Scheme

MAHATMA GANDHI UNIVERSITY

School of Biosciences

Priyadarsini Hills P. O., Kottayam – 686560

Learning Outcomes based Curriculum Framework (LOCF) for Post Graduate Programme

MSc Microbiology

Under the CSS scheme for University

(EFFECTIVE FROM 2021 ADMISSIONS)

Preface

Mahatma Gandhi University

Mahatma Gandhi University is an Indian collegiate public University based in Kerala, established in 1983, approved by UGC, and accredited with NAAC "A" Grade, 3.24 CGPA. With its academic excellence, the University has bagged Chancellor's Award twice for the best University (2015-16 and 2017-18) within the state of Kerala. It has also secured 30th position in NIRF ranking (April 2019) and 11th position in India Today-MDRA ranking, 2018. CSIR has ranked the University 13th for its intellectual productivity and NISTADS has rated it as 19th in terms of h-index.

At present, Mahatma Gandhi University offers research programs in forty disciplines through its own Schools and approved Research Centers. It has close collaboration for academic, research and extension programs with a number of national agencies and institutions including the UGC, DST-FIST, DRS, ISRO, COSIT, DIT, DST (Nano Mission), CSIR, DAAD, STEC, ICMR, BARC and MOEF. The University is also involved in active collaboration with research institutions of international reputation such as the Max Planck Institute of Technology, Germany; Brown University, USA; University of Nantes, France; California Institute of Technology, USA; University of Toronto, Canada; Catholic University, Belgium; Heidelberg University, Germany; the Institute of Political Studies, Rennes, France; Trent University, Canada; IPF Dresden, Germany; University of Paris and University of Strasbourg.

Mahatma Gandhi University has made immense strides in the fields of inter disciplinary teaching and research. The faculty comprises of outstanding scholars, many of whom have made original contributions in their respective fields of specialization. The faculty andresearch scholars of several departments have gained widespread recognition for the commendable quality of their research publications. The web enabled University library has large collection of books, journals, e-journals and online theses. The digital library provides open access to its enviable collection of digitized Ph.D dissertations. All these work in tandem with the academic business transacted by the University, making the whole experience a holistic one. The University has a well established instrumentation facility with many sophisticated equipments functioning at the various departments and also at the platform provided by the common Inter University Instrumentation Centre (IUIC).

The University has well established and internationally reputed facility and academic expertise in various areas like Nanoscience, Environmental science, Bioscience, Chemical science, Physics, Arts and Humanities.The Centre for Nanoscience and Nanotechnology focus on the enhancement of research and higher studies in the cutting edge areas of Nanoscience and Nanotechnology. The Centre is motivated to thrust its research and development focusing on developing novel materials and devices prospering the outrage of Nanoscience. With a vision to consolidate the existing and to pay focus attention to the frontier areas of Environmental Science, the University has established the School of Environmental Sciences as a Centre of learning for advanced studies in different branches of environmental science. The major mandate of the School is to develop appropriate technologies and skilled human resource for sustainable utilization, management and conservation of natural resources. The school has established a Centralized Remote Sensing and GIS facility, the first ofits kind in a University in the state, with the support of Indian Space Research Organization (ISRO). It has also established a regional center, the Highrange Environmental Research center (HERC) at Nedumkandam, Idukki district. The School has a live laboratory named as "Jeevaka" which consists of areas with rich biodiversity within the Mahatma Gandhi University Campus.

Vision and Mission of MGU

Vision of Mahatma Gandhi University

"Mahatma Gandhi University envisions to excel in the field of higher education and cater to the scholastic and developmental needs of the individual, through continuous creation of critical knowledge base for the society's sustained and inclusive growth."

Mission of Mahatma Gandhi University

- **To conduct and support undergraduate, postgraduate and research-level programmes of quality in different disciplines**
- **To foster teaching, research and extension activities for the creation of new knowledge for the development of society**
- **To help in the creation and development of manpower that would provide intellectual leadership to the community**
- **To provide skilled manpower to the professional, industrial and service sectors in the country so as to meet global demands**
- **To help promote the cultural heritage of the nation and preserve the environmental sustainability and quality of life**
- **To cater to the holistic development of the region through academic leadership**

Preamble

OUTCOME BASED EDUCATION (OBE)FROM THE ACADEMIC YEAR 2020-21

MAHATMA GANDHI UNIVERSITY SCHOOL OF BIOSCIENCES

Introduction

A high priority task in the context of education in India is improvement of quality of higher education for equipping young people with skills relevant for global and national standards and enhancing the opportunities for social mobility. Mahatma Gandhi University has initiated an Outcome Based Education (OBE) for enhancing employability of graduates through curriculum reforms based on a learning outcomes-based curriculum framework, upgrading academic resources and learning environment.

Learning outcomes specify what graduates completing a particular programme of study are expected to know, understand and be able to do at the end of their programme of study. The fundamental premise underlying the learning outcomes-based approach to curriculum development is that higher education qualifications are awarded on the basis of demonstrated achievement of outcomes, expressed in terms of knowledge, understanding, skills, attitudes and values. Outcomes provide the basis for an effective interaction among the various stakeholders. It is the results-oriented thinking and is the opposite of input-based education where the emphasis is on the educational process.

Benefits of OBE

1. The OBE Framework is a paradigm shift from traditional education system into OBE system where there is greater focus on programme and course outcomes. It guarantees that curriculum, teaching and learning strategies and assessment tools are continuously enhanced through a continuous improvement process. All decisions including those related to curriculum, delivery of instruction and assessment are based on the best way to achieve the predetermined outcomes. Traditionally, educators have measured learning in terms of standardised tests. In contrast, outcome-based education defines learning as what students can demonstrate that they know.

Benefits of OBE:

*More directed & coherent curriculum.

*Graduates will be more “relevant” to industry & other stakeholders (more well-rounded Graduates)

*Continuous Quality Improvement is in place.

*OBE shifts from measuring input and process to include measuring the output (outcome)

Outcome Based Education (OBE) process

OBE is a comprehensive approach to organise and operate a curriculum that is focused onand defined by the successful demonstrations of learning sought from each learner. The term clearly means focusing and organising everything in an education system around “what is essential for all learners to be able to do successfully at the end of their learning experiences”.

OBE is an approach to education in which decisions about the curriculum and instruction are driven by the exit learning outcomes that the students should display at the end of a programme or a course. By the end of educational experience, each student should have achievedthe outcomes.

Learning Outcomes based Curriculum Framework (LOCF) for Post Graduate Programmes-

IQAC MG University

One of the main objectives of OBE is to ensure continuous improvement of programmes in terms of maintaining the relevance in curriculum as well as responding to the requirements of the stakeholders. In other words, it ensures that Post graduate programme next year is better than Post graduate programme this year, offered by a department.

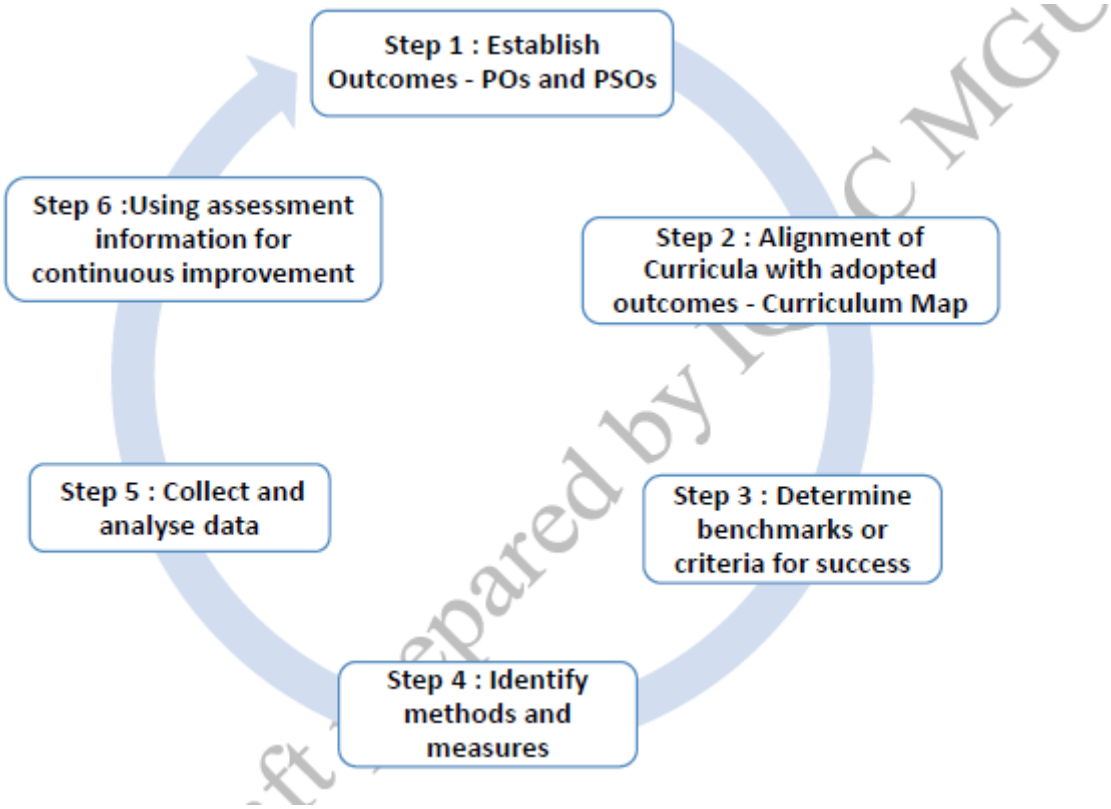
An OBE system has been proposed and to be implemented at various Departments of Mahatma Gandhi University, as a quality-assurance approach to improve teaching and learning

outcomes and processes. This OBE plan incorporates the "outcomes assessment" process to be followed in the departments. OBE should be a key driver of the curriculum management in allthe departments of the university.

The OBE is a 6 step process as shown in the figure

Figure: OBE Process

The process is presented as a cycle or a loop. The cycle represents the continuous nature of assessing learning outcomes.



As envisaged by the IQAC of Mahatma Gandhi university, an OBE based curricular framework has been proposed for the School of Biosciences from the academic year 2020-2021 which is presented hereafter.

School of Biosciences

The Life Science research of the University is carried out under the School of Biosciences, which is another prestigious department of the University and it provides academic expertise to students in advanced areas of Biochemistry, Microbiology, Biotechnology and Biophysics. The established research areas at School of Biosciences specifically include the Bioprocess technology, toxicology, ethnopharmacology, inflammation, ecology, ecotechnology, agricultural microbiology, immunobiology, medicinal plant research, probiotic development, microbial and natural product research, molecular microbiology etc. The department harbours a state -of-the-art instrumentation facility, animal maintenance facility and animal cell culture facility as well. The institute has been a successful aspirant in producing a large number of PhDs,and has completed several funded projects with significant number of publications.

Our Vision

* An Institution of excellence developing professional competence, ambition and determination in students to face new challenges and find new opportunities in the field of Biological Sciences and facilitating the wellbeing and prosperity of mankind especially our Mother Land by utilising the opportunities in advanced Biological research.

Key points

1. Institution of excellence
2. Professional competence, ambition and determination
3. New challenges and new oppurtunities
4. Well being and prosperity of nation and humanity
5. Utilise opportunities in research

Our Mission

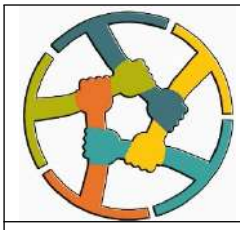
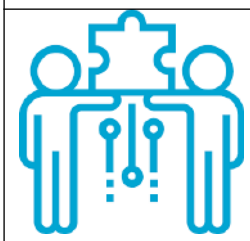
* To provide advanced knowledge and technological knowhow to the students in the field ofBiological sciences.
* To utilise the expertise of faculty in diverse areas of biology for benefitting the students inachieving their career goals.
* To conduct cutting-edge research in areas of life Sciences and to extend the knowledge gainedfrom lab to land and benchtop to bedside.

Key points

1. provide advanced knowledge and technological knowhow
2. To utilise the expertise of faculty
3. benefitting the students in achieving their career goals.
4. conduct cutting-edge research
5. extend the knowledge gained from lab to land and benchtop to bedside

	Mahatma Gandhi University **Graduate attributes**

	**Critical thinking and analytical reasoning**	Capability to analyze, evaluate and interpret evidence, arguments, claims, beliefs on the basis of empirical evidence; reflect relevant implications to the reality; formulate logical arguments; critically evaluate practices, policies and theories to develop knowledge and understanding; able to envisage the reflective thought to the implication on the society.
	**Scientific reasoning and Problem solving**	Ability to analyze, discuss, interpret and draw conclusions from quantitative/qualitative data and experimental evidences; and critically evaluate ideas, evidence and experiences from an unprejudiced and reasoned perspective; capacity to extrapolate from what one has learned and apply their competencies to solve problems and contextualize into researchand apply one's learning to real life situations.
	**Multidisciplinary/ Interdisciplinary/ Transdisciplinary approach**	Acquire interdisciplinary /multidisciplinary/ transdisciplinary knowledge base as a consequence of the learning they engage with their programme of study; develop a collaborative-multidisciplinary/interdisciplinary/transdisciplinary-approach for formulate constructive arguments and rational analysis for achieving common goals and objectives.
	**Intra and Interpersonal skills**	Ability to work effectively and respectfully with diverse teams;facilitate collaborative and coordinated effort on the part of a group,and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team; lead the team to guide people to the right destination, in a smooth and efficient way.
	**Digital literacy**	Capability to use ICT in a variety of learning situations, demonstrate ability to access, choose, collect and evaluate, and use a variety of relevant information sources; structure and evaluate those data for decision making.
	Global Citizenship	Building a sense of belonging to a common humanity and to become responsible and active

		global citizens. Appreciation and adaptation of different sociocultural setting and embrace and promote equity.
	**Social competency**	Possess knowledge of the values and beliefs of multiple cultures, appreciate and adapt to a global perspective; and capability to effectively engage in a multicultural society and interact respectfully, manage and lead with diverse groups.
	**Equity, Inclusiveness and Sustainability**	Appreciate and embrace equity, inclusiveness and sustainability and diversity; acquire ethical and moral reasoning and values of unity, secularism and national integration to enable to act as dignified citizens; able to understand and appreciate diversity
	**Lifelonglearning**	Continuous acquisition of knowledge and skills. Learn, unlearn and re-learn based on changing ecosystem. “Learning how to learn”, that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.

Programme Outcomes (PO)

PO 1: Critical Thinking and Analytical Reasoning
Capability to analyse, evaluate and interpret evidence, arguments, claims, beliefs on the basis of empirical evidence; reflect relevant implications to the reality; formulate logical arguments; critically evaluate practices, policies and theories to develop knowledge and understanding; able to envisage the reflective thought to the implication on the society.

PO 2 : Scientific Reasoning and Problem Solving
Ability to analyse, discuss, interpret and draw conclusions from quantitative/qualitative data and experimental evidences; and critically evaluate ideas, evidence and experiences from an unprejudiced and reasoned perspective; capacity to extrapolate from what one has learned and apply their competencies to solve problems and contextualise into researchand apply one's learning to real life situations.

PO 3: Multidisciplinary/Interdisciplinary/Transdisciplinary Approach
Acquire interdisciplinary /multidisciplinary/transdisciplinary knowledge base as a consequence of the learning they engage with their programme of study; develop a collaborative-multidisciplinary/interdisciplinary/transdisciplinary-approach for formulate constructive arguments and rational analysis for achieving common goals and objectives.

PO 4: Communication Skills
Ability to reflect and express thoughts and ideas effectively in verbal and nonverbal way; Communicate with others using appropriate channel; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner and articulate in a specific context of communication.

PO 5: Leadership Skills
Ability to work effectively and lead respectfully with diverse teams; setting direction, formulating an goal, building a team who can help achieve the goal, motivating and inspiring team members to engage with that goal, and using management skills to guide people to the right destination, in a smooth and efficient way.

PO 6: Social Consciousness and Responsibility
Ability to contemplate of the impact of research findings on conventional practices, and a clear understanding of responsibility towards societal needs and reaching the targets for attaining inclusive and sustainable development.

PO 7: Equity, Inclusiveness and Sustainability
Appreciate equity, inclusiveness and sustainability and diversity; acquire ethical and moral reasoning and values of unity, secularism and national integration to enable to act as dignified citizens; able to understand and appreciate diversity, managing diversity and use of an inclusive approach to the extent possible.

PO 8: Moral and Ethical Reasoning
Ability to embrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstrating the ability to identify ethical issues related to one's work and living as a dignified person in the society.

PO 9: Networking and Collaboration
Acquire skills to be able to collaborate and network with scholars in an educational institutions, professional organizations, research organizations and individuals in India and abroad.

PO 10: Lifelong Learning
Ability to acquire knowledge and skills, including "learning how to learn", that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed atpersonal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.

Programme outcome of MSc courses in School of Biosciences (PO)

To develop competent personnel in applied branches of life sciences with good academic standards, skill, technical knowhow, research aptitude, scientific ethics and societal consciousness.

Programme specific outcomes of M.Sc Microbiology

PSO1. To get in depth scientific knowledge about the prokaryotic and eukaryotic cellular, physiological and biochemical processes, interaction of microorganisms among themselves, with physical and chemical agents and beneficial and harmful effects and applications of microorganisms and to explore its immense scope both at the basic and application aspects.

PSO2. To meet the global demand for skilled scientific resources in microbiology, the program has been designed to understand the basics and advances of microbiology to accelerate the microbiological contributions for diverse applications by integrating the knowledge through interdisciplinary approach.

PSO3. To translate the technical knowhow in various branches of microbiology like the medical, industrial, food, agricultural and environmental microbiology for the well being of humans, other living forms and the environment and to motivate the innovation in microbiological applications for the emerging and existing challenges

PSO4. To generate trained human resources with the skills to use the microbiological methods, instrumentation tools, and technologies by following the standard operation procedures and scientific ethics for the research, clinical, agricultural, industrial and other commercial applications through the design and execution of microbiological experiments for both the local and global societies.

PSO5. To provide a vibrant and internationally competitive educational environment that fosters the development of scientific vocabulary, reasoning skills, entrepreneurial skills, communication abilities and societal consciousness

Programme Specific Outcomes (PSO) to Programme Outcomes (PO) Mapping – M.Sc. Microbiology

PSO	Programme Specific Outcomes (PSO)	MGU PO
1	To get in depth scientific knowledge about the prokaryotic and eukaryotic cellular, physiological and biochemical processes, interaction of microorganisms among themselves, with physical and chemical agents and beneficial and harmful effects and applications of microorganisms and to explore its immense scope both at the basic and application aspects.	**PO1, PO 2**
2	To meet the global demand for skilled scientific resources in microbiology, the program has been designed to understand the basics and advances of microbiology to accelerate the microbiological contributions for diverse applications by integrating the knowledge through interdisciplinary approach.	**PO1, PO4, PO6**
3	To translate the technical knowhow in various branches of microbiology like the medical, industrial, food, agricultural and environmental microbiology for the well being of humans, other living forms and the environment and to motivate the innovation in microbiological applications for the emerging and existing challenges	**PO3, PO5**
4	To generate trained human resources with the skills to use the microbiological methods, instrumentation tools, and technologies by following the standard operation procedures and scientific ethics for the research, clinical, agricultural, industrial and othercommercial applications through the design and execution of microbiological experiments for both the local and global societies.	**PO7, PO8, PO4**
5	To provide a vibrant and internationally competitive educational environment that fosters the development of scientific vocabulary, reasoning skills, entrepreneurial skills, communication abilities and societal consciousness	**PO9, PO10**

SCHEME OF MSc BIOTECHNOLOGY PROGRAMME

FIRST SEMESTER SCHEME

Course Code	Course Title	Credits
BSM 21C 01	Biochemistry	3
BSM 21C 02	Microbiology	3
BSM 21C 03	Cell Biology, Genetics & Evolution	3
BSM 21C 04	Biophysics & Biostatistics	3
BSM 21C 05	Physiology	3
	Entry level orientation programme in applied life sciences	0
BSM 21C 06	Laboratory Course – 1	2
BSM 21C 07	Laboratory Course – 2	2
	Total Credits for the first semester programme	19

SECOND SEMESTER SCHEME

BSM 21C 08	Immunology	3
BSM 21C 09	Molecular Biology and Genetic Engineering	3
BSM 21C 10	Metabolism and Bioenergetics	3
BSM 21C 11	Biophysical Techniques and Bioinstrumentation	3
BSM 21C 12	Laboratory Course–3	2
BSM 21C 13	Laboratory Course–4	2
	Two Elective Course to be selected from the options given below	3+3
	Total credits for the second semester programme	22
BSM 21E 14	Microbial Technology	3
BSM 21E 15	Ecology and Environment	3
BSM 21E 16	Neurobiology	3
BSM 21E 17	Environment Science	3
BSM 21E 18	Molecular Microbiology	3
BSM 21E 19	Developmental Biology	3
	Total Credits for the first semester programme	22

SCHEME OF THIRD SEMESTER MICROBIOLOGY		
Course No.	**Subject of the Course**	**Credits**

BSM 21C 30	Medical Microbiology	3
BSM 21C 31	Food Microbiology	3
BSM 21C 32	Industrial Microbiology	3
BSM 21C 33	Environmental Microbiology	3
BSM 21C 34	Laboratory Course – 5 (Microbiology)	2
BSM 21C 35	Laboratory Course – 6 (Microbiology)	2
Course from other departments	Open course	4
Total Credits of the 3rd Semester Programme in M.Sc. Microbiology		20

SCHEME OF FOURTH SEMESTER MICROBIOLOGY (Core courses 14 credits + Elective 6 credits: two elective courses)		
Course No.	**Subject of the Course**	**Credits**
BSM 21C 55	Agricultural Microbiology	3
BSM 21C 56	Lab Course 7 (Microbiology)	4
BSM 21C 57	Major Research Project	6
Elective 1	To be selected from among the elective courses offered	3
Elective 2	To be selected from among the elective courses offered	3
	Internship programme of 1-2 weeks	0
Total Credits of the 4th Semester Programme in M.Sc. Microbiology		19

MAHATMA GANDHI UNIVERSITY

BSM 21C 01: BIOCHEMISTRY

SchoolName	**School of Biosciences**					
Programme	**M.Sc. Biochemistry/Microbiology/Biotechnology/Biophysics**					
Course Name	**BIOCHEMISTRY**					
Type of Course	Core					
Course Code	**BSM 21C 01**					
Names of Academic Staff & Qualifications	1. **Prof. M S Latha – M. Sc (Biochemistry), PhD** 2. **Dr. Anie Y – M. Sc (Biochemistry), PhD** 3. **Guest faculty – M. Sc (Biochemistry), PhD**					
Course Summary & Justification	The course is designed to get a clear idea on the basic biomolecules and their importance in the various biochemical processes in life so that the course builds a base for the students to comprehend and articulate the advanced concepts in life sciences.					
Semester	First					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total LearningHours
	Eg. Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	Basic understanding of chemical groups and bonding; basics of cell biology and physiology					

O No.	**Expected Course Outcome**	**Learning Domains**	**PSO No.**
1	To identify the different types of biomolecules such as lipids, carbohydrates, proteins and nucleic acids	U	1
2	To differentiate the structural and functional characters of different biomolecules	A	1
3	To narrate the coordinated functions of different biomolecules in a complex living system	A/Ap	2
4	To compare the structure and functions of biomolecules in plants, animals and microbes	A	2
5	To describe the structure and functions of vitamins and hormones	U	1
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Course outcome	Hours
1	**Carbohydrates:** Classification of Carbohydrates with examples- monosaccharides, disaccharides and oligosaccharides; their structure and functions; Polysaccharides - occurrence, structure, isolation, properties and functions of homoglycans- starch, glycogen, cellulose, dextrin, inulin, chitins, xylans, arabinans, galactans. Occurrence, structure, properties, and functions of heteroglycans – bacterial cell wall polysaccharides, glycoaminoglycans, agar, alginic acid, pectins, amino sugars and deoxv sugars, blood group substances and sialic acids. Glycolipids and Glycoproteins and their biological applications. Lectin- structure and functions.	1,2,3 & 4	10
2	**Lipids:** Classification of lipids with examples; their structure and functions Complex lipids- phospholipids - classification, structure and functions. Ceramides and sphingomyelins. Eicosanoids, structure and functions of prostaglandins, thromboxanes, leukotrienes Types and functions of plasma lipoproteins. Amphipathic lipids - membranes, micelles, emulsions and liposomes. Steroids - cholesterol structure and biological role -bile acids, bile salts. Sterols in Plant system: Phytohormones: Brassinosterroids (functions); Sterols in microbial system: mycosterols.	1,2,3 & 4	10
3.	**Proteins:** Amino acids- Structure amd properties**,** Classification of proteins on the basis of solubility and shape, structure, and biological functions. Isolation, fractionation and purification of proteins. Denaturation and renaturation of proteins. Primary structure -determination of amino acid sequence of proteins. Ramachandran plot, Secondary, tertiary and quartenary structures of proteins. Detailed study on structure and function with an example: Fibrous Protein (Collagen) Globular protein (Hemoglobin)., Enzymes- Different classes and functions. Enzyme co factors, Enzyme kinetics, Enzyme substrare association models	1,2,3 & 4	20
4	**Nucleic Acids: Components of nucleic acids,** Watson - Crick model of DNA structure. A, B and Z DNA Cruciform structure in DNA, miscellaneous alternative conformation of DNA. Higher order organization of DNA. Methods for nucleic acid sequence determination, isolation and purification of DNA, molecular hybridization, Cot value curve, Reassociation kinetics, RNA Structure: Types of RNA; structure of mRNA, tRNA and rRNA, Si RNA, micro	1,2,3 & 4	10

