Unit I  
d) Short answer type question from Unit I
- Q 2. Long answer type question from Unit II 10 Marks  
OR  
a) Short answer type question from Unit II 2½ Marks each  
b) Short answer type question from Unit II  
c) Short answer type question from Unit II  
d) Short answer type question from Unit II
- Q 3. Long answer type question from Unit III 10 Marks  
OR  
a) Short answer type question from Unit III 2½ Marks each  
b) Short answer type question from Unit III  
c) Short answer type question from Unit III  
d) Short answer type question from Unit III
- Q 4. Long answer type question from Unit IV 10 Marks  
OR  
a) Short answer type question from Unit IV 2½ Marks each  
b) Short answer type question from Unit IV  
c) Short answer type question from Unit IV  
d) Short answer type question from Unit IV
- Q 5. Solve any 10 out of 12 questions (3 questions from each unit) 10 Marks

Course Code – USMBT-09		DSE-1	Marks: 50
Credits: 2		Total Hours :48	
Medical Microbiology			
Objective: To make the students to understand the fundamental knowledge of Medical Microbiology.			
Unit No.	Content	Hrs	
1	<b>Host-Parasite Relationship</b>	12	
	<p>a. <b>Infection:</b> Definition, types of infections, primary infection, Secondary infection, Acute and chronic infection, Local and systemic infection, Fulminating infection, Nosocomial infection, Iatrogenic infection, Teratogenic infection, Congenital infection, Bacteremia, Septicemia, Pyaemia, Sappremia, Toxemia, Viremia</p> <p>b. <b>Disease :</b> Definition and example of Disease, Sign, Symptom, Syndrome, Types of disease – Infectious &amp; noninfectious disease, Epidemic, Endemic, Pandemic, Prosodemic, Sporadic, Exotic, Venereal, Zoonotic, Epizootic, Exoti c</p> <p>c. <b>Stages of Infectious disease-</b> Incubation period, Prodromal phase, invasive phase, decline phase, convalescence.</p> <p>d. <b>Normal flora of human body-</b> Characteristic of normal flora, beneficial and harmful effects of normal flora, Normal flora of skin, eye, respiratory tract, digestive tract, urino-genital tract, blood and tissues.</p>		
2	<b>Dynamics of Disease Transmission and Control</b>	12	
	<p>a. Diseases of skin, eye, digestive tract, respiratory tract, urinary tract, reproductive system, nervous system, cardiovascular and lymphatic system (only list with causative organism).</p> <p>b. <b>Sources/reservoir of infections-</b> endogenous sources, exogenous sources, case, carriers, animals, insect, non-living sources.</p> <p>c. <b>Portals of exit, Portals of entry.</b></p> <p>d. <b>Modes of transmission-</b> Contact, Vehicle, Vector, airborne, Trans -placental, Laboratory, Hospital.</p> <p>e. Susceptibility of host.</p> <p>f. <b>Control of communicable diseases -</b> different methods.</p>		
3	<b>Microbial Mechanism of Pathogenicity</b>	12	
	<p>a. <b>Pathogenicity and Virulence, difference</b></p> <p>b. <b>Variation of virulence,</b> Exaltation, Attenuation, methods of attenuation.</p> <p>c. <b>Virulence determining factors</b> i) Infectivity – MID, MLD, ID50, LD50</p> <p>d. <b>Invasiveness,</b> factors responsible (aggresins)</p> <p>e. <b>Toxigenicity</b> – Exotoxin, Endotoxin, comparison, enterotoxin.</p> <p>f. Vaccine and toxoid, types</p>		
4	<b>Microbial Diseases of Human</b>	12	
	<p>Epidemiology, Pathogenesis, laboratory diagnosis, Treatment and Prevention of following diseases.</p> <p>i. Typhoid ii) Tuberculosis iii) Cholera iv) Malaria v) Swine flu vi) Dengue virus vii) AIDS viii) Hepatitis A &amp; B ix) Candidiasis</p>		

**COURSE CODE: USMBP-05: MEDICAL MICROBIOLOGY (PRACTICAL)**

1. Laboratory diagnosis of i) *E.coli* ii) *S. aureus* iii) *P. vulgaris* iv) *S. typhi*
2. To study normal flora of skin and oral cavity.
3. Detection of Malarial parasite from blood sample.
4. Detection of Chikungunia and Dengue fever (demonstration only)
5. Determination of Minimum Inhibitory Concentration (MIC) of Antibiotics.
6. Estimation of Blood sugar by GOD-POD method
7. Liver function test - SGOT and SGPT
8. Kidney function test- Creatinine , Urea
9. Estimation of Blood cholesterol.

### **Suggested Readings for Medical Microbiology**

1. Ananthnarayan and Panikars ,Textbook of Microbiolology(8th edition), University Press, Hyderabad
2. Jayaram Paniker CK (2004). Text book of Medical Parasitology. Fifth edition, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi.
3. Essentials of Medical Microbiology. 4th Edition. Rajesh Bhatia. JAYPEE Publisher
4. Tortora G.J., Funke B.R., Case C.L.(2006). Microbiology: an Introduction. 8th edition. Pearson Education Inc.
5. Powar and Dagainawala General Microbiology Vol.I&II ( Himalaya Publication)
6. Dubey R. C. and Maheshwari D.K. Text Book of Microbiology, S. Chand Publisher
7. Pelzar, Chan and Kreig, Microbiology 5th edition, TMH Publishe
8. Frobisher , Hindsdill et al., Fundamentals of Microbiology : W.B. Saunders Company, 7th edition USA, Topman co. Ltd. Japan
9. Stainer, Roger et al., General Microbiology
10. Atlas R.A. Microbiology- Fundamental and Applications, Macmillan
11. Brock T.D. and Madigan M.T. Biology of Microorganisms, Prentice Hall of India Private Limited
12. Alcamo, Fundamentals of Microbiology
13. Purohit, Microbiology fundamentals and applications
14. Davis, Dulbecco, Microbiology
15. Thomas , Clinical Microbiology, University Press, Hyderabad
16. Ramkrishnan, Textbook of Medical Biochemistry University Press, Hyderabad
17. Medical Microbiology and parasitology , Day and Day, Himalaya Publisher
18. Manual of Practical Microbiology and Parasitology, P. Chakroborty. NCBA, Kolkata

