St Aloysius College (Autonomous)

Mangaluru

Re-accredited by NAAC "A" Grade

Course structure and syllabus of

B.Sc.

MICROBIOLOGY

Under NEP Regulations, 2021

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Re-accredited by NAAC with 'A' Grade with CGPA 3.62/4
Recognised by UGC as "College with Potential for Excellence"
Conferred "College with "STAR STATUS" by DBT, Government of India.
Centre for Research Capacity Building under UGC-STRIDE

Date:

NOTIFICATION

Sub: Syllabus of **B.Sc. MCROBIOLOGY** under NEP Regulations, 2021.
(As per Mangalore University guidelines)

Ref: 1. Decision of the Academic Council meeting held on 18-12-2021 vide Agenda No: 6.16 (2021-22)
2. Office Notification dated 21-02-2022

Pursuant to the above, the Syllabus of **B.Sc. MCROBIOLOGY** under NEP Regulations, 2021 which was approved by the Academic Council at its meeting held on 18-12-2021 is hereby notified for implementation with effect from the academic year **2021-22**.

PRINCIPAL **REGISTRAR**

To:

1. The Chairman/Dean/HOD.
2. The Registrar Office
3. Library

Total Credits for the Program : B.Sc. Basic – 136 and B.Sc. Hons. –176

Starting year of Implementation : 2021-22

Learning Outcomes based Curriculum Framework (LOCF) for MICROBIOLOGY

Undergraduate Programme

Preamble

Microbiology is the study of microorganisms or microbes such bacteria, viruses, fungi, algae, cyanobacteria, protozoa and prions. They are extremely important as their diverse activities range from causation of deadly diseases in humans, animals and plants to production of highly useful products like antibiotics, enzymes, alcohol, fermented foods, and recycling of dead and decaying organic matter in the nature. Thus the science of microbiology has an important role to play in health, agriculture, environment and industry. Several discoveries in the last two to three decades, which significantly impact these area have put Microbiology on the centre stage of teaching, research and development all over the globe.

The Choice Based Credit System (CBCS) curriculum for Microbiology at the undergraduate level has now been developed into a new system called Learning Outcome Curriculum Framework (LOCF) under the recommendations and guidance of University Grants Commission (UGC). The LOCF approach first envisioned the programme learning outcomes of the program in Microbiology as well as the learning outcomes of the courses being taught under this programme, keeping in view the graduate attributes of the subject. The curriculum was then developed in tune with the learning outcomes. It is envisaged that the students trained under this curriculum will have the required attributes of knowledge, skills, temperament and ethics related to the subject of Microbiology. Besides the contents of the curriculum, the teaching learning processes have also been designed to achieve these attributes. A variety of learning assessment tasks have been included in the curriculum. Besides assessing the knowledge/skills acquired by the students, these tasks would also help to supplement the teaching learning processes.

There are 8 core courses which encompass all important aspects of the discipline of Microbiology and are all compulsory courses.

1. Introduction:

In the increasingly globalized society, it is important that the younger generation especially the students are equipped with knowledge, skills, mindsets and behaviors which may enable them to perform their duties in a manner so that they become important contributors to the development of the society. This will also help them to fully utilize their educational training for earning a decent living so that the overall standard of their families and surroundings improve leading to development of welfare human societies. To achieve this goal, it is imperative that their educational training is improved such that it incorporates the use of newer technologies, use of newer assessment tools for mid-course corrections to make sure that they become competitive individuals to shoulder newer social responsibilities and are capable of undertaking novel innovations in their areas of expertise. In the face of the developing knowledge society, they are well aware about the resources of self-development using on-line resources of learning which is going to be a major component of learning in the future. The learning should also be a continuous process so that the students are able to re-skill themselves so as to make themselves relevant to the changing needs of the society. In the face of this need, the educational curricula, teaching learning processes, training, assessment methods all need to be improved or even re-invented. The higher educational institutions (HEI) all over the globe are in the grip of this urgent task and India needs to keep pace with all these developments.

2. Learning Outcomes based approach to Curriculum Planning:

Learning Outcome based approach to curriculum planning (LOCF) is almost a paradigm shift in the whole gamut of higher education such that it is based on first and foremost identifying the outcomes of the learning required for a particular subject of study, and then planning all components of higher education so as to achieve these outcomes. The learning outcomes are the focal point of the reference to which all planning and evaluation of the end learning is compared and further modifications are made to fully optimize the education of the individuals in a particular subject. For the subject of

Microbiology the outcomes are defined in terms of the understanding and knowledge of the students in microbiology and the practical skills the students are required to have to be competitive microbiologist so that they are able to play their role as microbiologist wherever required in the society such as the diseases caused by the microbes, their diagnosis and remedies; the role of microbiologists in the biotechnology industry and how they may be able to fit the bill in the industry.

The students are also trained in such a way that they develop critical thinking and problem solving as related to microbiology. The curriculum developed and the teaching and the evaluation tasks are such that the students are able to apply their knowledge and training of microbiology to solve the problems of microbiology as these exist or appear from time to time in the society. The curriculum envisions that the student, once graduate as specialists in a discipline, have an important role to play in the newer developments and innovations in the future in the subject for advancement of the discipline.

2.1 Nature and extent of the Programme:

The undergraduate programme in Microbiology is the first level of college or university degree in the country as in several other parts of the world. After obtaining this degree, a microbiologist may enter into the job market or opt for undertaking further higher studies in the subject. After graduation the students may join industry, academia, public health and play their role as microbiologists in a useful manner contributing their role in the development of the welfare society. Thus the undergraduate level degree in microbiology must prepare the students for all these objectives. Thus the LOCF curriculum developed has a very wide range covering all aspects of Microbiology with reasonable depth of knowledge and skills so as to diversify them in various specialties of the subject and play their role professionally as expected of them. It is also imperative that microbiologists are evaluated in a manner appropriate to assess their proper development as microbiologists. The current LOCF in Microbiology has been designed keeping all these important points in mind.

2.2 Aims of Bachelor's degree programme in MICROBIOLOGY:

The aim of the undergraduate degree in Microbiology is to make students knowledgeable about the various basic concepts in a wide ranging context which involve the use of knowledge and skills of Microbiology. Their understanding, knowledge and skills in Microbiology needs to be developed through a thorough teaching learning processes in the class, practical skills through the laboratory work, their presentation and articulation skills, exposure to industry and interaction with industry experts, write short research-based projects where they are guided and mentored by the academic and other experts of the subject.

3. Graduate Attributes in Microbiology:

As mentioned earlier, a degree in Microbiology is the first college/university level degree in the country as in several parts of the world. The students graduating in this degree must have thorough understanding of basic knowledge or understanding of the fundamentals of Microbiology as applicable to wide ranging contexts. They should have the appropriate skills of Microbiology so as to perform their duties as microbiologists. They must be

able to analyze the problems related to microbiology and come up with most suitable solutions. As microbiology is an interdisciplinary subject the students might have to take inputs from other areas of expertise. So the students must develop the spirit of teamwork. Microbiology is a very dynamic subject and practitioners might have to face several newer problems. To this end, the microbiologists must be trained to be innovative to solve such newer problems.

