DAV UNIVERSITY, JALANDHAR
DEPARTMENT OF MICROBIOLOGY

Course Scheme & Syllabus
For
Doctor of Philosophy - Microbiology
Examinations 2020–2021 Session Onwards

Course Scheme and Syllabus Applicable to Admissions in 2020-2021

Mission

To prepare students with in-depth knowledge and research skills for professional careers in microbiology and expand the body of knowledge of this scientific field through research.

Learning Outcomes

Students will be proficient in fundamental and advanced knowledge in microbiology. They will be able to conduct independent research and communicate scientific concepts and results in both written and oral forms.

Scheme of Course
Ph.D Microbiology

Semester 1

S.No.	Course Code	Course Title	L	T	P	Credits	Course Type
1.	BCH801	Research Methodology in Life Sciences	4	0	0	4	**Core**
2.	MIC804	Seminar	0	0	2	2	**Core**
		Total	**12**	**0**	**2**	**14**	

List of Elective Courses:

S.No.	Course Code	Course Title	L	T	P	Credits	Course Type
1.	MIC802	Advances in Fermentation and Enzyme Technology	4	0	0	4	**Elective**
2.	MIC803	Advances in Soil Microbiology	4	0	0	4	**Elective**
3.	MIC805	Advanced Microbial Physiology and Biosynthesis	4	0	0	4	**Elective**
4.	BTY804	Advances in Genetic Engineering	4	0	0	4	**Elective**
5.	BTY806	Advanced Virology	4	0	0	4	**Elective**
		Total	**4**	**0**	**0**	**4**	

*Student will choose any two elective courses as per the direction of Advisory Committee

L: Lectures
T: Tutorial
P: Practical **s**
Cr.:Credit

Course Name: RESEARCH METHODOLOGY IN LIFE SCIENCES
Course Code: BCH801
Total Credits: 4
Credits components: Theory-4, Practical-0, Tutorial-0

Course Learning Objective:
To make the students learn how to design an experiment and what are the various research strategies.

Course Content:

Unit-1 No. of hours -15 Biostatistics: Definition and relevance in biological research; Measures of Central

Tendency:Arithmetic Mean, median, mode, quartiles and percentiles; Measures of Dispersion: Range, variance, standard deviation, coefficient of variation; Skewness and Kurtosis. Inferential Statistics: Hypothesis testing, Errors in Hypothesis Testing-Null Hypothesis, Alternative Hypothesis, Type I and Type II errors, Confidence Limits. Setting up of level of significance. One tailed and Two-tailed tests. Correlation and Regression: Correlation coefficient (r), properties, interpretation of r, partial and multiple correlations, linear

regression: Fitting of lines of regression, regression coefficient, Bivariate and Multiple Regression.

Unit-2 No. of hours -15

Parametric and Non-Parametric Statistics: Definition, Advantages, Disadvantages, Assumptions; Parametric Tests: Student's t-test, One Way Analysis of Variance, Two Way Analysis of Variance; Non-Parametric Tests: Analysis of Variance, Chi square and Kendall Rank Correlation

Experimental Set-up**:** Basic principles and significance of research design; Randomized Block Designs (RBD), completely randomized designs (CRD); Latin square design and Factorial design

Unit-3 No. of hours -10

Data collection, organization and interpretation. Research articles, research papers, popular research articles and reviews; difference between periodicals; journals; monographs, magazines; proceedings.

How to write a research paper, reference styles, process of submission of a paper; process of proof reading of a research manuscript; process of reviewing.

Unit-4 No. of hours -20 Important journals in life-sciences. An introduction to Science citation index; H-index, i10

index, Impact factor calculation, Impact factor of a journal; Eigen factor, Major journal search engines. Copyright act; Academic frauds; Plagiarism; Softwares to check plagiarism.