<b>Course Code- USMBT-10</b>		<b>DSE-2</b>	<b>Marks: 50</b>
<b>Credits: 2</b>		<b>Total Hours :48</b>	
<b>Bioinstrumentation</b>			
<b>Objective:</b> To make the students to understand the fundamental knowledge of Bioinstruments and Analytical techniques.			
<b>Unit No.</b>	<b>Content</b>	<b>Hrs</b>	
<b>1</b>	<b>Spectrophotometry</b>	<b>12</b>	
	<ul style="list-style-type: none"> <li>a. Concept of electromagnetic radiation, spectrum of light,</li> <li>b. Concept of chromophores, extinction coefficient</li> <li>c. Beer's law and its deviations, Difference between spectrophotometer and colorimeter.</li> <li>d. Basic principle, Instrumentation and Application - UV and visible Spectrophotometer, IR Spectrophotometer and Mass spectrophotometer.</li> </ul>		
<b>2</b>	<b>Chromatography</b>	<b>12</b>	
	<ul style="list-style-type: none"> <li>a. Partition principle, partition coefficient, Nature of partition forces.</li> <li>b. Adsorption Chromatography - Methods of paper chromatography, Thin layer chromatography and their Applications.</li> <li>d. Column Chromatography - Basic principle, method and application of - Gel filtration, Ion-exchange, and Affinity chromatography.</li> <li>d. Basic principles of HPLC and Gas Chromatography</li> </ul>		
<b>3</b>	<b>Electrophoresis and Blotting</b>	<b>12</b>	
	<ul style="list-style-type: none"> <li>a. Electrophoresis- Migration of ions under electric field, factors affecting electrophoretic mobility,</li> <li>b. Paper electrophoresis, cellulose acetate electrophoresis, Immuno electrophoresis. Electrofocusing.</li> <li>c. Gel electrophoresis-Types of gels, solubalizers, procedure, and application</li> <li>d. SDS-PAGE electrophoresis - principle, procedure and applications.</li> <li>e. Blotting technique-Southern blotting, Northern blotting, Western blotting, Immunoblotting.</li> </ul>		
<b>4</b>	<b>Centrifugation and Radioactivity</b>	<b>12</b>	
	<ul style="list-style-type: none"> <li>a. Centrifugation - Basic principles, concept of RCF, Sedimentation coefficient, factors affecting sedimentation velocity.</li> <li>b. Types of Centrifuges- Ultracentrifuge (Preparative and Analytical), Density gradient centrifugation (Rate zonal and Isopynic) and their application.</li> <li>c. Radioactive and stable isotopes, units of radioactivity, isotopic tracer techniques and Application in biology.</li> <li>d. Measurement of radioactivity- GM counter and Scintillation counter</li> <li>e. Radioactive labeling and Autoradiography.</li> </ul>		



**COURSE CODE: USMBP-06 : BIOINSTRUMENTATION ( PRACTICAL)**

1. Paper chromatography of Amino acids/Sugars.
2. TLC of lipid/amino acids.
3. Demonstration of separation of components by paper electrophoresis
4. Demonstration of column packing in any form of column chromatography.
5. Separation of protein mixtures by any form of chromatography.
6. Separation of protein by SDS-PAGE (Sodium dodecyl sulfate -Polyacrylamide gel electrophoresis)
7. Separation of components of a given mixture using a laboratory scale centrifuge.
8. Blotting of DNA by Southern Blotting technique.

## **Suggested Readings for Bioinstrumentation**

1. Upadhyay & Nath, Biophysical Chemistry, Himalaya publishing house, New Delhi, 2009
2. Bajpai PK (2010). Biological Instrumentation and Methodology. Revised edition, S.Chand & Co. Ltd., New Delhi.
3. Palanivelu P (2004). Analytical Biochemistry and Separation techniques. Third edition, MKU Co-op, Press Ltd., Palkalai Nagar, Madurai.
4. Subramanian MA (2005). Biophysics – Principles and Techniques. First edition, MJP Publishers, A Unit of Tamil Nadu Book House, Chennai
5. Aneja KR (2005). Experiments in Microbiology, Plant pathology and Biotechnology. Fourth edition, New Age International Publishers, Chennai.
6. Dubey RC and Maheswari DK (2004). Practical microbiology First edition, S Chand and Company Ltd., New Delhi.
7. James G Cappuccino and Natalie Sherman (2004). Microbiology: A laboratory manual. Sixth edition, Published by Pearson Education
8. Jayaraman., Lab Manual in Biochemistry
9. David T. Plummer, An Introduction to Practical Biochemistry
10. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed., Cambridge University Press.
11. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5th Ed., W.H. Freeman and Company.
12. Willey MJ, Sherwood LM & Woolverton C J. (2013). Prescott, Harley and Klein's Microbiology. 9th Ed., McGraw Hill.
13. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
14. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
15. Cooper G.M. and Hausman R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington D.C., Sinauer Associates, MA.
16. Nigam A and Ayyagari A. 2007. Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill.

<b>Course Code- USMBT-11</b>	<b>DSE-3</b>	<b>Marks: 50</b>
<b>Credits: 2</b>	<b>Total Hours :48</b>	
<b>Virology</b>		
<b>Objective:</b> To make the students to understand the fundamental knowledge of Virology		
<b>Unit No.</b>	<b>Nature and Properties of Viruses</b>	<b>Hrs</b>
<b>1</b>	Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Structure of Viruses: Capsid, Helical and Icosahedra symmetry. Cultivation of viruses, Isolation and purification of Virus.	<b>12</b>
<b>2</b>	<b>Taxonomy, Bacteriophage and Virus replication</b> Viral taxonomy: Classification and nomenclature of different groups of viruses. lytic and Lysogenic phages (lambda phage). Modes of viral transmission: Persistent, non-persistent, vertical and horizontal Salient features of viral Nucleic acid: Unusual bases (TMV,T4 phage), overlapping genes ( $\phi$ X174, Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B).	<b>12</b>
<b>3</b>	<b>Oncogenic Virus and Application of Virology</b> Introduction to oncogenic viruses, Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes. Use of viral vectors in cloning and expression, Gene. Antiviral compounds and their mode of action Interferon and their mode of action	<b>12</b>
<b>4</b>	<b>Prevention &amp; control of viral diseases, Application of Virology</b> Antiviral compounds and their mode action Interferon and their mode of action. General principles of viral vaccination, Application of Virology: Use of viral vectors in cloning and expression, Gene therapy and Phage display.	<b>12</b>