	RNA with emphasis on importance of structure to its function		
5	**Vitamins and Hormones:** Vitamins -water soluble - thiamine, riboflavin, niacin, pyridoxine, folic acid, ascorbic acid-source, structure, biochemical functions, deficiency diseases, daily requirements; fat soluble -vitamin A, vitamin D2, vitamin E and vitamin K -sources, structure, biochemical functions, deficiency diseases, daily requirements. Hormones: different types, structures, their biological role and disorders. Mechanism of action of peptide and steroid hormones.	5	20
	Total Credits of the Course	3	

Books for Reference

Compulsory Reading:

1. Principles Of Biochemistry, 4/e (2006) by Robert Horton H , Laurence A Moran, Gray Scrimgeour K **Publisher:** Pearsarson **ISBN:** 0131977369, **ISBN-13:**9780131977365, 978-0131977365
2. Biochemistry 6th Edition (2007) by Jeremy M. berg John L. tymoczko Lubert Stryer **Publisher:** B.i.publicationsPvt.Ltd **ISBN:**071676766X **ISBN-13:** 9780716767664, 978-716767664

Lehninger Principles of Biochemistry, Fourth Edition by David L. Nelson
Michael M. Cox

13. Publisher: W. H. Freeman; Fourth Edition edition (April 23, 2004) ISBN-10: 0716743396 ISBN-13: 978-0716743392

Further Reading:

- Biochemistry: A Students survival Guide by Hiram. F. Gilbert (2002) Publishers: McGraw-Hill ISBN 0-07-135657-6
- Introduction to Biophysics by Pranab Kumar Banerjee (2008) Publishers: S. Chand & Company ltd ISBN: 81-219-3016-2
- **E.S. West**, **W.R. Todd**, **H.S. Mason and J.T. van Bruggen**, A **Text Book of Biochemistry**, Oxford and IBH Publishing Co., New Delhi, 1974
- Biochemistry [with Cdrom] (2004) by Donald Voet, Judith G. Voet **Publisher:** John Wiley & Sons Inc **ISBN:** 047119350X **ISBN-13:** 9780471193500, 978-0471193500
- Principles Of Biochemistry (1995) by Geoffrey L Zubay, William W Parson, Dennis E Vance **Publisher:** Mcgraw-hill Book Company – Koga **ISBN:**0697142752
  ISBN-13: 9780697142757, 978-0697142757

Molecular Biology of the Cell by Bruce Alberts, Alexander Johnson, Julian Lewis B000AP9VV4

, Martin Raff B000APBO7I

- , Keith Roberts, Peter Walter Publisher: Garland Science; 5 edition ISBN-10: 0815341059 ISBN-13: 978-0815341055
- Genes IX by Benjamin Lewin (2008) Publisher: J&b ISBN:0763752223 ISBN-13: 9780763752224, 978-0763752224

- Molecular Biology Of The Gene 5/e (s) by James D Watson, Tania A Baker, Stephen P Bell (2008) Publisher: Dorling Kindersley (India) Pvt Ltd ISBN: 8177581813 ISBN-13: 9788177581812, 978-8177581812
- Cell and Molecular Biology, 3e (2003) by Karp Publisher: Jw ISBN: 0471268909 ISBN-13: 9780471268901, 978-0471268901

Molecular Cell Biology (2002) by H.S. Bhamrah Publisher: Anmol Publications ISBN: 8126111429 ISBN-13: 9788126111428, 978-8126111428

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments, Authentic learning, Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** **A. Continuous Internal Assessment (CIA)** Internal Test -20 marks Assignment – Every student needs to write an assignment on a given topic based on the available published literature – 10 marks Seminar Presentation – A topic needs to be presented and discussed with the class- 10 marks **B. Semester End examination – 60 marks**

Approval Date	
Version	
Approval by	
Implementation Date	

MAHATMA GANDHI UNIVERSITY

BSM 21C 02: MICROBIOLOGY

SchoolName	**School of Biosciences**					
Programme	**Msc Biochemistry/ Microbiology/ Biotechnology/ Biophysics**					
Course Name	**MICROBIOLOGY**					
Type of Course	Core					
Course Code	**BSM 21C 02**					
Course Summary & Justification	This course on Microbiology introduces the milestones of Microbiology key components and their functions. The objective of the course content is to impart Knowledge on Landmark discoveries in Microbiology and different domains classification of living organisms. To develop 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.					
Semester	First					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	**Basics of General microbiology**					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Summarize the contributions made by prominent scientists in microbiology and bacterial taxonomy	E	1
2	Understanding of basic microbial structure and similarities and differences among various groups of microorganisms	U/ An	1
3	Exemplify basic tools to study these in the laboratory	S	2
4	Explain various factors affecting the microbial growth and nutritional requirements and will be acquainted with methods of measuring microbial growth	U/R	2
5	Analyse various methods for identification and sterilization of isolated microorganisms.	An	4

6	Create an insight to the interactions and characteristics of microorganisms	An/ C	2
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	**History and scope of microbiology:** The historical foundations and development of microbiology. An overview of microbial world. The bacteria and the archae. Classification of bacteria and Archaea according to the Bergey's Manual of Systematic Bacteriology. Tools for Systematics: Numerical taxonomy, Phylogenetic analysis, Polyphasic approach; Modern methods of studying microbial diversity; Microbial culture collections.	1 & 2	10
2	**Microbial Diversity:** Prokaryotic and eukaryotic microbial diversity. General characteristics of various groups of prokaryotes: bacteria including, Rickettsiae, Chlamydiae and Actinomycetes, Cyanobacteria and Mycoplasmas. Morphology and structure of bacteria. Viruses unique properties, morphology, structure and cultivation; Viroids and Prions.Viral replication. Viral diversity–bacterial, plant and animal viruses; Fungi – properties and classification. Microorganism in extreme environments.	1,2 & 3	20
3.	**Microbial physiology:** Factors influencing microbial growth. Environmental and nutritional factors. Nutritional types of bacteria. Microbial growth curve. Mathematical expression of growth- continuous and batch cultures. Diauxic and synchronous growth. Measurement of bacterial growth. Cultivation of bacteria- culture media and methods. Aerobic and Anaerobic culture methods. Culture preservation techniques. Microbial locomotion – flagellar motility, gliding motility and amoeboid motion. Chemotaxis, Phototaxis and other taxes. Microbial photosynthesis.	4	20
4	**Identification of bacteria and Sterilization methods:** Identification of bacteria. Staining reactions. Cultural, physiological and biochemical properties. Molecular methods for identification. Sterilisation – Principles and methods, physical and chemical methods. Disinfectants – modes of action. Testing of disinfectants. Antibiotics – mechanism of action. Drug resistance in bacteria. Antibiotic sensitivity tests	5	10
	Total Credits of the Course	3	

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning,

	interactive Instruction: Active co-operative learning, Seminar, Group Assignments Authentic learning: Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** C. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar. Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks D. **Semester End examination – 60 marks**

References

Compulsory Reading:

1. Prescott, L. M., Harley, J. P. and Klein, D. A.2014. *Microbiology*. 9th Edition. Edition, McGraw Hill Higher Education.
2. Pelczar, M. J. Jr., Chan, E. C. S. and Krieg, N. R. 1993. *Microbiology*, 5th Edition, Tata MacGraw Hill Press.

Further Reading:

1. Jeffrey C.Pommerville.2016.Alcamos fundamentals of microbiology. Tenth Edition. Jones and Bartlett Learning.
2. Tortora G. J., Funke B. R. and Case C. L. 2015. *Microbiology: An Introduction*. 12th Edition. Pearson Education Inc.
3. Madigan, M. T. and Martinko, J. M. 2015. *Brock's Biology of Microorganisms*. 14th Edition. Pearson Education Inc.
4. .Willey, J. M., Sherwood, L. M. and Woolverton, C. J. 2013. *Prescott's Microbiology*. 8th Edition, McGraw-Hill Higher Education.
5. Stanier, R. Y., Adelberg, E. A. and Ingraham, J. L. 1987. *General Microbiology*, 5th Edition. Macmillan Press Ltd.
6. Russell, A. D., Hugo, W. B., and Ayliffe, G. A. J. 2013. *Principles and practice of disinfection, preservation and sterilization*, 5thEdition. Blackwell Science, Oxford.
7. Black, J. G. 2013. *Microbiology: Principles and Explorations*. 6th Edition, John Wiley and Sons, Inc.

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	MAHATMA GANDHI UNIVERSITY
	BSM 21C 03: CELL BIOLOGY, GENETICS & EVOLUTION

SchoolName	**School of Biosciences**					
Programme	**Msc Biochemistry/ Microbiology/ Biotechnology/ Biophysics**					
Course Name	**CELL BIOLOGY, GENETICS & EVOLUTION**					
Type of Course	Core					
Course Code	**BSM 21C 03**					
Course Summary & Justification	This course on Cell Biology and Genetics deals with the frontier areas of basic biology The objective of the course content is to create a sound awareness about the current developments taking place in different fields of cell biology and genetics The course content is designed with a view to augment CSIR/UGC syllabus					
Semester	First					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	**Basics of cell biology and genetics**					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	**Build a perspective on current developments in the fields of cell biology, genetics and evolution and the cellular level organization of organisms**	E	1
2	**Compare and analyze the processes of cell cycle, cell division, cell differentiation and cell death and analyze the relationship between cell cycle, ageing, cell death and cancer**	U/ An	2
3	**Explain the processes, laws, and theories related to inheritance and evolution**	R	1
4	**Perform genetic mapping based on data supplied**	S	1 & 2

5	**Evaluate the behavior of genotypes and alleles in natural populations**	E	1 & 2
6	**Communicate effectively about a given topic in cellbiology/ genetics/ evolution both verbally and in writing**	An/ C	5
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	**Cell and its constituents: Cell constituents -** Mitochondria,Chloroplast, Endoplasmic Reticulum Golgi complex, Peroxisomes, Lysosome, Ribosome, Nucleus, Nucleolus, Chromosomes, Nucleosomes, Histones, Genome, Genomics, Proteomics. **Cell cycle and Cancer: Cell cycle-** Different stages, variations, checkpoints, regulations of cell cycle, maturation Promoting factor, cells, cyclins , ubiquitin, protein ligases, Anaphase Promoting complex, inhibitors of CdK, growth factors and D cyclins. Rb protein and E2F transcription factors. **Cancer -** Stages in cancer development, causes, properties of cancerous cells, tumor Viruses, oncogenes, functions of oncogene products, oncogene and signal Transduction , oncogene and G proteins, oncogene and cell survival, Tumor Suppressor gene, functions of tumor suppressor gene products, Diagnosis ,prevention and treatment of cancer	1, 2 & 6	10
2	**Cell Differentiation**-Stages of development, regulation of development, cascade control/ Differentiation in Drosophila, maternal, Segmentation and homeotic Genes, Genetic control of embryonic development, Bi thorax mutant, Antennapediac mutant ,Hemeobox **Aging** Process of aging, theories of aging, Arking's contribution Oxidative stress, Telomere problem, DNA repair defects. **Cell Death** Necrosis and Apoptosis, Differences between necrosis and Apoptosis, stages in Apoptosis, mitochondrial damage DNA ladders, transglutaminase activity, programmed cell death in *Ceanorhabdtis elegans* CED 3, CED 4, CED 9 and their roles in Apoptosis Bax, Bid, Bcl2 protein	1, 2 & 6	10
3.	**Classical Genetics:** Genetics, the evolution of the subject through pre mendelian, Mendelian and post Mendelian Peroids. Mendelism – the basis principles of inheritance, gene interactions – allelic and no allelic. Environment and gene expression, penetrance and expressivity. Multiple alleles and polygenic inheritance, Heritability and genetic advance **Evolution:** Origin of the universe and origin of life; concept of Oparin, Miller-Urey Experiments; Evolution of Prokaryotes -	3 & 6	20

	origin of eukaryotic cells - Margulis Endosymbiotic theory; **Geological Timescale:** Tools and techniques in estimating evolutionary time scale; **Theories of evolution of life**: Pre-Darwinian concepts – Lamarkism, Darwinism – major concepts - variation, adaptation, struggle, fitness and natural selection, Neo-Darwinian theories – theories of speciation – allopatric and sympatric speciation - Rose Mary and Peter Grant (Molecular evolution in Darwinian finches) - Neutral Theory of Molecular Evolution.		
4	**Chromasome genetic mapping ,Organelle Genetics and Population Genetics:** Linkage and linked genes with special reference to inheritance, Chromosome mapping with three - point test crosses. Organelle Genetics and cytoplasmic inheritance. Population Genetics – types of gene variations, Measuring genetic variations, Hardy Weinberg principle and its deviations. Medical genetics - an introduction	4, 5 & 6	10
5	**Genetic System in Microbe, Yeast and Neurospora:** Plasmids & bacterial sex. Types of plasmids. Plasmids copy number and incompatibility, Replication of plasmid. Plasmid a cloning vector. Episomes. Transposable element-IS element and transposon, Integrons and Antibiotic resistance cassettes, Multiple antibiotic resistant bacteria, Mu-virus. Gene mapping in Bacteria. Bacteriophage genetics-Plaque formation & phage mutants, genetic recombination in lytic cycle. Genetic system in Yeast & Neurospora.	4, 5 & 6	10
	Total Credits of the Course	3	

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks B. **Semester End examination – 60 marks**

REFERENCES

Compulsory Reading:

1. Jonathan B (2016) Principles of Evolution, Garland Science, Taylor and Francis
2. Strickberger M W (2015) Genetics 3rd Edition, Pearson
3. Genetics a conceptual approach. 6th edition. Benjamin Pierce, Macmillan Learning, New York
4. The Cell-A Molecular approach, Fifth edition, Geoffrey M Cooper and Robert E .Hausman. , ASM Press ,Washington DC

Further Reading:

1. Principles of Genetics, Snustad, Simmons and Jenkins, John Wiley And Sons Inc
2. Genetics, Robert Weaver and Philip Hendricks, WH.C. Brown Publishers, Iowa
3. Introduction to Genetic Analysis, Griffiths, Wessler, Lewontin, Gelbart,Suzuki and Miller, Freeman's and Co, New York
4. REA's Problem Solvers in Genetics, Research Education Association,61, Ethel Roadwest, New Jersey
5. Cell and Molecular Biology by Gerald Karp,7th Edition,
6. Cell and Molecular Biology by De Robertis E.D.P, 8th Edition

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MAHATMA GANDHI UNIVERSITY

BSM 21C 04: BIOPHYSICS AND BIOSTATISTICS

SchoolName	**School of Biosciences**					
Programme	**Msc Biochemistry/ Microbiology/ Biotechnology/ Biophysics**					
Course Name	**BIOPHYSICS AND BIOSTATISTICS**					
Type of Course	Core					
Course Code	**BSM 21C 04**					
Course Summary & Justification	This course is to introduce interdisciplinary Biophysics area, its scope and its importance. The objective of the course is to give an insight into the basic concepts of thermodynamics, importance of basic biophysical phenomena, conformation and conformational changes, interaction of protein with other molecules and basic knowledge about radiation, its interaction with matter and its applications. The course content is to familiarize the basic concepts of biostatistics and its importance in research area of Life sciences The course content is designed with a view to augment CSIR/UGC syllabus					
Semester	First					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	**Basics of** Biophysics and Biostatistics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Explain the scope and importance of biophysics	E	1
2	Describe the concepts of thermodynamics and applications of	U/ An	2

	basic biophysical phenomena.		
3	Narrate the conformation and interaction of proteins and nucleic acids	R	1 & 2
4	Explain the electromagnetic radiation, its interaction with matter and applications.	S	1 & 2
5	Perform the retrieval of biological information by using structural and sequence databases	E	1 & 2
6	Explain the basic concept of biostatistics and analyze, interpret statistical softwares and to do statistical design for their research	An/ C	1 & 2
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	**Biophysical phenomena and Thermodynamics of biomolecular interactions**: Scope and definition of Biophysics, Principle and biological importance of Osmosis, Electroosmosis, osmotic pressure, osmotic equilibrium, Donnan equilibrium, Diffusion, Sedimentation, Filtration, Surface tension, Dialysis, Adsorption and Colloids. Laws of thermodynamics, Enthalpy, Entropy, Free energy, Redox reactions, Redox potential and its calculation by Nernst equation, examples of redox reactions in biological system.	2	10
2	**Structural Biophysics and computational biology**: The molecular interactions between proteins and nucleic acids: DNA- protein interaction and RNA- protein interactions, DNA-binding motifs: Helix-turn-Helix motif, Zn fingers, Helix-loop helix motifs and Leucine zippers. Molecular forces: Hydrogen bonding, hydrophobic interactions, Dipole interactions: charge-dipole interactions, induced dipoles, steric repulsion, Vander waals force in biomolecules, Structural and Sequence databases, Alignment algorithms; Retrieval of biological information from widely used resources: NCBI and PDB, Molecular modelling and Structure based drug designing.	1, 3 & 5	10
3.	**Radiation Biophysics**: Electromagnetic spectrum, Ionizing and non ionizing radiation. Properties and biological effects of ultraviolet radiation, infrared and microwave radiations. Radioactivity, Interaction of radiation with matter. Units of Radiation. Biological effects of radiation. Applications of ionizing and non-ionising radiations in industry, agriculture and research. Radiation hazards.	1 &4	20

4	**Introduction to Biostatistics:** Scope of Biostatistics, probability and probability distribution analysis. Variables in biology- collection, classification and tabulation of data-graphical and diagrammatic representation- scatter diagrams, histograms- frequency polygon- frequency curve-logarithmic curves. Descriptive statistics- measures of central tendency, Arithmetic mean, median, mode, geometric mean, harmonic mean. Measures of dispersion, standard deviation, standard error, variance, coefficient of variation. Correlation and Regression	5	10
5	**Test of significance:** Basic idea of significance test-hypothesis testing, levels of significance. Testing of single mean, double mean, single proportion, double proportion in large sample. Testing of single mean, double mean and Paired-t in small sample. ANOVA- One way and Two way; Chi-square test of goodness of fit and Chi-square test of independence, comparison of means of two samples, three or more samples. Fundamentals of field experiments-randomization, replication and local control. CRD and RBD. Statistical packages	5 & 6	10
	Total Credits of the Course	3	

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks B. **Semester End examination – 60 marks**

REFERENCES

Compulsory Reading:

1. Proteins, Structure and molecular properties, Thomas E Creighton
2. Fundamentals of Biostatistics: Irfan.A. khan, Atiya Khanum, Ukaaz publications
3. Principles of Biostatistics: Marcello Pagano, Kimberlee Gauvreau, Duxbury Press

4. Biochemistry: Donald Voet and Judith G Voet, Wiley Publications

Further Reading:

5. Biophysics-Hoope W etal
6. Biophysics-Volkenstain M.V
7. Molecular Biophysics- Volkenstain M.V
8. Introduction to thermodynamics of irreversible process-John Wiley
9. Statistical methods in Biology- Briley N.J.T
10. Introduction to Biophysics-Sokal R.R & Rohl F.J
11. Biostatistics: Pardeep.K.Jasra, Gurdeep Raj, Krishna prakashan Media.(P) Ltd
12. Bloomfield, V. (2009) Computer Simulation and Data Analysis in Molecular Biology and Biophysics. Springer

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MAHATMA GANDHI UNIVERSITY

BSM 21C 05: PHYSIOLOGY

SchoolName	**School of Biosciences**					
Programme	**MSc Biochemistry/ Microbiology/ Biotechnology/ Biophysics**					
Course Name	**PHYSIOLOGY**					
Type of Course	Core					
Course Code	**BSM 21C 05**					
Course Summary & Justification	This course is designed to provide an overview of human physiology. Course topics will include the various systems of the body, functions of each system, and interrelationships to maintain the internal environment. The course also provides inputs to physiological stress and adaptive strategies to overcome stress					
Semester	First					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total LearningHours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	**Basics Knowledge in Biology**					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Students should be capable of effectively communicating how the human body works	U	1
2	Students should be able to explain interrelationships among molecular, cellular, tissue, and organ functions in each system	E	1 & 2
3	Students should be able to describe the interdependency and interactions of the systems	A	1 & 2
4	Students should be able to explain contributions of organs and systems to the maintenance of homeostasis	A	1 & 2
5	Students should be able to identify causes and effects of homeostatic imbalances	E	1 & 2
6	Able to gain the approaches used to study various	I	1 & 2

	functional systems of the human body and physiologic adaptation		

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	The system as a basic unit in physiology: different systems in physiological process, interaction of different systems in normal and stress conditions, homeostasis, Neuro-Musculo-Skeletal systems: brain and peripheral nervous systems, neurotransmitters, synapse, neuro-muscular junction, musculoskeletal systems	1	10
2	Cardio-Pulmonary & Renal Physiology: Anatomy and general function of heart, blood and hemodynamic, blood pressure, heart rate, cardiac cycle, cardiac output, electrocardiography, echocardiography; anatomy of the respiratory system, principles of respiratory mechanisms, respiratory rate, lung volumes, oxygen uptake, lung function tests, gas transport; anatomy of the excretory system, nephron, glomerular filtration rate, urine formation, renal clearance test, renal regulation of electrolytes, dialysis	1, 2 & 3	20
3.	Principles of endocrinology: Role of hormones for maintenance of the internal environment, hormone transport in blood, mechanism of hormone action, hormone metabolism and excretion, types of endocrine disorders, hypothalamus and pituitary, thyroid, adrenal glands, endocrine control of growth, sex hormones, pancreatic hormones, neurohormones	1, 4 & 5	10
4	Gastrointestinal Physiology & Nutrition: Gastrointestinal structure, food digestion, and absorption, gastrointestinal hormones, central control of gastrointestinal functions, pathological situations of gastrointestinal functions. role of liver and bile in gastrointestinal functions.	3 & 6	10
5	Stress physiology: Stress-responses, the role of the hypothalamic-hypophyseal-adrenal axis, oxidative stress and mechanism, effect of stress-inducing and anti-stress agents, cardio-respiratory responses during high altitude acclimatization, stress-induced diseases, and remedy, Human tolerances to stresses in space including space flight: Physiological adaptation to space flight, physiology in deep-sea diving and other high-pressure operations	6	10
	Total Credits of the Course	3	60

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks B. **Semester End examination – 60 marks**

REFERENCES

Compulsory Reading

1. Vander's Human Physiology- The mechanism of body function. Widmaier, Raff & Strang
2. Textbook of Medical Physiology. Arthur.C. Guyton& John.E. Hall
3. Physiological basis of Medical Practice. John.B. West
4. Endocrinology- Mac E Hadley

Further Reading:

1. Review of Medical Physiology- Ganong, William F
2. Biochemistry and Physiology of the cell. An introductory text second edition- Edwards, N. A Hassall, K.A
3. Notebook of medical physiology: endocrinology, with aspects of maternal, fetal and neonatal physiology- Hawker, Ross Wilson
4. Human Physiology: an integrated approach- Silverthorn, Dee Unglaub
5. Principles of anatomy and physiology- Tortora, Gerald J Derrickson, Bryan
6. Textbook of Endocrine Physiology- Griffin, James E; Ed. Ojeda, Sergio R;Ed

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MAHATMA GANDHI UNIVERSITY

BSM 21C 06: LABORATORY COURSE 1

SchoolName	**School of Biosciences**					
Programme	**M.Sc. Biochemistry/Microbiology/Biotechnology/Biophysics**					
Course Name	**LABORATORY COURSE 1**					
Type of Course	Core					
Course Code	**BSM 21C 06**					
Course Summary & Justification	The course is designed to develop in students the essential skills to perform the basic biochemical assays, qualitative analysis of biomolecules and techniques for the separation of biomolecules. This will enhance the practical abilities of the students to carry out the analysis of biomolecules.					
Semester	First					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Eg. Authentic learning Collaborative learning Independent learning	10	20	180	30	240
Pre-requisite	General idea on reagents and solvents					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	To prepare reagents, buffers and other solutions in required concentrations and required pH.	Ap	4
2	To extract and estimate different bio-molecules (sugar, cholesterol, and proteins) in biological samples	Ap/S	4
3	To identify the different components in a mixture of carbohydrates	S	4
4	To detect the presence of albumin, casein and gelatin in biological samples	S	4 & 5
5	To perform separation by Paper and Thin layer chromatography	S	4 & 5

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Module No	Module Content	Course outcom	Hours

		e	
1	Preparation of solutions: Percentage solutions, Molar solutions, Normal solutions, Dilution of Stock solutions, Preparation of buffers using the Henderson Hasselbach equation	1	30
2	Spectrophotometric experiments: Verification of Beer Lambert's law, Determination of UV-Visible spectrum of compounds, Determination of Concentration of molecules from Molar Extinction Coefficient values Extraction of Polysaccharides (Starch/Glycogen), Proteins, and Lipids from appropriate sources and their estimations. Estimations: Estimation of reducing sugars by Dinitrosalicylic acid method, Estimation of proteins (Biuret and Lowry's methods), Estimation of Methionine by Nitroprusside method, Estimation of Cholesterol by Zak's method.	2	60
3.	Qualitative analysis of Carbohydrate mixtures (a combination of polysaccharide, disaccharide and monosaccharide) following systematic scheme for analysis. (Starch, dextrin, glycogen, glucose, fructose, xylose, galactose, sucrose, maltose, lactose) Qualitative analysis of proteins- Albumin, casein, gelatin	3 & 4	60
4	Chromatographic techniques: Separation of amino acids by Paper chromatography (Descending or Ascending), Separation of Plant pigments by Thin layer chromatography	5	30
	Total Credits of the Course	3	

Books for Reference

Compulsory Reading:

1. Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi, ISBN 81-7319-302-9, p 195 – 303

2. Standard Methods of Biochemical Analysis, S. K. Thimmaiah (ed), Kalyani Publishers, Ludhiana ISBN 81-7663-067-5, p 12 - 182.