Biosafety and Bioethics in Research: Guidelines for Biosafety and Bioethics; Safety practices and Bio-waste in the laboratory; Radioactivity and Safety; Fire hazards and safety; Institutional Biosafety, Ethics and Animal Ethics compliance and concerns; Genetically modified organisms; Patents and Intellectual property rights; Reproduction of published material, Citation and acknowledgement; Guidelines for Ph.D. thesis.

Learning outcomes:

This course will impart the comprehensive knowledge of designing a research experiment, how to write a research paper, the relevant ethics, copy right, impact factor etc.

Suggested Readings:

1. Kothari, C.R.Research Methodology–Methods and Techniques. 2nd revised ed. New Delhi: New Age International (P) Ltd. Publishers, 2007. Print.

2. McKillup, S. Statistics Explained. An Introductory Guide for Life Scientists. Cambridge, UK: Cambridge University Press, 2006. Print.

3. Selvin, S. Biostatistics–How it Works. First Impression. New Delhi: Pearson Education Inc., 2007. Print.

4. Agarwal, B.L. Basic Statistics. New Delhi: New Age International, 2006. Print.

Websites and Audio Video lectures:

1. https://onlinecourses.nptel.ac.in/noc18_bt21/preview
2. https://ehs.mit.edu/site/biosafety/biosafety-specific-training
3. https://ocw.mit.edu/courses/comparative-media-studies-writing/21w-732-5-introduction-to-technical-communication-explorations-in-scientific-and-technical-writing-fall-2006/related-resources/

Course Name: ADVANCES IN FERMENTATION AND ENZYME TECHNOLOGY
Course Code: MIC802
Total Credits: 4
Credits components: Theory-4, Practical-0, Tutorial-0

Course Learning Objective: The objective of the course is to help the students in comprehending the various aspects of microbial fermentation including various types of fermentations, kinetics of growth, production and sterilization as well as recent advances in production of various microbial enzymes and their applications.

Course Content:

Unit-1 **No. of hours- 15**

Fermentation: Submerged and solid state fermentations, Types of fermenters, Design and operation of Fermenters, Concepts for selection of a reactor. Growth and product formation kinetics: Monod growth kinetics, Kinetics of colony formation and pellet growth. Concepts for calculation of yield coefficient, specific growth rate, specific productivity. Biomass and substrate balance calculations for chemostat, chemostat with recycles. Multistage chemostat systems and fed-batch systems.

Unit -2 **No. of hours-15**

Stoichiometry of cell growth: Elemental balance, Electron balance, Theoretical calculation of oxygen demand & mass transfer, Upper limit of yield and energy changes occurring due to growth and product formation.

Sterilization: Kinetics of cell death and nutrient degradation during heat killing ; Batch and continuous sterilization; Scale up of sterilization. Brief account of Downstream processing: Downstream process economics, Cost cutting strategies in downstream processing industry.

Unit -3 **No. of hours-15**

New strategies for isolation of industrially important microbes and their genetic manipulations; Microbial production of health care products. Enzymes: commercial applications; Production of industrially important enzymes such as Amylases, Proteases, Lipases, Enzymes used for analytical purpose: Glucose oxidase, cholesterol oxidase; Medicinal enzymes: L-Asparaginase.

Unit -4 **No. of hours-15**

Techniques of enzyme immobilization; Kinetic Parameters for soluble and Immobilized Enzyme Systems, Reactors for Enzyme Catalyzed Reactions. Idealized Enzyme Reactor Performance, Mass transfer limitations in immobilized enzyme reactors.

Learning outcomes: The students will be able to gain knowledge about the various developments in the field of fermentation as well as their potential application in different aspects of life.