Several newer developments are taking place in microbiology. The students are trained to pick up leads and see the possibility of converting these into products through entrepreneurship. To this end, the students are made to interact with industry experts so that they may be able to see the possibility of their transition into entrepreneurs. They are also made aware of the requirements of developing a Microbiology enterprise by having knowledge of patents, copyrights and various regulatory processes to make their efforts a success.

Besides attaining the attributes related to the profession of Microbiology, the graduates in this discipline should also develop ethical awareness which is mandatory for

practicing a scientific discipline including ethics of working in a laboratory and ethics followed for scientific publishing of their research work in future. The students graduating in microbiology should also develop excellent communication skills both in the

written as well as spoken language which are must for them to pursue higher studies from some of the best and internationally acclaimed universities and research institutions spread across the globe.

4. Qualification Descriptors:

The following may serve as the important qualification descriptors for a UG degree in Microbiology:

1. Knowledge of the diverse places where microbiology is involved.
2. Understanding of diverse Microbiological processes.
3. Basic skills such as culturing microbes, maintaining microbes, safety issues related to handling of microbes, Good Microbiological practices etc.
4. Moderately advanced skills in working with microbes such as pilot scale culturing, downstream processes, diagnostics etc.
5. Generation of new knowledge through small research projects
6. Ability to participate in team work through small microbiology projects.
7. Ability to present and articulate their knowledge of Microbiology.
8. Knowledge of recent developments in the area of Microbiology.
9. Analysis of data collected through study and small projects.
10. Ability to innovate so as to generate new knowledge.
11. Awareness how some microbiology leads may be developed into enterprise.
12. Awareness of requirements for fruition of a microbiology-related enterprise.

Program Outcomes:

Competencies need to be acquired by the candidate securing B.Sc.(Basic) or B.Sc.(Hons)

By the end of the program the students will be able to:

1. **PO**. Have a knowledge and understanding of concepts of microbiology and its application in pharma, food, agriculture, beverages, nutraceutical industries.
2. **PO.**Understand the distribution, morphology and physiology of microorganisms and demonstrate the skills in aseptic handling of microbes including isolation, identification and maintenance.
3. **PO**. Competent to apply the knowledge gained for conserving the environment and resolving the environmental related issues.
4. **PO.** Learning and practicing professional skills in handling microbes and contaminants in laboratories and production sectors.
5. **PO.** Exploring the microbial world and analyzing the specific benefits and challenges.
6. **PO.** Applying the knowledge acquired to undertake studies and identify specific remedial measures for the challenges in health, agriculture, and food sectors.
7. **PO**. Thorough knowledge and application of good laboratory and good manufacturing practices in microbial quality control.
8. **PO.** Understanding biochemical and physiological aspects of microbes and developing broader perspectives to identify innovative solutions for present and future challenges posed by microbes.
9. **PO.**Understanding and application of microbial principles in forensic and working knowledge about clinical microbiology.
10. **PO.** Demonstrate the ability to identify ethical issues related to recombinant DNA technology, GMOs, intellectual property rights,biosafety and biohazards.
11. **PO.**Demonstrate the ability to identify key questions in microbiological research, optimize research methods, and analyze outcomes by adopting scientific methods, thereby improving the employability.
12. **PO**. Enhance and demonstrate analytical skills and apply basic computational and statistical techniques in the field of microbiology.

PROGRAMME SPECIFIC OUTCOMES

PSO.1. Acquired knowledge and understanding of the microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others.
PSO.2. Demonstrate key practical skills/competencies in working with microbes for study and use in the laboratory as well as outside, including the use of good microbiological practices.
PSO.3. Competent enough to use microbiology knowledge and skills to analyze problems involving microbes, articulate these with peers/ team members/ other stakeholders, and undertake remedial measures/studies etc.
PSO.4. Developed a broader perspective of the discipline of Microbiology to enable him to identify challenging societal problems and plan his professional career to develop innovative solutions for such problems.

UG Program BA / B.Sc	Discipline Core(DSC) (Credits) (L+T+P)	Discipline Elective(DSE) / Open Elective (OE) (Credits) (L+T+P)	Ability Enhancement Compulsory Courses (AECC), Languages (Credits) (L+T+P)		Skill Enhancement Courses (SEC)			Total Credits
					Skill based (Credits) Credits (L+T+P)	Value based (Credits) (L+T+P)		
I	DSC A1(4+2) DSC B1(4+2)	OE-1 (3)	*English (3) Languages (3) 4*		***Digital Fluency (1+0+2) +Value Education (1)***	Physical Education - Yoga (1) (0+0+2)	Health & Wellness (1) (0+0+2)	*25*
II	DSC A2(4+2) DSC B2(4+2)	OE-2 (3)	*English (3) Languages (3) 4*	Environmental Studies (2)		Physical Education - Yoga (1) (0+0+2)	NCC/NSS/R&R(S&G)/ Cultural (1) (0+0+2)	*25*
Exit option with Certificate (48 credits)								
III	DSC A3(4+2) DSC B3(4+2))	OE-3 (3)	L1-3(3),L2-3(3) (4 hrs. each)		SEC-2: Artificial Inte-lligence (2)(1+0+2)	Physical Education - Yoga (1) (0+0+2)	NCC/NSS/R&R(S&G)/ Cultural (1) (0+0+2)	*25*
IV	DSC A4(4+2) DSC B4(4+2)	OE-4 (3)	L1-4(3),L 2-4(3) (4 hrs. each)	Constitution Of India (2)		Physical Education - Yoga (1) (0+0+2)	NCC/NSS/R&R(S&G)/ Cultural (1) (0+0+2)	*25*
Exit option with Diploma (96 credits)								
V	DSC A5(3+2) DSC A6(3+2) DSC B5(3+2) DSC B6(3+2)				SEC-3: SEC such as Cyber Security (2) (1+0+2)	Physical Education - Yoga (1) (0+0+2)	NCC/NSS/R&R(S&G)/ Cultural (1) (0+0+2)	*23*
VI	DSC A7(3+2) DSC A8(3+2) DSC B7(3+2) DSC B8(3+2)				SEC-4: Professional Communication (2)	Physical Education - Yoga (1) (0+0+2)	NCC/NSS/R&R(S&G) / Cultural (1) (0+0+2)	*25*

Curriculum Structure for the Undergraduate Degree Program BSc (Basic /Hons.)
Total Credits for the Program : 176
Starting year of implementation: 2021-22
Name of the Degree Program :B.Sc. (Basic/Hons.) Microbiology

Microbiology Program Articulation Matrix:

Semester	Title / Name of the course	Program outcomes that the course addresses (not more than 3per course)	Pre- requisite course (s)	Pedagogy	Assessment
I	**G 509 DC1.1** **General Microbiology** **4 Credits** **100 Marks**	1. Knowledge and Understanding of Concepts of microbiology. 2. Learningand practicing Professional skills in handling microbes. 3. Thorough Knowledge an Application of Good laboratory and good manufacturing Practices in Microbial quality control.	PUC or +2 (Life Sciences As One of the Core disciplines)	The general pedagogy to be followed for theory and practical are as under. Lecturing, Tutorials, Group / Individual Discussions, Seminar, Assignments, Counseling, Remedial Coaching. Field/Institution/Industrial visits, Hands on training, Case observations, Models/charts, preparations, Problem Solving mechanism, Demonstrations, Project presentations, Experiential Documentation and Innovative methods.	LSSSDC (NSDC) assessment and certification For lab Technician or Lab assistant Job role
	G 509 DC2.1 P **General Microbiology** **2 Credits** **50 Marks**				

II	**G 509 DC2.2** **Microbial Biochemistry and Physiology 4 Credits** **100 Marks**	Thorough knowledge and understanding of concepts of microbiology and its application in different microbiological industries.		The general pedagogy to be followed for theory and practical areas under. Lecturing, Tutorials, Group/Individual Discussions, Seminars, Assignments, Counseling, Remedial Coaching. Field/Institution/Industry visits, Hands on training, Case observations, Models/charts preparations, Problem solving mechanism, Demonstrations, Project presentations, Experiential documentation and Innovative methods.	LSSSDC(NSDC) Assessment and certification for lab technician or Lab assistant job role
	G 509 DC2.2 P **Microbial Biochemistry and Physiology** **2 Credits** **50 Marks**				

Theory: 60:40

Practicum: 50:50 converted as 25+25=50

1. **Ratio of weightage (marks) between Internal & End Semester Examinations for THEORY: 60:40**

   THEORY INTERNAL COMPONENT: 40

   - Two internal tests: **10×2=20**
   - Assignment: **05**
   - Attendance: **05**
   - Continuous Unit wise tests (objective/MCQ): **05**
   - Group/ teams of two projects:**05**

2. Practicum component marks: 50

Internal component of practicum:50 (converted to 25)

Internal:

- Continuous Assessment of all practical experiments: **15**
- Attendance: **05**
- Model practical Test: **20**
- Maintenance of Records: **05**
- Viva: 05

End semester Practicum: 50 (converted to 25)

B. Sc., Microbiology (Basic / Hons.)Semester 1

Course Title : G 509 DC1.1 General Microbiology	
Total Contact Hours : **56**	Course Credits : **4+2**
Formative Assessment Marks : **60%**	Duration of ESA/Exam : **2Hrs**

Course Prerequisite(s): *Mention only course titles from the curriculum that are needed to be taken by the students before registering for this course.*

Course Learning Outcomes

Outcome 1. Have developed a good knowledge of the development of the discipline of Microbiology and the contributions made by prominent scientists in this field.

Outcome 2. Have developed a very good understanding of the characteristics of different
types of microorganisms, methods to organize/classify these into and basic tools to study these in the laboratory.

Outcome 3. Describe the nutritional requirements of bacteria for growth; developed knowledge and understanding that besides common bacteria there are several other microbes which grow under extreme environments.

Outcome 4. Perform basic laboratory experiments to study microorganisms; methods to preserve bacteria in the laboratory; calculate generation time of growing bacteria.

Outcome 5. Are able to perform basic experiments to grow and study microorganisms in the laboratory.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes(POs1-12)

Course Outcomes (COs) /Program Outcomes (POs)	1	2	3	4	5	6	7	8	9	10	11	12
1. Thorough knowledge and understanding of concepts of microbiology												
2. Learning and practicing professional skills in handling microbes												
3. 3. Thorough knowledge and application of good laboratory and good manufacturing practices in microbial quality control.												

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular program outcome.

B.Sc., Microbiology (Basic/ Hons.) Semester 1

Title of the Courses:

Course1: G 509 DC1.1 General Microbiology
Course2: G 509 OE1.1 Microorganisms for Human Welfare
Course3: G 509 SB1.1 , Microbiological Methods and Analytical Techniques

Course1: **G 509 DC1.1, General Microbiology**		Course 2: **G 509 OE1.1 Microorganisms for Human Welfare**		Course 3: **G 509 SB1.1 Microbiological Methods and Analytical Techniques**	
Number of Theory Credits	Number of lecture hours/semester	Number of Theory Credits	Number of lecture hours/ semester	Number of Theory Credits	Number of lecture hours/semester
4	**56**	**3**	**42**	**1**	**14**

Content of Course 1: Theory: G 509 DC1.1 General Microbiology----56Hrs

UNIT – 1:HISTORICAL DEVELOPMENT OF MICROBIOLOGY----------14Hrs

1. **HISTORICAL DEVELOPMENT OF MICROBIOLOGY**-Theory of spontaneous generation, Biogenesis and Abiogenesis. Contributions of Anton Van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister and Edward Jenner, Alexander Fleming, Martinus Beijirinck, Segei Winogrodsky, Elie Metechnikoff. Contributions of Indian scientists in the field of Microbiology. Scope of Microbiology.

   Fossil evidence of microorganisms. Origin of life, primitive cells and evolution of microorganisms.

2. **MICROCOPY-** working principle, construction and operation of simple and compound microscopes. Dark -Field Microscope, Fluorescence Microscope, Electron Microscope-Scanning Electron and Transmission Electron Microscopes.

UNIT –2 : STAINING, STERILIZATION AND PRESERVATION OF MICROORGANISMS-14Hrs

1. **STAINING**: Nature of strains, principles, mechanism, methods and types of staining- Simple, Differential-Gram staining, Acid fast staining, staining of capsule, cell wall, en dospore.

   Sterilization: Principles, types and techniques, Physical, chemical, radiation and mechanical.

2. **MICROBIAL CULTURE METHODS :**Types and uses of Different culture media: Commonly Used Media-Peptone, Meat extract, Yeast agar, Nutrient agar & Nutrient broth. Selective media, Differential Media, Assay media, Maintenance media, Enrichment media. Anaerobic Media, Media for culture of Fungi.

   Culture of Bacteria and Fungi: Methods- The streak plate, pour plate, spread plate. Cultivation of anaerobic bacteria. Maintenance and Preservation of Pure cultures: Methods of Maintenance and Preservation. Culture Collections. Colony Characteristics.

UNIT–3: BACTERIAL GROWTH AND GROWTH CURVE----------14HRS

1. **BACTERIAL GROWTH CURVE**: The lag Phase, The logarithmic Phase, The Stationary Phase and The Decline Phase. Synchronous Growth and Continuous Culture- Chemostat

and Turbidostat.Mathematics of Growth: Generation time and growth rate. Factors influencing growth curve.