Further Reading:

3. Hawk's Physiological Chemistry, Bernard L. Oser (ed) TATA McGRAW Hill Publishing Company LTD, New Delhi, p 60 – 127, 1317- 1334

4. Experimental Biochemistry: A Student Companion, Beedu Sasidhar Rao & Vijay Deshpande (ed), I.K International Pvt. LTD, New Delhi ISBN 81-88237-41-8, p 13-17, p 49 - 72

5. Practical Biochemistry, R.C. Gupta & S. Bhargava (eds) CBS Publishers and Distributors, New Delhi, ISBN 81-239-0124-0 p 9 – 27

6. Practical Clinical Chemistry, Harold Varley, CBS Publishers and Distributors, New Delhi,

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Explicit Teaching, interactive Instruction: Active co-operative learning and skill development, Demonstrations, Group Assignments, Authentic learning, Library work and Group discussion, Preparation of experiment design and reports
Assessment Types	**Mode of Assessment** **C. Continuous Internal Assessment (CIA)** Assessment of the performance of student in the lab- 10 marks Internal Test -20 marks Project report (student needs to perform experiments on a specific project and report should be prepared)– 10 marks **D. Semester End examination – 60 marks**

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MAHATMA GANDHI UNIVERSITY

BSM 21C 07LABORATORY COURSE-2

SchoolName	**School of Biosciences**					
Programme	**MSc Biochemistry/ Microbiology/ Biotechnology/ Biophysics**					
Course Name	**LABORATORY COURSE-2**					
Type of Course	Core					
Course Code	**BSM 21C 07**					
Course Summary & Justification	The purpose of this laboratory course is to provide the student with the opportunity to observe many physiological principles. The course is designed to understand the mechanisms related to cardiovascular and respiratory functions.					
Semester	First					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	5	5	180		190
Pre-requisite	**Basics Knowledge in Biology**					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Apply appropriate safety standards in laboratory	A	4 & 5
2	Acquire laboratory skills in haematology, cardiovascular and respiratory physiology	S	4
3	Appropriately utilize laboratory equipment, such as microscopes, dissection tools, general labware, physiology data acquisition systems	S	4 & 5
4	Communicate results of scientific investigations, analyse data, and formulate conclusions	C	5

5	Students should be able to identify cell structure	U	4
6	Work collaboratively to perform experiments	I	5
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	**Haematology** i) Determination of haemoglobin concentration ii) Enumeration of formed elements- red blood cells & white blood cells iii) Study of blood smear for the differential count and cell morphology iv) Erythrocyte sedimentation rate v) Determination of the bleeding time vi) Determination of clotting time	1, 2, 5 & 6	60
2	**Respiratory physiology- Pulmonary function testing** i) Demonstration on the recording of tidal volume ii) Demonstration on the recording of vital capacities iii) Demonstration on the recording of inspiratory & expiratory flow rates	1, 3 & 6	60
3.	**Cardiovascular physiology- Electrocardiography** i) Demonstration on ECG recording- human or animal model ii) Identification of ECG waves iii) Calculation of heart rate from ECG	1, 3, 4 & 6	60
	Total Credits of the Course	3	180

Teachingand LearningApproach	**Laboratory Procedure (Mode of transaction)** Direct Instruction: lecture, Explicit Teaching, Demonstration, Hands on experimental sections, Skill acquisition by laboratory training
Assessment Types	**Mode of Assessment** E. Continuous Internal Assessment (CIA) 1. Internal Laboratory Skill Tests of maximum 20 marks 2. Seminar Presentation – Laboratory material and methods Maximum marks 10 3. Write a detailed report on instrumentation – 10 marks F. **Semester End Practical examination – 60 marks**

REFERENCES

1. Medical Laboratory Technology-A Procedure Manual for Routine Diagnostic Tests- Kanai L Mukherjee
2. Pocket Guide to Spirometry- David P Johns and Rob Pierce
3. Spirometry in Practice- A practical guide to using spirometry in primary care- Dr. David Bellamy, British Thoracic Society COPD consortium.
4. ECGs made easy- Barbara J Aehlert

Further Reading:

1.ECG Assessment and Interpretation- Cascio, Toni
2.Introduction to medical laboratory technology- Baker, F J Silverton, R E
3.Practical haematology- Dacie, John V Lewis, S.M

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MAHATMA GANDHI UNIVERSITY

SBSNCC 1 Entry level orientation programme in applied life sciences

SchoolName	School of Biosciences
Programme	M.Sc. Biochemistry, Biotechnology, Microbiology, Biophysics
Course Name	Entry level orientation programme in applied life sciences
Type of Course	Noncredit course
Course Code	SBSNCC 1
Course Summary & Justification	The proposed course is offered as a noncredit mandatory course at the entry level for all the PG students of school of Biosciences. The course content is inclusive of the scope and opportunities in various branches of

	applied life sciences along with suitable discussion on the preliminary aspects of lab training. It gives an orientation to the students coming from different disciplines of life science graduation and brings them to a common platform for further learning. This is a two week long bridging course					
Semester	First					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60		0		60
Pre-requisite	Fundamental Knowledge in Life Sciences					

COURSEOUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1.	The students from various branches of life sciences are brought to a common platform	R/U	1
2.	The students will be getting a clear understanding of the different opportunities in their subject	R/U	1
3.	The course focusses on the requirement of awareness on good laboratory practices	U/ An	1
4.	The proposed entry stage training offers a good exposure to the field of research	U/An	1
5.	The students will be exposed to certain preliminary requirements for initiating startups, getting into QC, R&D	C/S	1
6.	The students on completing this entry stage course will be able to get along with the two-year course with a defined objective	A/S	1
******Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	**Scope of the subject** Introducing the subject of Biochemistry, Biotechnology, Microbiology, Biophysics. Importance and recent trends, Opportunities. Method of teaching, learning and evaluation. Outcome based Education, Credit and semester system.	1	10
2	**Good laboratory practices** Laboratory instructions , Handling of Chemicals, Basics of weights and measureents, handling of equipment, Lab procedure, keeping of Lab record, Personal qualities and scientific conduct.	3	20
3.	**Basic Chemistry for Lab Work** Preparation of solutions, Methods for expressing concentration of solution, Colligative properties, Normality, Molarity, Molality, Mole fraction. pH, Buffering system, Examples Henderson Hasselbalch Equation.	5	10
4	**Research opportunities** Introduction to research, research aptitude, experimental design and research conduct, research problems, recent trends, Concept of research paper and review writing, plagiarism, Grammar editing softwares Regulatory bodies in life sciences, Patents and patent rules, Ethical Concepts-Research ethics, Bioethics. CSIR, UGC, GATE, DBT, DST, ICMR, ICAR, KSCSTE, fellowships, Projects, Opportunities.	1, 2 & 4	10
5	**Job opportunities** Introduction to Entrepreneurial process and types of Business, opportunities, Startups, Basics of marketing, Quality control and management, R and D management, Innovation and knowledge management, Knowledge economy, Upskilling, Project preparation, team building,	1, 5 & 6	10
	Total Credits	**0**	

Teaching And Learning Approach	**Classroom Procedure (Mode of transaction)**
	Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction, Active co-operative learning, Seminar, Group Assignments Authentic learning, Library work and Group discussion, Presentation by individual student/ Group representative

Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) B. Write a detailed report on a given topic based on research findings and literature search (Graded as very good, satisfactory and not satisfactory)

REFERENCES

Compulsory Reading: **1.Principles and techniques of Biochemistry and Molecular biology, Andreas Hofmann and Samuel Clokie, Cambridge University Press, 8 th edition,2018** **2.Holmes D ., Moody P and Dine D.(2010).Research methods for the Biosciences,2 nd Editions, Oxford University Press,Oxford, UK.** **3.Smith D (2003).Five Principles for research ethics, Monitor on Psychology 34. 56.**
Further Reading: **4.Taylor P.L.(2007).Research sharing, ethics and public benefit. Nature Biotechnology, 25,398-401.** **5.Duke C.S. and Porter J.H (2013).The ethics of data sharing and reuse in Biology, Bioscience 63,483-489.**

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SECOND SEMESTER

MAHATMA GANDHI UNIVERSITY

BSM 21C 08 IMMUNOLOGY

SchoolName	School of Biosciences					
Programme	M.Sc. Microbiology/Biotechnology/Biochemistry/Biophysics					
Course Name	IMMUNOLOGY					
Type of Course	Core					
Course Code	**BSM 21C 08**					
Course Summary & Justification	This course on Immunology deals with various mechanisms and processes involved in the defense responses. This course is an important branch of life science. Human body has different lines of defense to fight against pathogens. The content in this course has been designed with an objective to provide detailed understanding on the process and mechanisms involved in the defense responses. Understanding on the functioning of immune system is highly essential for a student to explore its theoretical and practical aspects for the benefit of society.					
Semester	Second					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	Basic understanding on defense responses Knowledge in any branch of Life science					

COURSEOUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1.	Students will able to understand and explain basic principles of immunology	R/U	1
2.	Students will able to learn the recent advances in immunology	R/U	1
3.	Students will able to analyse the clinical importance of immunological reactions	U/ An	5
4.	Students will become able to identify the correlation between immunological abnormalities and health status of humans	U/An	4
5.	Students will get theoretical and technical know-how for the laboratory diagnosis of infectious diseases	C/S	1 & 4
6.	Students can apply the knowledge and skills for clinical and diagnostic applications	A/S	4 & 5
**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	Infection, Source and methods of transmission, Immunity- Types of immunity. Mechanisms of innate immunity, PAMPs, pattern recognition receptors, types, scavenger receptors and toll – like receptors, Phagocytes and Phagocytosis, Organs and cells with immune functions. Lymphocytes and lymphocyte maturation. PAMPs and PRRs in plants	1	10
2	Antigens, Epitopes and paratopes, B-cell and T-cell epitope, Antigenicity and Immunogenicity, Antibodies, Immunoglobulin – structure, classes and functions. Genetic basis of antibody diversity, Organization and Expression of Immunoglobulin Genes, V(D)J rearrangements; recombination signal sequences and their role, somatic hypermutation and affinity maturation	1 & 2	20

	Antigen-antibody reactions, Agglutination, Precipitation, Immunoflourescence, Complement fixation, Radioimmuno assay, ELISA, Western blotting		
3.	Immune response- Humoral and cell mediated, Receptors on T and B cells for antigens, MHC, TCR- mediated signalling, Signal transduction pathways associated with T-cell activation, Signal transduction by activated B- cell receptor, Antibody production, Primary and secondary immune response, Factors influencing antibody production, Clonal selection theory, Monoclonal antibodies – production and application, Antibody engineering. Complement system, Complement activation, Biological effects of complements, Antigen processing and presentation, Activation of T-cells, T cell function, Cytokines. Human microbiome and immunity	2, 3 & 4	10
4	Immunology of organ and tissue transplantation, Allograft reaction and GVH reaction, Factors influencing allograft survival, Immunology of malignancy, Tumor antigens, Immune response in malignancy, Immunotherapy of cancer, Immunohematology, ABO and Rh blood group system, Immunology of blood transfusion, Hemolytic disease of new born	2, 4 & 5	10
5	Immunological Tolerance, Autoimmunity, Mechanisms of autoimmunization, Autoimmune diseases. Inflammation, Hypersensitivity – immediate and delayed reactions, Clinical types of hypersensitivity, Immunodeficiency diseases, Immunoprophylaxis, Vaccines –types of vaccines, DNA vaccine, recent trends in vaccine development.	2 & 6	10
	Total Credits	**3**	

Teaching And Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction, Active co-operative learning, Seminar, Group Assignments Authentic learning, Library work and Group discussion, Presentation by individual student/ Group representative

Assessment Types	**Mode of Assessment** C. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar - Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks D. Semester End examination – 60 marks

REFERENCES

Compulsory Reading:

1. Immunology - Thomas J. Kindt, Barbara A. Osborne, Richard A. Goldsby, and Janis Kuby, W H Freeman and Co., 2013
2. Immunobiology - Charles A. Janeway Jr.,Paul Travers, Mark Walport and Mark J. Shlomchik, Garland Publishing., 2016

Further Reading:

3. Essential Immunology - Ivan M. Roitt and Peter J delves, Blackwell Publishing, 2016
4. Essential Clinical Immunology – Helen Chappel and Mansel Haeney, ELBS/Blackwell Scientific Publications, 2014
5. Introduction to Immunology – John W, Kimball Maxwell, Mac Millan International Edition, 1990
6. Text book of Microbiology – R. Ananthanarayanan and C K Jayaram Panicker. Orient Longman,2013

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MAHATMA GANDHI UNIVERSITY

BSM 21C 09 MOLECULAR BIOLOGY AND GENETIC ENGINEERING

School Name	**School of Biosciences**					
Programme	**Msc Biochemistry/ Microbiology/ Biotechnology/ Biophysics**					
Course Name	**Molecular Biology and Genetic Engineering**					
Type of Course	Core					
Course Code	**BSM 21C 09**					
Course Summary & Justification	1. Molecular Biology and Genetic Engineering is one of the most dynamic and attractive courses in all branches of applied life sciences 2. The syllabus content in this paper is designed with an objective to train the students in both theoretical and practical aspects of the subject 3. This will also enable the students to get an idea about the latest developments taking place in this subject					
Semester	second					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	Basics of cell and molecular biology, Basics of tools and techniques of genetic engineering					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	On completing this course the students will be able to Explain the processes of replication, transcription and translation and analyse the importance of these processes in health and disease	E	1
2	Explain the concepts of gene regulation in prokaryotes and RNA world	R/ E	1
3	Analyse the use of different tools and techniques of gene cloning in E coli and explain the applications of DNA technology	U	4
4	Ability to develop a protocol for cloning a gene from a selected organism	A	4 & 5

5	Ability to explain verbally and orally the concepts of molecular biology and genetic engineering	E	1 &5
6	Ability to write a research proposal based on the concepts discussed in the course	An/ C	5
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	**DNA Rr Replication–** Process of DNA replication, Semiconservative, discontinuous uni and bidirectional , Okazaki fragments, DNA polymerases in eukaryotes and prokaryotes , Klenov fragment, modes of replication, theta, rolling circle, d-loop replication, Primasome, SSB, Helicase, Ligase, methylation and control, repetitive DNA sequences, minisatellite, microsatellite, DNA protein interation DNA Linking number and topoisomerase, Inhibition of replication.	1, 5 & 6	10
2	**Transcription**. Process of transcription, stages in transcription, RNA polymerases in prokaryotes and enkaryotes, sigmafactor in prokaryotes, Rho dependant and Rho independent termination. Enhancers, Transcription factors in Eukaryotes, Differences in transcription between prokaryotes and Eukaryotes, post transcriptional modifications-Polyadenylation, capping, r-RNA processing, Splicing-Spliceosome, lariat structure, Group 1, II and III Introns Rihozyme, Importance of ribozyme, properties, application, RNase P, RNAse III, RNAse H. monocistonic and polysistronic m-RNA, Joint transcript of r-RNA and t-RNA in prokaryotes and their processing, Transplicing, alternate splicing, inhibitors of Transcription. Molecular mechanism of gene regulation in prokaryotes-Transcriptional regulation in prokaryotes; Inducible & repressible system,+ & -ve regulation; Operon concept, structure of operon, Lac, Trp, Arc operon, Catabolic repression, Atteunation. Role of Hormones in gene regulation. RNA World, RNA based technology- Molecular mechanism of Ribozyme, Antisense RNA, SiRNA, MicroRNA, Ribozwitches & their applications; Telomerase structure and function, Nucleic acid as therapeutic agent	1, 2, 5& 6	15
3.	**Translation:** Process of translation. Stages in translation, genetic code, properties, wobble hypothesis, eukaryotes and prokaryotes ribosomes, m-RNAs, t-RNAs, aminoacyl t-RNA synthatases, protein factors initiation complex, peptidyl transferase, releasing factors, differences between prokaryotic and eukaryotic systems, inhibition of translation. Post translation modification by cleavage, self assembly assisted self assembly chaperones, acylation, phosphorylation,	2, 5 & 6	10

	acetylation and glycosylation, Histone acetylation and deacetylases, chromosome remodeling complex. Intein splicing. Protein targeting, cotranslational import, post translational import, SRP- structure and function, Blobel's concept, Lysosome targeting, M6P address Glycosylation core glycosylation terminal glycosylation, Dolichol phosphate.		
4	**Tools and techniques for genetic Engineering:** History of rDNA Technology ,Cohen And Boyer Patents, Isolation of DNA and RNA from different sources, enzymes used in genetic engineering with special reference to restriction enzymes, ligases, and other DNA modifying enzymes. End modification of restriction fragments, vaccinia topoisomerases mediated ligation of DNA, TA cloning, and homopolymer tailing Vectors for E coli with special reference to plasmid vectors (pSC101, pBR322,pUC,their development, features and selection procedures),direct selection plasmid vectors, low copy number plasmid vectors, runaway plasmid vectors, Bacteriophages (λ and M13) with special reference to Charon phages, λEMBL, λWES λB', λ ZAP- their development, features, selection procedures, *in vitro* packaging mechanisms for phage vectors, cosmids, features, advantages and cosmid cloning schemes, phagemids with special reference to pEMBL, pBluescript, pGEM3Z , pSP64, pcDNA, pLITMUS Construction of genomic libraries and cDNA libraries, procedures for recombinant selection and library screening, PCR enzymes, types of PCR, primer design, real time PCR, RTPCR, Nested PCR, Inverse PCR, Assymmetric PCR, applications of PCR Cloning, Chemical synthesis of DNA, DNA sequencing:- plus and minus sequencing, Sangers dideoxy sequencing, Maxam and Gilberts method. Advanced sequencing procedures: – pyrosequencing, Illumina, ABI / SOLiD and their applications	3, 4, 5 & 6	20
5	**Appications of Genetic Engineering:** Applications of transgenic Technology Improving quality, quantity and storage life of fruits and vegetables. Plants with novel features, Engineering metabolic pathways, Pharming. Animal cloning, Ethics of cloning. Applications of Molecular Biology in forensic sciences, medical science, archeology and paleontology	3, 4, 5 & 6	5
	Total Credits of the Course	3	

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion, Presentation by individual student/ Group representative
Assessment	

Types	Mode of Assessment
	E. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks F. **Semester End examination – 60 marks**

REFERENCES

Compulsory Reading:

1. Principles of gene manipulation – Old and Primrose, Blackwell Scientific publishers, Edn.5th
2. Cell and Molecular Biology by Cooper

Further Reading:

8. Principles of gene manipulation – Old and Primrose, Blackwell Scientific publishers, Edn.5th
9. Principles of gene manipulation – Old, Primrose, and Twyman, Blackwell Scientific publishers, Edn. 6th
10. Principles of gene manipulation – Old, Primrose, and Twyman Blackwell Scientific publishers, Edn 7th
11. Molecular biotechnology, Principles and Applications of Recombinant DNA, Glick Pasternak and Patten, 4th edition ISBN 978-1-55581-498-4 Wiley International Publishers
12. From gene to genomes – Concepts and applications of DNA technology Jeromy W Dale and Malcom von Shantz , John Wiley and sons
13. Principles of plant biotechnology: An introduction to genetic engineering in plants – SH Mantell
14. Cell and Molecular Biology by Gerald Karp, Academic Press
15. Cell Biology by DeRobertis
16. Genes-Benjamin Lewin

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MAHATMA GANDHI UNIVERSITY

BSM 21C 10: METABOLISM AND BIOENERGETICS

SchoolName	**School of Biosciences**					
Programme	**M.Sc. Biochemistry/Microbiology/Biotechnology/Biophysics**					
Course Name	**METABOLISM AND BIOENERGETICS**					
Type of Course	Core					
Course Code	**BSM 21C 10**					
Course Summary & Justification	The course is designed to get a deep knowledge of metabolic processes taking place in the biological systems and their regulation, which is needed to understand the more specialised areas of Biochemistry.					
Semester	Second					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Eg. Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	Basic understanding of chemical groups and bonding; basics of cell biology and physiology					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	To be able to categorize, differentiate and predict the fates of different biomolecules via the metabolic pathways.	U/A	1 & 2
2	To draw conclusions on the energetics of the metabolic pathways and to find out the variations in ATP	A	2

	generation during physiological and pathological conditions		
3	To analyse different methods of regulation of the metabolic pathways.	A/An	4
4	Describe the different steps involved and the importance of metabolomics in toxicity analysis and health management	A	4
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Course outcome	Hours
1	**Metabolic Pathways:** Detailed study on the catabolic pathways & anabolic Pathways -Carbohydrate, Protein, Amino acid and Nucleic acid metabolic pathways.	1	20
2	**Bioenergetics:** Functional significance of the mitochondrial respiratory chain and oxidative phosphorylation, Electron transport chain: structural components of the chain, complexes, free elements; Structure and functional properties of cytochromes, ferro-sulphurated proteins and CoQ; Generation of the electrochemical proton gradient: Chemiosmosis ATP synthesis- Proton flow through ATP synthase, Rotational catalysis. Inhibitors and uncouplers	1 & 2	15
3.	**Regulation of metabolism:** Hormonal and Allosteric regulation of pathways in carbohydrate, lipid, nucleotide, amino acid and protein metabolism; Coordinated regulation of opposing metabolic pathways; Regulation of mitochondrial electron transport and oxidative phosphorylation.	3	10
4	**Signal Transduction:** intracellular receptor and cell surface receptors signaling: Cyclic AMP-dependent protein kinase; Cyclic GMP-dependent protein kinase; Protein kinase C; Ca^{2+} -calmodulin-dependent protein kinases ; AMP-dependent protein kinase ; Receptor tyrosine kinases; Protein kinase B; Cytokine activation of the JAK'/STAT pathway; Cell cycle control; Receptor serine/threonine kinases; Other protein kinases ; Phosphoprotein phosphatases; Cancer Pathways: MAPK, P13K, TP53 network, NF*k*B pathways; Signalling by TGF β factor , STAT factor	3	10
5	**Metabolomics:** Introduction to origins of metabolomics; define terms: Metabolite, Metabolome, Metabonomics; Analytical techniques in study of Metabolomics (Principle	4	5

