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UNIVERSITY OF MYSORE
Estd. 1916

VishwavidyanilayaKaryasoudha
Crawford Hall, Mysuru- 570 005

No.AC2(S)/151/2020-21

Dated: 01.09.2023

Notification

Sub:- Syllabus and Scheme of Examinations of Microbiology (UG) (V & VI Semester) with effect from the Academic year 2023-24.

Ref:- 1. This office letter No: AC6/303/2022-23 dated: 28-07-2023.
2. Decision of BOS in Microbiology (UG) meeting held on 05-08-2023.

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The Board of Studies in Microbiology (UG) which met on 05-08-2023 has resolved to recommended and approved the syllabus and scheme of Examinations of Microbiology programme (V & VI Semester) with effect from the Academic year 2023-24.

Pending approval of the Faculty of Science & Technology and Academic Council meetings the above said syllabus and scheme of examinations are hereby notified.

The syllabus and scheme of Examinations contents may be downloaded from the University website i.e., www.uni-mysore.ac.in.

Registrar
University of Mysore
Mysore

Registrar

To:-

1. All the Principal of affiliated Colleges of University of Mysore, Mysore.
2. The Registrar (Evaluation), University of Mysore, Mysuru.
3. The Chairman, BOS/DOS, in Microbiology, Manasagangothri, Mysore.
4. The Director, Distance Education Programme, Moulya Bhavan, Manasagangotri, Mysuru.
5. The Director, PMEB, Manasagangothri, Mysore.
6. Director, College Development Council , Manasagangothri, Mysore.
7. The Deputy Registrar/Assistant Registrar/Superintendent, Administrative Branch and Examination Branch, University of Mysore, Mysuru.
8. The PA to Vice-Chancellor/ Registrar/ Registrar (Evaluation), University of Mysore, Mysuru.
9. Office Copy.

UNIVERSITY OF MYSORE

Curriculum Framework for Undergraduate Programme in Colleges at University of Mysore, Mysuru

NATIONAL EDUCATION POLICY 2021

5th and 6th Semester Model Syllabus for B. Sc. in Microbiology

Board of Studies in Microbiology
Department of Studies in Microbiology
University of Mysore
Manasagangotri, Mysuru 570 006

2023-24 onwards

B. Sc.: Curriculum and Credit Framework for Undergraduate Programme

Sem.	Discipline Specific Courses - Core (DSC), Elective (DSE)(Credits) (L+T+P)	Minor/ Multidisciplinary/Open Elective (OE) Courses(Credits) (L+T+P)	Ability Enhancement Courses (AEC) (Credits)(L+T+P) (Languages)	Skills Enhancement Courses (SEC) (Credits) (L+T+P)/ Value Added Courses (Credits) (L+T+P) (common for all UG Programs)/ Summer Internship.		Total Credits
I	DSC-A1(4), A2(2) DSC-B1(4), B2(2)	OE-1 (3)	L1-1(3), L2-1(3) (4 hrs each)	**SEC-1**: Digital Fluency (2) (1+0+2)/ Env. Studies (3)	Health, Wellness & Yoga (2) (1+0+2)	25/26
II	DSC-A3(4), A4(2), DSC-B3(4), B4(2)	OE-2 (3)	L1-2(3), L2-2(3) (4 hrs each)	Env. Studies (3)/ SEC-1: Digital Fluency (2)(1+0+2)	Sports/NCC/NSS/R&R(S&G) / Cultural (2) (0+0+4)	26/25
Students exiting the programme after securing 46 credits will be awarded UG Certificate in Disciplines A and B provided they secure 4 credits in work based vocational courses during summer term or internship/Apprenticeship in addition to 6 credits from skill-based courses earned during the first year.						
III	DSC-A5(4), A6(2), DSC-B5(4), B6(2)	OE-3 (3)/ India and Indian Constitution (3)	L1-3(3), L2-3(3) (4 hrs. each)	**SEC-2**:AI/CyberSecurity/Financial Edu. & Inv. Aw. (2) (1+0+2)	Sports/NCC/NSS/R&R(S&G) /Cultural (2) (0+0+4)/ SEC(2)	25
IV	DSC-A7(4), A8(2), DSC-B7(4), B8(2)	India and Indian Constitution (3) / OE-3(3)	L1-4(3), L2-4(3) (4 hrs. each)	**SEC-3**: Financial Edu. &Inv. Aw. /AI /Cyber Security (2) (1+0+2)	Sports/NCC/NSS/R&R(S&G) / Cultural (2) (0+0+4)/ SEC (2)	25
Students exiting the programme after securing 92 credits will be awarded UG Diploma in Disciplines A and B provided they secure additional 4 credits in skill based vocational courses offered during first- or second-year summer term.						
V	DSC-A9(4), A10(2), A11(4), A12(2);	DSC-B9(4), B10(2), B11(4),B12(2)		**SEC-4**: Employability Skills/Cyber Security (3) (2+0+2)		27
VI	DSC-A13(4), A14(2), A15(4), A16(2);	DSC-B13(4), B14(2), B15(4), B16(2)		Internship (2)		26
Students exiting the programme after 3-years will be awarded UG Degree in Disciplines A and B as double majors upon securing 136 credits and satisfying the minimum credit requirements under each category of courses prescribed.						