## **COURSE CODE: USMBP-07 : VIROLOGY (PRACTICAL)**

1. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo hepatitis B and retroviruses) using electron micrographs.
2. Studying isolation and propagation of animal viruses by chick embryo technique.
3. Study of cytopathic effects of viruses using photographs.
4. Perform local lesion technique for assaying plant viruses.
5. Study of the structure of important plant viruses (caulimo, Gemini, tobacco ring spot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs
6. Study of the structure of important bacterial viruses ( $\phi$ X 174, T4,  $\lambda$ ) using electron micrograph.
7. Isolation and enumeration of bacteriophage (PFU) from water/sewage sample using double agar layer technique.

### **Suggested Readings for Virology**

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
2. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
3. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
4. Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.
5. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
6. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
7. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
8. Bos L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
9. Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.

<b>Course Code- USMBT-12</b>	<b>DSE-4</b>	<b>Marks: 50</b>
<b>Credits: 2</b>		<b>Total Hours :48</b>
<b>PHARMACEUTICAL MICROBIOLOGY</b>		
<b>Objective:</b> To make the students to understand the fundamental knowledge of Pharmaceutical Microbiology		
<b>Unit No.</b>	<b>Content</b>	<b>Hrs</b>
<b>1</b>	<b>Phytopharmaceuticals</b>	<b>12</b>
	Introduction – Overview of products, classification of pharmacologic agents based on chemistry and source. Phytopharmaceuticals: screening tests for phytoconstituents – alkaloids and terpenoids. Three examples of commercial natural products from marine and terrestrial organisms.	
<b>2</b>	<b>Drug Development</b>	<b>12</b>
	Drug development: Biology guided fractionation methods: in vitro assay systems based on enzymes, tissue, and organ or growth inhibition. Animal models: transgenic animals, cell lines. Antimicrobial activity studies (antibacterial, antiviral, antifungal and antiparasitic activities).	
<b>3</b>	<b>Gene Therapy and Vaccines</b>	<b>12</b>
	Gene therapy: general introduction, ex vivo and in vivo gene therapy, potential targets for gene therapy, inherited disorders. Vaccine design and production, classification, genetically recombinant vaccines, advantages and disadvantages – examples, DNA vaccines – principles and mechanism. Immunologicals: Antisera – hyper immune gamma globulin – monoclonal antibodies – uses. Recombinant proteins: strategies and genetic manipulations for overproduction of biomolecules	
<b>4</b>	<b>Probiotics and Neutraceuticals</b>	<b>12</b>
	Other biomolecules: Probiotic and neutraceuticals – economic and legal considerations in pharmaceutical biotechnology: FDA guidelines – preclinical trials, acute, sub-acute, chronic and teratogenic studies. Clinical trials – Phases I, II, III and IV. ICMR guidelines for design and conduct of clinical trials, licensing and drug control.	

**COURSE CODE: USMBP-08 : PHARMACEUTICAL MICROBIOLOGY (PRACTICAL)**

1. Preparation of medicinal plant extracts.
2. Sterility testing of vaccines and injections.
3. Antibacterial activity of antibiotic preparations.
4. Antifungal tests.
5. Estimation of thiamine, riboflavin, ascorbic acid content of multivitamin formulations.
6. Phenol co-efficient test.
7. Proteolytic digestion of antibodies.
8. Analysis of digested fragments.

**Distribution of Marks During Practical Examinations of B.Sc. Semester V  
( From Any Two DSE Practicals)**

1. One major experiment-	10
2. Two minor experiment-	2 X 5 =10
3. Viva voce-	5
4. Practical record-	5
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Total	30

**(Duration of Practical exam will be 6 hrs., 3hrs. each for two consecutive days)**

### **Suggested Readings for Pharmaceutical Microbiology**

1. Denyer S.P., Hodges N.A. and Gorman S.P. (2004) Hugo and Russell's Pharmaceutical Microbiology, 7th Edn. Blackwell Publishers.
2. Mehra P.S. (2011) A text book of Pharmaceutical Microbiology, IK International Publishing House.
3. Baird R.M., Hodges N.A. and Denyer S.P. (2005) Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis Inc.
4. Saghee M.R., Sandle T. and Tidswell E.C. (2011) Microbiology and Sterility Assurance in Pharmaceuticals and Medical devices, Business Horizons publishers.
5. Hanlon G. and Sandle T. (2015) Industrial Pharmaceutical Microbiology: Standards and Controls, Euromed Communications.



## Skill Enhancement Courses (SEC) (Any One)

<b>Course Code-USMBSEC-01</b>	<b>Paper - I</b>	<b>Marks: 30</b>
<b>Credits: 2</b>		<b>Total Hours :12</b>
<b>Microbial Diagnosis in Health Clinics</b>		
<b>Objective:</b> To make the students to understand the fundamental knowledge of clinical diagnosis of microbial disease.		
Unit No.	Content	Hrs
<b>1</b>	<b>Introduction to disease diagnosis and sample collection</b>	<b>3</b>
	A) Common diseases and their causative agents: Typhoid, cholera, malaria and AIDS. Causative agents: Bacteria, viruses, parasites, fungi and sporozoites. B) Collection and processing and of clinical samples: Blood, Urine, Sputum, CSF and Faeces.	
<b>2</b>	<b>Laboratory Diagnosis - I</b>	<b>3</b>
	A) Steps in disease diagnosis: Microscopy, smear preparation, staining and staining types-Grams staining, acid fast staining. B) Cultivation of microorganisms: preparation of nutrient media-Nutrient agar, Blood agar, salmonella shigella agar, EMB agar and McConkey's agar, Inoculation and incubation in brief.	
<b>3</b>	<b>Laboratory Diagnosis - II</b>	<b>3</b>
	A) Serology- definition and role of serum, plasma, serological methods- Agglutination, precipitation, common tests- WIDAL test, VDRL test and ELISA test. B) Rapid disease diagnosis tests and kits-HIV, Dengue kit, swine flu kit.	
<b>4</b>	<b>Action of antibiotic study</b>	<b>3</b>
	A) Introduction to antibiotics: Definition, source, common antibiotics- Penicillin and ampicillin, action of antibiotics in brief. B) Methods of antibiotic sensitivity and resistance detection: sensitivity, resistance sensitivity test- Disc diffusion, MIC.	