2. **MEASUREMENT OF MICROBIAL GROWTH**-Methods for Measuring Bacterial Growth: Microscopic Count, Electronic Counter, Plate count, Membrane filter, Turbidimetric measurement, Nitrogen determination, Dry Weight determination, Measurement of biochemical activity.

UNIT–4 PROKARYOTIC MICROORGANISMS: ----------14HRS

1. **OVERVIEW OF PROKARYOTIC CELL STRUCTURE:** Size, shape, arrangement. Ultrastructure of prokaryotic cell: Bacterial and Archaeal-cell wall and cell membrane. Components external to cell wall- capsule, slime, s-layer, pili, fimbriae, flagella; structure, motility, chemotaxis.
2. **CYTOPLAMS COMPOSITION AND ENDOSPORE**. Cytoplasmic matrix- Cytoskeleton, ribosome, inclusion granules: Nuclear Materials – Bacterial structure (its differences with the Eukaryotic chromosome); Extra Chromosomal material. Bacterial Endospore - Examples of spore forming organisms, habitats, function,formation and germination. Reproduction in bacteria

COURSE1 : PRACTICAL: DSC-1P,MBL101.GENERAL MICROBIOLOGY

1. Microbiological laboratory standards and safety protocols.
2. Operation and working principles of Light/Compound microscope.
3. Working principles and operations of basic equipments of microbiological laboratory-Laminar Air Flow Chamber, Autoclave, Hot air Oven, Incubator, pH meter, Anaerobic jar, Magnetic stirrer, Common Glassware used in Microbiology laboratory
4. Study of bacterial motility by hanging drop method.
5. Staining –simple and differential staining- Gram staining.
6. Negative staining – capsule staining by India Ink Method
7. Bacterial endospore staining.
8. Measurement of Bacteria by Micrometry.
9. Total count of Bacteria by Haemocytometer.
10. Preparation of Culture media: Nutrient Broth and Nutrient Agar.

Suggested Readings:

1. A Textbook of Microbiology, R. C. Dubey and D. K. Maheshwari, 1st edition, 1999, S. Chand & Company Ltd.
2. Alexopoulos, C.J., Mims, C.W., and Blackwell, M. 2002. Introductory Mycology. John Wiley and Sons (Asia) Pvt. Ltd. Singapore. 869 pp.
3. Atlas, R.M. 1984. Basic and practical microbiology. MacMillan Publishers, USA. 987pp.
4. Black, J.G. 2008. Microbiology principles and explorations. 7edn. John Wiley and Sons Inc., New Jersey 846 pp.
5. Brock Biology of Microorganisms, M.T.Madigan, J.M.Martinko, P. V. Dunlap, D. P. Clark- 12th edition, Pearson International edition 2009, Pearson Benjamin Cummings.
6. Foundations in Microbiology, K. P. Talaro, 7th International edition 2009, McGraw Hill.
7. General Microbiology, Stanier, Ingraham et al, 4th and 5th edition 1987, Macmillan education limited.
8. Microbiology – An Introduction, G. J.Tortora, B. R.Funke, C. L. Case, 10th ed. 2008, Pearson Education.
9. Microbiology- Concepts and Applications, PelczarJr,Chan, Krieg, International ed, McGraw Hill.
10. Pommerville, J.C. Alcamo's Fundamentals of Microbiology. Jones and Bartlett
11. Prescott, Harley, Klein's Microbiology, J.M. Willey, L.M. Sherwood, C.J. Pub.Sudbury, 835 pp.
12. Schlegel, H.G. 1995.General Microbiology. Cambridge University Press, Cambridge, 655 pp.
13. Toratora, G.J., Funke, B.R. and Case, C.L. 2007. Microbiology 9th ed. Pearson Education Pte. Ltd., San Francisco. 958pp.Woolverton, 7th International, edition 2008, McGraw Hill.

OPEN ELECTIVE-1st Semester

SEMESTER-I-OE: Microorganisms for Human Welfare -G509.IOE

COURSE OUTCOMES:

- Acquire the knowledge of importance of microbes in human welfare.
- Acquire the knowledge of importance of microbes in agriculture.
- Acquire the knowledge of importance of microbes in pharmacy.

Course Title & Code: Microorganisms for Human Welfare G509.1OE	
Total Contact Hours: **42**	Course Credits: **3**
Formative Assessment Marks: **60%**	Duration of ESA /Exam: **2.5Hrs**
Microorganisms for Human Welfare- G509.1OE	**42Hrs**
Unit–1: Food and Fermentation Technology	14Hrs
Fermented Foods–Types, Nutritional Values, Advantages and Health Benefits Prebiotics, Probiotics, Synbiotics and Nutraceuticals Fermented Products: Alcoholic-Beer and whisky; nonalcoholic beverages-coffee and tea; fermented dairy products-yoghurt and cheese; fermented fruit drinks-wine	
Unit–2: Agriculture	14Hrs
Bio-fertilizers and bio-pesticides - types and applications, beneficial microorganisms in agriculture, AM fungi, Mushroom cultivation, Biogas production.	
Unit –3: Biopharmaceuticals	14Hrs
Microbial Drugs–Introduction, Discovery, Antibiotic –Definition, characteristics, Types, Functions. Antibiotic Therapy and Development of Drug Resistance Vaccines–Types, Properties, Functions and Schedules	

Suggested Readings:

1. A Textbook of Microbiology, R. C. Dubey and D. K. Maheshwari, 1st edition, 1999, S. Chand & Company Ltd.
2. Atlas, R.M. 1984. Basic and practical microbiology. MacMillan Publishers, USA. 987pp.
3. Black, J.G. 2008. Microbiology principles and explorations. 7edn. John Wiley and Sons Inc., New Jersey 846 pp.
4. Brock Biology of Microorganisms, M.T.Madigan, J.M.Martinko, P. V. Dunlap, D. P. Clark- 12th edition, Pearson International edition 2009, Pearson Benjamin Cummings.

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Course 3: Theory: SEC 1T, MBL701, Microbiological Methods and Analytical Techniques

DIGITALSKILLS:

The components of digital skills provided by KSHEC, will be followed accordingly.

SEC1T, MBL701, Microbiological Methods and Analytical Techniques--------14Hrs

LEARNING OUTCOMES

- Demonstrate skills as per National Occupational Standards (NOS) of "Lab Technician/Assistant" Qualification Pack issued by Life Sciences Sector Skill Development Council-LFS/Q0509,Level3.
- Perform microbiology and analytical techniques. Knowledge about environment, health, and safety (EHS), good laboratory practices (GLP), good manufacturing practices (GMP) and standard operating procedures(SOP)
- Demonstrate professional skills at work, such as decision making, planning, and organizing, Problem solving, analytical thinking ,critical thinking, and documentation.

1. Principles which underlies sterilization of culture media, glassware and plasticware to be used for microbiological work.
2. Principles of a number of analytical instruments which the students have to useduringthestudyandalsolaterasmicrobiologistsforperformingvariouslaboratorymanipulations.