List of Courses from I to VI Semesters for Undergraduate Program in MICROBIOLOGY

Sem. No.	Course Category	Course Code	Course Title	Credits Assigned	Instructional hours per week		Duration of Exam (Hrs.)	Exam/ Evaluation Pattern (Marks)		
					Theory	Practical		IA	Exam	Total
I	DSC	DSC-1T	General Microbiology	4	4		$2^1/_2$	40	60	100
		DSC-2P	General Microbiology	2		4	3	25	25	50
	OEC	OE-1T	Microbial Technology for Human Welfare	3	3		$2^1/_2$	40	60	100
II	DSC	DSC-3T	Microbial Biochemistry and Physiology	4	4		$2^1/_2$	40	60	100
		DSC-4P	Microbial Biochemistry and Physiology	2		4	3	25	25	50
	OEC	OE-2T	Environmental and Sanitary Microbiology	3	3		$2^1/_2$	40	60	100
III	DSC	DSC-5T	Microbial diversity	4	4		$2^1/_2$	40	60	100
		DSC-6P	Microbial diversity	2		4	3	25	25	50
	OEC	OE-3T	Microbial Entrepreneurship	3	3		$2^1/_2$	40	60	100
IV	DSC	DSC-7T	Microbial Enzymology and Metabolism	4	4		$2^1/_2$	40	60	100
		DSC-8T	Microbial Enzymology and Metabolism	2		4	3	25	25	50
	OEC	OE-4T	Human Microbiome	2	2		$2^1/_2$	20	30	50
V	DSC	DSC-9T	Microbial Genetics	4	4		$2^1/_2$	40	60	100
		DSC-10P	Microbial Genetics	2		4	3	25	25	50
		DSC-11T	Food Microbiology	4	4		$2^1/_2$	40	60	100
		DSC-12P	Food Microbiology	2		4	3	25	25	50
	SEC	SEC-4T	Microbial and Biochemical Techniques	2	2		$2^1/_2$	20	30	50
		SEC-5P	Microbial and Biochemical Techniques	1		2	3	25	25	50
VI	DSC	DSC-13T	Immunology and Medical Microbiology	4	4		$2^1/_2$	40	60	100
		DSC-14P	Immunology and Medical Microbiology	2		4	3	25	25	50
		DSC-15T	Industrial Microbiology	4	4		$2^1/_2$	40	60	100
		DSC-16P	Industrial Microbiology	2		4	3	25	25	50
	Internship	DSC-	Internship	2	3-4 weeks (Report & Viva)			25	25	50

B. Sc. Microbiology 5th Semester

Program name	B. Sc. in MICROBIOLOGY		Semester	V
Course Title	MICROBIAL GENETICS (Theory)			
Course Code	DSC-9T		No. of Credits	04
Contact Hours	60 (4 Hrs. per week)		Duration of SEA/Exam (Hrs.)	$2\,^{1}/_{2}$
Formative Assessment Marks		40	Summative Assessment Marks	60

Course Outcomes (COs):

After the successful completion of the course, the student will be able to;

CO1. Understand the experimental evidences to prove DNA as genetic material.

CO2. Differentiate various method of recombination in bacteria.

CO3. Compare gene interaction in viruses and fungi.

CO4. Understand concepts involved in replication, transcription, translation in bacteria.

CO5. Outline regulatory mechanisms in bacteria to control cellular processes

Content of Course 5: Theory: Microbial Genetics	60 Hrs.
Unit 1 : DNA as genetic material and Bacterial genetics	**15 Hrs.**
DNA as a genetic material: Griffith experiment of Transformation, Avery, MacLeod and McCarty experiment, Hershey and Chase experiment to prove DNA carries the genetic information. Fraenkel-Conrat experiment to prove RNA as genetic material. Structure and organization of chromosomes in prokaryotes. Plasmid-types, Transposons in Prokaryotes. **Bacterial genetics**: Mechanism of genetic exchange in bacteria: Bacterial transformation- Principle and Types of transformation mechanisms found in prokaryotes. Bacterial Conjugation: U-tube experiment, properties of the F plasmid, F^+ x F^- conjugation, F' x F^- conjugation, Hfr x F^- conjugation, Transduction: Generalized and specialized transduction.	
Unit 2: Genetic Material and Replication and Transcription of DNA	**15 Hrs.**
Genetic Material: Chemical basis of heredity, Watson and Crick model of DNA, DNA types, RNA-types, structure, importance. Modern concept of gene-cistron, muton, recon. **DNA Replication:** Replicon, Enzymes and proteins involved in DNA replication; DNA polymerases, DNA ligase, primase, telomerase. General mechanism of replication. Models of DNA replication including rolling circle, Θ (theta) mode of replication. **Transcription**: Structure of bacterial RNA polymerase, Promoter concept, Recognition of promoters and DNA melting, Transcription bubble, Stages of transcription- initiation elongation and termination. Transcriptional attenuation	
Unit 3: Gene expression and Regulation	**15 Hrs.**
Gene expression: Genetic code- features, Wobble hypothesis. Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in prokaryotes. Post translational modifications of proteins. Protein maturation and secretion- protein splicing, molecular chaperones.	

Gene regulation: Regulatory mechanisms in bacteria. Operon concept, polycistronic mRNA. *lac* operon - negative inducible, allolactose, structure of *lac* repressor, mechanism of binding of repressor to operator. Catabolite repression of *lac* operon. Regulation by lac repressor and CAP. *trp* operon regulation – repressor control and attenuator control.	
Unit 4: Genetics of Viruses and Fungi and Mutation	**15 Hrs.**
Genetics of Viruses: Genetic recombination in phages, Heterozygosity in phages. Temperate phage and prophage, Non-genetic interaction of viral gene products-Complementation, Phenotypic mixing, Genotypic mixing and interference. **Genetics of Fungi**: Life cycle of *Neurospora*, Terad analysis, unordered tetrad analysis in yeast, ordered tetrad analysis in *Neurospora*, two point and three point test cross. **Mutation:** Nature and types, Mutagenic agents: physical and chemical mutagens, damage and repair of DNA: Photoreactivation and SOS repair, Ames test.	