	& Methodolgy): Separation methods: Gas Chromatography, HPLC, Capillary Electrophoresis; Detection Methods: Mass spectroscopy, NMR. Applications of Metabolomics in toxicity assessment/ toxicology, diagnostics and health Screening		
	Total Credits of the Course	3	

Books for Reference

Compulsory Reading:

1. Principles Of Biochemistry, 4/e (2006) by Robert Horton H , Laurence A Moran, Gray Scrimgeour K **Publisher:** Pearsarson **ISBN:** 0131977369, **ISBN-13:**9780131977365, 978-0131977365
2. Biochemistry 6th Edition (2007) by Jeremy M.berg John L.tymoczko Lubert Stryer **Publisher:** B.i.publicationsPvt.Ltd **ISBN:**071676766X **ISBN-13:** 9780716767664, 978-716767664

Lehninger Principles of Biochemistry, Fourth Edition by David L. Nelson
Michael M. Cox

13. Publisher: W. H. Freeman; Fourth Edition edition (April 23, 2004) ISBN-10: 0716743396 ISBN-13: 978-0716743392

Further Reading:

- **E.S. West, W.R. Todd, H.S. Mason and J.T. van Bruggen,** A**Text Book of Biochemistry**, Oxford and IBH Publishing Co., New Delhi, 1974
- Biochemistry [with Cdrom] (2004) by Donald Voet, Judith G. Voet **Publisher:** John Wiley & Sons Inc **ISBN:** 047119350X **ISBN-13:** 9780471193500, 978-0471193500
- Principles Of Biochemistry (1995) by Geoffrey L Zubay, William W Parson, Dennis E Vance **Publisher:** Mcgraw-hill Book Company – Koga **ISBN:**0697142752 **ISBN-13:** 9780697142757, 978-0697142757
- Biochemistry (2008) by Rastogi **Publisher:** Mcgraw Hill **ISBN:**0070527954 **ISBN-13:** 9780070527959, 978-0070527959

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments, Authentic learning, Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** **G. Continuous Internal Assessment (CIA)** Internal Test -20 marks Assignment – Every student needs to write an assignment on a given topic based on the

	available published literature – 10 marks Seminar Presentation – A topic needs to be presented and discussed with the class- 10 marks **H. Semester End examination – 60 marks**

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MAHATMA GANDHI UNIVERSITY

BSM 21C 11 BIOPHYSICAL TECHNIQUES AND INSTRUMENTATION

SchoolName	**School of Biosciences**					
Programme	**MSc Biochemistry/ Microbiology/ Biotechnology/ Biophysics**					
Course Name	**BIOPHYSICAL TECHNIQUES AND INSTRUMENTATION**					
Type of Course	Core					
Course Code	**BSM 21C 11**					
Course Summary & Justification	This course is designed to introduce different techniques used in life sciences This course gives knowledge of the principle of operation and design of scientific instruments It attempts to render a broad and modern account of scientific instruments					
Semester	Second					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	**Basics of** Biophysics and Biostatistics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	To explain the methods used for gaining information about biological systems on an atomic or molecular level.	E	1
2	To describe different spectroscopic techniques	U/ An	4

3	To perform various biophysical fractionation and separation of biomolecules	R	4
4	To describe how to perform electrophoretic techniques	S	5
5	To describe the procedures and applications of hydrodynamic techniques	E	5
6	To perform different microscopic techniques	An/ C	4
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	**Spectroscopic techniques**: Basic principles, nature of electromagnetic radiation, Interaction of light with matter, Absorption and emission of radiation; Atomic & Molecular Energy levels, Electronic, vibrational and Rotational spectroscopy of molecules, transition and selection rules; Atomic & Molecular spectra. Principle, Instrument Design, Methods & Applications of UV-Visible spectroscopy, Infrared spectroscopy, Raman Spectroscopy, Fluorescence spectroscopy, Nuclear magnetic Resonance Spectroscopy.	1 & 2	10
2	**Physicochemical Fractionation techniques**: Principle, Instrument Design, methods and Applications of all types of Adsorption and Partition Chromatography- Paper chromatography, Thin layer chromatography, High Performance Thin layer Chromatography, Gel filtration chromatography, Affinity chromatography, Ion-exchange chromatography, High Pressure Liquid Chromatography. Reversed phase chromatography, Hydrophobic interaction chromatography, Chiral chromatography, Counter current chromatography, Fast protein liquid chromatography, Two dimensional chromatography.	1 & 3	10
3.	**Electro analytical techniques and Hydrodynamic Techniques**: Principle, Electrophoretic mobility (EPM) estimation, factors affecting EPM, Instrument design & set-up, Methodology & Applications of Free and zone Electrophoresis – Paper electrophoresis, Gel electrophoresis, Poly Acrylamide gel electrophoresis, SDS PAGE, Capillary electrophoresis, Isoelectric focusing, Potentiometry, pH meter, Conductometry. Centrifugation & Ultracentrifugation-Basic principles, Forces	1, 4 & 5	20

	involved, RCF Centrifugation, techniques- principles, types and applications. Viscometry- General features of fluid flow and nature of viscous drag for streamlined motion		
4	**Optical & Diffraction Techniques**. Principle, Instrument Design, Methods & Applications of Polarimetry, Refractometry, Circular Dichroism and optical rotatory dispersion: Plain, circular and elliptical polarization of light, Relation between CD and ORD, application of ORD in conformation and interactions of biomolecules. Flow cytometry	6	10
5	**Microscopic techniques**: Principle and working of Compound microscope, Phase contrast microscope, Interference microscope , Fluorescence microscope , Polarizing microscope , Scanning and Transmission Electron Microscopy, CCD camera, Introduction to Atomic force microscopy, Confocal microscopy.	6	10
	Total Credits of the Course	3	

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks B. **Semester End examination – 60 marks**

REFERENCES

Compulsory Reading:

1. Principles and techniques of practical biochemistry: Keith Wilson and John walker, Cambridge
2. Modern Experimental Biochemistry. Rodney F Boyer. Nenjamin/ Cummings publishing company Inc. Redwood city, California

Further Reading:

1. Practical Biochemistry- Principles and techniques. Keith Wilson and John walker (Eds), University press, Cambridge UK.
2. Principles and Techniques of electron microscopy- Biological applications. M.A Hayat., Mac Millan Press, London UK.
3. Biophysical Chemistry: UpadhyayUpadhyay and Nath, Himalaya Publishing House
4. Chromatographic methods. A Braithwate and F J Smith. Chapman and hall, NewYork.
5. Gel Electrophoresis of Nucleic acids- A Practical approach. Rickwood D and BD Hames. IRL Press, New York. 53
6. Spectrophotometry and Spectrofluorimetry: A Practical Approach. Harris DA and CL Bashford (Ed.) IRL Press, Oxford.
7. Introduction to Spectroscopy. Donald L. Pavia Gary M Lipman, George S Kriz. Harcourt brace College Publishers, Orlands, Florida
8. Gradwohls Clinical Laboratory Techniques. Stanley s. Raphael. W.E. Company, London, UK
9. Fundamentals of molecular Spectroscopy: C N Banwell, Tata Mc Graw hill publishing Company Ltd.
10. Spectroscopic methods and analyses: Christopher Jones, Barbara Mulloy Adrian H.Thomas.
11. Methods in Modern Biophysics: Bengt Nolting, Springer.
12. Bio separations Science and Engineering: Roger G Harrison, Paul Todd, Scott .R. Rudge, Oxford University Press.

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MAHATMA GANDHI UNIVERSITY

BSM 21C 12 LABORATORY COURSE-3

SchoolName	**School of Biosciences**					
Programme	**MSc.Microbiology/Biochemistry/Biophysics/Biotechnology**					
Course Name	**LABORATORY COURSE-3**					
Type of Course	Core					
Course Code	**BSM 21C 12**					
Course Summary & Justification	The course includes training on sterilization and disinfection techniques, morphological, cultural and biochemical study of microbes and antibiotic sensitivity tests. The content of the course also include serological techniques. The technical knowhow of basic microbiological and serological methods is essential for post graduate programmes in all branches of Biosciences.					
Semester	Second					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	5	5	180		190
Pre-requisites	Theoretical knowledge inMicrobiology and Immunology Basic laboratory skills					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Students will acquire skills on practice of sterile and safety precautions in a Microbiology laboratory.	A	1 & 4
2	Students will be able to prepare and sterilize media and to culture bacteria and fungi in laboratory	S	1 & 4
3	Students will be able to examine morphological, physiological and biochemical properties of bacteria	S/E	1 & 4
4	Students will be able to perform and interpret antibiotic sensitivity tests	S/E	4
5	Students will be able to test and analyse the efficacy of	S/An	4

	disinfectants		
6	Students will be able to perform and interpret the various serological tests in a diagnostic laboratory	S/E	5
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	Microscopic examination of bacteria in living conditions Testing of motility Staining procedures	1, 2 & 3	60
2	Sterilisation methods Cultivation of bacteria and fungi Study of cultural characteristics and biochemical reactions of bacteria Testing of disinfectants Antibiotic sensitivity tests	1, 2, 4 & 5	60
3.	Serological tests for the diagnosis of microbial infecdtions Agglutination and precipitation tests Immunodiffusion in gel ELISA	1 & 6	60
	Total Credits of the Course	3	180

Teachingand LearningApproach	**Laboratory Procedure (Mode of transaction)** Direct Instruction: lecture, Explicit Teaching, Demonstration, Hands on experimental sections, Skill acquisition by laboratory training
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Laboratory Skill Tests of maximum 20 marks 2. Seminar Presentation – Laboratory material and methods Maximum marks 10 3. Write a detailed report on instrumentation – 10 marks B. **Semester End Practical examination – 60 marks**

EFERENCES

Compulsory Reading:

1. Medical Laboratory Manual for Tropical Countries Vol.2 Monica Cheesbrough ELBS, 2009
2. Mackie& McCartney Practical Medical Microbiology Churchil Livingstone, 1996

Further Reading:

1. Clinical Laboratory Methods Vol.2 Gradwohl The C.V.Mosby Company, 1981
2. London Practical Microbiology Dubey R.C.andMahaswari D.K. S.Chand& Company

Ltd. New Delhi, 2002 3. Experiments in Microbiology, Plant pathology and Biotechnology, K.R.Aneja,, New Age International (P) Limited, New Delhi, 2003

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	MAHATMA GANDHI UNIVERSITY

BSM 21C 13 LABORATORY COURSE-4

SchoolName	**School of Biosciences**					
Programme	**MSc.Microbiology/Biochemistry/Biophysics/Biotechnology**					
Course Name	**LABORATORY COURSE 4**					
Type of Course	Core					
Course Code	**BSM 21C 13**					
Course Summary & Justification	The course is intended to provide experience to students in handling protein and DNA, its isolation, quantification and separation using electrophoresis. Also, the course focusses on the technique of PCR technology and proposes a training in PCR technique to equip the students for the present demand in the modern diagnostic methods.					
Semester	Second					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	5	5	180		190
Pre-requisites	Theoretical knowledge in **Molecular Biology and Genetic Engineering,**Basic laboratory skills					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	On completing the course, the students will be able to isolate nucleic acids and proteins from tissues/ microorganisms	A	1 & 4
2	On completing the course, the students will be able to evaluate quantity and quality of nucleic acids	S	4
3	The students will be able to conduct PAGE and will be able to separate proteins using PAGE	S/E	4
4	The students will be able to amplify a DNA fragment selectively using the PCRtechnique	S/E	4 & 5

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	• PAGE- Protein separation Native PAGE-Reagent preparation, Apparatus handling, gel casting, electrophoresis and staining	1 & 3	60
2	• DNA isolation • Estimation of DNA • RNA isolation • Estimation of RNA • Separation of DNA and RNA by Agarose gel electrophoresis	1 & 2	90
3.	Selective PCR amplification of a desired fragment	1, 2 & 4	30
	Total Credits of the Course	3	180

Teachingand LearningApproach	**Laboratory Procedure (Mode of transaction)** Direct Instruction: lecture, Explicit Teaching, Demonstration, Hands on experimental sections, Skill acquisition by laboratory training
Assessment Types	**Mode of Assessment** G. Continuous Internal Assessment (CIA) 1. Internal Laboratory Skill Tests of maximum 20 marks 2. Seminar Presentation – Laboratory material and methods Maximum marks 10 3. Write a detailed report on instrumentation – 10 marks H. **Semester End Practical examination – 60 marks**

REFERENCES

Compulsory Reading:

1. Molecular cloning by Sambrook , Fritsch and Maniatis, Cold Spring harbour laboratories
2. Biochemical Methods Sadasivam and Manickam
3. Gel electrophoresis of proteins : A practical approach(second edition)B D H Ames and Rickwood D(eds) Oxford University press
4. Practical skills in Biomolecular Sciences, Weyers Jonathan, Reed Rob, Jones Allen, Holmes A D, Pearson publications

Further Reading:

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MAHATMA GANDHI UNIVERSITY

BSM 21E 14: MICROBIAL TECHNOLOGY

School Name	**School of Biosciences**					
Programme	**MSc Biotechnology**					
Course Name	**Microbial Technology**					
Type of Course	**Elective**					
Course Code	**BSM 21E 14**					
Course Summary & Justification	1. The course describes the application of microbes in various sectors 2. The course content explains the role of microbes and its utilization/application in various sectors especially in industrial & pharmaceutical area. 3. The course content also illustrates the various methods & process for production of bioactive compounds & products using microbes.					
Semester	Second					
Total StudentLearningTime (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisites	Basics of Microbiology					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	**On completing this course, the student will be able to** Explain the methods for studying microbial genome and describe how metabolic & protein engineering help to enhance the production of microbial metabolites	**U/A**	1 & 2
2.	Describe the methods , process & production of various microbial based food and dairy products also students have able to explain microbes are food for animal and human	**U/An**	**4**
3.	Students should explain the role of microbes as biofertilizer, biopesticide, fungicide, and herbicide and also able to describe the various plant microbe interactions	**U/A**	**5**

4.	Students have able to explain the methods and mechanism of microbes apply to protect various environmental sector.	**An/A**	**4 & 5**
5.	Illustrate the utilization of microbes in the production of industrial and pharmaceutical products	**S/C**	**4 & 5**
6.	Communicate effectively about a chosen topic in microbial technology both verbally and orally		**5**
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	**Microbial Genomics:** Introduction to Microbial genomics, Structural Genomics, Functional genomics, Comparative Genomics, Meta Genomics - Genome analysis of extremophiles, Metabolic engineering and protein engineering for optimization of microbial products	**1 & 6**	**10**
2.	**Microbes in food & dairy industry:** Fermented foods-Introduction, Role & Advantages of fermented foods. Production of cheese, yoghurt, koji & Idli. Knowledge of other fermented dairy products. Single cell proteins-algae, bacteria, fungi, yeast & actinomycetes. Alcoholic beverages-Distilled and non distilled, Production of beer, wine & ethanol. Microbe as animal feed additives. Probiotics, Prebiotic & Synbiotics	**2 & 6**	**15**
3.	**Microbes in Agriculture**: Nitrogen fixation; Symbiotic & Non symbiotic Mechanism;Biofertilizers-Rhizobium, Azolla, Azospirillum, Algal Biofertilizers; Phosphate solubilizing microorganisms; Microbial biopesticide, biofungicide and herbicide; Micorrhiza; Plant –Microbe Interactions. Mushroom cultivation	**3 & 6**	**10**
4	**Microbes & Environment**: Biotechnology and pollution control; Use of immobilized microbial cell & enzyme in waste water treatment. Microbial biotransformation-Steroid, Microbial degradation of Herbicides, Insecticides & Pesticides; Bioremediation & Bioleaching	**4 & 6**	**10**
5.	**Industrial &Pharmaceutical Applications**: Methanogens & Biogas Production; Microbial Hydrogen production; Microbes in plastic industry - Bioplastics; Microbial biosensors- Micro oxygen electrode. Biochips; Biofilm; Bioactive compounds from microbes. Bioethanol & biodieseal production. Microorganism for Bioassay & as Bio weapon	**5 & 6**	**15**
	Total Credits of the Course	**3**	

TeachingandLearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group

	Assignments Authentic learning, , Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** I. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks J. **Semester End examination – 60 marks**

REFERENCES

Compulsory Reading:

1. Biotechnology Fundamentals and Applications, S.S. Purohit and S.S. Mathur; Agro Botanical Publishers India.
2. Microbial Biotechnology, Alexander N Glazer & Hiroshi Nikaido Cambridge University Press.
3. Microbial Biotechnology, Farshad Darvishi harzevili Hongzhang Chen.CRC Press.
4. Microbial Biotechnology Principle & Applications Lee Yuan Kein.World Scientific Press.

Further Reading:

1. Microbial Technology-Fermentation Technology Vol 1 & 11 Peppler Perinas Elsiver.
2. Biofertilizers in Agriculture, N.S.Subha Rao;Oxford & IBH Publishing Co.Pvt.Ltd New Delhi.
3. Essentials of Biotechnology, R.C.Sobti & Suparna.S.Pachauri. Ane Books Pvt.Ltd.
4. Fermentation Technology Vol I&II.
5. Soil Microbiology – N.S. Subha Rao, 1999
6. Agriculture Microbiology – Rangaswamy
7. Microbial control and pest Management – S. Jayaraj.
8. Food Microbiology – Frazier W.C and Westhoff D.C., Tata Mc Graw-Hill
9. Food Microbiology – Rose A.H. in Economic Microbiology, Academic Pr

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	MAHATMA GANDHI UNIVERSITY
	BSM 21E 15 ECOLOGY AND ENVIRONMENT

School Name	**School of Biosciences**					
Programme	**M.Sc. Biochemistry/Microbiology/Biotechnology/Biophysics**					
Course Name	**ECOLOGY AND ENVIRONMENT**					
Type of Course	Elective					
Course Code	**BSM 21E 15**					
Names of Academic Staff	**Dr J G RAY**					
Course Summary & Justification	The course is designed to equip students in perceiving, understanding and analyzing environmental problems from an ecological perspective, and a critical analysis of the existing control measures from a holistic perspective.					
Semester	First					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Eg: Authentic learning Collaborative learning Independent learning	60	18	0	28	106
Pre-requisite	**Knowledge in Biology at Graduate level**					

No.	**Expected Course Outcome**	**Learning Domains**	**PSO No.**
1	Students will be able to understand and communicate the sustenance of natural biological systems on the earth effectively	R/U/A	1 & 5
2	They will acquire skills in explaining all kinds of interrelationships in natural biological systems	U/A	4
3	Students will be able to explain environmental degradation and pollution as outcomes of ignorant and irresponsible human actions	U/An/Ap	4 & 5
4	Students will be able to understand the significance of biodiversity and its conservation in the sustenance of natural ecosystems	An/Ap	1 & 2

5	Overall, students will be skilful in analyzing as well as designing and maintaining of environmental sustainability of all kinds of developmental activities	R/U/A/An/ Ap	4 & 5

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

Module No	Module Content	Course outcome	Hours
I Introducti	**Introduction to Ecology and different ecological objects**: Basic concept of the environment – components of the environment, the definition of ecology, ecological things. Autecological and Synecological concepts: **A. Population Ecology (Autecological concepts)**: **(a)** Characteristics of populations **(b)** Genecology - ecads, ecotypes, ecospecies, coenospecies; k-selection and r-selection populations **B. Synecological concepts(a)** Ecological processes of community formation, ecotone, edge effect. Classification of communities - criteria of classification, dynamic system of classification by Clement **(b)** Special plant communities - quantitative, qualitative and synthetic characteristics of plant communities**, (c)** Dynamic community characteristics - cyclic replacement changes and cyclic no-replacement changes	1 & 2	10 hrs
A. Popul			
2	**Ecological succession -(a)** The concept – autogenic and allogenic succession, primary and secondary, autotrophic and heterotrophic **(b)** Retrogressive changes or the concept of degradation, concept of climax or stable communities, resilience of communities, ecological balance and survival thresholds **Biosphere and Ecosystem - (a)** Significance of habitat, biodiversity, ecological niche, trophic level, primary and secondary productivity, food chains, food webs, ecological pyramids, energy flow and nutrient cycles **(b**) Comparative study of the significant world ecosystems: Different aquatic and terrestrial ecosystems concerning their productivity, 0.5 57 biodiversity, energy flow, food chains and trophic levels	1, 2 & 4	10 hrs
3.	**Natural Resources:** Soil, water and air Resources – soils and parent materials – ecology of soil fertility; Fresh water and marine resources – global distribution of water resources – surface and groundwater resources – water conservation – prevention of marine pollution – conservation of marine resources; Atmospheric resources – the structure of atmosphere – climate and weather – climatic factors – precipitation, wind temperature, aerosols	1 & 2	10 hrs
4	**Environmental pollution**: **(a)** Definition and classification **(b)**	3	20 hrs

	Water pollution: Water quality parameters and standards, different types of pollutants and their consequences. Types of water pollution, prevention and control - watershed management, different kinds of wastewater treatments; Phyto and bioremediation **(c)** Air pollution: Air quality standards and index, ambient air monitoring using high volume air sampler, types and sources of air pollutants, air pollution and human health hazards, control of air pollution **(d)** Noise pollution **(e)** Radioactive and thermal pollution: Causes and hazardous effects, effective management **(f)** Concept of solid wastes **(g)** Pollution Control - Bioremediation, Phytoremediation, bioaugmentation, biofilms, biofilters, bioscrubbers and trickling filters. Use of bioreactors in waste management		
5	**Climate Change and other Global Environmental issues** - Factors responsible for climate change, Climate change mitigation – global conventions and protocols on climate change - El-Nino and La Nina phenomenon and its consequences; Environmental laws, environmental monitoring and bioindicators, environmental safety provisions in the Indian constitution, major ecological laws in free India; UNEP and its role in climate change control– IPCC, UNFCC, annual environment summits – 1973 Stockholm conference to 2015 Paris Conference – new developments of annual UNFCC meetings in the coming years - Future Earth Programme	5	10 hrs
	Total Credits of the Course	**3**	**60 hrs**
	Books for Reference		
Compulsory Reading: 1. MC Dash (1993) Fundamentals of Ecology, Tata McGraw Hills 2. Odum EP 3rd Edition (1991) Fundamentals of ecology, Saunders and Com			
Optional Further Reading 1. Barbour MD et al. (1980) Terrestrial plant ecology. The Benjamin-Cummings Pub. Com 2. 2. Benton AH and Werner WE (1976) Field biology and Ecology, Tata McGraw Hill 3. Blanco-Canqui and Humberto LR (2008) Principles of Soil Conservation and Management, Springer 4. Molles MC (2012) Ecology – Concepts and applications, 6th Edition, Mc Graw Hill			
Course evaluation: **Assignments & Seminar (10 marks each); Two internal test papers (20 effects) end semester examination (60 marks)**			

	MAHATMA GANDHI UNIVERSITY
	BSM 21E 16: NEUROBIOLOGY

SchoolName	**School of Biosciences**					
Programme	**MSc Biochemistry/ Microbiology/ Biotechnology/ Biophysics**					
Course Name	**NEUROBIOLOGY**					
Type of Course	Elective					
Course Code	**BSM 21E 16**					
Course Summary & Justification	This course is designed to provide an overview of Neurobiology. Stress will be placed on methods and concepts rather than facts alone. The course will proceed from the basic biophysical properties of neurons and glia to the physiological basis of learning, memory, and sensory processing					
Semester	Second					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	**Basics Knowledge in Physiology**					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Students should be capable of effectively communicating how neural system works	U	1 & 2
2	Students should be able to explain electricity and the biophysics of cell	E	1 & 2
3	Students should describe how do neurons talk to one-another	A	5
4	Students should be able to explain how neural circuits organize information	A	4 & 5
5	Students should be able to narrate how is information stored	E	5
6	Lastly, students should gain a general understanding	I	5

	how is information collected and processed.		

