ETERNAL UNIVERSITY

(ESTABLISHED UNDER HIMACHAL PRADESH GOVERNMENT ACT NO.3 OF 2009)

BARU SAHIB
HIMACHAL PRADESH

WORLD PEACE THROUGH VALUE BASED EDUCATION

AKAL COLLEGE OF BASIC SCIENCE

PH.D.MICROBIOLOGY SYLLABUS

(Approved vide item No 62/10(ii)/2019 of academic council meeting held on 12th April 2019)

(EFFECTIVE FROM: ACADEMIC SESSION 2019-20)

Course Curriculum

Ph.D. MICROBIOLOGY

DEPARTMENT OF MICROBIOLOGY

ETERNAL UNIVERSITY

BARU SAHIB (H. P.)

Ph.D. Microbiology: Program Structure

SEMESTER I

S. No.	Course Type	Code	Course Title	Theory	Seminar	Research
1.	Compulsory	**MICRO-609**	Research Methodology	3	0	0
2.	Compulsory	**MICRO-601**	Research Techniques and Databases in Microbiology	3	0	0
3.	Compulsory	**MICRO-602**	Seminar	0	1	0
4.	Compulsory	**MICRO-701***	Thesis Work	0	0	5

*Non-credit course

Optional Courses (Any TWO courses taking ONE each from optional set A & B)

Optional Set A

S. No.	Code	Course Title	Theory	Seminar	Research
1.	**MICRO-603**	Recent Advances in Applied Microbiology	3	0	0
2.	**MICRO-604**	Current Topics in Molecular Microbiology	3	0	0
3.	**MICRO-605**	Advanced techniques for Microbiology Research	3	0	0

Optional Set B

S. No.	Code	Course Title	Theory	Seminar	Research
1.	**MICRO-606**	Advanced Medical Microbiology and Immunology	3	0	0
2.	**MICRO-607**	Current Topics in Food, Industrial and Environmental Microbiology	3	0	0
3.	**MICRO-608**	Advanced Agricultural Microbiology and Microbial Ecology	3	0	0
		Total	**12**	**1**	**5**

	S. No. / Course Code	Course Title
SEMESTER II	**1.**	**Comprehensive Examination** *(Will be evaluated satisfactory/unsatisfactory)*
	2.	**Synopsis writing**
	3.	**Synopsis Seminar & Approval of Synopsis** *(by Research Committee)*
	MICRO-701*	The student will undertake his/her research work by taking 15 credit hours each semester. The major advisor will evaluate his/her work in each semester and clear the credit hours by evaluating satisfactory/unsatisfactory credits depending upon the work undertaken by the student during the semester.
SEMESTER III	**MICRO-701***	The student will undertake his/her research work by taking 15 credit hours each semester. The major advisor will evaluate his/her work in each semester and clear the credit hours by evaluating satisfactory/unsatisfactory credits depending upon the work undertaken by the student during the semester.
SEMESTER IV	**MICRO-701***	The student will undertake his/her research work by taking 15 credit hours each semester. The major advisor will evaluate his/her work in each semester and clear the credit hours by evaluating satisfactory/unsatisfactory credits depending upon the work undertaken by the student during the semester.
SEMESTER V	**MICRO-701***	The student will undertake his/her research work by taking 15 credit hours each semester. The major advisor will evaluate his/her work in each semester and clear the credit hours by evaluating satisfactory/unsatisfactory credits depending upon the work undertaken by the student during the semester.
SEMESTER VI	**MICRO-701***	The student will undertake his/her research work by taking 15 credit hours each semester. The major advisor will evaluate his/her work in each semester and clear the credit hours by evaluating satisfactory/unsatisfactory credits depending upon the work undertaken by the student during the semester.
Total Credits: 13 + 80* = 93		

**Non-credit course*

Examination Schedule

As applicable to other postgraduate courses of Eternal University.