Pedagogy: Lectures, Seminars, Industry/Institute Visits, Debates, Quiz, Project and Assignments

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Attendance	10
Seminar	10
Debate/Quiz/Assignment	10
Class test	10
Total	**40**
Formative Assessment as per guidelines are compulsory	

Practical: Microbial Genetics

Course Title	MICROBIAL GENETICS (Practical)		
Course Code	DSC-10P	No. of Credits	02
Contact Hours	60 (4 Hrs. per session)	Duration of SEA/Exam (Hrs.)	03
Formative Assessment Marks	25	Summative Assessment Marks	25

Practical Content

1. Micropipeting: Moving very small volumes very accurately.
2. Isolation of DNA from microbial source.
3. Estimation of DNA by Diphenylamine method.
4. Isolation of coliphages from sewage.
5. Isolation of antibiotic resistant mutant by gradient plate method.
6. Demonstration of Ames test.
7. Preparation of master and replica plates.
8. Study survival curve of bacteria after exposure to ultraviolet (UV) light.
9. Preparation of competent cells for bacterial transformation.
10. Demonstration of bacterial conjugation by plate mating method.
11. Determination of purity of DNA.
12. Visualization of genomic DNA by agarose gel electrophoresis.
13. β-galactosidase activity assay in Yeast.
14. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).
15. Study of Griffith`s experiment, conjugation, transduction, plasmid DNA, T4 phage, ordered tetrad analysis in *Neurospora,* Watson and Crick model of DNA, tRNA, semi-conservative replication of DNA, bacterial RNA polymerase, transcription, translation and *lac* operon through micrographs/schematic representations

Pedagogy: Experiential learning, Problem solving, Project

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Class Records	05
Test	10
Attendance	05
Performance	05
Total	**25**
Formative Assessment as per guidelines are compulsory	

Text Books / References

1. Maloy et al., 1994. Microbial Genetics by Jones and Bartlett Publishers.
2. J. W. Dale, 1994. Molecular Genetics of Bacteria by John Wiley and Sons.
3. Streips and Yasbin, 1991. Modern Microbial Genetics by Niley Ltd.
4. J. D. Watson, N. H. Hoppkins, J. W. Roberts, J. A. Steitz and A. M. Weiner. 1987. Molecular Biology of the Gene 4th Edition by, Benjamin / Cummings Publications Co. Inc. California.
5. Lewin, 2000. Gene VII by Oxford University Press.
6. Bacterial and Bacteriophage Genetics. 4th Editions by Birge.
7. Microbial Genetics by Frefielder. 4th Edition.
8. Organization of Prokayotic Genome. 1999 by Robert L.Charlebois, ASM Publications.
9. Molecular Genetics of Bacteria, 1997 by Larry, Snyder and Wendy, Champness, ASM
10. James, D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick. Molecular Biology of the Gene, 7th edition. 2017
11. Freifelder's Essentials of Molecular Biology. George M Malacinski, 4th ed. 2015
12. Alberts Bruce, Johnson, A., Lewis, J., Raff, M., Roberts, K., Walter, P. (2014). Molecular Biology of the Cell. 5th Edition, Taylor and Francis. New York, USA.
13. Tropp, B. E. (2012) Molecular Biology: Genes to Proteins. 4rd Edition, Jones & Bartlett, Learning, Burlington, MA
14. Allison A. Elizabeth (2012) Fundamental Molecular Biology, 2nd Edition. J Willey and Sons, Hoboken,New Jersey
15. Frederick, M., Ausubel, Roger Brent, Robert, E., Kingston, David, D., Moore, J. G. Seidman, John A.Smith, Kevin Struhl (2003). Current Protocols in Molecular Biology. John Wiley & Sons, New York, United States.
16. Sambrook, J. F. and Russell, D. W. (2001). Molecular Cloning: a Laboratory Manual. 3rd edition. Cold Spring Harbor, N.Y. Cold Spring Harbor Laboratory Press
17. Yılmaz, M., Ozic, C., Gok, İ. (2012). Principles of Nucleic Acid Separation by Agarose Gel Electrophoresis. Gel Electrophoresis - Principles and Basics, Dr. Magdeldin S (Ed.), ISBN: 978-953-51-0458-2, InTech.

B. Sc. Microbiology 5th Semester

Program name	B. Sc. in MICROBIOLOGY		Semester	V
Course Title	FOOD MICROBIOLOGY (Theory)			
Course Code	DSC-11T		No. of Credits	04
Contact Hours	60 (4 Hrs. per week)		Duration of SEA/Exam (Hrs.)	$2\frac{1}{2}$
Formative Assessment Marks		40	Summative Assessment Marks	60

Course Outcomes (COs):

After the successful completion of the course, the student will be able to:

CO1. Understand the association of microbes in food and the quality testing of food

CO2. Understand the preservation and food safety protocols

CO3. Understand the methods of spoilage of food and the diseases associated with it

CO4. Learn the properties of milk and the types of preservation of milk.

CO5. Learn the types of fermented food and dairy products and its significance

Content of Course 6: Theory: Food Microbiology	60 Hrs.
Unit 1: Production of food crops and their diseases	**15 Hrs.**
Role of microbes in food crops production: Biofertilizers: Definition, Mass production, mode of applications, advantages and limitations of *Rhizobium, Azotobacter, Azospirillum,* cyanobacterial fertilizers. Role of *Frankia* and VAM in soil fertility. Biopesticides: Definition, types- bacterial, viral and fungal-mode of action, factors influencing, target pests. Microbial herbicides. **Diseases of food crops**: Study of symptoms, etiology, epidemioloyg and management of diseases caused by fungi (Tikka disease of groundnut, blast disease of paddy, Red rot of sugarcane), bacteria (Citrus canker, Bacterial blight of rice), viruses (Bean mosaic, Papaya ring spot) and viroid (Potato spindle tuber disease). Post-harvest diseases.	
Unit 2: Microbial quality of air and water for food processing and disposal of wastewater	**15 Hrs.**
Bioaerosols in food: Air borne microbes and their impact on food. Bioaerosol sampling: Vertical clinder spore trap, Hirst spore trap, Rotorod sampler, Andersen sampler, impingers and filtration. Control of bioaerosols- UV light, HEPA filters, desiccation, Incineration. **Water quality in food safety**: Water sample collection, methods to detect potability of water samples: presumptive/MPN tests, confirmed and completed tests for faecal coliforms, SPC, IMViC reactions, membrane filter technique. Water borne pathogens, Control of water borne pathogens- Precipitation, filtration, chemical disinfection, UV light. **Disposal of wastewater in food industries**: Microbiological characteristics of wastewater. Wastewater treatment- primary (screening, coagulation and sedimentation), secondary (trickling filter, oxidation pond) tertiary (reverse osmosis, ion exchange). Methods of solid waste disposal (composting and biogas). BOD and COD.	
Unit 3: Food spoilage, Infection and Preservation	**15 Hrs.**