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	Introduction to neurobiology, the structure and distinguishing features of neurons, how is a neuron recognized? The architecture of nervous systems. Neuronal model systems. Chemical/electrical synapses. Recording/monitoring techniques.	1 & 6	10
2	Ionic basis of the resting potential. Maintenance of resting membrane potential, passive and active mechanisms, channels and pumps, ionic permeability	2 & 6	10
3.	Action potentials and ion channels, Mechanism of nerve action potential: Characteristics of action potential, initiation and propagation of action potential, voltage dependent sodium channels, mechanism of action potential propagation, factors affecting the speed of action potential propagation, molecular properties of voltage sensitive sodium channels, molecular properties of voltage dependent potassium channels, calcium dependent action potentials, voltage- clamp analysis of action potentials	3 & 6	20
4	Synaptic transmission: Chemical and electrical synapse, neurotransmitter release, synaptic potential, excitatory synaptic transmission between neurons, excitatory neurotransmitters, inhibitory synaptic transmission, inhibitory neurotransmitters, neurotransmitter gated ion channels, presynaptic inhibition and facilitation, neuronal integration, synaptic transmission at neuromuscular junction	4 & 6	10
5	Synaptic plasticity, language and cognition: Short term changes in synaptic strength, long term changes in synaptic strength, modification of synaptic strength in reflex circuits, learning, language function and cortical areas involved in language, cognition, dementia and loss of cognitive abilities	5 & 6	10
	Total Credits of the Course	3	60

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion,

	Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks B. **Semester End examination – 60 marks**

REFERENCES

Compulsory Reading

1. Basic Neurochemistry- Molecular, cellular and medical aspects. George J Siegel, Bernard W Agra noff R, Wayne Albers, Stephen K Fisher & Michael D Uhler
2. Neurobiology: Molecules, cells and systems. Gary G Mattews
3. From Neuron to Brain- John G Nicholls, A Robert Martin, Bruce G Wallace & Paul A Fuchs

Further Reading:

1. Neuroscience, edited by Purves, Augustine, Fitzpatrick, Hall, LaMantia, Mooney, Platt and White. Sinauer (2018) Sixth Edition.
2. Foundations of Neurobiology, Delcomyn, F. 1st edition W. H. Freeman and Company (1998)
3. Behavioral Neurobiology: An Integrative Approach, Zupanc, G. K. H. Oxford University Press. 2nd edition (2010)
4. Neurobiology: molecules cells and systems Gary G. Mathews 2nd edition. Blackwell Science Inc. (2001).
5. Neuroscience: exploring the brain. Bear, M., Connors, B.W. and Paradiso, M.A. 2nd edition Lippincott, Williams and Wilkins (2001)

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MAHATMA GANDHI UNIVERSITY

BSM 21E 17 **ENVIRONMENT SCIENCE**

SchoolName	**School of Biosciences**					
Programme	**Msc Biochemistry/ Microbiology/ Biotechnology/ Biophysics**					
Course Name	**ENVIRONMENT SCIENCE**					
Type of Course	Elective					
Course Code	**BSM 21E 17**					
Course Summary & Justification	This course on environmental Science deals with principles and scope of environment science. The objective of the course content is to create a sound awareness about the environment impact and its monitoring and Predict the consequences of human actions on the web of life, global economy and quality of human life The course content is designed with a view to augment CSIR/UGC syllabus					
Semester	First					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total LearningHours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	**Basics of cell biology and genetics**					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Gain in-depth knowledge on natural processes that sustain life and govern economy.	U/A	1
2	Able to describe the principles of ecology	U/ C	5
3	Develop critical thinking for shaping strategies (scientific, social, economic and legal) for environmental protection and conservation of biodiversity, social equity and sustainable development.	R/An	4 & 5
4	Acquire values and attitudes towards understanding complex environmental-economic social challenges	U/R	1
5	Understand the current environmental problems and	U/R	1

	preventing the future ones.		
6	Create an insight to the strategies and methodologies of environmental impact assessment	An/ C	1 & 5
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	Definition, principles and scope of environmental science, Earth, Man and environment, ecosystem, pathways in ecosystem. Physic-Chemical and Biological factors in the environment Geographical classification and Zones. Structure and functions of ecosystem, Abiotic and biotic components, energy flows, food chains, Food, web, Ecological pyramids, types and diversity Terrestrial (Forest, grass land) and Aquatic (Fresh water, marine, eustarine) ecosystems. mineral cycling. Habitat and niche. Major terrestrial biomes. Impact of microorganisms on global ecology, microorganisms in extreme environment	1, 2 & 3	10
2	Definition, Principles and scope of ecology, Human ecology and Human settlement, evolution, origin of life and speciation Population ecology characteristics and regulation. Community ecology structure and attributes. Levels of species diversity and its management, Edges and ecotones. Ecological succession. Concept of climax. Common Flora and fauna in India. Endangered and Threatened Species	2 & 3	10
3.	Biodiversity status, monitoring and documentation Biodiversity management approaches. Conservation of biological diversity, methods and strategies for conservation. Natural resources, conservation and sustainable development. Hotspots of biodiversity, National parks and Sanctuaries	3 & 4	10
4	Environmental pollution- Air: Natural and anthropogenic source of pollution, Primary and Secondary pollutants , Methods of monitoring and control of air pollution, effects of pollutant on human beings, plants animals, material and on climate, Acid rain, Air Quality standards Water: types, Sources and consequences of water pollution, Physio-chemical and Bacteriological sampling and analysis of water quality, Soil: Physio-chemical and Bacteriological sampling as analysis of soil quality, Soil pollution- control, Industrial waste effluents, and heavy metals Their interaction with soil components, Noise: Sources of noise pollution, Noise control and battement measures. Impact of noise on human health, Radioactive and thermal Pollution. Bioremediation- Strategies for bioremediation, Biosensors, biological indicators of pollution and monitoring. Detoxification of hazardous chemicals,	5	20

	mycotoxins. Biological weapons		
5	Introduction to environmental impact analysis, Impact Assessment Methodologies Generalized approach to impact analysis, Guidelines for Environmental Audit Introduction to environmental Planning, Environmental priorities in India and Sustainable development, Environment protection-issues and problems, International and national efforts for environment Protection. Global environmental problems-Ozone depletion, global warming, climatic change, desertification, green movement, ecofeminism. Current environmental issues in India	6	10
	Total Credits of the Course	3	

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** K. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks L. **Semester End examination – 60 marks**

REFERENCES

Compulsory Reading:

1. Jonathan B (2016) Principles of Evolution, Garland Science, Taylor and Francis.
2. Odum E. P and Barret G W. Fundamentals of ecology. W. B Saunders company, Philadelphia
2. Chapman and Reiss, Ecology principles and applications. Cambridge University

Further Reading:

1. Jobes A. M., Environmental biology, Routledge, London.
2. Odum E. P. Basic ecology. Saunders College.
3. A textbook of environmental sciences, Arvind kumar.

4. Alleby M.Basics of environmental science. Routledge, Newyork
5. Cunningham, W. P and Siago, B. W, Environmental science.
6. Kewin T. P and Owen C. A., Introduction to global environmental issues. Routledge, London.
7. Chiras,D.D, Environmental science Cell and Molecular Biology by De Robertis E.D.P, 8th Edition

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MAHATMA GANDHI UNIVERSITY

BSM 21E 18 MOLECULAR MICROBIOLOGY

SchoolName	School of Biosciences					
Programme	M.Sc. Microbiology/Biotechnology/Biochemistry/Biophysics					
Course Name	MOLECULAR MICROBIOLOGY					
Type of Course	Elective					
Course Code	**BSM 21E 18**					
Course Summary & Justification	This course on Molecular Microbiology deals with the applications of various molecular biological techniques in Microbiology. This course is an important branch of Microbiology. Rapid identification of microorganisms is very important for the clinical, diagnostic and research purposes and the methods used for the same have developed significantly with the advances in Molecular biology. The content in this course has been designed with an objective to provide detailed understanding on the techniques, principle and applications of molecular biology for the microbial identification, production of recombinant proteins and also for studying the unculturable microorganisms through metagenomics. This will enable the students to identify the research, learning and job opportunities based on the latest developments in this subject.					
Semester	Second					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total LearningHours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	Basic understanding on microorganisms and molecular biology Knowledge in any branch of Life science					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1.	Students will able to understand and explain molecular	R/U	1

	biological applications in microbiology		
2.	Students will able to learn rapid methods used for the microbial identification	R/U	1
3.	Students will able to understand the functioning of human microbiome and its beneficial role	U/ An/E	1, 2 & 3
4.	Students will become able to understand molecular basis of microbial virulence	U/An/A	1 & 2
5.	Students will able to apply the knowledge for advanced microbiological applications	C/S	4 & 5
6.	Students will able to identify the research and technical opportunities in molecular microbiology	A/S	4 & 5
**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

COURSE CONTENT

odule No	Module Content	Course outcome	Hrs
1	Molecular biology of Microbial evolution, rRNA sequence and cellular evolution, Signature sequence and phylogenetic probe. Identification and characterization of microorganisms, Molecular methods for microbial identification, Molecular typing methods: Bacterial strain typing, Pulsed Field Gel Electrophoresis, PCR-based microbial typing, Genotyping by Variable Number Tandem Repeats, Multilocus Sequence Typing, Automated Ribotyping	1 & 2	20
2	Unculturable bacteria and Metagenomics, Methods used in metagenomics, New generation sequencing technologies for metagenome study, Human microbiome, Importance of human microbiome in relation to human health and disease.	3	20
3.	Molecular basis of microbial virulence. Bacterial adherence: basic principles, effects of adhesion on bacteria and host cells. Bacterial invasion of host cells; mechanism. Bacterial toxins: classification based on molecular features, Molecular detection and characterisation of bacterial pathogens, detection of bioterrorism.	4	10
4	Microbial production of recombinant proteins: expression, purification and applications, Microbes in plant transformation, Agrobacterium tumefaciens T-DNA transfer process, Application of microorganisms for combinatorial and engineered biosynthesis, Engineering *E.coli* for the production of curcumin	5 & 6	10
	Total Credits of the Course	3	

Teaching And Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction, Active co-operative learning, Seminar, Group Assignments Authentic learning, Library work and Group discussion, Presentation by individual student/ Group representative

Assessment Types	Mode of Assessment A. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar - Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks B. Semester End examination – 60 marks

REFERENCES

Compulsory Reading:

1. Molecular Microbiology – Diagnostic Principles and Practice, David H. Persing, Fred C. Tenover, James Versalovic, Yi-Wei Tang, Elizabeth R. Unger, David A. Relman, Thomas J. , ASM Press., 2016
2. Brock Biology of Microorganisms- Michael T. Madigan and John M.Martinko, Prentice Hall, 2015

Further Reading:

3. Microbial Physiology – Albert G. Moat, John W. Foster and Michael P. Spector , 2002
4. Metagenomics for Microbiology, Jacques Izard Maria Rivera , 1st edition, Academic Press Published Date: 12th November 2014
5. Production of Recombinant Proteins: Novel Microbial and Eukaryotic Expression Systems, Gerd Gellissen, May 2005Longman,2013

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MAHATMA GANDHI UNIVERSITY

BSM 21E 19 DEVELOPMENTAL BIOLOGY

School Name	**School of Biosciences**					
Programme	**M.Sc. Biochemistry/Microbiology/Biotechnology/Biophysics**					
Course Name	**DEVELOPMENTAL BIOLOGY**					
Type of Course	Elective					
Course Code	**BSM 21E 19**					
Names of Academic Staff & Qualifications	**Dr J G RAY**					
Course Summary & Justification	The course is designed to equip students in perceiving, understanding, and analyzing reproductive and embryological developmental processes in plants to apply the principles towards increasing plant productivity through breeding.					
Semester	First					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	E.g., Authentic learning Collaborative learning Independent learning	60	18	0	28	106
Pre-requisite	**Knowledge in Botany at the Graduate level**					

No.	Expected Course Outcome	Learning Domains	PSO No.
1	Students will be able to understand and communicate the reproductive and developmental events in plants effectively	R/U/A	1 & 5
2	They will acquire the skills to explain all kinds of reproductive parts and seed developmental processes, including seed storage in plants	U/A	4 & 5
3	They will be able to explain how developmental processes initiates and proceeds in plants	U/An/Ap	5
4	Students will be able to explain the specific developmental	An/Ap	5

	process and its ultimate impact on the productivity or successful completion of lifecycle in plants		

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

Module No	Module Content	Course outcome	Hours
1	**Introduction:** Basic concepts of developmental Biology; An overview of plant and animal development, Potency, Commitment, Specification, Induction, Competence, Determination and Differentiation morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in the analysis of development	1, 2 & 3	20 hrs
2	**Development in flowering plants**: **(a)** Angiosperm life cycle **(b)** Anther: Structure and development, microsporogenesis, male gametophyte development. Palynology: Pollen morphology, exine sculpturing, pollen kit, NPC formula. Applications of palynology- palynology concerning taxonomy. Viability of pollen grains Pollination, pollen germination, growth and nutrition of pollen tube**. (c)** Ovule: Structure, ontogeny and types. Megasporogenesis. Embryosac – development, classes, ultrastructure, and nutrition of embryosac. Female gametophyte development.	1, 2 & 3	10 hrs
3.	**Fertilization in Plants:** Double fertilization; embryo development - different types. Endosperm development, types of endosperm, haustorial behaviour of endosperm. Xenia and metaxenia. Polyembryony – types and causes. Seed formation, dormancy and germination. Apomixis, Parthenogenesis.	1, 2 & 3	10 hrs
4	**Morphogenesis and organogenesis in plants:** Shoot and root development; Leaf development and Phyllotaxy. Transition to flowering, floral meristems and floral development; Homeotic genes in plants; Senescence, programmed cell death and hypersensitive response in plants	4	20 hrs
	Total Credits of the Course	**3**	**100 hrs**
Books for Reference			
Compulsory Reading: 1. Maheswari P. 1950. An introduction to the embryology of Angiosperms.			

McGraw Hill 2. Wolpert L, C Tickle and AM Arias (2015) Principles of development	
Optional Further Reading 1. Krishnamurthy KV (2015) Growth and Development in Plants 2. Raghavan V (2000) Developmental Biology of Flowering Plants 3. Gilbert SF (2000) Developmental Biology 4. Developmental Biology, 8th Ed, Gilbert 5. Developmental Biology Paperback – 2008 by Werner A. Muller	
Course evaluation: **Assignments, 1 Seminar, and one assignment (10 marks each) Two internal test papers (20 marks) end semester examination (60 marks)**	

THIRD SEMESTER

BSM 21C 30 MEDICAL MICROBIOLOGY

SchoolName	**School of Biosciences**					
Programme	**M.Sc Microbiology**					
Course Name	**MEDICAL MICROBIOLOGY**					
Type of Course	Core					
Course Code	**BSM 21C 30**					
Course Summary & Justification	This course on Medical Microbiology deals with systematic study of medically important bacteria, viruses, fungi and protozoa Medical Microbiology is an important branch of Microbiology. Theoretical knowledge of medically important microbes is highly essential for a student to effectively complete the practical course in Medical Microbiology. The course will augment the student's ability to work in the field of Medical Microbiology.					
Semester	Third					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total LearningHours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	Basic understanding on Human Anatomy, Physiology and Biochemistry Knowledge in General Microbiology, Molecular Microbiology, Immunology Protozoology and Mycology					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1.	Students will be able to review the Developments in Medical Microbiology They will get a brief yet systematic understanding on various types of microbial pathogens	R/U	3
2	Students will be able to compare and analyze the properties of various bacteria, viruses, fungi and protozoans which are pathogenic in humans	U/ An	3

3	Students will become able to explain the process of pathogenesis of various microbial diseases	U/An	3
4	Students will get theoretical and technical know-how for the laboratory diagnosis of infectious diseases	A/S	4 & 5
5	Students can evaluate the behaviour of different microbial strains based on their virulence properties and to apply the knowledge for the prophylaxis of microbial diseases	E/A	4 & 5
6	Students will be able to communicate effectively about a given topic in Medical Microbiology both verbally and in writing	An/ C	5
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	History of development of Medical Microbiology, Contributions made by eminent scientists. Study of important properties, pathogenicity and laboratory identification of bacteriaviz. *Staphylococci, Streptococci, Pneumococcus, Neisseria meningitidis, N.gonorrhoeae, Corynebacterium diphtheriae, Bacillus anthracis, Clostridium tetani, C.botulinum,C. difficile* Gas gangrene group	1, 2, 3, 4, 5 & 6	20
2	Study of important properties, pathogenicity and laboratory identification of *E.coli, Proteus, Klebsiella, Shigella , Salmonella, Vibrio cholerae, , Mycobacterium tuberculosis ,Mycobaterium leprae* and *Treponema pallidum;* A brief study of *Pseudomonas, HaemophilusBrucella*, *Bordetella, Yersinia, Helicobacter, Leptospira* and Actinomycetes	1, 2, 3, 4, 5 & 6	20
3.	General structure of viruses. Cultivation of viruses. A brief study of the properties of the important human viruses viz. V-Z virus, Polio, Rabies, Influenza, Hepatitis , HIV, Dengue and SARS-CoV-2.-Pathogenesis and laboratory diagnosis of diseases caused by these viruses	1, 2, 3, 4 & 6	10
4	Mycoses in man - pathogenesis and laboratory diagnosis of various superficial, cutaneous, subcutaneous and systemic fungal infections. Opportunistic fungal infections. Life cycle and pathogenesis of protozoan diseases- Entamoebiasis, Malaria, and Lieshmaniasis	1, 2, 3 & 6	10
	Total Credits of the Course	3	

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion,

	Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** I. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks J. **Semester End examination – 60 marks**

REFERENCES

Compulsory Reading:

1. 1 Ananthanarayan & Panicker's Text book of Microbiology. 9th Edition Arti Kapil (Ed) University Press (India) Pvt.Ltd.
2. Text book of Medical Parasitology (7th Edition)CK Jayaram Jaypee Brothers Medical Publishers (P) Ltd.

Further Reading:

1. Jawetz,Melnick&Adelberg's Medical Microbiology27 th Edition Carrol, Butel, Morse, Mietzner Mc Graw Hill
2. Sherri's Medical Microbiololgy-An Introduction to infectious diseases (6 th Edition) Ryan & Ray (Ed) Mc Graw Hill
3. Bailey & Scott's Diagnostic Microbiology (14 th Edition Patrica M.Tille ELsevier
4. Human Virology Fourth Edition Leslie Collier, John Oxford & Paul Kellam Oxford University Press.
5. Medical Mycology a Practical Approach Evans and Richardson (eds.)IRL Press

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MAHATMA GANDHI UNIVERSITY

BSM 21C 31 FOOD MICROBIOLOGY

SchoolName	School of Biosciences					
Programme	M.Sc. Microbiology					
Course Name	FOOD MICROBIOLOGY					
Type of Course	Core					
Course Code	**BSM 21C 31**					
Course Summary & Justification	Microorganisms play key role in the production of food materials. This course on Food Microbiology deals with the applications of microbiological processes in the production of various food products. The syllabus content in this course has been designed with an objective to provide importance of beneficial microorganisms and their functions in the production of both traditional and modern food products with theoretical, practical and industrial aspects. This will enable the students to learn the basics and advances and also to identify industrial and research opportunities in food microbiology.					
Semester	Second					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	Knowledge in general Microbiology					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1.	Students will able to explain the importance of microorganisms in production of various food materials	R/U	1 & 5
2.	Students will able to explain the health benefit of microorganisms	R/U	2 & 5
3.	Students will able to explain the advantages of fermented food	U/ An/E	1 & 5
4.	Students will able to analyze factors affecting growth of	U/An/A	1 & 4

	microorganisms in food		
5.	Students will able to understand the food borne diseases	C/S	4
6.	Students will able to apply the knowledge for the production of food and management of food borne diseases.	A/S/C	5
**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	Microbes associated with food, Factors influencing microbial growth infood, Intrinsic and extrinsic factors, implicit and processing factors,Probiotics, Prebiotics, Synbiotics, Health benefit and mechanism of action ofprobiotics, SCP, Edible mushrooms, Microbial spoilage of food, Foodpreservation and preservatives, Physical and chemical methods ofpreservation, natural food preservation	2 & 4	20
2	Hurdle effect, HACCP, Lactic acid bacteria, Homo and hetero fermentativelactic acid bacteria, Dairy products, Microbiology of cultured dairy products,Yogurt manufacture, cultured butter milk, Sour cream, Kefir andmicrobiology of kefir grains, cheese, structural model of casein micelle, role of chymosin, steps in cheese making with role of microorganisms, types ofcheese and cheese ripening	1 & 3	20
3.	Role of microorganisms in the preparation of traditional fermented food,vegetable fermentation, Microbial succession during production offermented vegetables, Manufacture of sauerkraut, kimchi, cucumberfermentation, Soy sauce production, Temph fermentation	1 & 3	10
4	Food borne infections and intoxications, Mycotic poisoning and mycotoxins, Prevention of food borne outbreaks, Laboratory testing of food borneoutbreaks	5 & 6	10
	Total Credits	**3**	

REFERENCES

Compulsory Reading:

1. Martin R. Adams and Maurice O. Moss- Food Microbiology, Third Edition, University of Surrey,Guildford, UK, 2008
2. Robert W. Hutkins, Microbiology and Technology of Fermented Foods , Whiley, 2013

Further Reading:

3. Food Microbiology – Frazier W.C and Westhoff D.C., Tata Mc Graw-Hill, 2008
4. Food Microbiology – Doyle M.P., Beuchat L.R., and Montville T.J., (Eds) ASM press,2012
5. Food Microbiology – Rose A.H. in Economic Microbiology, Academic Press,1983

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Teaching And Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction, Active co-operative learning, Seminar, Group Assignments Authentic learning, Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** K. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar - Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks L. Semester End examination – 60 marks
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MAHATMA GANDHI UNIVERSITY

BSM 21C 32 INDUSTRIAL MICROBIOLOGY

SchoolName	**School of Biosciences**
Programme	**M.Sc Microbiology**
Course Name	**INDUSTRIAL MICROBIOLOGY**

Type of Course	Core					
Course Code	**BSM 21C 32**					
Course Summary & Justification	The course deals with basics of fermentation process, industrially important microbes and microbial processes. Industrial Microbiology is an important branch of Microbiology. The course content is designed to augment the students' knowledge and skill to work in the field of fermentation industry.					
Semester	Third					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total LearningHours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1.	On completing this course student will be able to explain the principles and methods of fermentation	R/U	3
2.	Students can critically evaluate the merits and demerits of different types of fermentation	An	3
3.	Students will get understanding on factors to be considered for the design of fermentors	U/A	3 & 4
4.	Students will be able to evaluate different microbial strains based on their industrially useful properties and can apply the knowledge for the conduct of microbial processes	An/A	4 & 5
5,	Students will get theoretical and technical know-how of the microbial processes for various products	U/S	4 & 5
6	Students will be able to communicate effectively about a given topic in Industrial Microbiology both verbally and in writing	An/ C	5
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	History Fermentation, Advantages of microbial processes, Industrial fermentations. Types of fermentation: Batch, fed batch, continuous, dual and multiple Submerged and solid	1, 2 & 6	20

	substrate fermentation. Isolation and screening of industrially useful microorganisms, Primary and secondary screening, Strain improvement, Inoculum development		
2	Fermenter design and construction. Antifoam agents and devices. Bioreactors used for solid state fermentation Sterilization of media and fermenters Downstream processing, cell harvesting techniques, Solid –liquid separation, Cell disruption techniques, Purification of microbial products, Role of genetic engineering in facilitating downstream processing	3 & 6	20
3.	Microbial processes for the production of ethanol, alchoholic beverages viz ethanol, beer, wine, distilled liquors ,acetone, butanol, Citric acid, acetic acid, lactic acid and baker's yeast	4, 5 & 6	10
4	Microbial processes for the production of penicillin, alkaloids. Microbial production of vitamins and aminoacids. Microbial transformation of steroids. Microbes in mineral leaching and metal concentration, Microbial enhanced oil recovery, Microbial enzyme technology industrially useful microbial enzymes. Immobilization of enzymes and microbial cells	4, 5 & 6	10
	Total Credits of the Course	3	

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks B. **Semester End examination – 60 marks**

REFERENCES

Compulsory Reading:

1. Industrial Microbiology, L.E Casida Jr. New Age International Pvt.Ltd. Publishers
2. Prescott and Dunns Industrial Microbiology 4th Edition, Gerald Reed (Ed) CBS Publishers and Distributors

Further Reading:

1. Industrial Microbiology A.H.Patel Mc Millan India Ltd.
2. Microbial Biotechnology Fundamentals of Applied Microbiology Second Edition Glazer and Nikaido Cambridge University Press
3. Industrial Microbiology Waites, Morgan , Rockey and Higton G, Black well

Science.
4. Manual of Industrial microbiology and Biotechnology 3rd Edition Baltz,Davies and Demain (Editors-in-Chief) ASM Press Washington DC

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MAHATMA GANDHI UNIVERSITY

BSM 21C 33 **ENVIRONMENTAL MICROBIOLOGY**

SchoolName	**School of Biosciences**
Programme	M.Sc. Microbiology
Course Name	**ENVIRONMENTAL MICROBIOLOGY**
Type of Course	Core

Course Code	**BSM 21C 33**					
Course Summary & Justification	This course develops concepts in Environmental Microbiology The major objective of this paper is to impart knowledge about structure and functioning of microbial communities of diverse environment. The course helps to understand the significance of microorganisms in creating environmental pollution,bioremediation of pollutants for developing strategies of environmental conservation and remediation. The students will develop set of skills to recognize the ecological problems and critical evaluation of the human impacts on pollution, climate changes and as well as environmental protection					
Semester	Third					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	**Basics of microbiology**					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Understand the diversity of microorganism and microbial communities inhabiting air andSummarise the role of microbes in air pollution and mitigating air pollution	U/R/ An	3
2	Know the Microorganisms responsible for water pollution especially Water-borne pathogenic microorganisms and their transmission	U/ An	3
3	Comprehend the various methods to determine the Sanitary quality of water and sewage treatment methods employed in waste water treatment	S/An/A	3 & 4
4	Able to describe the role of microbes in solid and liquid waste management	U/R	3 & 5
5	Understands the role of microbes in bioremediation of environmental pollutants like petroleum hydrocarbons, pesticides, plastic and electronic waste.	U/R	3
6	Create an insight to the strategies for bioremediation and understands utility of microbes in mineral and oil recovery	An/ C	3 & 5

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	**Aerobiology**: Air pollution -sources, major pollutants, adverse effect on living organisms and their impact on environment.Microbial indicators of air pollution. Enumeration of bacteria in air, Air sampling devices. Air sanitation. Air borne diseases and preventive measures	1	10
2	**Aquatic microbiology**: Microbiology of water – Water pollution and water borne pathogens. Potability of water. Indicator organisms Microbiological examination of drinking water. Purification and disinfection of water. Eutrophication. Microbial biofilms:, mechanism of microbial adherence, beneficial and harmful role of biofilms.extreme environments..	2 & 3	20
3.	**Liquid and solid waste management:** Treatment of sewage (primary, secondary and tertiary treatments) and treatment of industrial effluents. Bioreactors for wastewater treatment. Solid waste treatment - composting and land filling. Biosensors and biological indicators,	3 & 4	10
4	**Bioremediation**: Strategies for bioremediation. Microbial degradation of Petroleum hydrocarbons and pesticides, Microbial enhanced oil recovery, bioleaching of copper and gold. Plastic and electronic waste management. Role of microbes in metal corrosion and biofouling.	5 & 6	20
	Total Credits of the Course	3	

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction: Active co-operative learning, Seminar, Group Assignments Authentic learning: Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** M. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic

	based on research findings and literature search – 10 marks N. **Semester End examination – 60 marks**

REFERENCES

Compulsory Reading:

1. Atlas RM &Bartha R (1998) *Microbial ecology : fundamentals and applications* (Benjamin/Cummings, Menlo Park, Calif. ; Harlow) 4th ed.
2. K. Vijaya Ramesh.2004. Environmental microbiology.MJP Publishers.