MICRO-609 :: Research Methodology

T+S+R	:	**3+0+0**	Internal Examination	:	**50**
Credits:	:	**3**	End-Semester Examination	:	**50**
Contact hours	:	**42**			

Unit	Contents	Lectures
I	History, myths and ethnic practices; need, importance and impact of research; types of research; research process.	3
II	Synopsis writing; Selecting research problem; formulation of research projects; survey of literature; allied and critical literature. Research infrastructure; experimental designs; sampling designs; recording of observations; measurement and scaling techniques; GLPs.	4
III	Formulation and types of hypothesis; collection, maintenance, storage and analysis of data; measures of central tendencies and relationships and error analysis; tests of significance.	6
IV	Compilation and presentation of results. Writing of manuscripts; research reports and thesis; organization of reference material using endnote; bibliography; plagiarism; IPR and patent application. Entrepreneurship.	6
V	Financial support and various funding agencies; Multidisciplinary, multi-institutional research network initiatives; writing research proposal for external funding	3
VI	Computer and informatics; introduction; word processing, excel, power point presentation; graph and figure plotting; web browsing; information resources and various databases.	6
VII	Demonstration of departmental research activities and instrumentation	14

Unit No. I - VI: Common for all streams; Unit VII: Offered by concerned department

Suggested readings

S. No.	Title and authors	Publisher	Edition/Year
1.	**Research Methodology-Methods and Techniques** Kothari C.R., Garg G.	New Age International	4th ed. / 2019
2.	**Research Methodology: A Step by Step Guide for Beginners** Kumar R.	SAGE Publications	4th ed. / 2014
3.	**Research Methodology in the Medical and Biological Sciences** Laake P., Benestad H.B., Olsen B.R.	Elsevier	1st ed. / 2007
4.	**Introduction to Biostatistics and Research Methods** Sundar Rao P.S., Richard J.	PHI Learning	5th ed. / 2012
5.	**Research Methodology For Biological Sciences** Gurumani N	MJP Publishers	1st ed. / 2013

MICRO-601 :: Research Techniques and Databases in Microbiology

T+S+R	:	**3+0+0**	Internal Examination	:	**50**
Credits:	:	**3**	End-Semester Examination	:	**50**
Contact hours	:	**42**			

Unit	Contents	Lectures
I	Principles, components and functioning of Autoclave, Laminar air flow, Biosafety cabinet, BOD incubator, Hot air oven, CO_2 incubator, Colony counter, Anaerobic chamber, PCR, Agarose gel electrophoresis, SDS-PAGE, Microplate reader, Fermenter, Bioreactor.	10
II	Tools/accessories of microbiology labs (Petri dish, inoculating loop, inoculating needle, spreader, cotton plug, agar slants, agar deeps etc.). Safety guidelines and precautions in microbiology lab, Biosafety levels (BSL-1, BSL-2, BSL-3, BSL-4), Select agents/bioweapons.	8
III	Pure culture, Pure culture isolation techniques (pour plating, spread plating, streak plating), Isolation from soil, water, air, nodules and food samples. Culture transfer methods, Serial dilution methods, Microplate culture methods. Bacteriological media, cell culture media. Physical and chemical methods of sterilization, Membrane filtration.	8
IV	Microbial pure culture preservation methods (refrigeration, glycerol stocks, liquid nitrogen, lyophilization) Anaerobic culture techniques. Identification of microbes based on markers viz. 16S rRNA, ITS, *mcrA* etc.	8
V	Microbial databases: LPSN, Integrated Microbial Genomes & Microbiomes, AlgaeBase, MycoBank, RDP, KEGG. Procurement of desired microbes from different repositories (MTCC, ATCC, NCDC, NCIM, NFCC). Microbial projects: Human Microbiome Project, Earth Microbiome Project.	8

Suggested readings/journals/websites

S. No.	Title and authors	Publisher	Edition/Year
1.	**Brock Biology of Microorganisms** Madigan M.T., Bender K.S., Buckley D.H., Stahl D.A.	Pearson Education Ltd., UK	15th ed. / 2019
2.	**Prescott, Harley & Klein's Microbiology** Willey J., Sherwood L., Woolverton C.	McGraw-Hill Education	10th ed. / 2016
3.	**Microbiology: A Laboratory Manual** Cappuccino J., Welsh C.	Pearson Education Ltd. UK	11th ed. / 2018
4.	**Experiments in Microbiology, Plant Pathology and Biotechnology** Aneja K.R.	New Age International	5th ed. / 2018
5.	(a) Zhulan IB (2015) Databases for microbiologists. *J Bacteriol* 197: 2458-67. (b) Clarridge III JE (2004) Impact of 16S rRNA Gene Sequence Analysis for Identification of Bacteria on Clinical Microbiology and Infectious Diseases. *Clin Microbiol Rev*, 17: 840-62.		

MICRO-602 :: Seminar

T:S:R:	:	**0+1+0**
Credits:	:	**1**
Contact hours	:	**14**

Assessment will be made on the basis of write-up, viva-voce and oral presentation.