Microbes and food: Food as a substrate for microorganisms- Intrinsic and extrinsic parameters affecting the growth of microbes. Spoilage**:** Sources of food contamination, Principles of food spoilage, Spoilage of meat and poultry, Fish and sea foods. Spoilage cereals, fruits and vegetables. Spoilage of canned food. Food borne infection and intoxication- Salmonellosis*,* Listeriosis*,* Botulism and Aflatoxicosis*.*

Food preservation: Principles of food Preservation. Methods of preservation-Physical (temperature, drying, irradiation, HPP), chemical (Class I and Class II). Bio preservation. Canning. Food Packaging- Types of packaging materials, properties and benefits. Food sanitation and control- Good Hygiene practices, GLP, GMP, HACCP, FSSAI, FDA and BIS in brief.

Unit 4: Microbiology of milk and fermented food products	**15 Hrs.**

Dairy Microbiology: Composition of milk. Sources of contamination of milk. Biochemical changes of milk- souring, gassy fermentation, proteolysis, lipolysis, ropiness. Microbiological analysis of milk- Rapid platform tests (COB, Phosphatase test, DMC), SPC and Reduction tests. Preservation of milk and milk products- Pasteurization, dehydration, sterilization. Packing of milk and dairy products. Starter culture- types and role.

Fermented foods: Fermented milk (Cheese- types and production of Cheddar, Tofu, Yoghurt, Acidophilus milk), vegetable (sauerkraut, pickles) Meat (sausage) and fish (fish sauce). Beverages-kombucha. Microbes as food- SCP, SCO. Prebiotics, Probiotics, Synbiotics and Neutrceuticals

Pedagogy: Lectures, Seminars, Industry/Institute Visits, Debates, Quiz, Project and Assignments

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Attendance	10
Seminar	10
Debate/Quiz/Assignment	10
Class test	10
Total	**40**
Formative Assessment as per guidelines are compulsory	

Practical: Food Microbiology

Course Title	FOOD MICROBIOLOGY (Practical)		
Course Code	DSC-12P	No. of Credits	02
Contact Hours	60 (4 Hrs. per session)	Duration of SEA/Exam (Hrs.)	03
Formative Assessment Marks	25	Summative Assessment Marks	25

Practical Content

1. Isolation and characterization of *Rhizobium* spp. associated with root nodules.
2. Microscopic observation of diseased specimen of food crops: Citrus canker, Downy mildew of grapes, Tikka disease of groundnut and Potato spindle tuber disease
3. Determination of microbial contamination of air by passive sampling method.
4. Standard analysis of water samples and Determination of MPN.
5. Biochemical differentiation of Enterobacteriaceae isolates by IMViC reactions.
6. Determination of bacteriological quality of water by H_2S paper strip test.
7. Measurement of Biochemical Oygen Demand (BOD) of food processing wastewater.
8. Estimation of total solids of wastewater from food processing unit.
9. Isolation and identification of indegenous wine yeast and its use in alcohol fermentation
10. Determination of mesophilic aerobic count in foods and expression of count in logCFU/g
11. Turbidity index for the detection of efficiency of sterilization of milk.
12. Methylene blue and Resazurin reduction test for assessing the raw milk quality.
13. Laboratory scale production of yogurt and its sensory evaluation.
14. Culturing of *Spirulina* sp. as single cell protein.
15. Demonstation of air samplers, display of photographs of water purification process and wastewater treatment.

Note: Visit to agriculture research station, water/sewage treatment plant & food industry

Pedagogy: Experiential learning, Problem solving, Project

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Class Records	05
Test	10
Attendance	05
Performance	05
Total	**25**
Formative Assessment as per guidelines are compulsory	

Text Books / References

1. Rangaswamy, G. and Bagyaraj, D. J. (2001), Agricultural Microbiology, 2nd ed. Prentice hall of India pvt.ltd., New Delhi.
2. Rao, M. N. and Datta , A. K. (1987).Waste Water Treatment. Oxford and I.B.H.
3. Rheinhermer, G. (1986). Aquatic Microbiology Jhon Wiely and sons, New york.
4. Subha Rao, N. S., 1988. Biofertilizers in Agricultural 2nd ed.Oxford and IBH Pub.Co., New Delhi.
5. Daniel Environmental Microbiology.
6. Grant, W. D. and P. E, Long: 1981 Environmental Microbiology, Thomson Litho ltd.
7. Mehrotra, R. S., Plant Pathalogy, Tata Mc Graw Hill Pubilications Limited, New Delhi.
8. Michael, J. Pelczar, Jr.E. C. S. Chan, Moel: Microbiology, Mc Graw Hill Book Company, New york).
9. Mitchell, R. (1992), Introduction to Environmental Microbiology, Prentice Hall Inc, Englewood Cliffs.
10. Adams, M. R. and Moss, M. O. (1995) Food Microbiology. Royal Society of Chemistry , Cambridge University Press.
11. Frazier & Westhoff, D. C. (1995) Food Microbiology Tata McGraw Hill Pub. Company Ltd.,New Dehli.
12. Jay, J. M. (1985). Modern Food Microbiology.CBS Publishers and distributors, New Delhi.
13. Doyle M. P. and Beuchat L. R. (2007). Food Microbiology- Fundamentals. Frontiers, ASM Press.
14. Garbutt J. (1997). Essentials of Food Microbiology, Armold- International Students edition,London. 8. Marriott N. G. and Gravani R. B. (2006).
15. ThomasJ., Matthews,Karl; Kniel, Kalmia E (2017), Food Microbiology: An Introduction, AmericanSociety for (ASM).
16. Deak T. and Beuchat L. R. (1996). Hand Book of Food Spoilage Yeasts, CRC Press, New York.