Further Reading:

3. P.K..Mohapatra(2008).Environmental microbiology. I.K.International publishing House.
4. Campbell, R. E. 1983. *Microbial ecology*. 2nd Edition, Blackwell ScientificPublications, Oxford; Boston.
5. W. D. Grant, P. E. Long.2013. Environmental microbiology. Springer Science & Business Media
6. Nduka Okafor (2013).Environmental Microbiology of Aquatic and Waste Systems.Springer
7. Ahmad, I., Ahmad, F. and Pichtel, J. 2011. *Microbes and Microbial Technology: Agricultural and Environmental Applications*.Springer, New York.
8. Atlas RM (Ed.) .1998.Petroleum Microbiology. Mac Millan.

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MAHATMA GANDHI UNIVERSITY

BSM 21C 34 LABORATORY COURSE-5
(MICROBIOLOGY)

SchoolName	**School of Biosciences**
Programme	**MSc.Microbiology**
Course Name	**LABORATORY COURSE-5 (MICROBIOLOGY)**
Type of Course	Core
Course Code	**BSM 21C 34**
Course Summary &	The course includes morphological, cultural, biochemical and antibiotic sensitivity study of medically important microbes. The

Justification	content of the course also include serological techniques. The technical knowhow of isolation and identification of medically important microbes and other diagnostic methods is essential for a student to pursue a career in the field of Medical Microbiology					
Semester	Second					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	5	5	180		190
Pre-requisites	Theoretical knowledge inMicrobiology and Immunology Basic laboratory skills					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	The students will acquire skills on safe laboratory practices in a Medical Microbiology laboratory.	S	4
2	The students will be able to test and analyse morphological and biochemical properties of medically important microorganisms	S/An	4
3	Students will be able to isolate and identify bacterial and fungal pathogens from specimens	S	4
4	Students will be able to perform and Interpret antimicrobial sensitivity tests	S/E	5
5	Students will be able to culture pathogenic strains and to maintain a stock culture collection for study purpose,	S/A	4
6	Students will familiarize with basic virus cultivation technique and will develop aptitude for further studies in this field.	S/I	5
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	Study of the morphology, staining characters, cultural characters and identification of follthe medically important bacteria *Staphylococci,Streptococci,Neisseria,Pneumococcus,E.coli,Klebsiella,Salmonella,Shigella,Proteus,Pseudomonas,Vibrio,Bacillus and Mycobacterium tuberculosis* Z-N Staining of AFB in sputum Demonstration of volutin granules by Albert's/ Neisser' technique. Antibiotic susceptibility test by Kirby-Bauer method	1, 2, 3, 4 & 5	60

2	KOH mount preparation and examination of fungal elements in skin scrapings, nail clippings and hair bits Needle mount preparation and Lactophenol cotton blue staining Slide culture technique Gram staining of *Candida albicans* Germ tube test	1 & 3	60
3.	Direct microscopic examination of clinical specimens such as urine deposit pus, sputum etc. Culture and isolation of pathogens from urine, pus, sputum etc. Demonstration of inoculation of embryonated eggs.	1, 5 & 6	60
	Total Credits of the Course	3	180

Teachingand LearningApproach	**Laboratory Procedure (Mode of transaction)** Direct Instruction: lecture, Explicit Teaching, Demonstration, Hands on experimental sections, Skill acquisition by laboratory training, Journal Club
Assessment Types	**Mode of Assessment** M. Continuous Internal Assessment (CIA) 1. Internal Laboratory Skill Tests of maximum 20 marks 2. Seminar Presentation – Laboratory material and methods Maximum marks 10 3. Write a detailed report on instrumentation – 10 marks N. **Semester End Practical examination – 60 marks**

REFERENCES

Compulsory Reading:

1. District Laboratory Practice in Tropical Countries Part.2 Second Edition Monica Cheesbrough Cambridge University Press

2. Mackie& McCartney Practical Medical Microbiology 14th Edition J.G.Collee,A.G.Frase,BP Marmion&A.Simmons Elsevier

Further Reading:

1. Clinical Laboratory Methods Vol.2 Gradwohl The C.V.Mosby Company, 1981
2. Medical Mycology: A Practical Approach 1989 E. Evans &. Richardson (Editors)Oxford University Press

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MAHATMA GANDHI UNIVERSITY

BSM 21C 35 LABORATORY COURSE-6

SchoolName	School of Biosciences					
Programme	M.Sc.Microbiology					
Course Name	LABORATORY COURSE -6 (Microbiology)					
Type of Course	Core					
Course Code	**BSM 21C 35**					
Course Summary & Justification	The objective of this course is to familiarize students with the methods and techniques used for the enumeration of microorganisms in food and also to detect pathogenic microorganisms from food products. This also involves the lab work on the methods and techniques used for the microbiological analysis of milk. This course also covers the lab training for the production of ethanol and also solid-state fermentation which have significant industrial applications. This will enable the students to develop technical skills for further research or job in food industry.					
Semester	Third					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total LearningHours
	Authentic learning Collaborative learning Independent learning	5	5	180		60
Pre-requisites	Theoretical understanding on food microbiology and microbial association with food and also industrial microbiology					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Students will acquire skills to conduct basic microbiological analysis of food	S	3
2	Students will acquire skills to conduct food quality evaluation	S	3 & 4
3	Students will acquire skills to conduct microbiological analysis of milk	S/E	3 & 4

4	Students will acquire skills on ethanol production and fermentation	S/E	3 & 4
5	Students will get hands-on experience in procedures used in food and industrial microbiology lab	S/An	3 & 4
6	Students will acquire technical skills to further continue research and industrial job in food microbiology	S/E	3 & 4
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	Enumeration of microorganisms in foods Determination of aerobic colony count in foods Food sampling and preparation of sample Collection of food materials for microbiological analysis	1, 2, 5 & 6	60
2	Preparation of sample Isolation and enumeration of pathogenic Microorganisms in food Culture methods Molecular methods	1, 2, 5 & 6	60
3.	Microbiological analysis of milk MBRT Test Screening of microbes for enzyme production Screening of microbes for antibiotic production-Crowded plate technique Giant colony technique	3, 5 & 6	30
4.	Production of ethyl alcohol, Alcoholimetry Production of wine Submerged fermentation using conical flask Solid substrate fermentation	4, 5 & 6	30
	Total Credits of the Course	3	180

Teachingand LearningApproach	**Laboratory Procedure (Mode of transaction)** Direct Instruction: lecture, Explicit Teaching, Demonstration, Hands on experimental sections, Skill acquisition by laboratory training
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) 1. Internal Laboratory Skill Tests of maximum 20 marks 2. Seminar Presentation – Laboratory material and methods Maximum marks 10 3. Write a detailed report on instrumentation – 10 marks B. **Semester End Practical examination – 60 marks**

REFERENCES

Compulsory Reading:

1. Practical Food Microbiology, 3rd Edition, Diane Roberts, Melody Greenwood , ISBN: 978-1- 4051-0075-5, Wiley-Blackwell, 2002 71
2. Laboratory Manual of Food Microbiology, Neelima Garg, K. L. Garg, K. G. Mukerji, Neelima Garg, K. L. Garg, K. G. Mukerji . K. International Pvt Ltd, 2010

Further Reading:

3. Food Microbiology: A Laboratory Manual, Ahmed E. Yousef, Carolyn Carlstrom, John Wiley & Sons, 05-May-2003
4. Practical Microbiology R.C.Dubey and D.K. Mahaswari 2nd Edition S.Chand& Company Pvt. Ltd. New Delhi, 2002
5. Experiments in Microbiology,Plant Pathology and Biotechnology K.R.Aneja New Age International Pvt.Ltd. Publishers NewDelhi, 2003 4. Industrial Microbiolgy A Laboratory Manual Nupur Mathur& Anuradha Singh Avishkar Publishers and Distributors Jaipur, 2007

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FOURTH SEMESTER

MAHATMA GANDHI UNIVERSITY

BSM 21C 55 AGRICULTURAL MICROBIOLOGY

SchoolName	**School of Biosciences**					
Programme	M.Sc. Microbiology					
Course Name	**AGRICULTURAL MICROBIOLOGY**					
Type of Course	Core					
Course Code	**BSM 21C 55**					
Course Summary & Justification	The objective of the course content is to develope a clear understanding of the multifarious roles of microorganisms in soil, in association with plants and thus in the field of agriculture This course on agricultural microbiology thus appreciate the diversity of microorganism inhabiting in soil and their role in improving soil fertility and productivity					
Semester	Fourth					
Total StudentLearningTime (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total LearningHours
	Authentic learning Collaborative learning Independent learning	80	30	0	50	160
Pre-requisite	**Basics of Microbiology**					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	To acquire a comprehensive overview of occurrence, abundance and distribution of major types of microorganisms found in soil and the methods for their quantitative estimation and characterization	U/An/S	1 & 4
2	Understand various biogeochemical cycles – Carbon, Nitrogen, Phosphorus cycles etc. and microbes involved	U/ R	1 & 2

3	Understand various plant microbes' interactions especially rhizosphere, phyllosphere and mycorrhizae and their applications especially the biofertilizers and their production techniques	U/S	2 & 3
4	Analyse various aspects of N2 fixation, Phosphate solubilisation and PGPR	An/A	3 & 4
5	Explain the role of microorganisms in plant growth enhancement through improving nutrient availability, production of plant growth promoting substances and inhibiting pathogens	An/A/E	4 & 5
6	To familiarize microbial diseases of plants and control measures	U/ An/S	4
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	Microbial biodiversity in bulk soil and rhizosphere: copiotrophs and oligotrophs. Methods for quantitative and qualitative estimation of soil microbial populations. Measurement of biological activity in the soil: Microbial biomass, Metabolic reactions: Molecular methods of microbial diversity analysis.	1 & 3	20
2	Influence of soil and environmental factors on soil microbial cenoses. Microbial interactions in soil and other soil activities. Role of microorganisms in the Cycling of elements (C, N, P, S). Humus formation, composting, Methanogenesis and Biogas production	2, 3 & 4	10
3.	Nitrogen metabolism - Biological nitrogen fixation-Physiology, Biochemistry and genetics of nitrogen fixation. Mechanism and regulation. Nitrogen fixation in symbiotic, associative and free-living system, Physiology of legume root nodulation. Frankia induced nodulation	3 & 4	20
4	Importance of microbiology in sustainable agriculture.Rhizoshere and phyllosheremicroflora and their importance. Biofertilisers-Types and importance. Mycorrhiza-Classification and significance. Microbial products influencing plant growth-Plant growth regulators and phytotoxins. Plant growth promoting rhizobacteria (PGPR) and their direct and indirect mechanism of action	5	10
5	Microbial diseases of plants---Common bacterial, fungal and viral plant pathogens. Transmission of plant pathogens and control measures. Biopesticide and biological control of plant diseases and pests. Integrated pest management. Microbial warfare on plants.	6	20

Total Credits of the Course	4	

TeachingandLearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction: Active co-operative learning, Seminar, Group Assignments Authentic learning: Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** O. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks P. **Semester End examination – 60 marks**

REFERENCES

Compulsory Reading:

1. Subba Rao, N.S. 2005. Soil Microorganisms and Plant Growth, Oxford and IBH Publishing Co.
2. G.Rangaswamy and D.J.Bagyaraj.2007.Agriculture Microbiology 2nd Editon .Prentice Hall of India

Further Reading:

1. Microbial control and pest Management – S.Jayaraj.
2. Paul, E.A. 2007. Soil Microbiology, Ecology and Biochemistry, Academic Press.
3. Sylvia, D.M., Fuhrmann, T.A., Hartel, P.G. and Zuberer, D.A. 2005. Principles and Applications in Soil Microbiology (2nd Edition).
4. H.S.Chaube and V.S.Pundhir, 2005. Crop diseases and their management .Prentice hall of India
5. Soil Microbiology, Ecology and Biochemistry.2015.Eldor.A.Paul. , Academic Press
6. Soil Microbiology and Sustainable crop production.2010.Dixon and Telton.Springer
7. Soil Microbiology and Biochemistry.2009. Ghulam Hassan Dar New India Publishing
8. Soil Microbiology, Ecology and Biochemistry.2006.Eldor A. Paul.Academic Press, 2006 .
9. Microbial Ecology.2011. Larry L. Barton, Diana E. Northup. John Wiley & Sons, 2011

10. Alexander, M. 1977. Soil Microbiology, John Wiley

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MAHATMA GANDHI UNIVERSITY

BSM 21C 56 LABORATORY COURSE - 7
(Microbiology)

SchoolName	**School of Biosciences**					
Programme	M.Sc. Microbiology					
Course Name	**LABORATORY COURSE-7 (Microbiology)**					
Type of Course	Core					
Course Code	**BSM 21C 56**					
Course Summary & Justification	The objective of this course is to familiarize students with the methods and techniques used for the enumeration of microorganisms in Soil and to study plant microbial interactions like antagonism, symbiosis, mycorrhizae and endophytic associations. This also involves the lab work to demonstrate practical skills in the use of tools, technologies and methods common to agricultural microbiology.This will enable the studentsto acquire the skills to qualify for a broad range of positions in research, industry, consultancy, education and public administration, or for further education in a doctoral program.					
Semester	Fourth					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	5	5	180		190
Pre-requisite	Theoretical understanding on agricultural microbiology and microbial association with plant					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Students will acquire skills for isolation and enumeration of microorganisms from soil.	S	2 & 4
2	Students will acquire skills for isolation and characterisation of beneficial microflora from soil	S/A	2 & 4
3	Students will acquire skills to demonstrate antagonistic activities among soil microbes	S/A	4
4	Students will acquire skills to isolate and characterize nitrogen fixing and endophytic microorganisms	S/E	4
5	Students will acquire skills to detect air and water quality parameters	S/U	4
6	Students will acquire technical skills to further continue research and job in agricultural industry	S/E	5

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	Isolation and study of common soil bacteria, fungi and actinomycetes Enumeration of soil microbes by plate culture methods Study of antagonistic activities among soil microbes	1 & 2	30
2	Estimation of rhizosphere microbial population and calculation of R:S ratio Isolation of free-living nitrogen fixing bacteria Isolation of Rhizobium from root nodules of leguminous plants	3 & 4	60
3.	Isolation and characterisation of endophytic microorganisms Isolation of phosphate solubilising microorganisms Isolation of mycorhizal spores and its identification	4	30
4	Bacteriological examination of air Bacteriological examination of water BOD and COD determination	5 & 6	60

	Total Credits of the Course	3	180

Teachingand LearningApproach	**Laboratory Procedure (Mode of transaction)** Direct Instruction: lecture, Explicit Teaching, Demonstration, Hands on experimental sections, Skill acquisition by laboratory training
Assessment Types	**Mode of Assessment** Q. Continuous Internal Assessment (CIA) 1. Internal Laboratory Skill Tests of maximum 20 marks 2. Seminar Presentation – Laboratory material and methods Maximum marks 10 3. Write a detailed report on instrumentation – 10 marks R. **Semester End Practical examination – 60 marks**

REFERENCES

1. Practical Microbiology R.C.Dubey and D.K. Mahaswari 2nd Edition S.Chand& Company Pvt. Ltd. New Delhi, 2002
2. Experiments in Microbiology,Plant Pathology and Biotechnology K.R.Aneja New Age International Pvt.Ltd. Publishers NewDelhi, 2003
3. Industrial Microbiolgy A Laboratory Manual Nupur Mathur& Anuradha Singh Avishkar Publishers and Distributors Jaipur, 2007

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MAHATMA GANDHI UNIVERSITY

BSM 21E 61: QUALITY CONTROL IN HERBAL DRUGS

SchoolName	**School of Biosciences**					
Programme	**M.Sc. Biochemistry/Microbiology/Biotechnology/Biophysics**					
Course Name	**QUALITY CONTROL IN HERBAL DRUGS**					
Type of Course	Elective`					
Course Code	**BSM 21E 61**					
Course Summary & Justification	The course is designed to get a clear idea on quality control approaches in natural herbs and products and modern analytical techniques for the analysis of the herbal drugs.					
Semester	Fourth					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Eg. Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	Basic understanding of plant-based drugs					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	To estimate the quality assurance of herbal materials.	C	4
2	To isolate, purify and characterize the photochemical from medicinal plants.	A	4
3	To interpret the structure of natural products	U/E	5

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Module No	Module Content	Course outcome	Hours
1	WHO Guidelines for Quality Control of herbal raw materials. Determination of pesticide residue, arsenic and heavy metals, afflatoxins and microbial contaminants	1	10
2	Definition, principle of the various extraction techniques like maceration, percolation, hot continuous extraction, pilot scale extraction, microwave assisted extraction and supercritical fluid extraction. GMP for the production of quality botanicals.	2	20
3.	General methods for isolation and purification of active principles from medicinal plants. Application of chromatographic techniques in isolation & characterisation of phytochemical constituents viz., paper chromatography, thin layer chromatography, column chromatography, gas chromatography (GC), high performance liquid chromatography (HPLC) and high performance thin layer chromatography(HPTLC).	2 & 3	10
4	Role of chemical and biological markers in standardization of herbal products	1 & 3	10
5	General methods for structural elucidation of natural products, Application of spectroscopy for characterization of phytoconstituents	2 & 3	10
	Total Credits of the Course	3	

Books for Reference

Compulsory Reading:

1. Herbal Drug Technology, S. S. Agrawal, M. Paridhavi, Publisher Universities Press, 2007, ISBN 8173715793, 9788173715792

Further Reading:

2. Pharmaceutical Analysis Hiquchi, Bechmman,Hassan.
3. Methods of Drug Analysis Gearien,Graboski.
4. Text Book of BioPharmaceutic Analysis Robert Smith and JamesStewart.
5. harmaceutical Analysis Modern methods Part A and B Munson James.W.
6. Quantitative Analysis of DrugsGarrot.
7. Quantitative Analysis of Drugs in Pharmaceutical Formulations P. D.Sethi.

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction, Explicit Teaching, E-learning, interactive Instruction:,

	Active co-operative learning, Seminar, Group Assignments, Authentic learning, Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** **O. Continuous Internal Assessment (CIA)** Internal Test -20 marks Assignment – Every student needs to write an assignment on a given topic based on the available published literature – 10 marks Seminar Presentation – A topic needs to be presented and discussed with the class- 10 marks **P. Semester End examination – 60 marks**

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	MAHATMA GANDHI UNIVERSITY

BSM 21E 62: ENVIRONMENT BIOTECHNOLOGY

School Name	**School of Biosciences**					
Programme	**Msc Biotechnology/ Biochemistry/ Biophysics/ Microbiology**					
Course Name	**ENVIRONMENT BIOTECHNOLOGY**					
Type of Course	Elective					
Course Code	**BSM 21E 62**					
Course Summary & Justification	Environmental Biotechnology is offered to train the students both in the theoretical and practical aspects of identifying environmental problem where a solution is possible through Biotechnological methods. Enabling students in formulating ideal solution to environment problems based on green chemistry concept is the need of this time. Students have to earn a sense of Environmental concern and to get experience in the applications of Biotechnological methods for environmental protection.					
Semester	Fourth					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisites	None					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	**On completing this course, the student will be able to** Understand the effect of a specific environmental problem identified	u	1
2	**Analyse** Apply the most suitable biological method for the effective treatment of the pollutant	An	4
3	**Compare** Explore into the possibility of applying the developed method in the field.	U	5
4	**Acquiring** awareness about emerging challenges in environmenetal threat	uAn	5
5	**Communicate** effectively about choosen topic of current environmental issues	AP	5
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs

1	Introducti I**ndustrial pollution causes, problems:** Air, Soil and Water pollutants, Types of pollutants characterization, Persistence and Biomagnification of Xenobiotics, recalcitrant molecules, nitroaromatic polychlorinated, biphenyls and dioxans, synthetic polymers, alkylbenzyl sulphonates, Hydrocarbons, Pesticides, Phenolics, Anilines, Inorganic pollutants, Heavy metals. Detection and Quantification of pollutants. Environmental laws	1 & 4	10
2	**Biodegradation, Process and application:** Microbial infallibility, types of biodegradation, factors affecting biodegradation, enzymes involved in biodegradation, catabolic plasmids, Molecular Approaches, Biogeochemical cycles, Bioleaching. Biodegradation of Hydrocarbons, cellulose, lignin, Phenoland pesticides. Application of TOC, FT/IR, GC-MS analysis in biodegradation studies	2 & 5	10
3.	**Industrial wastewater:** Types of industrial effluents, characterization of the wastewater. Chemical Oxygen Demand, Biological Oxygen Demand, Total organic carbon, Nitrogen contents, Suspended solids. Total heterotrophic bacterial population. Bacteriological analysis of drinking water, Presumptive, completed, and confirmed test. Treatment strategies primary, Secondary and tertiary treatment Physical, Chemical and Biological treatment. Floc based and film based strategies, aerobic and anaerobic methods	1, 2 & 5	20
4	**Biological treatment of industrial wastewater:** Activated sludge process, different stages, Types. Oxic/Anoxic, Extended aeration methods, Nitrification and denitrification. Trickling filter process, Different stages Types, Biofilm applications, Rotating Biological contactor,UASB, Submerged aerobic filters, Fluidized Bed Reactor, Packed bed reactor, Oxidation lagoons. Bioreactors for wastewater treatment. Advanced treatment strategies Teritiary treatment methods, Disinfection, Chlorination, Chlorination dosage chlorination derived byproducts	4 & 5	10
5	**Solid waste management:** Solid waste, Types, Problems, Characterization and sorting of wastes. Municipal and industrial waste management, Land fills composting, stages in composting, Types of composting vermicomposting. Methanogenesis, stages in anaerobic digestion, methanogens Anaerobic reactors Biogas generation, Household treatment strategies, Present problem and Possible remedies	4 & 5	10
	Total Credits of the Course	3	

TeachingandLearningAppro	**Classroom Procedure (Mode of transaction)**

ach	Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** S. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks T. **Semester End examination – 60 marks**

REFERENCES

Compulsory Reading:

1. Microbial Ecoology, Atlas and Bartha, Pearson Publication
2. Comprehensive Biotechnology—2 nd Edition,Murray Moo Young ISBN-9780444533524,Pergman
3. Industrial Microbiology, Samuel Cate Prescot and Cecil Gordan Dunn,Third edition Mac Graw-Hill
4. Waste water microbiology, Gabriel Bitton,Third edition, Wiley, ISBN-9780471717966
5.

