DEPARTMENT OF MICROBIOLOGY				*CLASS: I M.Sc. Microbiology*				
Sem	**Course Type**	**Course Code**	**Course Title**	**Credits**	**Contact Hours/week**	**CIA**	**Ext**	**Total**
II	Major Elective - 2	21P2RME2	Research Methodology	4	5	25	75	100

Nature of Course				
Knowledge and skill	✓		Employability oriented	✓
Skill oriented	✓		Entrepreneurship oriented	✓

Course Objectives

1. To understand the basic principles of research
2. To present the report in the prescribed format
3. To develop creative thinking and analytical skills
4. To analyze scientific results using biostatistical tools
5. To gain knowledge in basic computer softwares

Course Learning Outcomes

On successful completion of the programme, the students will be able to

1. Understand the basic concepts of research methodology and scientific writing
2. Analyze the Research Problem & Hypothesis making for the scientific problem
3. Explain research, research methods, preparation of research reports, research articles, books, book chapters, impact factors, citation index.
4. Apply concepts of biostatistics and computers, analysis and interpretation of data, writing of thesis, and preparation of manuscript for publication.
5. Analyze the basic concepts of statistical and other softwares

Unit	Description	Hours	K-level	CLO
I	**Unit - I: Research Methodology** Research Methodology – Introduction, importance, identification of research areas. Review of Literature- documentation and scientific writing. Writing of research proposal, Preparation of research paper and review articles, thesis writing and graphical abstract.	15Hrs	Up to K2	1
II	**Unit- II: Formulation of Research Problem and Hypothesis** Research Problem – meaning, sources, theory and facts. Criteria of a good research problem. Definition and statement of the problem, delimitation of the problem. Hypothesis – meaning, importance, types, sources, characteristics of a valid hypothesis. Formulation and verification of hypothesis.	15Hrs	Up to K3	2

III	**Unit- III: Scientific Writing** Steps in scientific writing - format of the research report. Referencing – use of quotations and bibliography compilation. Guidelines for preparing the research article. International Standard Serial Number (ISSN), International Standard Book Number (ISBN), impact factor, citation index, downloading index, h-index, i-index, Google scholar, Scopus, Thomson & Reuters, Web of Science and Science Citation Index (SCI) and Web of Science (WOS). Plagiarism.	15Hrs	Up to K3	3
IV	**Unit- IV Biostatistics** Principles and practice of statistical methods in biological research – data collection and presentation of data. Measures of central tendency - mean, median, mode, sampling and its types, correlation co-efficient, standard deviation, student 't' test, chi-square test. Analysis of variance (ANOVA) and its uses.	15Hrs	Up to K4	4
V	**Unit- V Basic Computer and Software** Basics of computers – types, servers, operating systems – Windows, UNIX and Linux. Plagiarism checking softwares. Phylogenetic analysis – Molecular Evolutionary Genetics Analysis (MEGA) and PHYLogeny Inference Package (PHYLIP). Statistical softwares - Statistical Package for the Social Sciences (SPSS), Graph pad prism and 'R' software. Bibliography softwares – Mendeley. PRIDE (PRoteomics IDEntification database).	15Hrs	Up to K4	5

Total 75 Hours

Books for study

1. Arora, P.N. and Malhon, P.K. (1996). Biostatistics. Imalaya Publishing House, Mumbai.
2. Gurumani, N. (2007). Research Methodology. MJP Publishers, Chennai.
3. Ramadass, P. and Aruni, A.W. (2009). Research and Writing - Across the Disciplines. MJP Publishers, Chennai.

Books for reference

1. Kothari, C.R. (2004). Research Methodology: Methods and Techniques. New Age International Publishers, New Delhi.
2. Miles, M.B., Huberman, A.M. and Saldana, J. (2018). Qualitative data analysis: A methods sourcebook. Sage publications, California.
3. Strauss, A.L. (1990). Basics of Qualitative Research. Sage publications, California.

Web Resources

1. https://books.google.co.in/books?id=BS8rDAAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false
2. https://thesis.extension.harvard.edu/biology-research-methods
3. https://online-learning.harvard.edu/series/data-analysis-life-sciences

Rationale for nature of the course

Enables the students to familiarize with research methods used in various fields of microbiology. It is a very important part of our publications as it justifies the significance and novelty of the study. It contributes to the level of professional development of the researcher. It eliminates the gap existing in the pool of scientific literature

Activities having direct bearing on skill development/ employability/entrepreneurship

Identify, justify and critically appraise the use of specific methods when used in the scientific literature.
Analyse data in and present it in a written report using appropriate academic style.
To identify the problems in scientific research and to rectify the same.