Suggested Readings:

1. Stanbury PF, Whitaker A, Hall SJ. Principles of Fermentation Technology. 2nd edition.,Elsevier Science. 1995. Print

2. Glazer AN and Nikaido H. Microbial Biotechnology. 2nd edition, Cambridge University Press. 2007. Print

3. Demain, A. L and Davies, J. E. Manual of Industrial Microbiology and Biotechnology. 2nd Edition, ASM Press. 1999. Print

4. Swartz, J. R. Advances in Escherichia coli production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201. 2001. Print

5. Willey JM, Sherwood LM, WoolvertonCJ.Prescott, Harley and Klein's Microbiology. 10th edition, McGraw Hill Publishers. 2016. Print

Websites and Audio Video lectures:

1. https://nptel.ac.in/courses/102105058/
2. https://swayam.gov.in/course/3716-industrial-biotechnology
3. https://www.coursera.org/lecture/industrial-biotech/microbial-fermentation-processes-and-bioreactor-design-35cbb
4. https://freevideolectures.com/course/85/enzyme-science-and-engineering

Course Name: ADVANCES IN SOIL MICROBIOLOGY
Course Code: MIC803
Total Credits: 4
Credits components: Theory-4, Practical-0, Tutorial-0

Course Objective: The aim of this course is to expose the students to some recent developments in the field of soil microbiology more particularly towards the recent developments in understanding the positive aspects of soil microorganisms like their role as biofertilizers and biopesticides as well as the negative aspects like disease development and various methods of their control.

Course Content:

Unit 1 **(No of hours 15)**

(i) Soil habitat and Biota (ii) Types of Soil, Soil Profile, Physico-Chemical Characteristics (iii) Suitability of soil for agriculture (iv) Soil Enzymes and significance (v) Inter-relationship of soil and microorganisms (vi) Importance of humic & fulvic acids in soil mineralization. (vii) Effect of soil on microorganisms; fate of microbes introduced into soil (viii) Factors influencing bacterial survival in soils: Biotic & Abiotic (ix) Establishment of microbial inoculant (x) Rhizosphere and Rhizoplane Microflora

Unit 2 **(No of hours 25)**

(i) Plant growth promoting rhizobacteria and their mechanisms of plant growth promotion (ii) Mycorrhiza – Ectomycorrhiza, Endomycorrhiza , VAM structure & significance (iii) Plant growth promoting hormones from microbes viz. bacteria and fungi & their significance (iv) Nitrogen Fixing Microbes – Free living N_2 fixing bacteria, symbiotic N_2- fixers, *Azolla*, Cyanobacteria, *Frankia*. (v) Biochemistry and Genetics of Nitrogen fixation with reference to free living and symbiotic nitrogen fixers viz. *Azotobacter vinelandii*, *Rhizobium* and *Bradyrhizobium*, Significance of nif H, D, K, A, L, nod, nodulin and fix genes in the process of microbial nitrogen fixation. (vi) Biofertilizers: An overview, types, Compost as biofertilizer (vii) Microbial pesticides-development and their significance, Source organisms: Bacteria--*Bacillus thuringiensis*, Bt based commercial products, other Bacilli producing pesticides; Fungi--*Beauveria bassiana*, *Metarhizium anisopliae*, *Trichoderma* Viruses--Baculoviruses for insect pest control (Nuclear polyhedrosis virus)

Unit 3 **(No of hours 10)**

(i) Common bacterial pathogens of crop plants and symptoms (ii) Common fungal pathogens of crop plants and their symptoms (iii)Virus and viroid diseases of crop plants and their symptoms (iv) Virulence in plant pathogens: biochemical and genetic basis of virulence (v) Toxins as virulence factors

Unit 4 **(No of hours 10)**

(i) Plant defense responses or mechanisms of control; anatomical changes and biochemical synthesis of toxins, alkaloids and other biocontrol molecules (ii) Phytoalexins and their induction (iii) Other means of pathogen control (iv) Application of viral proteins in controlling

viral diseases (v) Antisense RNA technology in disease control, RNA in controlling plant pathogens (vi) Mycoviruses acting against fungal plant pathogens.

Learning outcomes:

At the end of this course, students will better comprehend about the beneficial effects of soil microorganisms on soil health, which is helpful in the production of food and fiber. The knowledge acquired about microbial pathogenesis and plant defence responses will enhance their competency in the research about biocontrol of plant diseases.