## **PRACTICAL for Skill Enhancement Courses – SEC 01**

1. Detection of malaria parasite from given blood sample
2. Perform rapid disease diagnosis test and kits for HIV
3. Determination of MIC of the given antibiotic against the clinical isolates
4. Visit to Pathological lab. / Blood bank.

## **SUGGESTED READING**

1. Ananthanarayan R and Paniker CKJ (2009) Textbook of Microbiology, 8th edition, Universities Press Private Ltd.
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology 2nd edition, Elsevier India Pvt Ltd
4. Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby
5. Collee JG, Fraser, AG, Marmion, BP, Simmons A (2007) Mackie and McCartney Practical Medical Microbiology, 14th edition, Elsevier.

<b>Course Code -USMBSEC-02</b>		<b>Paper - II</b>		<b>Marks: 30</b>	
<b>Credits: 2</b>		<b>Total Hours :12</b>			
<b>Fermented Food and Microbial Quality Control in Food</b>					
<b>Objective:</b> To make the students to understand the fundamental knowledge of Food Fermentation Techniques					
<b>Unit No.</b>	<b>Content</b>				<b>Hrs</b>
<b>1</b>	<b>Fermented Food</b>				<b>3</b>
	A) Fermented Foods – Definitions, types, advantages and health benefits. B) Probiotic foods - Definitions, types, Microorganisms and health benefits.				
<b>2</b>	<b>Types of Fermented Food</b>				<b>3</b>
	Milk based fermented food – Examples and production process of Dahi. Grain based fermented food – Examples and production process of Idli. Vegetable based fermented food – Examples and production process of Pickel. Fermented Meat and Fish – Types and Microorganism involved.				
<b>3</b>	<b>Microbial Analysis of Food</b>				<b>3</b>
	Determining Microbes in Food : Culture and Microscopic Methods – Standard Plate Count, Most Probable Number, Direct Microscopic Count, Enrichment Culture Technique, Selective Media, MBRT, Rapid detection methods of microbiological quality at milk collection centers.				
<b>4</b>	<b>Microbial Standards</b>				<b>3</b>
	HACCP for food safety and Microbial Standards – Hazard analysis of critical control point (HACCP) – Principles, flow diagram, limitations Microbial Standards for different foods and water – BIS standards for common foods and drinking water				

## **PRACTICAL for Skill Enhancement Courses– SEC 02**

1. Preparation of fermented food- Pickle/Dahi/Idli at laboratory scale (any one).
2. To perform MPN (Most Probable Number) for determination of coliforms in food materials.
3. To perform MBRT for detection of quality of milk.
4. To perform rapid detection method of microbiological quality at milk collection centers.
5. Visit to food industry.

### **Suggested Readings**

1. Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004) Handbook of food and fermentation technology, CRC Press
2. Holzapfel W (2014) Advances in Fermented Foods and Beverages, Woodhead Publishing.
3. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan
4. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer

**GONDWANA UNIVERSITY**

**GADCHIROLI**



**FACULTY OF SCIENCE AND  
TECHNOLOGY**

**Syllabus for the T.Y.B.Sc.**

**Semester VI**

**Program: B.Sc.**

**Course: Microbiology**

**Choice Based Credit System with Effect from the Academic Year**

**2019–2020**

# GONDWANA UNIVERSITY, GADCHIROLI

## CHOICE BASED CREDIT SYSTEM

### T.Y.B.Sc.

### MICROBIOLOGY

### (SEMESTER VI)

(With effect from academic session 2019-20)

- There shall be two semesters in B.Sc. Part III. Each semester comprise of two theory papers, practical and internal assessment.
- The syllabus is based on six theory periods and six practical periods per week.
- Each theory paper divided into four units.
- **Scheme of examination:** The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment (college assessment) in the first part & by conducting the Semester End Examinations (conducted by university) in the second part.
- **Internal Assessment:** It is defined as the assessment of the learners on the basis of continuous evaluation as envisaged in the Credit based system by way of participation of learners in various academic and correlated activities in the given semester of the program.
- **Semester End Assessment:** It is defined as the assessment of the learners on the basis of Performance in the semester end Theory/ written/ Practical examination.
- The internal assessment marks assigned to each theory paper shall be awarded on the basis of Attendance/Assignment / Class test / Project assignment / Seminar / Case studies/ Quizzes/ Viva, any other innovative practice / activity.
- **The Semester End Examination for MICROBIOLOGY course will be as follows:**
  - External assessment- University examination : 50 marks each for DSE- I, DSE- II, DSE- III, DSE- IV (Any Two): Total 100 marks
  - Internal assessment- College Assessment : 10 marks each for DSE- I, DSE- II, DSE- III, DSE- IV (Any Two): Total 20 marks  
(External assessment+ Internal assessment= Total - 120 Marks for theory)
  - One practical course: 30 marks(For any two selected from DSE)
  - The practical course will be concerning with the DSE theory papers.
- Duration of examination for each theory paper will be 3 hours.
- The practical examination shall be of 6 hours duration.
- Practical examination for odd semester will be at college level and for even semester at university level with external examiner.
- **Skill Enhancement Course (SEC):** The students have to choose one Skill Enhancement Course from a pool of courses designed to provide value-based and/or skill-based knowledge.
- Marks distribution for SEC: Theory- 15 marks, Exercise/Practical-35 Marks
- Assessment of skill Enhancement Course shall be done at college level.
- The B.Sc. students of Microbiology shall pay at least one visit to any Industry, Microbiological Research Institute as a study tour during three year (six semesters) degree course.
- The marks will be given for all examinations and they will be converted into grade points. The final grade card will have marks, credits, grades, grade points, SGPA & CGPA.