Pedagogy

Chalk and talk, PPT, Group discussion, Seminar, Screening of educational videos and quiz

Course Learning Outcomes (CLO)

On the completion of the course the student will be able to

CLOs	Course Learning Outcome	Knowledge Level
CLO1	Understand the basic concepts of research methodology and scientific writing	Up to K2
CLO2	Analyze the Research Problem & Hypothesis making for the scientific problem	Up to K3
CLO3	Explain research, research methods, preparation of research reports, research articles, books, book chapters, impact factors, citation index.	Up to K3
CLO4	Apply concepts of biostatistics and computers, analysis and interpretation of data, writing of thesis, and preparation of manuscript for publication.	Up to K4
CLO5	Analyze the basic concepts of statistical and other softwares	Up to K4

K1 –Remembering and recalling facts with specific answers
K2 – Basic understanding of facts and stating main ideas with general answers
K3 – Application oriented – Solving Problems
K4 – Examining, analyzing, presentation and make interferences with evidences

Mapping of Course Learning Outcome with Programme Specific Outcome

	PSO1	PSO2	PSO3	PSO4	PSO5
CLO1	1	1	1	2	1
CLO2	1	2	2	2	1
CLO3	2	2	2	3	3
CLO4	3	3	3	3	3
CLO5	3	3	3	3	3

Advance application–3 Intermediate level –2 Basic level –1

Mapping of Course Outcome with Programme Outcome

	PO1	PO2	PO3	PO4	PO5
CLO1	1	1	1	1	1
CLO2	1	1	1	1	1
CLO3	2	2	2	2	1
CLO4	2	2	2	3	2
CLO5	3	2	3	3	2

Advance application–3 Intermediate level –2 Basic level –1

Learning Outcome Based Education & Assessment (LOBE)

Blue Print

Articulation Mapping – K Levels with Courses Learning Outcomes (CLOs)

S. No.	CLOs	K-Level	Section A		Section B		Section C (Either / or Choice)	Section D (Open Choice)
			MCQs		Short Answers			
			No. of Questions	K-Level	No. of Questions	K-Level		
1.	CLO 1	Up to K2	2	K2 & K2	1	K1	2 (K1&K1)	1(K2)
2.	CLO 2	Up to K3	2	K3 & K3	1	K1	2 (K3&K3)	1(K3)
3.	CLO 3	Up to K3	2	K3 & K3	1	K2	2 (K2&K2)	1(K3)
4.	CLO 4	Up to K4	2	K4& K4	1	K2	2 (K4&K4)	1(K4)
5.	CLO 5	Up to K4	2	K1& K1	1	K3	2 (K4&K4)	1(K4)
No. of Questions to be asked			10		5		10	5
No. of Questions to be answered			10		5		5	3
Marks for each Question			1		2		5	10
Total Marks for each Section			10		10		25	30

K1 –Remembering and recalling facts with specific answers

K2 – Basic understanding of facts and stating main ideas with general answers

K3 – Application oriented – Solving Problems

K4 – Examining, analyzing, presentation and make interferences with evidences

Distribution of Section-wise Marks with K Levels

K Levels	Section A (No Choice)	Section B (No Choice)	Section C (Either/or)	Section D (Open Choice)	Total Marks	% of Marks without choice	Consolidated
K1	2	4	10	-	**16**	13.33	**35 %**
K2	2	4	10	10	**26**	21.67	
K3	4	2	10	20	**36**	30	**30%**
K4	2	-	20	20	**42**	35	**35%**
Total Marks	10	10	50	50	**120**	100.00	**100%**

K1 –Remembering and recalling facts with specific answers

K2 – Basic understanding of facts and stating main ideas with general answers

K3 – Application oriented – Solving Problems

K4 – Examining, analyzing, presentation and make interferences with evidences

LESSON PLAN

Units	Description	Staff	Hours	Mode
I Research Methodology	a) Research Methodology – Introduction, importance, identification of research areas.		5	Chalk and Talk and PPT Presentation
	b) Review of Literature- documentation and scientific writing.		6	
	c) Writing of research proposal, Preparation of research paper and review articles, thesis writing and graphical abstract.		4	
II Formulation of Research Problem and Hypothesis	a) Research Problem – meaning, sources, theory and facts.		4	Chalk and Talk, PPT Presentation
	b) Criteria of a good research problem. Definition and statement of the problem, delimitation of the problem.		6	
	c) Hypothesis – meaning, importance, types, sources, characteristics of a valid hypothesis. Formulation and verification of hypothesis.		5	

III Scientific Writing	a) Steps in Scientific Report writing- Format of the Research report- Mechanics of Report writing Referencing		4	Chalk and Talk & PPT
	b) Use of quotations- and Bibliography compilation Guidelines for preparing an article		4	
	c) International Standard Serial Number (ISSN), International Standard Book Number (ISBN), impact factor, citation index, downloading index, h-index, i-index, Google scholar, Scopus, Thomson & Reuters		3	
	d) Web of Science and Science Citation Index (SCI) of Web of Science (WOS). Plagiarism		4	
IV Biostatistics	a) Principles and practice of statistical methods in biological research – Data collection, presentation of Data		5	PPT & Chalk and Talk
	b) Measures of central tendency - Mean, Median, Mode, Correlation co-efficient, Standard deviation, student 't' test, chi-square test.		5	
	c) Analysis of variance (ANOVA) and its uses.		5	
V Basic Computer and Software	a) Basics of computers – types, servers, operating systems – Windows, UNIX and Linux. Plagiarism checking softwares.		5	PPT & Chalk and Talk
	b) Phylogenetic analysis – Molecular Evolutionary Genetics Analysis (MEGA) and PHYLogeny Inference Package (PHYLIP).		5	
	c) Statistical softwares - Statistical Package for the Social Sciences (SPSS), Graph pad prism and 'R' software. Bibliography softwares – Mendeley. PRIDE (PRoteomics IDEntification database).		5	
Total			**75 Hours**	

Course designers

1. Dr. K. Kannan