Description

Research student is required to make an oral presentation on a topic relevant to his/her proposed research topic or as decided by major advisor/advisory committee. The write-up is also required to be submitted. Students are expected to present latest facts and updated information about the topic for which various textbooks, reference books, monographs and peer-reviewed research journals may be consulted.

Suggested Journals/Resources/Databases

Research journals	• Annual Review of Microbiology • Nature • Cell • Science • Nature Microbiology • Nature Microbiology Reviews • Antonie van Leeuwenhoek • PLOS Pathogens • Journal of Antibiotics • Trends in Microbiology • Infection & Immunity • Frontiers in Microbiology • Environmental Microbiology	• Applied Microbiology and Biotechnology • Journal of Bacteriology • Journal of Microbiological Methods • Microbial Biotechnology • World Journal of Microbiology & Biotechnology • Applied and Environmental Microbiology • Microbiology and Molecular Biology Reviews • International Journal of Systematic & Evolutionary Microbiology • Journal of Industrial Microbiology & Biotechnology • Letters in Applied Microbiology • Enzyme Microbial Technology • Bioresource Technology
Research databases	• Pubmed/Medline • ScienceDirect • J-stage • SpringerLink • IngentaConnect • Google Scholar • Current Contents • Scopus • Biological Abstracts	

MICRO-701 :: Thesis Work

(Semester I, II, III, IV, V, VI)

Description
The student is required to start working on their research work / literature survey during 1st semester and will continue the assigned experimental work in the remaining semesters. The student will work on an assigned research topic and is required to collect, record and analyze the experimental research data. Upon satisfactory completion of the objectives, student is required to submit their thesis as per Ph.D. guidelines of the university. The student will undertake his/her research work by taking 15 credit hours each semester. The major advisor will evaluate his/her work in each semester and clear the credit hours by evaluating satisfactory/unsatisfactory credits depending upon the work undertaken by the student during the semester.

*credits for 1st semester: **5**

*Credits for 2nd, 3rd, 4th, 5th & 6th semester each: **15**

Suggested Journals/Resources/Databases		
Research journals	• Annual Review of Microbiology • Nature • Cell • Science • Nature Microbiology • Nature Microbiology Reviews • Antonie van Leeuwenhoek • PLOS Pathogens • Journal of Antibiotics • Trends in Microbiology • Infection & Immunity • Frontiers in Microbiology • Environmental Microbiology	• Applied Microbiology and Biotechnology • Journal of Bacteriology • Journal of Microbiological Methods • Microbial Biotechnology • World Journal of Microbiology & Biotechnology • Applied and Environmental Microbiology • Microbiology and Molecular Biology Reviews • International Journal of Systematic & Evolutionary Microbiology • Journal of Industrial Microbiology & Biotechnology • Letters in Applied Microbiology • Enzyme Microbial Technology • Bioresource Technology
Research databases	• Pubmed/Medline • ScienceDirect • J-stage • SpringerLink • IngentaConnect • Google Scholar • Current Contents • Scopus • Biological Abstracts	

MICRO-603 :: Recent Advances in Applied Microbiology

T+S+R	:	**3+0+0**	Internal Examination	:	**50**
Credits:	:	**3**	End-Semester Examination	:	**50**
Contact hours	:	**42**			

Unit	Contents	Lectures
I	International Code of Nomenclature of Prokaryotes (ICNP), International Committee on Systematics of Prokaryotes (ICSP), International Union of Microbiological Societies (IUMS), International Committee on Taxonomy of Viruses (ICTV), Bergey's Manual of Systematics of Archaea & Bacteria (BMSAB), International Journal of Systematic and Evolutionary Microbiology (IJSEM), List of Prokaryotic names with Standing in Nomenclature (LPSN).	10
II	Extraordinary microbes I: *Streptomyces, Prochlorococcus, Synechococcus, E. coli, Bacillus, Saccharomyces, Lactobacillus, Thermus aquaticus, Thiomargarita namibiensis,* Phylum *Bacteriodetes, Saccharomyces cerevisiae, Saccharomyces boulardii*	8
III	Extraordinary microbes II: *Corynebacterium glutamicum, Deinococcus, Methanopyrus kandleri, Wolbachia, Rhizobium, Azotobacter, Azospirrilum, Physarum polycephalum,* ARMAN, Prions, Giant viruses, *Armillaria solidipes* (honey fungus).	8
IV	Microbial cell factories, Microbial fuel cell, Bioethanol, Artificial lab-designed microbial cells (*Mycoplasma*, *MiniBacillus* etc.), Biocement, Marine microbes as untapped source of bioactives.	8
V	Novel microbial groups/processes: cable bacteria, polyextremophiles, endosymbionts of insects, anammox bacteria, anaerobic rumen fungi, hydrocarbon-degrading microbes, Soil-transmitted helminths (STH).	9