**SCHEME OF TEACHING AND EXAMINATION: B.Sc. Semester VI (MICROBIOLOGY)**

Semester	Paper No.	DSE T/P	Paper code	Discipline Specific Elective Title of Paper: (Any Two)	Periods / week	Max Marks	Internal(C.A.)	Total Marks	Credits	Total: Th+ Pract	
						External (U.A.)					
V I	XIII	DSE-I	USMBT-13	Recombinant DNA Technology	6	50	10	60	2	150	
	XI V	DSE-II	USMBT-14	Immunology	6	50	10	60	2		
	XV	DSE-III	USMBT-15	Bioinformatics	6	50	10	60	2		
	XV I	DSE-IV	USMBT-16	Microbes in Sustainable Agriculture and Development	6	50	10	60	2		
		Practical	USMBP-09 USMBP-10 USMBP-11 USMBP-12	DSE Practical (Concerning with selected DSE theory papers). <u>Any two Practical</u> courses from USMBP-09, USMBP-10, USMBP-11, USMBP-12	6	30	-	30	2		
		Paper No.	SEC	Paper code	Skill Enhancement Course (Any one) (College level)	Credit	Theory	Exercise	Total	Credits	Total Marks
	III	SEC III	USMBSEC-03	Biofertilizers and Biopesticides	2	15	35	50	2	50	
	IV	SEC IV	USMBSEC-04	Mushroom and Spirulina Cultivation	2	15	35	50	2		

**Internal Assessment for DSE Theory Paper:**

S.No	Type of Evaluation	Marks	
		Paper I	Paper II
1	Minimum Two Class Test	04	04
2	Attendance, Active participation in routine class activities/seminars etc.	03	03
3	One assignment	03	03
	Total	10	10

### Distribution of Marks in DSE Practical Examination:

S.No	External assessment	Marks
1	Experimental work	20
2	Practical record	05
3	Viva-voce	05
	Total	30

### QUESTION PAPER PATTERN

- e. Question paper will consist of five questions and each question will be of 10 marks.
- f. All questions will be compulsory and with internal choice.
- g. The first four questions will be from the four units separately.
- h. Fifth question will be compulsory with questions from each of the four units having equal weightage and there will be no internal choice.

### T.Y. B.Sc. Semester VI (CBCS) MICROBIOLOGY

**Time: 3 Hours**

**Max. Marks: 50**

**Note: A) All questions are compulsory and carry equal marks  
B) Draw well labeled diagrams wherever necessary**

- Q 1. Long answer type question from Unit I 10 Marks  
OR  
a) Short answer type question from Unit I 2½ Marks each  
b) Short answer type question from Unit I  
c) Short answer type question from Unit I  
d) Short answer type question from Unit I
- Q 2. Long answer type question from Unit II 10 Marks  
OR  
a) Short answer type question from Unit II 2½ Marks each  
b) Short answer type question from Unit II  
c) Short answer type question from Unit II  
d) Short answer type question from Unit II
- Q 3. Long answer type question from Unit III 10 Marks  
OR  
a) Short answer type question from Unit III 2½ Marks each  
b) Short answer type question from Unit III  
c) Short answer type question from Unit III  
d) Short answer type question from Unit III
- Q 4. Long answer type question from Unit IV 10 Marks  
OR  
a) Short answer type question from Unit IV 2½ Marks each  
b) Short answer type question from Unit IV  
c) Short answer type question from Unit IV  
d) Short answer type question from Unit IV
- Q 5. Solve any 10 out of 12 questions (3 questions from each unit) 10 Marks



Course Code : USMBT-13		DSE-1	Marks: 50
Credits: 2		Total Hours :48	
<b>Recombinant DNA Technology</b>			
<b>Objective:</b> To make the students to understand the fundamental knowledge of Genetic engineering and Recombinant DNA Technology.			
Unit No.	Content	Hrs	
1	<b>Tools of Genetic Engineering</b>	12	
	<b>A) DNA Cutting Enzymes</b> - Endonuclease, Exonuclease, Restriction Enzymes - Types and Nomenclature. <b>B) DNA modifying enzymes</b> - Liagases, Alkaline Phosphatase, DNA Polymerase, Reverse transcriptase, Polynucleotide Kinase, Terminal Transferase, DNase and RNase. <b>C) Cloning Vectors</b> - Features of cloning vectors (Site of cloning, Marker Gene, Reporter Gene, Expression Elements). <b>D) Types of cloning vectors</b> - Bacterial vectors (pBR322, pUC18), Bacteriophage vectors (Lambda), Plant vector (Ti Plasmid), Artificial Chromosome vectors (YAC, BAC), Shuttle vectors and Expression vectors.		
2	<b>Techniques of Genetic Engineering</b>	12	
	<b>A) Methods of DNA isolation</b> - Isolation of Genomic and Plasmid DNA, Determination of purity and concentration of DNA. <b>B) Insertion of r-DNA into vector</b> - by Homopolymer tailing, Linkers and Adapters. <b>C) Methods of r-DNA transfer into host</b> - Gene gun, Microinjection, Lipofection, and Electroporation. <b>D) Methods of selection of recombinant host cells</b> - Insertional inactivation, Blue-White selection, Colony hybridization.		
3	<b>Amplification and Sequence Analysis of DNA</b>	12	
	<b>A) Types of Gene Libraries</b> - Genomic and cDNA libraries. <b>B) Methods of DNA sequencing</b> - Maxam-Gilbert, Sangers, Automated sequencer and Express sequence tag (EST). <b>C) Polymerase Chain Reaction (PCR)</b> - Principle, Procedure and Application. <b>D) Detection of DNA sequence</b> - DNA fingerprinting, DNA microarray. <b>E) Genomics and Proteomics</b> and their types		
4	<b>Application of Genetic Engineering</b>	12	
	<b>A) Applications in Medical Field</b> - Hybridoma technology and Monoclonal antibody production, Gene therapy- Types and applications, Stem Cell technology, Transgenic Animal - Knockout Mice. <b>B) Applications in Agriculture Field</b> - Transgenic plant - Insect resistant (Bt Cotton), Herbicide resistant (Roundup), Virus resistant. <b>C) Application in Medicine Field</b> - Vaccines production (Hepatitis B vaccine, DNA vaccine, Edible vaccine), Production of Insulin, Somatotropin and Interferon. <b>D) GM Food</b> - Pros and Cons and Examples. <b>E) Molecular Farming</b>		