B. Sc. Microbiology 5th Semester

Program name	B. Sc. in MICROBIOLOGY		Semester	V
Course Title	MICROBIAL AND BIOCHEMICAL TECHNIQUES (Theory)			
Course Code	SEC-4T		No. of Credits	02
Contact Hours	30 (2 Hrs. per week)		Duration of SEA/Exam (Hrs.)	02
Formative Assessment Marks		20	Summative Assessment Marks	30

Course Outcomes (COs):

After the successful completion of the course, the student will be able to:

CO1: Demonstrate skills in microbiological and analytical techniques.

CO2: Understand principles which underlie sterilization of culture media, glassware and plastic ware to be used for microbiological work.

CO3: Understand principles of a number of analytical instruments which the students have to use during the study and also later as microbiologists for performing various laboratory manipulations.

CO4: Handle several separation techniques which may be required to be handled later as microbiologists.

Content of Course: Theory: Microbial and Biochemical Techniques	30 Hrs.
Unit 1: Microbial Techniques	**15 Hrs.**
Methods and practices of cleaning and management of lab: Learning and Practice of Integrated clean-in-place (CIP) and sterilize-in-place (SIP) as per industry standards, Standard Operating Procedure (SOP) for various equipment in the QC Lab. Sterility check, Bio-burden and Logbook maintenance. **Handling and calibration of lab equipment**- weighing balance, Micropipette Autoclave, Hot air Oven, Incubator, Centrifuge, Water bath, Colony Counter, and stability chamber, Preparation of Normality, Molarity, and buffer solutions. **Types of culture media and their maintenance:** Preparation of various culture media. Cultivation of Bacteria, Fungi, Actinomycetes and Algae. Isolation and preservation of pure culture. Morphological and biochemical characterization of bacteria.	
Unit 2: Biochemical Techniques	**15 Hrs.**
Centrifugation: Principles of Centrifugation and Ultracentrifugation techniques and its applications. **Chromatography**: Principle and techniques with applications (Partition, adsorption, ion exchange, exclusion and affinity chromatography). Electrophoretic technique (agarose and polyacrylamide gel) its components, working and applications. **Spectrophotoscopy and Radiobiology**: Principle, mechanism and application of instruments used in Spectrophotometric techniques (UV and visible).Radiobiological techniques – characters of radioisotopes, autoradiography, Radioisotope dilution technique and pulse chase experiments. Basic principles & Law of absorption and radiation and its application.	

Practical: Microbial and Biochemical Techniques

Course Title	Microbial and Biochemical Techniques (Practical)		
Course Code	SEC-5P	No. of Credits	01
Contact Hours	30 (2 Hrs. per session)	Duration of SEA/Exam (Hrs.)	03
Formative Assessment Marks	25	Summative Assessment Marks	25

Practical Content

1. Usage and maintenance of basic equipment of microbiology lab: Principles, calibrations, and SOPs of balances, pH meter, Autoclaves, Laminar flows, Biosafety cabinets, Microscopes, Homogenizers and Magnetic stirrers.
2. Cultivation of microorganisms: (i) Bacterial cultivation: (a) Streak-plate method (*E.coli, Staphylococcus aureus*) Streaking with inoculation loop. Streaking with toothpick. (b) Pour-plate method (*E.coli*).
3. Maintenance of microorganisms (slant culture, stab culture, glycerol stocks) (ii) Fungal cultivation (a) Yeast (*Saccharomyces cervisiae*) Moulds (*Penicillium notatum, Aspergillus niger*)
4. Estimation of CFU count by serial dilution- spread plate method/pour plate method.
5. Study of colony characteristics on nutrient agar
6. Biochemical characterization of bacteria:
   a. Sugar utilization test (minimal medium + sugar)
   b. Sugar fermentation test (peptone water method, Ammonium salt sugar method
   c. IMViC reactions
   d. Enzyme detection – Amylase, Gelatinase, lipase, caseinase, Catalase, and Oxidase
   e. Oxidative-fermentative test, arginine hydrolysis, ornithine, lysine decarboxylase, nitrate, nitrite reduction
7. Separation of mixtures by paper / thin layer chromatography.
8. Demonstration of column packing in any form of column chromatography.
9. Separation of protein mixtures by any form of chromatography.
10. Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE).
11. Determination of absorption max for an unknown sample and calculation of extinction coefficient.
12. Separation of components of a given mixture using a laboratory scale centrifuge.