Suggested readings/Journals

S. No.	Title and authors	Publisher	Edition/Year
1.	**Brock Biology of Microorganisms** Madigan M.T., Bender K.S., Buckley D.H., Stahl D.A.	Pearson Education Ltd., UK	15th ed. / 2019
2.	**Prescott, Harley & Klein's Microbiology** Willey J, Sherwood L & Woolverton C	McGraw-Hill Education	10th ed. / 2016
3.	**Advances in Applied Microbiology- Series Vol 107** Gadd & Sariaslani S	Elsevier, UK	1st ed. / 2019
4.	**Research journals:** Trends in Microbiology, Critical Reviews in Microbiology, Frontiers in Microbiology, Applied & Environmental Microbiology, Applied Microbiology & Biotechnology, Archaea, Int. Journal of Systematic and Evolutionary Microbiology (https://ijs.microbiologyresearch.org/content/journal/ijsem). LPSN (http://bacterio.net/).		

MICRO-604 : Current Topics in Molecular Microbiology

T+S+R	:	**3+0+0**	Internal Examination	:	**50**
Credits:	:	**3**	End-Semester Examination	:	**50**
Contact hours	:	**42**			

Unit	Contents	Lectures
I	Microbial genomes, Multi-chromosome containing bacteria, Evolution of mitochondria and plastids, Metagenome & metagenomics, Gut microbiome, Rhizospheric microbiome,	10
II	Structure of replisome, Structure of divisome, Prokaryotic photosynthesis machinery, PCR, RT-PCR, qRT-PCR, Importance of 16S rRNA, 28S rRNA, ITS1, mcrA	5
III	DNA polymerases (*Taq, Pfu Pwo*), Advanced cloning vectors, Genomic libraries, Next-generation sequencing techniques, Dual-barcoded shotgun expression library sequencing, Genetically engineered microbes.	6
IV	Quorum sensing, Horizontal gene transfer, Biofilms, CRISPER, Type IV secretion in bacteria, Molecular targets of antibiotics. Mechanisms of action of bacterial toxins. Genetic regulation of microbial secondary metabolites	5
V	Lactose operon & tryptophan operon of bacteria, Mechanism of lytic and lysogenic cycles of phage, Pathogenicity islands, Gene silencing, Genetics of nitrogen-fixation, Omics technologies: transcriptome, secretome, proteome.	6

Suggested readings/Journals

S. No.	Title and authors	Publisher	Edition/Year
1.	**Brock Biology of Microorganisms** Madigan M.T., Bender K.S., Buckley D.H., Stahl D.A.	Pearson Education Ltd., UK	15th ed. / 2019
2.	**Lewin's Genes XII** Krebs J.E., Goldstein E.S., Kilpatrick S.T.	Jones & Bartlett Learning	12th ed. / 2018
3.	**Gene Cloning and DNA Analysis : An Introduction** Brown T.A.	Wiley-Blackwell	7th ed. / 2016
4.	**Molecular Microbiology: Diagnostic Principles & Practice** Persing D.H. et al.	ASM Press	3rd ed. / 2016
5.	**Research journals:** Trends in Microbiology, Critical Reviews in Microbiology, Frontiers in Microbiology, Applied Microbiology & Biotechnology, Molecular Microbiology, Microbiology & Molecular Biology Reviews, Scientific Reports, Nature Microbiology etc.		

MICRO-605 :: Advanced Techniques for Microbiology Research

T+S+R	:	**3+0+0**	Internal Examination	:	**50**
Credits:	:	**3**	End-Semester Examination	:	**50**
Contact hours	:	**42**			

Unit	Contents	Lectures
I	Principles and applications of HPTLC, GL chromatography, HPLC and FPLC. Size exclusion chromatography, Affinity, ion exchange & hydrophobic interaction chromatography, Flow cytometry, Scanning Electron Microscopy, Transmission Electron Microscopy.	9
II	Principles and applications of Native PAGE, SDS-PAGE, 2D-PAGE, capillary electrophoresis, Agarose gel electrophoresis.	8
III	Principles and applications of UV-Visible spectroscopy, fluorescence, IR and FTIR, Raman, NMR and FTNMR, ESR and X- Ray spectroscopy. CD and ORD.	9
IV	Hydrodynamic methods of separation of biomolecules. Viscosity and sedimentation-their principles, variants and applications.	7
V	Tracer techniques in biology: concept of radioactivity, radioactivity counting methods with principles of different types of counters, concept of α, β and γ emitters, scintillation counters, x-rays spectrometers, autoradiography, and application of radioactive tracers in biology, principles and applications of phosphor imager.	9