## **Course Code: USMBP-09 :Recombinant DNA Technology (PRACTICAL)**

1. Isolation of plasmid DNA
2. Isolation of genomic DNA from bacterial cell and separation of isolated genomic DNA by agarose gel electrophoresis
3. Digestion of DNA using restriction enzyme and analysis by agarose gel electrophoresis
4. Ligation of digested DNA fragment
5. DNA amplification by PCR (Demonstration)
6. Gene cloning- cloning of GFP gene

## **Suggested Readings for Recombinant DNA Technology - DSE 1**

1. Singh B.D.(2007),Biotechnology, Kalyani Publisher
2. Mitra (2005). Genetic engineering. Published by Macmillan India Ltd., Chennai.
3. Jogdand SN (2005). Gene biotechnology. Himalaya Publishing House, Mumbai
4. JOGDAND S.N. (2007) Advances in Biotechnology , Himalaya Publishing House, 2007
5. Satyanarayana (2005). Biotechnology. First edition, Books and Allied (P) Ltd., Kolkata.
6. Preeti Joshi (2002). Genetic engineering and its application. First edition, Agrobios (India).
7. Dubey RC (2005). A Text of Biotechnology. Multicolour Illustrative edition, S.Chand and Company Ltd., New Delhi.
8. Bernad R Glick (2003). Molecular Biotechnology - Principles and Applications of Recombinant DNA. Third edition, ASM Press, Washington, D.C.
9. Ramawat K and ShailyGoyal (2010). Molecular Biology and Biotechnology. First edition, S.Chand and company Ltd., New Delhi.
10. Dale J.W, Molecular Genetics of bacteria, 1994, John Wiley & Sons.
11. James D. Watson, Nancy H. Hopkins, Jeffrey W. Roberts, Joan ArgetsingerSteitz, Alan M. Weiner 1987, 4th edition. The Benjamin/Cummings Pub.
12. Lewin B. 2002 Genes VIII. Oxford.
13. Nancy Hopkins -Microbial genetics :
14. Freifelder, D., 2000, Molecular Biology, second edition, Naros Publishing House, New Delhi.
15. Lehninger, 2010, Principles of Biochemistry, 5th edn., by Nelson & Cox, W.H. Freeman and Co.NYork.
16. Watson, J.D. et.al., 2004, Molecular Biology of the Gene, 5th edn., Pearson pub.,
17. Brown, T.A. 2000, Gene Cloning, fourth edition, Chapman and Hall Publication, USA.
18. Old R.W. and PrimroseS.B.,1996, Prin.of Gene Manipulations, Blackwell Science Publications, London.

Course Code- USMBT-14		DSE-2	Marks: 50
Credits: 2		Total Hours :48	
<b>Immunology</b>			
<b>Objective:</b> To make the students to understand the fundamental knowledge of Immunology.			
Unit No.	Content	Hrs	
1	<b>Structure and functions of Immune system</b>	12	
	<b>A)</b> General concept and short history of immunology <b>B)</b> Primary Lymphoid organs- Thymus and Bone marrow <b>C)</b> Secondary Lymphoid organs- Spleen and Lymph node <b>D)</b> Lymphoid tissues- MALT / GALT <b>E)</b> Cells of immune system- B Lymphocytes, T Lymphocytes, Comparison, Types of T lymphocytes, <b>F)</b> Other immune-competent cells- Monocytes, macrophages, Dendritic cells, Killer cells, Antigen presenting cells, Neutrophil, Eosinophil, basophil, Mast cell		
2	<b>Resistance/ Immunity of the host</b>	12	
	<b>A)</b> Concept of body resistance/ Immunity, types of immunity. <b>B)</b> Non-specific resistance (Natural/ Innate immunity- Species, racial and individual resistance. <b>C)</b> Factors influencing Innate immunity- Age, Sex, hormonal and nutritional. <b>D)</b> Mechanism of Innate immunity – anatomic and physiologic barriers, phagocytosis, inflammatory response, fever. <b>E)</b> Specific/Adoptive resistance(Acquired immunity)- Active and passive immunity, comparison, types, <b>F)</b> Humoral immune response, primary and secondary immune response <b>G)</b> Cell mediated immunity, mechanism, MHC complex and MHC molecules.		
3	<b>Antigens, Antibodies and Antigen-Antibody reactions.</b>	12	
	<b>A)</b> Definition of antigen, epitope, hapten, Types of antigen, Factors determining Antigenicity. <b>B)</b> Definition of Antibody, general structure, Classes of immunoglobulins, Structure and their functions <b>C)</b> Antigen-Antibody reactions. i) Precipitation reaction- precipitation in liquid, immuno-diffusion. ii) Agglutination reaction- Slide and Tube agglutination, Coomb's test. iii) Complement fixation reaction- Wasserman test. <b>D)</b> Tagged Antibody test- ELISA, Radioimmunoassay (RIA), Immunofluorescence.		
4	<b>Hypersensitivity and Autoimmunity</b>	12	
	<b>A)</b> Definition of Hypersensitivity, Gell and Coomb's classification -Immediate(Type I ,Type II & Type III),Delayed hypersensitivity( Type IV), examples. <b>B)</b> Mechanism of hypersensitivity – Type I (Anaphylaxis), Type II (erythroblastosis fetalis), Type III (Arthus reaction, serum sickness), Type IV (Contact dermatitis, Mantoux test). <b>C)</b> Immunological tolerance <b>D)</b> Autoimmunity, mechanism , causes of autoimmunity, autoimmune disorders (Rheumatic arthritis and Myasthenia gravis)		