3. Handling and use of microscopes for the study of microorganisms which are among the basic skills expected from a practicing microbiologist. They also get introduced to a variety of modifications in the microscopes for specialized viewing.
4. Several separation techniques which may be required to be handled later as microbiologists.

Course 3: Theory: G 509 SB1.1 , Microbiological Methods and Analytical Techniques

Microbiological Skills

Microbiological culture media: Composition, Preparation, Application and storage**;** Ingredients of media. Types- natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media.

Isolation and cultivation of microorganisms: Collection of samples, processing of samples, serial dilution, technique, Inoculation of samples, incubation and observations of microbial colonies.

Morphological characterization of microorganisms-Colony characteristics, Microscopic characters, biochemical / physiological tests or properties and identification.

Sub-culturing of microorganisms and pure culture techniques. Preservation of microorganisms.

Advanced Microscopic Skills: Different types of microscopes - Phase contrast, Bright Field, Dark Field, Fluorescent, Scanning and Transmission Electron Microscopy

Analytical Skills

Centrifugation, Chromatography and Spectroscopy, Electrophoresis: Principles, Types, Instrumentation, Operation and applications.

Course 3: Practicals : G 509 SB2.1 P Microbiological Methods and Analytical Techniques

1. Methods and practices in Microbiology lab: MSDS (Material Safety and Data Sheet),Good Clinical Practices (GCP),Standard Operating Procedure(SOP),Good Laboratory Practices(GLP),Good Manufacturing Practices (GMP)**.**

2. Usage and maintenance of basic equipments of microbiology lab: Principles, calibrations, and SOPs of balances, pH meter, autoclave, incubators, laminar air flow (LAF) and biosafety cabinets, microscopes, homogenizers, stirrers.
3. Preparation of bacterial culture media
4. Preparation of fungal culture media
5. Preparation of algal culture media
6. Isolation and cultivation of bacteria, actinobacteria, fungi and algae
7. Identification and characterization of bacteria, actinobacteria,fungi and algae.
8. Biochemical and physiological tests for identification of bacteria
9. Separation of biomolecules by paper / thin layer chromatography.
10. Demonstration of column chromatography.
11. Preparation of permanent slides (bacteria, fungi and algae).
12. Procedures for documentation, lab maintenance, repair reporting.

Pedagogy:

The general pedagogy to be followed for theory and practicals are as under. Lecturing, Tutorials, Group/Individual Discussions, Seminars, Assignments, Counseling,RemedialCoaching.Field/Institution/Industrialvisits,Handsontraining,Cas eobse rvations, Models/charts preparations, Problem solving mechanism, Demonstrations, Project presentations, Experiential documentation and Innovative methods.

Active learning as per LSSSDC (NSDC)LFS/Q0509 guidelines,at skill training Level 3. Case studies about application of microbial biomolecules in various industries. Seminar on topics of microbial biochemistry.

B.SC., MICROBIOLOGY (BASIC / HONS.) SEMESTER 2

Title of the Courses:

Course 1: G 509 DC1.2 Microbial Biochemistry and Physiology

Course 2: G 509 OE1.2 , BACTERIOLOGY

Course1: G 509 DC1.2 , Microbial Biochemistry and	Course 2: G 509 OE1.2 BACTERIOLOGY

Physiology			
Number of Theory Credits	Number of lecture hours/semester	Number of Theory Credits	Number of lecture hours/semester
4	**56**	**3**	**42**

Content of Course : G 509 DC1.2. MICROBIAL BIOCHEMISTRY AND PHYSIOLOGY. – 56Hrs

Course Learning Outcomes

Outcome 1. Have developed a good knowledge of biochemical concepts with regard to the chemical bonds in biological compounds.

Outcome 2. Have developed a very good understanding of the characteristics of Structure and properties of Water as an universal solvent, polarity, hydrophilic and hydrophobic interactions, properties of water, Acids, bases, electrolytes, hydrogen ion concentration, pH, buffers.

Outcome 3. Describe the definition, classification, structure and properties of carbohydrates and amino acids and proteins, lipids; fatty acids: types and classification, Vitamins

Outcome 4. Have an understanding the principles of bioenergetics and role of respiration in synthesis of energy molecules.

Outcome 5. Perform biochemical tests with application of biochemical principles.

UNIT-1. BIOCHEMICAL CONCEPTS1 **14Hrs**

1.BASIC BIOCHEMICAL CONCEPTS: Major elements of life and their primary characteristics, atomic bonds and molecules – bonding properties of carbon, chemical bonds- covalent and non covalent, Hydrogen bonds and Vander Waal Forces.

2.BIOLOGICAL SOLVENTS: Structure and properties of water molecule, Water as an universal solvent, polarity, hydrophilic and hydrophobic interactions, properties of water, Acids, bases, electrolytes, hydrogen ion concentration, pH, buffers and physiological buffer system, Handerson–Hasselbalch equation.

UNIT- 2. MACROMOLECULES **14HRS**

1. **CARBOHYDRATES:** Definition, classification, structure and properties. Amino acids and proteins: Definition, structure, classification and properties
2. **LIPIDS AND FATS:** Definition, classification, structure, properties and importance

of lipids; fatty acids: types and classification, Vitamins, Definition, structure, properties and importance of chlorophyll, cytochromes and hemoglobin.

UNIT- 3. MICROBIAL NUTRITION AND THE INFLUENCE OF ENVIRONMENTAL FACTORS ON GROWTH 14hrs

1. UPTAKE OF NUTRIENTS BY THE CELL: Passive Diffusion Facilitated Diffusion, Active Transport Group Translocation and Iron uptake.

Common Nutritional Requirements, Requirements for Carbon, Hydrogen, Oxygen, Nitrogen, Phosphorus Sulphur and Electrons. Nutritional types of Microorganisms. Growth Factors. Nutritional Classifications. Phototrophs and Chemotrophs, Autotrophs and Heterotrophs.

2. ENVIRONMENTAL FACTORS FOR GROWTH: Temperature-Cardinal Temperatures, Temperature classes of organisms. pH: Microbial growth at low and high pH , Osmotic effects on Microbial Growth , Compatible solutes, Oxygen and Microbial Growth-Oxygen classes of Microorganisms., Toxic forms of Oxygen-Superoxide and Other Oxygen Species, Hydrostatic Pressure and Radiation.

UNIT–4 : BIOENERGETICS & RESPIRATION 14hrs

1.BIOENERGETICS: Free energy, Enthalpy, Entropy, Classification of high energy compounds, Oxidation reduction reactions, equilibrium constant, Redox potential, Laws of thermodynamics, Energy coupling reactions, Exothermic and Endothermic reactions.

2. RESPIRATION: Glycolysis, TCA cycle and electron transport chain, oxidative and substrate level phosphorylation. Anaerobic respiration, Fermentation(homo and heterolactic fermentation).