Text Books / References

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3. John M. Walker and Ralph Rapley (2014). "Molecular Biomethods Handbook". HumanaPress.
4. Wilson and Walke, r(2000). Principles and Techniques in Practical Biochemistry. 5th Edition
5. Cambridge University Press.
6. Murphy, D. B. (2001). Fundamental of Light Microscopy &Electron Imaging.1st Edition. Wiley-Liss.
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8. Pranav Kumar, (2016). Fundamentals and Techniques of Biophysics and Molecular Biology
9. Aurora Blair. Laboratory Techniques & Experiments in Biology. Intelliz Press
10. Plummer, D. T. (1987). An Introduction to Practical Biochemistry. McGraw Hill Publication
11. Beckner, W. M., Kleinsmith, L. J. and Hardin, J. (2000). The world of cell. IV edition Benjamin/Cummings
12. Prescott, M. J., Harley, J. P. and Klein, D. A. (2002). Microbiology. 5th Edition WCB Mc GrawHill, New York,
13. Black J. G. (2002). Microbiology- Principlesand Explorations. JohnWiley & SonsInc. NewYork,
14. Maheswari, D. K. (2010). Practical Microbiology. S Chand publications
15. Cowan and Steel's Manual for the Identification of Medical Bacteria. G. I. Barrow (Editor), R. K. A. Feltham (Editor) 3rd Edition. 2004

B. Sc. Microbiology 6th Semester

Program name	B. Sc. in MICROBIOLOGY		Semester	VI
Course Title	IMMUNOLOGY AND MEDICAL MICROBIOLOGY (Theory)			
Course Code	DSC-13T		No. of Credits	04
Contact Hours	60 (4 Hrs. per week)		Duration of SEA/Exam (Hrs.)	$2\,^{1}/_{2}$
Formative Assessment Marks		40	Summative Assessment Marks	60

Course Outcomes (COs):

After the successful completion of the course, the student will be able to:

CO1: Gain a preliminary understanding about various immune mechanisms.

CO2: Familiarize with immunological techniques and sero-diagnosis of infectious diseases

CO3: Understand pathogenic bacterial infections, symptoms, diagnosis and treatment

Content of Course 7: Immunology and Medical Microbiology	60 Hrs.
Unit 1 : Introduction to Immune system	**15 Hrs.**
Immune system: Historical perspective of immunology. Immunity-Definition and types. Cells and organs of immune system: B and T Lymphocytes, Natural killer (NK) cells, Granulocytes (Neutrophils, Eosinophils and Basophils), Monocytes and macrophages, Dendritic cells and Mast cells. Primary lymphoid organs-Bone marrow and Thymus. Secondary lymphoid organs-Spleen and Lymphnodes. Lymphoid tissues- MALT and GALT. **Antigen and Antibody**: Antigen- Definition, properties and types. Immunogenicity and antigenicity, epitopes, haptens. Degree of foreignness, molecular weight, degradability. Adjuvants and their importance. Antibody: Definition, Basic structure of antibody, Structure and functions of different types of antibodies (IgG, IgA, IgM, IgD and IgE). Antigenic determinants on immunoglobulins: Isotype, allotype and idiotype.	
Unit 2: Antigen-antibody interactions and Hypersensitive reactions	**15 Hrs.**
Antigen-antibody reactions: Definition, salient features, antibody affinity and avidity, cross reaction. Agglutination reactions: Hemagglutination-blood grouping, Immunoprecipitation: Radial (Mancini) and double (Ouchterlony) immunodiffusion and Immunoelectrophoresis. Complement mediated opsonization, complement fixation test. Immunotechniques: ELISA, Radioimmunoassay and Immunofluorescence. **Hypersensitive reactions**: Classification, antibody mediated hypersensitivity; Type I (IgE), Type II (IgG and IgM-ADCC), Type III (Antigen-antibody complex), and Cell mediated hypersensitivity Type IV (DTH). Autoimmne diseases and Transplantation Immunology in brief. Immunoprophylaxis-Vaccines-Types-Killed, Live attenuated and Toxoid with an example each. National Immunization Schedule and Mission Indradhanush.	
Unit 3: Host-pathogen interaction and Medical Bacteriology	**15 Hrs.**
Host pathogen interaction: Normal microflora of human skin, oral cavity, gastrointestinal tract, urogenital tract and their importance. Host pathogen interaction: Definitions - Infection, Invasion, Pathogenicity, Virulence, Attenuation, Exaltation,	

Toxigenicity, Carriers andtheir types. Infection-types of infection, modes of transmission of infection, portal of entry of pathogen. Sample collection, transport and diagnosis. **Medical Bacteriology:** Symptoms, mode of transmission, prophylaxis and control of the following- respiratory diseases caused by *Streptococcus pyogenes*, *Haemophilus influenzae, Mycobacterium tuberculosis.* Gastrointestinal Diseases caused by: *Escherichia coli*, *Salmonella typhi*, *Vibrio cholerae*, Others: *Treponema pallidum, Staphylococcus aureus, Clostridium tetani*.
Unit 4: Medical Virology, Parasitology and Mycology and Chemotherapy **15 Hrs.**
Medical Virology Parasitology and Mycology: Symptoms, mode of transmission, prophylaxis and control of Polio, Hepatitis-B, Rabies, Dengue, AIDS, Corona and Chikungunya. Malaria, Kala-azar, Amoebic dysentery. Fungal infections: Cutaneous mycoses- Tinea infections, Systemic mycoses- Histoplasmosis and Opportunistic mycoses- Candidiasis. **Antimicrobial agents**: General characteristics and mode of action Antibacterial agents: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism. Mechanism of action of antifungal agents: Amphotericin B, Griseofulvin; Antiviral agents: Acyclovir, Azidothymidine. Antibiotic resistance, MDR,XDR, MRSA, NDM-1

Pedagogy: Lectures, Seminars, Industry/Institute Visits, Debates, Quiz, Project and Assignments

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Attendance	10
Seminar	10
Debate/Quiz/Assignment	10
Class test	10
Total	**40**
Formative Assessment as per guidelines are compulsory	

Practical: Immunology and Medical Microbiology

Course Title	IMMUNOLOGY AND MEDICAL MICROBIOLOGY (Practical)		
Course Code	DSC-14P	No. of Credits	02
Contact Hours	60 (4 Hrs. per session)	Duration of SEA/Exam (Hrs.)	03
Formative Assessment Marks	25	Summative Assessment Marks	25