## **Course Code: USMBP-10 : Immunology (PRACTICAL)**

1. Blood group and Rh factor
2. Total Leucocyte count
3. Differential Leucocyte count
4. Hemoglobin % in Blood.
5. Detection of Typhoid and Paratyphoid fever by slide/tube agglutination test (WIDAL)
6. Detection of Syphilis by TRUST antigen test.
7. Detection of Pregnancy in women by strip method
8. Demonstration of HBsAg by Hepacard test
9. Estimation of Antigen by Single Radial Immune Diffusion (RIA).
10. Detection of AIDS by ELISA test.
11. Test for Rheumatoid Arthritis (RA)

## **Suggested Readings for Immunology - DSE 2**

1. Mahadav Sharma & Nirmal Tripathi, Immunobiotechnology,
2. Kannan, Immunology
3. Roitt Ivan M. ,Brostoff Jonathan, Male DevidK.,Immunology 3rd edn,
4. Richard A. Goldsby, Thomas J. Kindt, JanisKuby Immunology 5th edn, .
5. Principles of Immunology, N.V. Shastri. Himalaya publisher.
6. P. Chakroborty. NCBA, Kol kata Manual of Practical Microbiology and Parasitology,
7. R.P. Singh ,Immunology and Medical Microbiology -Kalyani publishers
8. Bansal M P , Molecular Biology & Biotechnology, Basic exp. Protocol,TERI,New Delhi
9. Immunology and Microbiology, Dulsy Fatima, A. Mani. Saras Publication

<b>Course Code: USMBT-15</b>		<b>DSE-3</b>	<b>Marks: 50</b>
<b>Credits: 2</b>		<b>Total Hours :48</b>	
<b>Bioinformatics</b>			
<b>Objective:</b> To make the students to understand the fundamental knowledge of Bioinformatics.			
<b>Unit No.</b>	<b>Introduction to Computer, Bioinformatics and Biological Databases</b>	<b>Hrs</b>	
<b>1</b>	RDBMS - Definition of relational database, Mode of data transfer (FTP, SFTP, SCP), advantage of encrypted data transfer. Biological databases - nucleic acid, genome, protein sequence and structure, gene expression databases, Database of metabolic pathways, Mode of data storage - File formats - FASTA, Genbank and Uniprot, Data submission & retrieval from NCBI, EMBL, DDBJ, Uniprot, PDB.	<b>12</b>	
<b>2</b>	<b>Sequence Alignments, Phylogeny and Phylogenetic trees</b> Local and Global Sequence alignment, pairwise and multiple sequence alignment. Scoring an alignment, scoring matrices, PAM & BLOSUM series of matrices, Types of phylogenetic trees, Different approaches of phylogenetic tree construction - UPGMA, Neighbour joining, Maximum Parsimony, Maximum likelihood.	<b>12</b>	
<b>3</b>	<b>Genome organization and analysis</b> Diversity of Genomes: Viral, prokaryotic & eukaryotic genomes, Genome, transcriptome, proteome, 2-D gel electrophoresis, MaldiToff spectroscopy, Major features of completed genomes: <i>E. coli</i> , <i>S. cerevisiae</i> , Arabidopsis, Human.	<b>12</b>	
<b>4</b>	<b>Protein Structure Predictions</b> Hierarchy of protein structure - primary, secondary and tertiary structures, modeling Structural Classes, Motifs, Folds and Domains, Protein structure prediction in presence and absence of structure template, Energy minimizations and evaluation by Ramachandran plot, Protein structure and rational drug design.	<b>12</b>	

## **Course Code: USMBP-11 :Bioinformatics (PRACTICALS)**

1. Introduction to different operating systems - UNIX, LINUX and Windows
2. Introduction to bioinformatics databases (any three): NCBI/PDB/DDBJ, Uniprot, PDB
3. Sequence retrieval using BLAST
4. Sequence alignment & phylogenetic analysis using clustalW & phylip
5. Picking out a given gene from genomes using Genscan or other softwares (promoter region Identification, repeat in genome, ORF prediction). Gene finding tools (Glimmer, GENSCAN), Primer designing, Genscan/Genetool
6. Protein structure prediction: primary structure analysis, secondary structure prediction using psipred, homology modeling using Swiss model. Molecular visualization using jmol, Protein structure model evaluation (PROCHECK)
7. Prediction of different features of a functional gene

## **Books Recommended for Bioinformatics**

1. Saxena Sanjay (2003) A First Course in Computers, Vikas Publishing House
2. Pradeep and Sinha Preeti (2007) Foundations of Computing, 4th ed., BPB Publications
3. Lesk M.A.(2008) Introduction to Bioinformatics . Oxford Publication, 3rd International Student
4. Rastogi S.C., Mendiratta N. and Rastogi P. (2007) Bioinformatics: methods and applications, genomics, proteomics and drug discovery, 2nd ed. Prentice Hall India Publication
5. Primrose and Twyman (2003) Principles of Genome Analysis & Genomics. Blackwell.



<b>Course Code : USMBT-16</b>		<b>DSE-4</b>	<b>Marks: 50</b>
<b>Credits: 2</b>		<b>Total Hours :48</b>	
<b>Microbes in Sustainable Agriculture and Development</b>			
<b>Objective:</b> To make the students to understand the fundamental knowledge of Sustainable Agriculture.			
<b>Unit No.</b>	<b>Content</b>	<b>Hrs</b>	
<b>1</b>	<b>Soil Microbiology</b>	<b>12</b>	
	Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil. Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium.		
<b>2</b>	<b>Microbial Activity in Soil and Green House Gases</b>	<b>12</b>	
	Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control. Microbial Control of Soil Borne Plant Pathogens : Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds.		
<b>3</b>	<b>Biofertilization, Phytostimulation, Bioinsecticides</b>	<b>12</b>	
	Plant growth promoting bacteria, biofertilizers – symbiotic (Bradyrhizobium, Rhizobium, Frankia), Non Symbiotic (Azospirillum, Azotobacter, Mycorrhizae, MHBs, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs.		
<b>4</b>	<b>Secondary Agriculture Biotechnology</b>	<b>12</b>	
	Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters. GM crops: Advantages, social and environmental aspects, Bt crops, golden rice, transgenic animals.		