COURSE 1: PRACTICALS: G 509 DC2.2 P MICROBIAL BIOCHEMISTRY AND PHYSIOLOGY

1. Biochemical Estimations: Colorimetric estimation of Protein by Lowry's method.
2. Colorimetric estimation of sugar by DNS method.

   Biochemical tests used for identification of bacteria:
3. Fermentation of Glucose, Sucrose, Lactose
4. Gelatin hydrolysis
5. Catalase test
6. Oxidase test
7. IMViC test

8. Urease test
9. β-galactosidase test
10. TSI test

Text Books/References

1. Boyer R.(2002),Concepts in Biochemistry2nd Edition,Brooks/Cole, Australia.
2. Caldwell, D.R.(1995) –Microbial Physiology and Metabolism. Brown Publishers.
3. Felix Franks, 1993;ProteinBiotechnology,HumanaPress,New Jersey.

Course Title & Code: BACTERIOLOGY - G509.2OE

4. Harper,1999;Biochemistry,McGrawHill,NewYork.
5. LodasH,T.Baltimore,A.BerckB.L.Zipursky,P.MatsudairaandJ.Darnell.(2004)–
6. Moat A. G., Foster J.W. Spector. (2004), Microbial Physiology 4th Edition Panima Book Distributors. Molecular Cell Biology, Scientific American Books, Inc. New York.
7. NelsonandCox,2000;LehningerPrinciplesofBiochemistry, Elsevier Publ.
8. Palmer T. (2001), Biochemistry, Biotechnology and Clinical Chemistry, Harwood Publication, Chichester.
9. StryerL, 1995; Biochemistry, Freemanand Company, NewYork.
10. Voet & Voet, 1995;Biochemistry,John Wiley and Sons, New York.

SEMESTER-II-OE: -G509.2OE

COURSE OUTCOMES:

- Acquire the knowledge of bacteria.
- Acquire the knowledge of control of microorganisms.
- Acquire the knowledge of nutrition of microbes.

Total Contact Hours: **42**	Course Credits: **3**
Formative Assessment Marks: **60%**	Duration of ESA /Exam: **2.5Hrs**

Suggested Readings:

5. A Textbook of Microbiology, R. C. Dubey and D. K. Maheshwari, 1st edition, 1999, S. Chand & Company Ltd.
6. Atlas, R.M. 1984. Basic and practical microbiology. MacMillan Publishers, USA. 987pp.
7. Black, J.G. 2008. Microbiology principles and explorations. 7edn. John Wiley and Sons Inc., New Jersey 846 pp.
8. Brock Biology of Microorganisms, M.T.Madigan, J.M.Martinko, P. V. Dunlap, D. P. Clark- 12th edition, Pearson International edition 2009, Pearson Benjamin Cummings.

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	42Hrs
Unit–1: Bacteria:	**14Hrs**
Bacteria: Cell size, shape and arrangement, glycocalyx, capsule, flagella, fimbriae and pili. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, lipopolysaccharide (LPS), spheroplasts, protoplasts, and L-forms. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes. Cytoplasm- Ribosomes, mesosomes, inclusion bodies, nucleoid, genome and plasmids Endospore: Structure, formation, stages of sporulation.	
Unit–2: Control of Microorganisms	**14Hrs**
Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation.	
Unit –3: Nutritional requirements of Bacteria	**14Hrs**
Nutritional requirements in bacteria and nutritional categories; Culture media: natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media. Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate.	

SECOND YEAR B.SC -III & IV SEMESTERS- MICROBIOLOGY CURRICULUM

Microbiology Program Articulation Matrix:

Semester	Title /Name of the course	Program outcomes that the course addresses.	Pre- requisite course (s)	Pedagogy	Assessment
III	**G509.3DC1.1 Microbial Diversity 4 Credits 100 Marks**	1.Knowledge and understating the concepts of Microbial ecology. 2.Knowledge and understanding the presence of microbes in natural habitats. 3.Knowledge and understanding of the water treatment and their utilities.	Eligibility from 2nd semester	The general pedagogy to be followed for theory and practical are as under. Lecturing, Tutorials, Group/Individual Discussions, Seminar, Assignments, Counseling, Remedial Coaching. Field/Institution/Industrial visits, Hands on training, Case observations, Models/charts , preparations, Problem Solving mechanism, Demonstrations, Project presentations, Experiential Documentation and Innovative methods.	LSSSDC (NSDC) assessment and certification For lab Technician or Lab assistant Job role
	G509.4DC1.1P Microbial Diversity 2 Credits 50 Marks	Applying the skills in designing and estimation by performing experiments.			
	G509.3OE Virology 3 Credits ,50 Marks	1.Knowlegde of viruses. 2.Understading the replication mechanisms of viruses.			
IV	**DSC-4T G509.4DC1.1 Microbial Enzymology and Metabolism 4 Credits 100 Marks**	1 Knowledge and Understanding of metabolism. 2. Learning and practicing Professional skills in performing experiments. 3. Knowledge and understanding of the role of microbes in geochemical cycles and cycling of elements.	Eligibility from 3rd semester	The general pedagogy tobe followed for theory and practical areas under. Lecturing, Tutorials, Group/Individual Discussions, Seminars, Assignments, Counseling, Remedial Coaching. Field/Institution/Industry visits, Hands on training, Case observations, Models/charts preparations, Problem solving mechanism, Demonstrations, Project presentations, Experiential documentation and Innovative methods.	LSSSDC(NS DC) Assessment and certification for lab technician or Lab assistant job role
	G509.3DC1.1P Microbial Enzymology and Metabolism 2 Credits 50 Marks	Applying the skills in designing and estimation by performing experiments.			
	G509.4OE Environmental and Sanitary Microbiology				

Second Year B.Sc
Third Semester- Paper-3- Subject: Microbiology
MICROBIAL DIVERSITY--G509. 3 DC3.1

Course Title:DSC-3T, MBL301 Microbial Diversity	
Total Contact Hours: **56**	Course Credits: **4+2**
Formative Assessment Marks: **60%**	Duration of ESA /Exam: **2.5hrs**

TOTAL 56 hours

Course Learning Outcomes

Course Outcomes (COs): At the end of the course the student should be able to:

1. Knowledge about microbes and their diversity
2. Study, characters, classification and economic importance of Pro-eukaryotic and Eukaryotic microbes.
3. Knowledge about viruses and their diversity

UNIT-1

1. **BIODIVERSITY AND MICROBIAL DIVERSITY:** Concept, definition, and levels of biodiversity; Biosystematics – Major classification systems- Numerical and Chemotaxonomy.
2. **STUDY AND MEASURES OF MICROBIAL DIVERSITY:** Conservation and Economic values of microbial diversity. An overview of Bergey's Manual of Systematic Bacteriology.

14 hours

UNIT-2

1. **DIVERSITY OF PROKARYOTIC ORGANISMS:** Archaea: General characters and types, Actinomycetes: General Characters, Rickettsia- General Characters. Cyanobacteria: General Characters and Classifications. Similarities and Dissimilarities between Cyanobacteria and Bacteria. Morphology and Reproduction of Nostoc, Stigonema and Scytonema.