Further Reading:

1. Environmental Biotechnology -Theory and application , Gareth m Evans and Judith C Furlong , Wiley 2003
2. Envoronmental Chemistry-Anilkumae DE,

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BSM 21E 63: IPR AND PATENTING

School Name	**School of Biosciences**					
Programme	**Msc Biotechnology/ Biochemistry/ Biophysics/ Microbiology**					
Course Name	**IPR AND PATENTING**					
Type of Course	Elective					
Course Code	**BSM 21E 63**					
Course Summary & Justification	To introduce students the concept of intellectual property and IPR					
Semester	Fourth					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisites	None					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	**On completing this course, the student will be able to** **Define different international agreement on IPR**	u	1
2	**Analyse the patentability of an invention and laws on plant variety protection**	An	4
3	**Compare the patentability of biological entities**	U	4
4	**File a patent**	S	5
5	**Communicate effectively about a patent related topic both verbally and in writing**	An/ C	5

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	Introducti Introduction. Definitions General Agreement on Trade and Tariff (GATT) and World Trade Organizations	1 & 5	10

	Establishment and functions of GATT, WTO, and WIPO. WTO Guidelines and Summits. Physical and Intellectual Property		
2	TRIPS Different types of intellectual property rights (IPR) - Patents, Trade mark, Trade secret, copyright and Geographical indications Requirement of patentability, Biotechnological examples of patents, trademark, trade secret and copy right	1 & 5	10
3.	Patenting research tools and the law: Patents as a Strategy for Protection of Intellectual Property, Benefits and Costs of Patents, Requirements for Patent Protection, patentable subjects and protection in biotechnology, international convention for the protection of new varieties – Strasbourg convention, UPOV convention. Experimental Use Exemption	2 & 5	10
4	Patent filing and Infringement Patent application- forms and guidelines, fee structure, time frames; Types of patent applications: provisional and complete specifications; PCT and convention patent applications; International patenting-requirement, procedures, and costs; financial assistance for patenting-introduction to existing schemes; Indian Patent Act, 1970 and recent amendments Publication of patents in India Status of patenting in Europe and US. Patenting by research students, lecturers, and scientists University/organizational rules in India and abroad, credit sharing by workers, financial incentives, Patent infringement- meaning, scope, litigation, case studies and examples	4 & 5	20
5	The patentability of microorganisms, legal protection for plants and other higher organisms, new plant varieties by rights, tissue culture protocols, transfer of technology. Patentability of vectors. Licensing - Flavr Savr™ tomato as a model case, Biopiracy and case studies on patents (Basmati rice, Turmeric, and Neem)	3 & 5	10
	Total Credits of the Course	3	

TeachingandLearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** Q. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to

	prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks R. **Semester End examination – 60 marks**

REFERENCES

Compulsory Reading:

1. Patents (2003), N.Subbaram, Pharma Book Syndicate, Hyderabad.
2. WIPO Hand book on Intellectual Property
3. IPR , Biosafety, and Bioethics Deepa Goel and Shomoni Parashar

Further Reading:

1. Revised guidelines for research in Transgenic plants (August 1998), Department of Biotechnology, Ministry of Science & Technology, Government of India, New Delhi.
2. Intellectual Property, W.R. Cornish, Sweet and Maxwell publishers, London

Web resources

3. https:// worldwide. espacenet.com
4. https:// patentscope. wipo. int
5. https:// ipindiaservices.gov.in

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	MAHATMA GANDHI UNIVERSITY

	BSM 21E 64: OMICS IN BIOTECHNOLGY					
School Name	**School of Biosciences**					
Programme	**MSc Biotechnology**					
Course Name	**Omics in Biotechnology**					
Type of Course	**Elective**					
Course Code	**BSM 21E 64**					
Course Summary & Justification	1. The course describes new approach, the concept of "OMICS" in various levels.It is a multi-disciplinary emerging field that encompasses genomics, epigenomics, transcriptomics, proteomics, and metabolomics. 2. The course content explain the high-quality techniques, methods & analysis from genome level will help in the complete understanding of a biological process.These approaches are targeted towards understanding complex systems more thoroughly at the molecular level.					
Semester	Fourth					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisites	Basics of Molecular Biology					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	**On completing this course, the student will be able to Explain genome and types of genomics, tool and methods in genomic study, as well as Genome structure of selected organisms.**	**U/E**	5
2.	**Explain the Proteomics, Transcriptomics & Metabolomics & Describe the tool and methods employed to study. Students have able to explain the various application of Proteomics, Transcriptomics & Metabolomics study**	**An/A**	**4**
3.	**Students have able to illustrate the techniques employed for metagenomic analysis and application of metagenomic study**	**S/I**	**5**
4.	**Describe the classification and types of databases & applications of data bases**	**U/R**	**1**

5.	**Communicate effectively about a chosen topic in Omics in Biotechnology both practically and theoratically.**	**C/S**	**5**
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	**Genome & Genomics**: Definition of Genome & Genomics.Types of genomics,, Functional Genomics.Structural genomics&Comparative genomics, Tools in Genomics,Structural genomics:-Classical ways of genome analysis, large fragment genomic libraries; Physical & Genetic mapping of genomes; Genome sequencing, sequence assembly, annotation& bioinformatics.Functional genomics:-DNA chips and their use in transcriptome analysis; Mutants and RNAi in functional genomicsNext generation sequencing methods; Structure of genomes: bacteria, yeast, nematode, Arabidopsis, rice, zebra fish, mouse and man.Applications of genomics	**1 & 5**	**20**
2.	**Proteomics,Transcriptomics & Metabolomics:** Basic concepts , Introduction to transcriptomics,proteomics and metabolomicsTools of proteomics- SDS PAGE, 2D PAGE , Liquid chromatography , Mass Spectrometry (ESI and MALDI) ,Protein identification by peptide mass fingerprinting ,Applications of proteomics-. Protein identity based on composition, Motifs and patterns, Analysis and characterization of proteins and metabolites:. Proteomics approaches to the analysis of protein-protein interactions, and metabolic profiling through emerging metabolomic techniques like 2D gel electrophoresis and Mass spectrometric and computational techniques.Applications of proteomics in agriculture, human health and industry	**2 & 5**	**10**
3.	**Metagenomics:** Definition of metagenomics**,**Techniques in metagenomics-Isolating DNA from an environmental sampleClone DNA,Insert into plasmid,Develop sample library,Screen or sequence,Analysis of metagenomic data.Application of metagenomics	**3 & 5**	**10**
4	**Biological data bases:** Classification databases. Biological databases-primary sequence databases- Composite sequence databases- Secondary databases-composite protein pattern databases,Pattern and profile databases Genome Information Resources: DNA sequence databases-specialized genomic resources, GRAIL, GENSCANProteome databases Protein sequence databases - SWISS-PROT and TrEMBL — PROSITE and BLOCKS - 2D PAGE databases – Structure databases - PDB- Metabolic databases – post translational	**4 & 5**	**20**

	modification databases		
	Total Credits of the Course	**3**	

TeachingandLearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** S. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks T. **Semester End examination – 60 marks**

REFERENCES

Compulsory Reading:

1. Introduction to proteomics, Daniel. C. Libeler, Humana Press 2002
2. Thompson, J.D., Schaeffer-Reiss, C., and Ueffing, M. 2008. *Functional Proteomics. Methods andProtocols*. Humana Press, New York.
3. Metabolomics- Methods and Protocols by Wolfram Weckwerth, Humana Press.
4. Aurthur M Lesk Introduction to Bioinformatics .Oxford University press.

Further Reading:

1. Bostjan Koba.,Mitchell Guss & Thomas Habs Structural Proteomics.Humana Press.
2. Twyman, R.M. 2004. *Principles of Proteomics*. Taylor & Francis
3. Mass Spectrometry for Biotechnology by Gary Siuzdak, Academic Press.
4. Proteomics for Biological Discovery by Timothy Veenstra and John Yates, Wiley.
5. Lipidomics- Technologies and Applications by Kim Ekroos, Wiley-VCH.
6. Web/Journal Resources.
7. Transcriptomics: Expression Pattern Analysis, Virendra Gomase, Somnath Tagore; VDM Publishing, 2009 – Science
8. Brown TA. 2007. Genome III. Garland Science Publ.
9. Campbell AM & Heyer L. 2004. Discovery Genomics, Proteomics and Bioinformatics. Pearson Education.
10. Jollès P & Jörnvall H. 2000. Proteomics in Functional Genomics: Protein

Structure Analysis.
11. Kamp RM. 2004. Methods in Proteome and Protein Analysis. Springer.
12. Primrose SB & Twyman RM. 2007. Principles of Genome Analysis and Genomics
13. Blackwell. Sensen CW. 2005. Handbook of Genome Research. Vols. I, II. Wiley CVH.

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MAHATMA GANDHI UNIVERSITY

BSM 21E 65: MOLECULAR PHYLOGENY

School Name	**School of Biosciences**					
Programme	**Msc Biotechnology/ Biochemistry/ Biophysics/ Microbiology**					
Course Name	**MOLECULAR PHYLOGENY**					
Type of Course	Elective					
Course Code	**BSM 21E 65**					
Course Summary & Justification	1. This elective course deals with the tools and techniques of Molecular phylogeny. The course has a theoretical and a practical dimension 2. The learner will develop an understanding about models of nucleic acid substitution, tree building algorithms, data mining tools and submission tools for nucleic acid data and applications of Molecular phylogeny					
Semester	Fourth					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisites	Basics of genome organisation and organic evolution, concepts of biological classification					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	**On completing this course, the students will be able to** **Compare and narrate the models of nucleic acid substitution, tree building algorithms, data mining tools, and submission tools for nucleic acid data**	An	5
2	**Deposit nucleic acid sequences in databases and able**	S	4

	to perform data mining		
3	**Perform sequence alignment and editing**	S	4
4	**Analyse sequence alignments by suitable software and perform phylogenetic analysis**	S	3 & 4
5	**Carry out a phylogenetic analysis from raw sequence data up to final conclusions**	S	3 & 4
6	**Communicate effectively about a phylogenetic problem both verbally and in writing.**	An/ C	5
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	Basic concepts of molecular evolution: Genetic information, population dynamics, evolution and speciation, data used for molecular phylogenetics, phylogenetic tree, methods for inferring phylogenetic trees, networking, RNA world	1 & 6	15
2	Sequence databases and data base searches: Sequence databases, composite databases, database mirroring, and search tools, data base searching by sequence similarity – BLAST and FASTA, multiple sequence alignments CLUSTAL, MUSCLE, T-COFFEE	2, 3 & 6	10
3.	Phylogenetic inference: Genetic distances and nuclear substitution models, phylogenetic inference based on distance methods- UPGMA, Neighbour Joining, Minimum Evolution, Least square	4, 5 & 6	10
4	Phylogenetic inference: Maximum Likelihood and Bayesian phylogenetic analysis, phylogenetic analysis based on parsimony, phylogenetic analysis using protein sequences, testing tree reliability – Bootstrapping and jackknifing	4, 5 & 6	10
5	Testing models and trees: Models of evolution and phylogeny reconstruction, model fit, likelihood ratio tests, Practising MEGA, Paup*, RaxML, Mr Bayes, J Model Test, Sequence submission tools- SEQUIN and BankIt	4, 5 & 6	15
	Total Credits of the Course	3	

TeachingandLearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion,

	Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** U. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks V. **Semester End examination – 60 marks**

REFERENCES

Compulsory Reading:

1. Molecular evolution And Phylogenetics, Masatoshi Nei and Sudhir Kumar, Oxford University Press, ISBN 0195135857
2. Baldauf, SL (2003) "Phylogeny for the faint of heart: a tutorial." Trends in Genetics; 19(6):345-351.

Further Reading:

3. The phylogenetic Hand book, 2nd Edition, Philippe Lemey, Marco Salemi, Anne –Mieke Vandamme, Cambridge University Press, ISBN-13 978-0-511-71963-9
4. Hall, BG. (2004) Phylogenetic Trees Made Easy: A How-To Manual, 2nded. Sinauer Associates, Inc.: Sunderland, M A. I*SBN: 978-0-87893-606-9*
5. Hartwell, LH, L Hood, ML Goldberg, AE Reynolds, LM Silver, RC Veres (2008) Genetics: From Genes to Genomes, 3rd Ed. McGraw-Hill: New York ISBN-13: 978-0073525266ISBN-10: 007352526X

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MAHATMA GANDHI UNIVERSITY

BSM 21E 66 HUMAN VIROLOGY

SchoolName	**School of Biosciences**					
Programme	**M.Sc Microbiology/Biochemistry/Biotechnology/Biophysics**					
Course Name	**HUMAN VIROLOGY**					
Type of Course	Core					
Course Code	**BSM 21E 66**					
Course Summary & Justification	This course on Human Virology deals with an important area of Medical Microbiology The objective of the course content is to create a sound awareness in human viruses and viral diseases. their The course will augment the student's knowledge in pathogenesis of viral diseases and their laboratory diagnosis and prophylaxis.					
Semester	Fourth					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	Basic understanding on Human Anatomy, Physiology and Biochemistry Knowledge in Basic Virology, Molecular Biology and Immunology					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1.	On completing this course student will be able to analyse comparatively the structure and properties of important human viruses	**U/An**	**3 & 4**
2.	Students will be able to understand and evaluate the mechanism of pathogenesis of viral diseases	**U/E**	**3 & 4**

3.	Students will become aware of the methods applicable in viral diagnostics	**U/A**	**4**
4.	Students will be able to analyse the various mechanisms of viral oncogenesis	An	3
5,	Students will be able to understand and compare the mechanisms of action of various antiviral agents	U/An	2 & 3
6	Students will be able to understand and evaluate the methods of prophylaxis of viral diseases in humans	U/E	3
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	Study of properties of human DNA viruses viz. Pox, Herpes, Adeno, Papova, and Parvo viruses. Pathogenesis and laboratory diagnosis of diseases caused by these viruses	1, 2 & 3	10
2	Study of properties of human RNA viruses viz. Picorna, Orthomyxo, Paramyxo, Rhabdo, and Rubella viruses	1, 2 & 3	20
3.	Arboviruses and Hepatitis viruses - Properties. Pathogenesis and laboratory diagnosis of diseases caused by these viruses. Viral haemorrhagic fevers, SARS CoV-2, HIV,Properties, pathogenesis and laboratory diagnosis of Slow virus infections, Prion diseases	1, 2 & 3	20
4	Viruses and cancer, Viral oncogenesis, Viruses implicated in the cancers of humans, Prophylaxis of viral diseases, Types of viral vaccines, antiviral agents and their mechanisms of action, Interferons	2, 3, 5 & 6	10
	Total Credits of the Course	3	

TeachingandLearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion, Presentation by individual student/ Group representative
Assessment	**Mode of Assessment**

Types	U. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks V. **Semester End examination – 60 marks**

REFERENCES

Compulsory Reading:

1. Jawetz,Melnick& Adelberg's Medical Microbiology27 th Edition Carrol, Butel, Morse, Mietzner Mc Graw Hill
2. Ananthanarayan & Panicker's Text book of Microbiology.9th Edition Arti Kapil (Ed) University Press (India) Pvt.Ltd.

Further Reading:

Further Reading:

1. Human Virology Fourth Edition Leslie Collier, John Oxford & Paul Kellam Oxford University Press.
2. Fundamental Virology 5th Edition David M.Knipe& Lippincott Williams & Wilkins
3. Viruses Biology,Applications & Control

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BSM 21E 67 ADVANCED TECHNIQUES IN DIAGNOSTIC MICROBIOLOGY

SchoolName	School of Biosciences					
Programme	M.Sc. Microbiology/Biotechnology/Biochemistry/Biophysics					
Course Name	ADVANCED TECHNIQUES IN DIAGNOSTIC MICROBIOLOGY					
Type of Course	Elective					
Course Code	**BSM 21E 67**					
Course Summary & Justification	Different methods are used to detect the diseases caused by microorganisms. The syllabus content in this course has been designed with an objective to provide the basic principle and applications of various methods used in diagnostic microbiology. This will enable the students to learn the basic and advanced methods in diagnostic microbiology which will enable them to identify the research and job opportunities based on the latest developments in this subject					
Semester	Fourth					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	Basic understanding on diseases caused by microorganisms, different methods used to detect the diseases					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1.	Students will able to understand the process and methods in medical microbiology lab	R/U	3
2.	Students will able to understand various clinical samples used for diagnostic applications	R/U	3
3.	Students will able to explain the principles of methods used in medical microbiology	U/ An/E	5

4.	Students will get exposed to both the conventional and rapid methods used for the microbial identification	U/An/A	1
5.	Students will able to identify research and job opportunities in diagnostic microbiology	C/S	5
6.	Students will able to analyze scope of technological advancement for rapid microbial identification	S/I	4
**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	Introduction to diagnostic microbiology, laboratory safety, hospital epidemiology. Lab methods in Medical Microbiology, basic virology, basic mycology, Clinical material - collection and transport. Etiological agents recovered from different clinical materials	1, 2 & 3	20
2	Biochemical profile based microbial identification systems, Urea breath test, Rapid antigen tests, Enzyme-Linked Immunoassay, Western blot, Advanced antibody detection, Bacterial antimicrobial susceptibility tests	1 & 4	20
3.	Polymerase chain reaction, Principle, applications and types of PCR in medical diagnostic field, Microbial Identification Based on PCR amplification of 16S rDNA, Sequence analysis, Application of Real Time PCR in Diagnostic Microbiology, Microbial Strain Typing Using Repetitive Sequences Advances in the Diagnosis of *Mycobacterium tuberculosis* and methicillin resistant *Staphylococcus aureus.*	4 & 5	10
4	Probe-Based Microbial Detection and Identification, Southern Blot Hybridization, Microarray- Based Microbial Identification and Characterization, Recent advances in medical microbiology	5 & 6	10
	Total Credits of the Course	3	

Teaching	**Classroom Procedure (Mode of transaction)**

And Learning Approach	Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction, Active co-operative learning, Seminar, Group Assignments Authentic learning, Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** W. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar - Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks X. Semester End examination – 60 marks

REFERENCES

Compulsory Reading:

1. Bailey and Scott's Diagnostic Microbiology Publisher: Elsevier Health, 28 Jun 2013
2. Advanced Techniques in Diagnostic Microbiology Editors: Wu, Shangwei, Stratton, Charles, 2012

Further Reading:

3. Textbook of Diagnostic Microbiology Hardcover, by Mahon (Author), Publisher: Elsevier Health - US; 5 edition (18 February 2014)
4. Koneman's Color Atlas and Textbook of Diagnostic Microbiology 7th Edition by Gary W. Procop MD MS , Elmer W. Koneman, Publisher: LWW; 7 edition (June 15, 2016)

	BSM 21E 68: RADIATION BIOPHYSICS
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SchoolName	**School of Biosciences**

Programme	**Msc Biochemistry/ Microbiology/ Biotechnology/ Biophysics**					
Course Name	**RADIATION BIOPHYSICS**					
Type of Course	Elective					
Course Code	**BSM 21E 68**					
Course Summary & Justification	To introduce the student to an important division of Biophysics- Radiation Biophysics To familiarize the topics of Radiation and Radioactivity, its interactions, biological effects, dosimetry, hazards, protection and application in medicine, industry and agriculture The course is designed to provide an overview of different imaging techniques used in medical field					
Semester	Fourth					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total LearningHours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	**Basics of** Radiation biophysics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	To describe various kinds of radiation and radiation units	E	1
2	To explain the various biological effects of radiation	U/ An	4
3	To narrate how to detect and measure radiation	R	5
4	To explain how to protect from radiation exposure	S	5
5	To describe the use of radioisotopes in medicine, industry and agriculture	E	4 & 5
6	To discuss about the biomedical imaging techniques	An/ C	4
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Course outcom	Hrs

		e	
1	**Radioactivity:** Laws of radioactivity, α, β, γ rays. Properties of electromagnetic radiation. Radiation units; Exposure and Dose, Dose equivalent unit, KERMA, Absorbed dose and Derived Units- Equivalent Dose and Effective dose, Dose rate. Interaction of radiation with matter- Bremsstrahlung, Photoelectric effect, Compton effect, Ion pair production. Interaction, absorption and scattering of electron. Heavy charged particles and Neutrons. Attenuation coefficient and absorption coefficient. HVL, Mean free path, Absorption edges, LET, Relative biological effectiveness (RBE)	1	10
2	**Biological effects of radiation:** Radiolysis of water, Production of free radicals & their interactions, Competition kinetics, Diffusion kinetics & Physicochemical effects, Role of scavengers, G-value, Genetic Effect of radiolysis, Chromosomal breakage and Aberrations Direct and Indirect action, Oxygen and temperature effect, OER. Target theory, Single hit & Multi hit theory, Multi target theory, Calculation of target, Mass, Volume & Molecular weight, Effect of radiation on Nucleic acids, Proteins, Enzymes & Carbohydrates, Somatic and genetic effects of radiation, Stochastic and deterministic effects, early and late effects, Radiation sickness, Radiation syndrome, Haemopoietic syndrome, G.I syndrome, CNS syndrome, Acute radiation damage, Early and late effects of radiation, Effect of chronic exposure to radiation. Acute radiation damage, LD-50, Dose effect relationship. Cell recovery and modification of Radiation damage	1 & 2	10
3.	**Radiation dosimetry**: Principles of radiation detection and measurement- Dosimetry- General requirements of Dosimeters, Radiation sources, Telegamma Unit (Cobalt unit), Gamma chamber, Nuclear reactors, Thermal & fast neutron sources. Dosimeters- Basic principles, Design & Working of physical dosimeters- Ionization chamber, Proportional counters, GM- Counter, Concepts of Gas amplification, Resolving time & Dead time, Scintillation Detectors, Thermolumeniscent Dosimeter, Semiconductor, Surface barrier & Lithium detectors, Area survey meter & Pocket dosimeter, Film badge, General principle of chemical dosimetry, Salient Features of Chemical dosimeter, Dose evaluation formula for chemical dosimetry, Principles of radiolytic reaction, Experimental methods- Influencing factors	3	20

	of Fricke dosimeter methyl orange, FBX dosimeter, Free radical dosimeter, Ceric sulphate dosimeter, PMMA, PVC, chlorobenzene dosimeter, High & low dose indicators		
4	**Radiation Hazards and Protection**: Natural and man-made radiation exposures, maximum possible dose, Radiation hazards- external and internal radiation hazards. Radiation protection measurement in industrial establishment, Radioisotope labs, diagnostic and therapeutic installation and during the transportation of radioactive substances, Disposal of radioactive wastes.	4	10
5	**Applications of radiation-** Radioisotopes in Biology, Agriculture, Plant breeding, Plant Physiology, Medicine. Internally administered isotopes. Radioiodine in thyroid function analysis. Renal, liver and lung function analysis. Radio Immuno Assay, Radiotracer techniques. Auto radiography. Specialized radio isotopic applications in industries **Biomedical imaging techniques-** Principle of analogue and digital imaging, Ultra sound imaging, Nuclear resonance imaging, X-ray imaging and CT scan, Principle of tomographic techniques, Computerised tomography, positron emission tomography, application and interpretation of image	5 & 6	10
	Total Credits of the Course	3	

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** W. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks X. **Semester End examination – 60 marks**

REFERENCES

Compulsory Reading:

1. Glenn.F.knoll., Radiation detection and Measurement; III Edition,John Wiley & Sons, Inc.
2. Edward L. Alphen., Radiation Biophysics©, Prentice Hall