Practical Content

1. Identification of human blood groups.
2. Perform WBC of the given blood sample using haemocytometer.
3. Perform Differential Leukocyte Count of the given blood sample.
4. Demonstration: separate serum from the blood sample.
5. Perform immunodiffusion by Ouchterlony method.
6. Demonsatration of Single Radial Immuno Diffusion.
7. Widal test / HCG test
8. RPR test / VDRL test.
9. Study of composition and use of important differential media for identification of pathogenic bacteria: EMB Agar, MacConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS agar.
10. Study of bacterial flora of skin by swab method
11. Identify bacteria (*E. coli, Bacillu*s) using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests
12. Cultural, morphological and biochemical characteristics of *Staphylococcus.*
13. Study of various stages of Malarial parasite in RBCs using permanent mounts
14. Perform antibiotic sensitivity by Kirby-Bauer method
15. Study symptoms of the diseases with the help of photographs: Polio, Rabies, Chikungunya, AIDS, Histoplasmosis, Candidiasis and Athlete's foot.

Note: Visit to pharmaceutical and pathology laboratory (Optional).

Pedagogy: Experiential learning, Problem solving, Project

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Class Records	05
Test	10
Attendance	05
Performance	05
Total	**25**
Formative Assessment as per guidelines are compulsory	

Text Books / References

1. Ananthanarayan, R. and Paniker C. K. J. (2009). Textbook of Microbiology, 8th Edition, University Press,Publication.
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. Goering, R., Dockrell, H., Zuckerman, M. and Wakelin, D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier
4. Willey, J. M., Sherwood, L. M., and Woolverton, C. J. (2013) Prescott, Harley and Klein's Microbiology.9th edition. McGraw Hill Higher Education
5. Madigan, M. T., Martinko, J. M., Dunlap, P. V. and Clark, D. P. (2014). Brock Biology of Microorganisms.14thedition. Pearson International Edition
6. Delves, P., Martin, S., Burton, D., Roitt, I. M. (2006). Roitt's Essential Immunology.11th edition Wiley-Blackwell Scientific Publication, Oxford.
7. Goldsby, R. A., Kindt, T. J., Osborne, B. A. (2007). Kuby's Immunology. 6th edition W. H. Freeman andCompany, New York.
8. Murphy, K., Travers, P., Walport, M. (2008). Janeway's Immunobiology. 7th edition Garland Science, Publishers, New York.
9. Peakman, M. and Vergani, D. (2009). Basic and Clinical Immunology, 2nd edition Churchill, Livingstone Publishers, Edinberg.
10. Richard, C. and Geiffrey, S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

B. Sc. Microbiology 6th Semester

Program name	B. Sc. in MICROBIOLOGY		Semester	VI
Course Title	INDUSTRIAL MICROBIOLOGY (Theory)			
Course Code	DSC-15T		No. of Credits	04
Contact Hours	60 (4 Hrs. per week)		Duration of SEA/Exam (Hrs.)	$2\,^{1}/_{2}$
Formative Assessment Marks		40	Summative Assessment Marks	60

Course Outcomes (COs):

After the successful completion of the course, the student will be able to:

CO1. Learn the overview of scope and importance of industrially important microbes.

CO2. Acquaint with different types of fermentation processes and equipment.

CO3. Acquire the knowledge of purification of value-added products.

CO4. Acquire knowledge on the concepts and terminology in genetic engineering.

CO5. Learn about principles involved in manipulating genes and DNA.

CO6. Familiar with various techniques used in genetic engineering.

Content of Course 8: Industrial Microbiology and Genetic Engineering	60 Hrs.
Unit 1: Introduction to Industrial Microbiology	**15 Hrs.**
Introduction to Industrial Microbiology: Scope and concepts. Microorganisms of industrial importance: Selection criteria, Strain improvement and Preservation. Fermentor: Design and components of a bioreactor. Specialized bioreactors: Airlift bioreactors, fluidized bed reactor, packed bed reactors, Photo-bioreactors and membrane bioreactors. Sterilization of fermentor. Control of air, temperature and pH. Aseptic inoculation and sampling methods. **Fermentation media and process**: Strategies for media formulation, Natural and synthetic media. Production medium and Inoculum medium. Raw materials (Molasses and its types, corn steep liquor, sulphite waste liquor and whey). Buffers, Precursors, Inhibitors and Antifoam agents. Types of fermentation process: Submerged fermentation, Solid state fermentation (Koji), Batch fermentation and continuous fermentation.	
Unit 2: Downstream processing, General production strategies of microbial products and Enzyme immobilization	**15 Hrs.**
Downstream processing- Definition, Stages in downstream processing. Methods of downstream processing: Precipitation, filtration, centrifugation, distillation, cell disruption, solvent recovery, drying and crystallization. **Microbial production of industrial products**: Industrial production and uses of Ethyl alcool, wine, Penicillin, Lactic acid, Citric acid, Amylase. Oyster mushroom cultivation. **Enzyme immobilization**: Immobilized enzymes, Revesible immobilization- Adsorption, Irrevesible immobilization- covalent coupling, entrapment, copolymerization. Applications of enzyme immobilization, Advantages and disadvantages of immobilized enzymes.	
Unit 3: Genetic Engineering tools used in Strain improvement of microbes of industrial importance	**15 Hrs.**

Introduction to genetic engineering: Definition, milestones in genetic engineering. Tools in genetic engineering: Restriction enzymes- Types, Mode of action, nomenclature, applications. DNA modifying enzymes and their applications: DNA polymerases, Methylases, Terminal deoxynucleotidyl transferase, Kinases, Phosphatases and Ligases.