2. **EUKARYOTIC ORGANISM:** Fungi: General characters and Reproduction: Asexual and Sexual Reproduction. Spores and Spore dispersal. Classifications. Morphology:

Microscopic and Macroscopic, Asexual and Sexual Reproduction of: Rhizopus, Penicillium, Fusarium and Yeast

14 hours

UNIT-3

1. STUDY OF PROTOZOA: Study of *Entamoeba histolytica*: Morphology; Trophozoite and Cyst and Life cycle: Encystations and Excystation-Quadrinucleate cyst.

Plasmodium: Organism Characteristics and Life cycle in man and Mosquito. Morphological forms seen in humans: Trophozoites, Schizonts, Merozoites, Gametocytes, Forms in Liver: Sporozoites and, Merozoites. Morphological forms in Mosquitoes: Macrogametes and Microgametes, Ookinete, Oocyst Sporozoites.

2. MORPHOLOGY AND LIFE CYCLE: Balantidium and *Trichomonas vaginalis*.

14 hours

UNIT -4

1. DIVERSITY OF VIRUSES: General properties of Viruses, Helical Capsid, Icosahedral Capsids, Viral envelopes and Enzymes.

Viruses of Bacteria**:** Classification**,** Multiplication of Bacteriophages –Lysogenic and Lytic cycle. One step growth curve of viruses. A brief account of Plants, Insects, Algal and Fungal Viruses.

Classification of viruses based on the basis of differences in their transcription processes. General account on Prions, Viroids, and Virusoides.

2. VIRUSES CULTIVATION AND QUANTIFICATION: Egg and cell cultures-monolayer and continuous cell cultures and Plaque assay.

14 hours

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Second Year B.Sc

Third Semester -Paper-3 -Subject: Microbiology

MICROBIAL DIVERSITY –G509.3DC3.1P

(Each Practical session is 4 hours duration)

1. Isolation of bacteria from air and water: Gravity Settle method
2. Isolation of Fungi from air and water: Gravity Settle method
3. Isolation of Bacteria from soil
4. Isolation of Fungi from soil
5. Slide culture technique for Fungi.
6. Tease Mount & Staining Techniques for Fungi
7. Study of Yeast Wet mount and Stained specimen observation.
8. Isolation of Coliphages from Raw Sewage.
9. Study of permanent slides: Protozoa*: Amoeba, Entamoeba, Balantidium, Plasmodium.*
10. Study of Cyanobacteria: Nostoc, Scytonema, Oscillatoria.
11. Demonstration of fungi from plant root.

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NEP-Fourth Semester-Paper-4-Subject: Microbiology
(MICROBIAL ENZYMOLOGY AND METABOLISM) G509.4DC4.1

Course Title & Code: **Microbial Enzymology and Metabolism- G509.4DC1.1**	
Total Contact Hours: **56**	Course Credits: **4+2**
Formative Assessment Marks: **60%**	Duration of ESA /Exam: **2.5Hrs**

Total 56 hours

Course Learning Outcomes

Outcome 1. Understand the enzymes and their role in metabolism.

Outcome 2. Understand the fermentation pathways and their importance.

Outcome 3. Describing the growth characteristics of the microorganisms which require different nutrient for growth and the associated mechanisms of energy generation for their survival like autotrophs, heterotrophs, chemolithotrophs.

Outcome 4. Describe the metabolic pathway of photosynthesis as an energy yielding metabolic pathway in bacteria.

Outcome 5. Describe the biogeochemical cycles and mineral transformation by microbes.

UNIT-1

1. ENZYMES. Structure and classification of Enzymes, Mechanism of Enzyme Reactions, Effect of environment on Enzyme Activity. Coenzymes & Cofactors.

2. THE NATURE AND SIGNIFICANCE OF METABOLIC REGULATION: Metabolic Channeling, Control of Enzyme Activity- Allosteric Regulation, Covalent Modification of Enzymes, Feedback Inhibition. Enzyme catalysis: Catalytic mechanisms with type examples, catalytic mechanisms and testing -Serine proteases and Lysozyme

14 hours.

UNIT-2

1. CATABOLISM: Catabolism of Lipid, Amino acid and Protein Catabolism. Protein and Amino Acid Catabolism, Reserve Polymers: Methylotrophs: i. Oxidation of methane, methanol,methylamines

2. FERMENTATIONS: Common Microbial Fermentations: Alcohol Fermentation, Lactic acid Fermentation-Homo Hetero Lactic acid, Mixed Acid Fermentation, Butanediol Fermentation, Propionic acid fermentation.

Molecular basis of Signal transduction in bacteria- Two-component regulatory systems, Examples of Two –Component Regulatory Systems: Protein kinases and Response regulators.

14 hours.

UNIT-3

1.BACTERIAL PHOTOSYNTHESIS: Photosynthetic Bacteria: Characteristic of Photosynthetic Bacteria- Chromatiaceae (Purple Sulphur Bacteria), Rhodospirillaceae (Purple Non Sulphur Bacteria), Chlorobiaceae (Non Motile Green and Brown Sulphur Bacteria) , Chloroflexaceae Filamentous Gliding Green Bacteria , Cyanobacteria (Blue Green Bacteria) and Prochlorophyta .

Bacteriochlorophylls, Carotenois and Phycobilins. Photosynthetic apparatus in prokaryotes.Reaction Centres, Antenna Pigments and Chlorosomes.

Types of Bacterial Photosynthesis: Photosynthesis in Purple and Green bacteria, Anoxygenic photosynthesis and Oxygenic Photosynthesis. Light reactions: Photophosphorylation-Cyclic and Non Cyclic Photophosphorylations.

Dark reactions: Reductive Pentose Pathway and Pyruvate Synthetase Pathway (Reductive Carboxylic Acid Cycle).

2. CHEMOLITHOTROPHY: Oxidation of Ammonium and Nitrites, Iron, Hydrogen and Sulphur Compounds.Microbiologically Influenced Corrosion: Microorganisms involved and their detection.Biofilms: Formation and development and Biofilm development factors.

Significance: Biofilms and infectious diseases and biofilm uses.

14 hours

UNIT-4

1. NITRIFICATION: Bioenergetics and Enzymology of Nitrification. Anammox. Nitrogen Fixation: Nitrogen Fixing Bacteria: Free Living Nitrogen Fixing Bacteria, Symbiotic Nitrogen Fixing Bacteria and Associative Nitrogen Fixing. Nitrogenasae. Electron flow in Nitrogen fixation. Nitrogen fixation by Rhizobium: Process of root nodule formation, Leghaemoglobin**.**

2. GEOMICROBIOLOGY AND MINERAL TRANSFORMATION: Biogeochemical cycle- Reservoir Cycling of Sulphur-Microorganisms involved in sulphur cycle., Acid rain. Cycling of Phosphorus-Eutrophication and Carbon cycling –Greenhouse effect and Global warming.