Further Reading:

1. Frank.H. Attix., Introduction to Radiological Physics & Radiation dosimetry
2. Wagner, Szabo, Buchanan., Principles of Nuclear medicine.
3. Orton, C.G., Radiation Dosimetry: Physical and Biological aspects.
4. Girish Lahari- Nuclear Physics,Mohit Books International.
5. S.P.Yarmonenko;Radiobiology, Mir Publishers.
6. JozsefKonya.Noemi M. Nagy; Nuclear and Radiochemistry,Elsevier insight

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BSM 21E 69 GOOD LABORATORY PRACTICES

SchoolName	**School of Biosciences**					
Programme	**MSc Biochemistry/ Microbiology/ Biotechnology/ Biophysics**					
Course Name	**GOOD LABORATORY PRACTICES**					
Type of Course	Elective					
Course Code	**BSM 21E 69**					
Course Summary & Justification	To equip the students with appropriate knowledge, skills to undertake general and quality management of laboratory practices and procedures. To adequately address quality issues and improve the overall delivery of clinical and public health laboratory services in their facilities/organizations. To sensitize the students with medical and public health ethics issues and to ensure its application in teaching and practice.					
Semester	Fourth					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	**Basics Knowledge in Biosciences**					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Understand basic good laboratory practice	U	1
2	Appreciate how to conduct research safely and efficiently	Ap	2
3	Understand the requirements for safe working practices and risk assessment	U	1
4	Apply experimental design and the need for controls	A	4
5	Consider ways in which student can maximise research effort	C	5

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Modul	Module Content	Course	Hr

e No		outcome	s
1	Introduction to good laboratory practices (GLP) and its application, history of GLP, fundamental points of GLP	1	10
2	Resources-personnel, Facilities - buildings and equipment, Characterization- test item, test system, rules for performing studies-the study plan or protocol, standard operating procedures (SOPs) raw data and data collection- records and recording, study report, archives and archiving, quality assurance, audit and inspections, implementation of GLP	2	20
3.	Applications of the GLP principles to field studies, applications of the GLP principles to short term studies, applications of the GLP principles to in vitro studies	3	10
4	Ethics in research- locating ethics in research, justice in research, science and society, ethical issues in biotechnology, ethical guidelines related to human experimentation, guidelines regarding animal use in research, institutional biosafety monitoring mechanisms.	4 & 5	20
	Total Credits of the Course	3	60

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** Y. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks Z. **Semester End examination – 60 marks**

REFERENCES

Compulsory Reading

1. Handbook on Good Laboratory Practice- World Health Organization
2. Ethical Guidelines for Biomedical Research on Human Participants- Indian Council of Medical Research
3. Guidelines on the regulation of scientific experiments on animals- Ministry of Environment and Forests, India
4. Textbook on Ethics in Research- European Commission, Publications Office of the European Union

Further Reading:

1. **Good Laboratory Practice Regulations, 4th edition edited By Sandy Weinberg- CRC Press, 2007**
2. **The Indispensable Guide to Good Laboratory Practice (GLP): Second Edition 2nd Edition- Mark Gregory Slomiany- Springer, 2009**

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BSM 21E 70: HEALTH AND NUTRITION

SchoolName	**School of Biosciences**					
Programme	**M.Sc. Biochemistry/Microbiology/Biotechnology/Biophysics**					
Course Name	**HEALTH AND NUTRITION**					
Type of Course	Elective					
Course Code	**BSM 21E 70**					
Course Summary & Justification	The course is designed to provide basic information on nutrition and its importance in providing health.					
Semester	Four					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Eg. Authentic learning Collaborative learning Independent learning	60	30	0	40	130
Pre-requisite	Basic understanding of food and food ingredients					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	To describe the basic principles of nutritional biochemistry and different methods of nutritional analysis.	R/U	1
2	To identify and compare the different ingredients and nutritional value of food components	A	4
3	To identify different diseases associated with nutritional deficiency and overnutrition	U	4

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Modul	Module Content	Course	Hour

e No		outcome	s
1	**Introduction to nutrition -** Food as source of nutrients, functions of food, definition of nutrition, nutrients & energy, adequate, optimum & good nutrition, malnutrition. Basics of energy metabolism, nutrition & dietetics - Unit of measuring energy, calorific value of food, BMR & factors affecting it, SDA of food, calculation of energy requirement, balanced diet, nutrition in health & disease. Nutritional disorders- Epidemiology, clinical features, prevention and dietary treatment for Protein Energy malnutrition, nutritional anaemias.	1 & 3	20
2	**Food sources:** Carbohydrates : Functions, classification, food sources, storage in body. Fats & oils : composition, saturated and unsaturated fatty acids, classification, food sources, function of fats. Proteins - composition, sources, essential & non-essential amino acids, functions, Protein deficiency	2	10
3.	**Water, Vitamins and minerals-** Water - as a nutrient, function, sources, requirement, water balance & effect. Minerals - macro & micronutrients. - functions, sources. Bioavailability and deficiency of Calcium, Iron, Iodine, Sodium & Potassium (very briefly). Vitamins (water & fat soluble) - definition, classification & functions. Effect of cooking & heat processing on the nutritive value of foods. Processed supplementary foods.	2	10
4	**Nutritional problems affecting the community-**Etiology, prevalence, clinical features and preventive strategies of- Undernutrition - Protein energy malnutrition: Nutritional Anaemias, Vitamin A Deficiency, Iodine Deficiency Disorders. Overnutrition – obesity, coronary heart disease, diabetes. Fluorosis	3	20
	Total Credits of the Course	3	

Books for Reference

Compulsory Reading:

1. Mudambi, SR and Rajagopal, MV. Fundame ntals of Foods, Nutrition and Diet Therapy; Fifth Ed; 2012; New Age International Publishers

2. Mudambi, SR, Rao SM and Rajagopal, MV . Food Science; Second Ed; 2006; New Age Publ.

Further Reading:

1. Srilakshmi B. Nutrition Science; 2012; New Age International (P) Ltd.
2. Swaminathan M. Handbook of Foods and Nu trition; Fifth Ed; 1986; BAPPCO.
3. Bamji MS, Krishnaswamy K and Brahmam GNV (Eds) (2009). Textbook of Human Nutrition, 3rd edition. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments, Authentic learning, Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** **AA. Continuous Internal Assessment (CIA)** Internal Test -20 marks Assignment – Every student needs to write an assignment on a given topic based on the available published literature – 10 marks Seminar Presentation – A topic needs to be presented and discussed with the class- 10 marks **BB. Semester End examination – 60 marks**

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BSM 21E 71: NEUTROPHIL BIOLOGY

SchoolName	**School of Biosciences**					
Programme	**M.Sc. Biochemistry/Microbiology/Biotechnology/Biophysics**					
Course Name	**NEUTROPHIL BIOLOGY**					
Type of Course	Elective					
Course Code	**BSM 21E 71**					
Course Summary & Justification	The course is designed to get a detailed idea about the functioning of neutrophils in providing immune response and the mechanisms behind it. This would be helpful for the students, in case they take up research in immunology, cell biology or cellular biochemistry.					
Semester	Four					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Eg. Authentic learning Collaborative learning Independent learning	60	20	10	40	130
Pre-requisite	Basic understanding of immunology and blood cells					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	To describe the role of neutrophils in imparting and fine-tuning immune response	R/U	1
2	To identify and compare different functions of neutrophils	U/A	4
3	To identify different techniques to perform neutrophil functional analysis	S	4

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Module No	Module Content	Course outcome	Hours
1	**Introduction to immune system-** innate and adaptive immune system, cells involved in immune system, humoral immunity, cytokines, antibodies, complement system. cell- mediated and humoral immune response	1	10
2	**Neutrophil Physiology**-Neutrophil structure, Granule types- azurophilic, specific, gelatinase, secretory vesicles, Antimicrobial peptides. Neutrophil Subpopulations. Neutrophil activation, apoptosis and clearance. Neutrophils in the resolution of inflammation. Neutrophil in immune cross-talk	2	10
3.	**Neutrophil defense mechanisms-** Chemotaxis, Phagocytosis, degranulation, ROS generation,NADPH oxidase, Neutrophil extracellular trap formation, NETosis vs. apoptosis and necrosis, Cytokine secretion. Diseases associated with altered neutrophil defence- Autoimmunity, cancers, thrombosis.	2	20
4	**Techniques to study neutrophils:** Neutrophil isolation and maintenance, Cell counting, Phagocytic assays, chemotactic assays, NBT assay, MTT assay, other assays of ROS production, Granule isolation, Neutrophil protein analysis, microscopic analysis of neutrophils and granules – Light and fluorescent microscopy, SEM and TEM	3	20
	Total Credits of the Course	3	

Books for Reference

Compulsory Reading:

1. Neutrophil Methods and Protocols, Quinn, Mark T., DeLeo, Frank R., Bokoch, Gary M. (Eds.). ISBN 978-1-59745-467-4.
2. Biochemistry and physiology of the neutrophil, Steven W Edwards, Cambridge university press Online ISBN-9780511608421
3. The Neutrophil, Murphy, Patrick , Springer, ISBN- ISBN 978-1-4684-7418-3

Further Reading:

1. Neutrophil function: Mechanisms to diseases. Borko Amulic, Christel Cazalet,Garret L. Hayes, Kathleen D. Metzlerand Arturo Zychlinsky; Annu. Rev. Immunol. 2012. 30:459–89.
2. Neutrophil biology: an update. Yoshiro Kobayashi, EXCLI J. 2015; 14: 220–227. doi: 10.17179/excli2015-102.
3. Advances in neutrophil biology: clinical implications. Cowburn AS, Condliffe AM, Farahi N, Summers C, Chilvers ER. Chest. 2008 Sep;134(3):606-12. doi: 10.1378/chest.08-0422.
4. The Neutrophils: New Outlook for Old Cells. 3rd Edition.Edited by: Dmitry Gabrilovich (H Lee Moffitt Cancer Center, USA & University of South Florida, USA). ISBN: 978-1-

84816-836-7

Teachingand LearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments, Authentic learning, Library work and Group discussion, demonstrations, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** **A. Continuous Internal Assessment (CIA)** Internal Test -20 marks Assignment – Every student needs to write an assignment on a given topic based on the available published literature – 10 marks Seminar Presentation – A topic needs to be presented and discussed with the class- 10 marks **B. Semester End examination – 60 marks**

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BSM 21E 72 PLANT-MICROBE INTERACTIONS

SchoolName	**School of Biosciences**					
Programme	M.Sc. Microbiology					
Course Name	**PLANT-MICROBE INTERACTIONS**					
Type of Course	Elective					
Course Code	**BSM 21E 72**					
Course Summary & Justification	This course develops concepts in plant- microbe interaction The major objective of this paper is to give an insight into the consequences, on population and ecosystem level, of compatible and incompatible interactions, to understand infection process and control measures and to familiarize with the microbial production of plant metabolites.					
Semester	First					
Total StudentLearning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Authentic learning Collaborative learning Independent learning	60	20	0	40	120
Pre-requisite	**Basics of agricultural microbiology**					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
1	Comprehensively discuss interactions between plants and microbes as well as the defense reactions of the host plant	U/R/ An	1
2	Gain insight into genetics of host-pathogen interactions and resistance mechanism in plants.	C/ I/An	2

3	Comprehend various methods to analyse plant diseases and biological methods of disease control	S/An/A	3
4	Analyse why plants and microbes react in certain ways in pathogenic and symbiotic interactions	U/R/An	5
5	Understands the role of microbes in developing plant immunity	U/R	4
6	Have an in-depth knowledge on biopesticides and their role in pest control	An/ C	5
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module No	Module Content	Course outcome	Hrs
1	Different interfaces of interactions -soil-plant-microbe interactions leading to symbiotic (rhizobial and mycorrhizal), associative, endophytic and pathogenic interactions	1 & 2	10
2	General concepts of plant immunity. PAMP-triggered immunity (PTI) and Effector triggered immunity (ETI). Outer membrane vesicles (OMVs) and their involvement in plant immunity. The type III secretion system. Hypersensitive response. Genetic basis of plant defences. Quorum-sensing in bacteria and their role in plant defence mechanisms. Phytohormones and antibiotics as plant therapeutics.	2, 3 & 4	20
3.	Plant pathogens and molecular basis of pathogenesis .Genetics of host-pathogen interactions, resistance genes, resistance mechanisms in plants. basal and induced defence mechanisms. Systemic Acquired Resistance (SAR) and Induced Systemic Resistance (ISR), Recognition mechanism and signal transduction during plant - pathogen interaction. Virulence determinants of plant pathogenic bacteria-Enzymes, Toxins, pili, siderophores, secretion systems	4 & 5	20
4	Microbial pest control: Bacillus thuringiensis-mode of action, Biocontrol agents– uses and practical constraints Biofungicide and bioherbicides. Plant growth promoting rhizobacteria. Use of plant–microbe symbiosis for remediation of pollutants and carbon (C)	6	10

	sequestration		
	Total Credits of the Course	3	

TeachingandLearningApproach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction: Active co-operative learning, Seminar, Group Assignments Authentic learning: Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**Mode of Assessment** Y. Continuous Internal Assessment (CIA) 1. Internal Tests of maximum 20 marks 2. Seminar Presentation – a theme is to be discussed and identified to prepare a paper and present in the seminar Maximum marks 10 3. Write a detailed report on a given topic based on research findings and literature search – 10 marks Z. **Semester End examination – 60 marks**

REFERENCES

Compulsory Reading:

1. Subba Rao, N.S. 2005. Soil Microorganisms and Plant Growth, Oxford and IBH Publishing Co.
2. B. Lugtenberg (ed). 2015.Principles of plant microbe interactions, Springer

Further Reading:

1. Microbial control and pest Management – S.Jayaraj.
2. Paul, E.A. 2007. Soil Microbiology, Ecology and Biochemistry, Academic Press.
3. M.Gillings and Holmes .2004.Plant microbiology-Bios Scientific publishers.
4. Kosuge T & Nester EW. 1989. Plant-Microbe Interactions: Molecular and Genetic Perspectives .Vols I-IV. McGraw Hill.
5. Verma DPS & Kohn TH. 1984. Genes Involved in Microbe-Plant

Interactions. Springer Verlag.

6. Gary Stacey, Noel T. Keen, 1995. Plant-Microbe Interactions. Vols I-VI Springer Science & Business Media.

7. Jeng-Sheng Huang **2001.**Plant Pathogenesis and ResistanceBiochemistry and Physiologyof Plant-Microbe Interactions .Springer Verlag

Approval Date	
Version	
Approval by	
Implementation Date	

MAHATMA GANDHI UNIVERSITY

BSM 21E 73 SUSTAINABLE AGRICULTURE

School Name	**School of Biosciences**					
Programme	**M.Sc. Biochemistry/Microbiology/Biotechnology/Biophysics**					
Course Name	**SUSTAINABLE AGRICULTURE**					
Type of Course	Elective					
Course Code	**BSM 21E 73**					
Names of Academic Staff & Qualifications	**Dr J G RAY**					
Course Summary & Justification	The course is to introduce the concept of sustainable agriculture, especially its principles of ecological sustainability. The course will equip students to understand the concept of organic farming. It will enable an understanding of plant nutrient management as well as pest management in sustainable agriculture. Organic farming is becoming an internationally significant agricultural practice, and the knowledge has global significance. Interdisciplinary biology students with a good understanding of organic farming will enable our students to find suitable job opportunities in such farming industries.					
Semester	First					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	E.g., Authentic learning Collaborative learning Independent learning	60	18	0	28	106
Pre-requisite	**Knowledge in Botany at the Graduate level**					

No.	Expected Course Outcome	Learning Domains	PSO No.
1	Students will develop a critical knowledge of the basic principles of sustainable agriculture	R/U/A	1
2	They will be able to analyze environmental issues related to	U/A	4

	chemicalized agriculture		
3	They will acquire the basic skills of sustainable organic agriculture	U/An/Ap	2
4	They will develop the skills to evaluate different kinds of farming	An/Ap	4

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

Module No	Module content	Course outcome
1	Introduction to Sustainable agriculture: Concept of ecological sustainability and sustainable agriculture-Natural, Ecological and organic farming – definition, concepts, and practices – management, principles, methods, merits and demerits.	1 & 2
2	Challenges to Sustainable agriculture – Productivity vs sustainability; Soil organic matterdecomposition, C: N ratios, mineralization and immobilization processes, hummus, the role of organic matter in soil quality – natural way to prevent soil degradation and erosion, types and control measures. Soil related water pollution- sources, different pollutants in soils and their managements Plant nutrient management in sustainable agriculture: Bio-availability of nutrients in soils, deficiency symptoms on plants, nutrient interactions and chelated micronutrients.Bio-fertilizers – benefits - classifications, production - maintenance and application	1 & 2
3	Organic Manures – bulky and concentrated – FYM – Biocomposting, Compost – rural, urban, vermicompost and coirpith; Panchagavya preparation and other organic nutrients application - Enrichment of organic manures; Sewage and sludge; Green manures – potentials and limitations; Quality parameters of organic manures and specifications – Biofertilizers -	3 & 4
4	Biopesticides and biological control agents: Types of biocontrol agentsbiological agents and pheromones, control of weeds, diseases and insect pests and field sanitation - competition, predation, antibiosis and fungistatic Efficacy of traditional biopesticides - Botanical insecticides- beneficial insects like the honeybee, lac insect, silkworm and pollinators Biological control - concepts and potentialities for managing soil-borne pathogens. Types of biological interactions, competition, 1.078 mycoparasitism; Mycorrhizal associations, Biodynamic products, Biodynamic composting, Liquid manure, Influence of Bio-dynamic products on crop production. Visit Organic Farms	3 & 4
	Total Credits of the course	3

Books for References

Compulsory Reading:

1. Dahama AK (2007). Organic Farming for Sustainable Agriculture. 2nd Edn. Published by AGROBIOS (India) Jodhpur

2. National Standards Programme for Organic Production and Organic Products (2000) Department of Commerce, Ministry of Commerce and Industry, Govt. of India

Further Reading:

3. Gehlot D (2005). Organic Farming: Standards, Accreditation, Certification and Inspection, AGROBIOS (India) Jodhpur

4. Gupta PK (2007). Soil, Plant, Water and Fertilizer Analysis Published by AGROBIOS (India), Jodhpur

5. Sadasivam S and Manickam A (1992). Biochemical Methods for Agricultural Sciences Wiley Eastern Limited and Tamil Nadu Agricultural University, Coimbatore

Rubrics selected for OBE implementation

1.Overall performance in each course of the semester on a continuous basis

2. Response to **critical theoretical questions** in each course

3. Procedural approach adopted towards **lab oriented critical questions** in each practical course

4. Response to **socially relevant issues and recent trends** in each course

5.Aptitude to research and **specific research problem** in each course

Part 1Task Description

1. Written Examination
2. Assignment
3. Seminar
4. Practical Exam
5. Viva voce

Part II Scale- Continuous mode

Excellent, Satisfactory, Needs improvement(remedial practices recommended)

Partt IIIDimensions

Written Examination-Content, Communicating

Assignment -Content, level of Comprehension

Seminar-Content, Performance

Practical exam- Conduct of practical, Observation and recording

Viva voce -Response to questions, Attitude

Part IV Description of the dimensions

Content-Brief and meaningful

Comprehension- Precise and effective

Communicating-Direct and orderly

Procedure adopted- ScientificSuitability and easiness

Conduct of practical-Accuracy and reproducibility

Observation and recording- Sharp and systematic

Response to questions- Analyticalapproach and level of accuracy

Attitude- Positive and self-inspiring

MODEL QUESTION PAPERS

School of Biosciences
Mahatma Gandhi University
III Semester MSc Microbiology Examination
BSM 21C 30 Medical Microbiology

SECTION A

Answer all questions. Each question carries two marks. 10x 2 = 20 marks

1. Explain the application of Thayer -Martin medium (CO4,Ap)
2. Explain the diagnostic significance of detection of HBs Ag.?(CO4,U)
3. Differentiate between free coagulase and bound coagulase?(CO5,E)
4. Compare live and killed polio vaccines? (CO5,E)
5. Evaluate the following titre values in Widal result: TO:160 TH:320 (CO5,E)
6. Differentiate between true hyphae and pseudohyphae (CO2,U)
7. Classify viruses based on their symmetry? (CO2,U)
8. *Bacillus anthracis* as a potent biological weapon. Analyze this statement (CO2,U,An)
9. Explain the principle of pock assay (CO4,U,Ap).
10. Explain the use of thick smears in the laboratory diagnosis of malaria (CO4,U,Ap)

SECTION B

Answer any four questions. Each question carries five marks 4 x 5 = 20 marks

11.Explain the pathogenesis of pulmonary tuberculosis? (CO3,U)

12.Summarise various types of antirabies vaccines and compare their merits and demerits (CO5,U,An)

13.Describe the infections caused by *Staphylococcus aureus*?(CO3,U)

14.Explain the pathogenesis of bacillary dysentery (CO3,U)

15.Appraise the contributions of Louis Pasteur to Medical Microbiology (CO1,R,U)

SECTION C

Answer any two questions. Each question carries ten marks 2x10 = 20 marks

16.Describe the various methods of virus cultivation. Evaluate the merits and demerits of each method (CO2 U,E)
17.Discuss the pathogenesis and laboratory diagnosis of amoebiasis. (CO3U, CO4S)
18.Explain the pathogenesis and clinical symptoms of dermatophytoses (CO2U, CO3U)

Mahatma Gandhi University
III Semester MSc Microbiology Examination
BSM 21C 32 Industrial Microbiology

SECTION A

Answer all questions. Each question carries two marks. 10x 2 = 20 marks

1.Differentiate between fed-batch fermentation and continuous fermentation (CO1,U)
2.Explain working of a rotary vacuum filter (CO5,U)
3.Differentiate between baker's yeast and brewer's yeast (CO5,An)
4.List the commercial applications of microbial amylases?(CO5,U)
5.Explain the principle of mashing (CO5,U)
6.Define ergot alkaloids(CO5,U)
7.State the advantages of MEOR(CO5,U)
8.Explain the development of inoculum for penicillin production(CO4,Ap)
9.Compare the quick and slow processes for vinegar production((CO2,An).
10.Name any four therapeutically useful microbial enzymes and mention their uses.(CO5,U,R)

SECTION B

Answer any four questions. Each question carries five marks 4 x 5 = 20 marks

11.Describe the various methods of primary screening of microbes for industrial applications? (CO4,Ap)

12.Explain the methods to control foaming in fermenters? (CO3,U,Ap)

13.Discuss the microbiological aspects of wine production? (Co5,U)

14.Explain the methods of immobilization of microbial cells(Co5U,S)

15.Explain solid substrate fermentation. (CO1U)

SECTION C

Answer any two questions. Each question carries ten marks 2x10 = 20 marks

16.Describe the various methods of solid-liquid separation applied in downstream processing (CO1,U)
17.Discuss fermentor design and construction. (CO3,U)
18.Describe the industrial uses of microbial enzymes.(CO,U)

School of Biosciences

Mahatma Gandhi University
III Semester MSc Microbiology Examination
BSM 21C 33 Environmental Microbiology

SECTION A

Answer all questions. Each question carries two marks. 10x 2 = 20 marks

1.Judge the merits and demerits of chlorinating water (CO3,An)
2.Explain causes of biofouling (CO4, U)
3.Define air sanitation (CO1, U)
4.Explain the working principle of membrane bioreactor (CO3,Ap)
5.Explain the working principle of trickling filter (CO3,Ap)
6.Explain the usage of Anderson air sampler (CO3,Ap)

7.Illustrate heap leaching (CO6,U)

8.Explain activated sludge process (CO4,U)

9.Stae the benefits of vermicomposting ((CO4,U)

10.Differentiate between slow and rapid sand filtration (CO3,An)

SECTION B

Answer any four questions. Each question carries five marks 4 x 5 = 20 marks

11.Describe the various methods of sampling air for microbiological analysis (CO1,U)

12Explain the process of eutrophication (CO2,U)

13.Explain the methods of disinfection of water (CO3,U,Ap)

14.Explain MEOR (

15.Explain the methods of solid waste management(CO6,U)

SECTION C

Answer any two questions. Each question carries ten marks 2x10 = 20 marks

16.Explain bacteriological examination of water (CO3,Ap,S)
17.Discuss aerobic methods of wastewater treatment. (CO4,U)
18.Prepare a comprehensive note on air-borne and waterborne diseases (CO1U,R;CO2,U,R)