Suggested readings

S. No.	Title and authors	Publisher	Edition/Year
1.	**Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology** Hofmann A., Clokie S.	Cambridge University Press	8th ed. / 2018
2.	**Biophysical Chemistry- Principles and Techniques** Upadhyay A., Upadhyay K., Nath N.	Himalaya Publishing House	4th ed. / 2019
3.	**Physical Biochemistry: Principles and Applications** Sheehan D.	Wiley-Blackwell	2nd ed. / 2009
4.	**Lewin's Genes XII** Krebs J.E., Goldstein E.S., Kilpatrick S.T.	Jones & Bartlett Learning	12th ed. / 2018
5.	**Gene Cloning and DNA Analysis : An Introduction** Brown T.A.	Wiley-Blackwell	7th ed. / 2016

MICRO-606 :: Advanced Medical Microbiology and Immunology

T+S+R	:	**3+0+0**	Internal Examination	:	**50**
Credits:	:	**3**	End-Semester Examination	:	**50**
Contact hours	:	**42**			

Unit	Contents	Lectures
I	International health regulatory bodies: WHO, FDA, CDC, WHO-TDR, DNDi, European Medicines Agency (EMA).	10
II	Indian regulatory bodies: MoHFW, NCDC, FSSAI, Clinical Trials Registry (CTRI), Central Drugs Standard Control Organization (CDSCO), Medical Council of India. Central Council of Indian Medicine, NACO.	8
III	Antimicrobial drug resistance, ESKAPE pathogens, MRSA, MDR/XDR pathogens, opportunistic pathogens. ESBL-producing bacteria, Detection systems (API, BACTEC, VITEK), Neglected tropical diseases, biological carcinogens (*Helicobacter*, viruses).	8
IV	Bone marrow, hematopoietic stem cell, Apoptosis, Antibodies, Stem cell therapy, Monoclonal antibodies as therapeutics, Novel antibiotics, Phage therapy. Autoimmune diseases. Allergies, Rapid diagnostic kits/cards.	8
V	Vaccine-preventable diseases, National Immunization Programme, Mission Indradhanush, Vaccine production and quality control. Vaccines in clinical trial phases, Research towards vaccines against malaria, HIV, Ebola, Dengue, Swine flu etc.	8

Suggested readings/Journals

S. No.	Title and authors	Publisher	Edition/Year
1.	**Mims' Medical Microbiology and Immunology** Goering R.V. et al.	Elsevier	6th ed. / 2019
2.	**Kuby's Immunology** Owen J.A., Punt J., Stranford S.A.	W. H. Freeman & Company, USA	6th ed. / 2013
3.	**Roitt's Essential Immunology** Delves P. et al.	Wiley-Blackwell	13th ed. / 2017
4.	**Brock Biology of Microorganisms** Madigan M.T., Bender K.S., Buckley D.H., Stahl D.A.	Pearson Education Ltd., UK	15th ed. / 2019
5.	**Research journals:** Journal of Immunology, Infection & Immunity, Immunity, Clinical Microbiology Reviews, Clinical Microbiology & Infection etc.		

MICRO-607 :: Current Topics in Food, Industrial and Environmental Microbiology

T+S+R	:	**3+0+0**	Internal Examination	:	**50**
Credits:	:	**3**	End-Semester Examination	:	**50**
Contact hours	:	**42**			

Unit	Contents	Lectures
I	Probiotics, Prebiotics, Synbiotics, Food-associated disease outbreaks and epidemics, Food intoxication, Bacterial toxins and mechanisms of action, Mycotoxins.	8
II	Aseptic packaging, Modified atmosphere packaging, UHT pasteurization, Canning methods, FSSAI guidelines, Good Manufacturing Practices (GMP), HACCP concept, Quality control in food production & processing industries, Rapid methods for detection of food infections, Biosensors.	9
III	Industrially important microorganisms, Single Cell Proteins (SCP), Single Cell Oils (SCO), Metabolic engineering of industrial strains for enhanced production, Microbial production of alcohols, organic acids, enzymes, biopharmaceuticals (antibiotics, lovastatin, vaccines, insulin, interferons, cytokines, monoclonal antibodies).	10
IV	Bioreactor, Fermenter, Alcoholic fermentation, Lactic acid fermentation, Submerged fermentation, Solid State Fermentation (SSF). Bioethanol, biodiesel, Biofuels (first, second and third generations).	8
V	Industrial effluents treatment, Solid waste management, Biomedical waste management.	7