**Course Code: USMBP-12 :Microbes in Sustainable Agriculture and Development (PRACTICALS)**

1. Study soil profile.
2. Study microflora of different types of soils.
3. *Rhizobium* as soil inoculants characteristics and field application.
4. *Azotobacter* as soil inoculants characteristics and field application.
5. Design and functioning of a biogas plant.
6. Isolation of cellulose degrading organisms.

**Distribution of marks during practical examinations of B.Sc. Semester VI**

1. One major experiment-	08
2. Two minor experiment-	2X 4 = 08
3. Viva voce-	04
4. Practical record-	04
5. Project	06
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<b>Total</b>	<b>30</b>

**(Duration of Practical exam will be 06 hrs., 3 hrs. each for two consecutive days)**

## **SUGGESTED READINGS for Microbes in Sustainable Agriculture and Development**

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,
2. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.
3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4<sup>th</sup> edition, ASM Press,
4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
5. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
9. Altman A (1998). Agriculture Biotechnology, 1st edition, Marcel decker Inc.
10. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.
11. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers.
12. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG

<b>Course Code USMBSEC-03</b>		<b>Paper - I</b>	<b>Marks: 30</b>
<b>Credits: 2</b>		<b>Total Hours : 12</b>	
<b>Biofertilizers and Biopesticides</b>			
<b>Objective:</b> To make the students to understand the fundamental knowledge of Biofertilizers and Biopesticides.			
<b>Unit No.</b>	<b>Content</b>		<b>Hrs</b>
<b>1</b>	<b>Biofertilizers</b>		<b>3</b>
	A) General account of the microbes used as biofertilizers (any one) for various crop plants and their advantages over chemical fertilizers. B) Symbiotic N <sub>2</sub> fixers: Rhizobium - Isolation, characteristics, types, inoculum production and field application, legume/pulses plants		
<b>2</b>	<b>Non Symbiotic Nitrogen Fixers</b>		<b>3</b>
	C) Free living Azotobacter - free isolation, characteristics, mass inoculums, production and field application.		
<b>3</b>	<b>Phosphate Solubalizers</b>		<b>3</b>
	A) Phosphate solubilizing microbes (any one) - Isolation, characterization, mass inoculum production, field Application. B) Mycorrhizal Biofertilizers: Importance of Mycorrhizal inoculum, types of Mycorrhizae and associated plants, Mass inoculum production of VAM, field applications of Ectomycorrhizae and VAM.		
<b>4</b>	<b>Bioinsecticides</b>		<b>3</b>
	A) General account of microbes used as bioinsecticides and their advantages over synthetic pesticides, Bacillus thuringiensis, production, Field applications.		

## **PRACTICAL for Skill Enhancement Courses– SEC 03**

1. Soil Sample collection for isolation of agriculturally important micro-organism
2. Identification and characterization of Micro-organism used for Biofertilizer production
3. Small scale production of Bio-inoculants in Laboratory
4. Efficacy check of developed inoculants by using Pot experiment and its comparison with already available commercial Biofertilizers
5. Visit to Biofertilizers Production Unit/ Industry

## **Suggested Reading for SEC 03**

1. Kannaiyan, S. (2003). Bioethnology of Biofertilizers, CHIPS, Texas.
2. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.
3. Reddy, S.M. et. al. (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers.
4. Subba Rao N.S (1995) Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd. NewDelhi.
5. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG
6. Aggarwal SK (2005) Advanced Environmental Biotechnology, APH publication.

<b>Course Code- USMBSEC-04</b>		<b>Paper - II</b>	<b>Marks: 30</b>
<b>Credits: 2</b>		<b>Total Hours : 12</b>	
<b>Mushroom and Spirulina Cultivation</b>			
<b>Objective:</b> To make the students to understand the fundamental knowledge of Food Fermentation Techniques			
<b>Unit No.</b>	<b>Content</b>		<b>Hrs</b>
<b>1</b>	Edible and non-edible mushroom, historical account, most commonly cultivated mushroom in the world, distribution and production in various countries. Cultivation of button, oyster and paddy straw mushroom, raising a pure culture, spawn preparation and mass cultivation, harvest pests diseases in mushroom.		<b>3</b>
<b>2</b>	Economics of mushroom cultivation, precaution of mushroom cultivation, precaution to be taken while selecting the area, spawn preparation, spawn run, during cropping harvesting etc. mushroom recipes -western and Indian recipes, pickles, powder and jams.		<b>3</b>
<b>3</b>	Introduction to SCP production- historical use and rediscovery of Spirulina importance, morphology, taxonomy and habitat of Spirulina, biochemical composition including proximate composition, amino acids, unsaturated fatty acids, Minerals and vitamins. Human health benefits of Spirulina.		<b>3</b>
<b>4</b>	<b>Microbial Standards</b>		<b>3</b>
	Natural production, laboratory cultivation, small production commercial and mass cultivation (tank construction, culture medium, strain selection, scaling up of the process), importance of light and pH in Spirulina cultivation, harvesting, drying and packing.		

## **PRACTICALS for Skill Enhancement Courses– SEC 04**

1. Spawn preparation of mushroom
2. Lab scale cultivation of button mushroom.
3. To check disease in mushroom
4. Preparation of mushroom powder
5. To study the morphology of Spirulina
6. Lab Scale production of Spirulina
7. Visit to mushroom cultivation plant.
8. Visit to Spirulina cultivation plant.

### **Suggested Readings for SEC 04**

1. Biswas S., Datta M. and Ngachan S.V. (2012) Mushrooms: A Manual for Cultivation, PHI.
2. Selvendran D. (2015) Large Scale Algal Biomass (*Spirulina*) Production in India. In: D. Das (Ed.) Algal Biorefinery: An Integrated Approach, Springer.
3. Zadrazil F. and Grabbe K. (1983) Edible Mushroom, Biotechnology Vol. 3, Weinheim: Verlag Chemie, Berlin.