Cloning Vectors and Cloning host: Cloning Vectors- Definition and Properties. Characteristics of cloning vectors. Plasmid vectors: pBR and pUC series. Bacteriophage lambda, Cosmids, BACs, YACs. Use of linkers and adaptors. Expression vectors: Baculovirus based vectors, mammalian SV40-based expression vectors. Cloning host- Cloning in *Escherichia coli* and *Saccharomyces cerevisiae*.

Unit 4: Genetic engineering techniques in industrial production of recombinant products	**15 Hrs.**

Techniques in genetic engineering: Isolation of DNA, restriction digestion and ligation of DNA, Agarose gel electrophoresis, Blotting techniques, DNA sequencing- Sanger's method. PCR techniques and applications. DNA transfer methods: Microinjection, Biolistic, Electroporation, Calcium phosphate mediated DNA transfer. Identification and selection of recombinants: DNA hybridisation, blue white selection, colony and plaque hybridization.

Industrial production of recombinant products: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt Cotton, Bt Brinjal. Gene therapy, recombinant vaccines. Biological, ethical and social issues of gene cloning and IPR. Gene Library: Construction and application of cDNA and genomic libraries. Application of recombinant microorganisms in basic research, industry, medicine, agriculture, environment.

Pedagogy: Lectures, Seminars, Industry/Institute Visits, Debates, Quiz, Project and Assignments

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Attendance	10
Seminar	10
Debate/Quiz/Assignment	10
Class test	10
Total	**40**
Formative Assessment as per guidelines are compulsory	

Practical: Industrial Microbiology

Course Title	INDUSTRIAL MICROBIOLOGY (Practical)		
Course Code	DSC-16P	No. of Credits	02
Contact Hours	60 (4 Hrs. per session)	Duration of SEA/Exam (Hrs.)	03
Formative Assessment Marks	25	Summative Assessment Marks	25

Practical Content

1. Preparation of natural and synthetic media used in industry.
2. Production of amylase by solid substrate fermentation.
3. Preservation of industrial important microbes with glycerol/soil.
4. Preparaion of wine from grapes.
5. Preparation of alcohol using jaggery/molasses.
6. Estimation of citric acid produced from *Aspergillus niger* by titrimetric method
7. Estimation of % alcohol in a given sample by specific gravity bottle method
8. Cultivation and processing of edible Mushroom.
9. Preparation of buffers-TE, TAE and Lysis buffer.
10. Isolation of plasmid DNA from *Escherichia coli.*
11. Digestion of DNA with restriction enzymes.
12. Demonstration of amplification of DNA by PCR.
13. Demonstration of Southern blotting.
14. Demonstration of cloning of DNA inserts and Blue white screening of recombinants.
15. Study of specialized bioreactors, Microbial production of industrial products, Cloning vectors, Techniques in genetic engineering and recombinant products as per theory.

Note: Visit to to distilleries and molecular biology laboratory.

Pedagogy: Experiential learning, Problem solving, Project

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Class Records	05
Test	10
Attendance	05
Performance	05
Total	**25**
Formative Assessment as per guidelines are compulsory	

Text Books / References

1. Arindam Kuila and Vinay Sharma (2018). Principles and Applications of Fermentation Technology,Wiley.
2. Casida, L. (2016). Industrial Microbiology, 2nd edition, New Age International Publisher.
3. Crueger, W. and A Crueger. (2017). Cruegers Biotechnology: A Text Book of Industrial Microbiology.Edited by K.R. Aneja. Panima Publishing Corporation.
4. Michael, J. W., Neil, L. Morgan. (2013). Industrial Microbiology: an Introduction. Blackwell science
5. Nduka Okafor and Benedict Okeke (2017). Modern Industrial Microbiology and Biotechnology. 2ndEdition :CRC Press Publishers
6. Stanbury P. F., W. Whitaker and S. J. Hall (2016). Principles of Fermentation Technology. 3rd edition. Elsevierpublication
7. Alexander, N. Glazer, Hiroshi Nikaido (2014). Microbial Biotechnology: Fundamental of appliedMicrobiology, 2nd Edition, Cambridge University Press
8. Brown, T. A. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
9. Clark, D. P. and Pazdernik, N. J. (2009). Biotechnology: Applying the Genetic Revolution. ElsevierAcademic Press, USA
10. Krebs, J., Goldstein, E., Kilpatrick, S. (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
11. Primrose, S. B. and Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics, 7thedition. Blackwell Publishing, Oxford, U.K.
12. Primrose, S. B. and Twyman, R. M. (2008). Genomics: Applications in human biology. BlackwellPublishing, Oxford, U.K.
13. Russell, P. J. (2009). Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings
14. Sambrook, J. and Russell, D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold SpringHarbor Laboratory Press
15. Sambrook, J. and Russell, D. W. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring HarbourLaboratory press.
16. Watson, J. D., Baker, T. A., Bell, S. P. et al. (2008). Molecular Biology of the Gene, 6th Ed., Benjamin Cummings Wiley
17. Sherwood, L. M. and Woolverton, C. J. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill HigherEducation.

B. Sc. Microbiology 6th Semester

Internship for Graduate Programme

Course title	**Internship Discipline specific**
No of contact hours	**90**
No of credits	**2**
Method of evaluation	**Presentations/Report submission/Both**

Project Assessment			
Formative Assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion/Type	Weightage in Marks	Practical Exams	**50**
Data maintenance	10	Presentation/Report/Both 25	
Assessment	10		
Attendance	05		
Total	**25**	**25**	

- Internship shall be Discipline Specific of 90 hours (2 credits) with duration 4-6 weeks.
- Internship may be full-time/part-time (full-time during semester holidays and part-time in the academic session)
- Internship mentor/supervisor shall avail work allotment during 6th semester for a maximum of 20 hours.
- The student should submit the final internship report (90 hours of Internship) to the mentor for completion of the internship.
- The detailed guidelines and formats shall be formulated by the universities separately as prescribed in accordance to UGC and AICTE guidelines.