14 hours

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Third Semester-Paper-4-Subject: Microbiology

MICROBIAL ENZYMOLOGY AND METABOLISM - G509. 4DC4.1P

(Each Practical session is 4 hours duration)

1. Nitrate Reduction Test
2. Starch Hydrolysis Test
3. Ammonification Test
4. Amylase Assay
5. Effect of pH on growth.
6. Effect of Temperature on growth.
7. Determination of Thermal Death Point
8. Growth of Bacteria in high salt concentration-Growth on Mannitol salt agar.
9. Measurement of Enzyme Activity of Alfa Amylase.
10. Effect of Temperature on Enzyme Activity.
11. Identification of amino acids by TLC.
12. Paper chromatography for Chlorophyll.

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OPEN ELECTIVE

Course Title & Code: VIRIOLOGY - G509.3OE	
Total Contact Hours: **42**	Course Credits: **3**
Formative Assessment Marks: **60%**	Duration of ESA /Exam: **2.5hrs**

III SEMESTER -VIRIOLOGY Course 2 : G509.3OE

COURSE OUTCOMES:

- Understand the concepts of viruses.
- Acquire the knowledge of virus replication.
- Understand the mode of infections by viruses.

III SEMESTER OE-VIRIOLOGY Course 2 : Theory: OE- 2T, MBL 302	**42 Hrs**
Unit – 1: Introduction to Viruses	**14 Hrs**
Properties of viruses; general nature and important features Subviral particles; viroids, prions and their importance Isolation and cultivation of viruses	
Unit – 2 Structure, and multiplication of viruses	**14 Hrs**
Morphological characters: Capsid symmetry and different shapes of viruses with examples Viral multiplication in the Cell: Lytic and lysogenic cycle Description of important viruses: salient features of the viruses infecting different hosts - Bacteriophages (T4 & Lambda); Plant (TMV & Cauliflower Mosaic Virus), Human (HIV & Hepatitis viruses)	
Unit – 3: Role of Viruses in Disease and its prevention	**14 Hrs**
Viruses as pathogens: Role of viruses in causing diseases Prevention and control of viruses: Viral vaccines, interferons and antiviral compounds	

References

1.Prescott, L.M.; J.P. Harley and D.A.Klein. 2010. Microbiology. 8th edition. McGrow Hill.

2.Michael T.Madigan and John M. Martinko.2010.13th Edition..Brock Biology of Microorganisms, Pearson Prentice Hall.

3. Michael Pelczar.1998. Microbilogy-5th Ed ,McGraw Hill Book Company.

4. Jacquelyn G. Black .2012 .Microbiology: Principles and Explorations, 8th Edition. Wiley.

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OPEN ELECTIVE

IV SEMESTER-OE- Environmental and Sanitary Microbiology Course 2 : G509.4OE

Course Title & Code: Environmental and Sanitary Microbiology G509.4OE	
Total Contact Hours: **42**	Course Credits: **3**
Formative Assessment Marks: **60%**	Duration of ESA /Exam: **2.5hrs**

COURSE OUTCOMES:

- **Acquire the knowledge of microbes in environment.**
- **Acquire the knowledge of water borne infections.**
- **Understand the importance of the role of microbes in public health.**

IV SEM-OE-Environmental and Sanitary Microbiology Course 2 : Theory: OE- 2T, G509.4OE	**42 Hrs**
Unit – 1: Soil and Air Microbiology	**14 Hrs**
Soil and Air as a major component of environment. Types, properties and uses of soil and air. Distribution of microorganisms in soil and air. Major types of beneficial microorganisms in soil. Major types of harmful microorganisms in soil	
Unit – 2: Water Microbiology	**14 Hrs**
Water as a major component of environment. Types, properties and uses of water. Microorganisms of different water bodies. Standard qualities of drinking water	
Unit – 3: Sanitary Microbiology	**14 Hrs**
Public health hygiene and communicable diseases. Survey and surveillance of microbial infections. Airborne microbial infections, waterborne microbial infections, Food borne microbial infections. Epidemiology of microbial infections, their detection and control.	

References

1. Atlas, R.M. and Bartha R. 1998. Microbial Ecology: Fundamentals and Applications. 4th Ed. Redwood city. CA. Benjamin / Cummings.

2. Mitchell, R. 2010. Introduction to Environmental Microbiology. 2nd Ed. Prentice - Hall. Inc. Englewood Cliffs - New Jersey.

3. Michael T.Madigan and John M. Martinko.2009.12th Edition, Brock Biology of Microorganisms. Pearson Prentice Hall.

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Theory End Semester Examination Question Paper pattern. Time 2 hours

End Semester theory Examination will be common for all science departments.

The duration of the examination is **2** hours carrying **60 marks.**

Question paper is divided into Part –**A, Part – B and Part-C.**

Part –A -Objective type carrying from each unit **10** marks.

Part-B -Analytical questions carrying from each unit **20** marks and

Part –C- Descriptive answer for **30** marks.

Question Paper Pattern Sample

I. Section A –Any 5 out of 6- 2 x 5=10 marks.

Q.I a, b, c, d, e, f.

II. Section-B -Answer any ONE question "a" or "b" from each unit - 5 x 4=20 marks

Unit-I. Q. 2A OR 2B =5 marks.

Unit-2. Q. 3A OR 3B =5 marks.

Unit.3. Q. 4A OR 4B= 5 marks.

Unit.4. Q. 5A OR 5B= 5 marks.

III. Section-C -15 marks = Answer any TWO= 15 X2=30 marks

Theory: 60:40

1. Ratio of weightage (marks) between Internal & End Semester Examinations **for THEORY: 60:40**

THEORY INTERNAL COMPONENT: 40

- Two internal tests: 10×2=20
- Assignment: 05
- Attendance: 05
- Continuous Unit wise tests (objective/MCQ): 05
- Group/ teams of two projects:05

Total Maximum Marks: 50 :IA25 + End Semester Practical Exam 25 Marks

Practicum component marks: 50

Internal component of practicum : 50 (converted to 25)

Internal:

- Continuous Assessment of all practical experiments: 15
- Attendance: 05
- Model practical Test: 20
- Maintenance of Records: 05
- Viva: 05

End semester Practicum: 50 (converted to 25)

Practical End Semester Examination Question Paper pattern. Time 2hours

PATTERN OF QUESTION PAPER SEMESTER END EXAMINATION

End Semester Practical Exam: Experiments-20 marks + Class Record-5marks = Total 25 Marks.

Practical Examination Question Paper Model for I to IV semester.

Q.1. Major Experiment-Experiment to be conducted and result to be reported—

7 Marks.

Q.2. Minor Experiment- Experiment to be conducted and result to be reported

4 Marks.

Q.3. Identification and Comment of Spotters "A", "B" and "C"----- 3 x 3 = **9 Marks.**

Q.4 Class Record **05 Marks.**

Total -**25 Marks**

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