Suggested readings/Journals

S. No.	Title and authors	Publisher	Edition/Year
1.	**Brock Biology of Microorganisms** Madigan M.T., Bender K.S., Buckley D.H., Stahl D.A.	Pearson Education Ltd., UK	15th ed. / 2019
2.	**Prescott, Harley & Klein's Microbiology** Willey J., Sherwood L., Woolverton C.	McGraw-Hill Education	10th ed. / 2016
3.	**Industrial Microbiology** Casida L.E.	New Age International	2nd ed. / 2016
4.	**Food Microbiology** Frazier W., Westhoff D., Vanitha N.M.	McGraw-Hill Education	5th ed. / 2013
5.	**Research journals:** Trends in Microbiology, Critical Reviews in Microbiology, Frontiers in Microbiology, Applied & Environmental Microbiology, Environmental Microbiology, Applied Microbiology & Biotechnology, Biotechnology for Biofuels, Microbial Cell Factories etc.		

MICRO-608 :: Advanced Agricultural Microbiology and Microbial Ecology

T+S+R	:	**3+0+0**	Internal Examination	:	**50**
Credits:	:	**3**	End-Semester Examination	:	**50**
Contact hours	:	**42**			

Unit	Contents	Lectures
I	Microorganisms for sustainable agriculture, Microbial bio-fertilizers, Phosphorus & potassium solubilizing microbes, Microbe-plant associations: symbiotic nitrogen-fixing bacteria, Free-living nitrogen-fixing bacteria, PGPR, siderophores. Fungi-like organisms (water molds).	9
II	Mycorrhiza, Arbuscular mycorrizal fungi (AMF), Lichens, Nitrification & denitrification. *Bacillus thuringiensis* applications, biopesticides, bioinsecticides, bioherbicides, Phytobiomes, Rhizospheric microbiome. Endophytic microbes.	9
III	Distribution of microbes on Earth, LUCA & microbial evolution, Photosynthetic microbes (green sulphur bacteria, purple sulphur bacteria, cyanobacteria, algae), Case studies on *Procholorococcus, Synechococcus, Rhizobium, Azotobacter, Azospirillum*, microalgae etc. Microbial food chains & webs in aquatic and terrestrial ecosystems.	10
IV	Chemolithotrophs & chemoorganotrophs, Microbiology of extreme environments (hot springs, acidic mines, dead sea, marshes, saline, oligotrophic environments, hydrothermal vents, arid regions, permafrosts). Geochemical cycles: Carbon cycle, Nitrogen cycle, Phosphorus cycle, Anaerobic environments and associated microbes.	9
V	Bioremediation, Wastewater microbiology, Waste disposal: municipal wastes, industrial effluents, xenobiotics degradation; Rumen methanogenesis and global warming, Methods for studying microbial diversity of various environments. Metagenomics.	8

Suggested readings/Journals			
S#	**Title and authors**	**Publisher**	**Edition/Year**
1.	**Brock Biology of Microorganisms** Madigan M.T., Bender K.S., Buckley D.H., Stahl D.A.	Pearson Education Ltd., UK	15th ed. / 2019
2.	**Environmental Microbiology** Pepper I.L., Gerba C.P., Gentry T.J.	Academic Press, Elsevier	3rd ed. / 2014
3.	**Microbial Ecology of the Oceans** Gasol J.M., Kirchman D.L.	Wiley-Blackwell	3rd ed. /2018
4.	**Advances in Soil Microbiology: Recent Trends and Future Prospects, Vol 1: Soil-Microbe Interaction** Adhya T.K., Lal B., Mohapatra B., Paul D., Das S. (Eds)	Springer Singapore	1st ed. /2018
5.	**Soil Microbiology, Ecology & Biochemistry** Paul E.A.	Academic Press, Elsevier	4th ed. / 2014
6.	**Geomicrobiology** Ehrlich H.L., Newman D.K., Kappler A.	CRC Press	6th ed. /2015
7.	**Research journals:** Trends in Microbiology, Critical Reviews in Microbiology, Frontiers in Microbiology, Applied & Environmental Microbiology, Environmental Microbiology, Applied Microbiology & Biotechnology, Microbial Ecology, FEMS Microbiology Ecology, ISME Journal, mBio,		