Suggested Readings:

1. Subba Rao NS. *Soil Microbiology*. 4th edition. Oxford & IBH Publishing Co. New Delhi. 1999. Print.
2. Atlas RM and Bartha R. *Microbial Ecology: Fundamentals & Applications*. 4th edition. Benjamin/Cummings Science Publishing, USA. 2000. Print.
3. Coyne MS. *Soil Microbiology: An Exploratory Approach*. Delmar Thomson Learning. 2001. Print
4. Altman A. *Agriculture Biotechnology*, 1st edition, Marcel decker Inc. 1998. Print.
5. Agrios GN. *Plant Pathology*. 5th edition. Academic press, San Diego. 2006. Print.
6. Mahendra K. Rai. *Hand Book of Microbial Biofertilizers.* The Haworth Press, Inc. New York. 2005. Print.

Websites and Supportive Material:

1. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/soil-microbiology
2. https://www.omicsonline.org/scholarly/soil-microbiology-journals-articles-ppts-list.php
3. https://www.nature.com/subjects/soil-microbiology

Course Name: ADVANCED MICROBIAL PHYSIOLOGY AND BIOSYNTHESIS
Course Code: MIC805
Total Credits: 4
Credits components: Theory-4, Practical-0, Tutorial-0

Course Objective:
This course will help the students in understanding molecular aspects and regulation of a variety of different microbial processes like differentiation, stress response, virulence, biosynthesis of microbial metabolites etc.

Course Content:

Unit 1 **(No of hours 15)**
Origin, evolution, structure, function and molecular aspects of various cell components, Differentiation in bacteria, slime moulds and yeast. Extracellular protein secretion by bacteria along with its significance in bacterial virulence.

Unit 2 **(No of hours 15)**
Molecular biology of bioluminescence, bacterial virulence. Biofilms and quorum sensing Heat shock response- heat shock proteins, chaperones, amino acid starvation- stringent control, Oxidative stress control, SOS regulatory control.

Unit 3 **(No of hours 15)**
Regulation of initiation, termination and anti-termination of transcription, Global regulation and differentiation by sigma factor, Regulatory controls in bacteria-inducible and biosynthetic pathways, Fermentation and respiratory regulatory pathways of microbes.

Unit 4 **(No of hours 15)**
Regulation of cell cycle and carcinogenesis, Lytic and lysogenic cascade in lambda phage, Anti-sense RNA regulation of gene, RNA interference, Global nitrogen control, and regulation of nitrogen fixation and other recent topics of regulatory systems of current interest.

Learning outcomes:
After the end of this course students will be able to better understand the various aspects of microbial biosynthetic and regulatory processes like differentiation, microbial bioluminescence, microbial stress responses, molecular regulatory control in prokaryotes, lytic-lysogenic cascade etc.

Suggested Readings:
1. Lin E. C. C. and Lynch, A. S. Regulation of Gene Expression in *Escherichia coli*, 2nd edition, Springer, 2012, Print.
2. Carter, J and Saunders, V. Virology: Principles and Applications, 2nd Edition, 2012, Print
3. Maloy, S., Cronan, J. and Freifelder, D. Microbial Genetics, Jones and Bartlett, 1994 2nd Edition, Print
4. Swartz, J. R. Advances in *Escherichia coli* production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201. 2001. Print

5. Moat, A. G and Foster, J. W. Microbial Physiology. 4th edition. John Wiley & Sons. 2002. Print
6. Atlas, R. M. and Bartha R. Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing. 2000. Print.

Websites, Audio video lectures and other supportive material:
https://www.sciencedaily.com/news/plants_animals/microbiology/
https://www.microbes.info/news/index.php

Course Name: SEMINAR
Course Code: MIC804
Total Credits: 2
Credits components: Theory-0, Practical-2, Tutorial-0

Seminar Objective:
During the course students will come to know about the general understanding of the most common problems, recent advances in biotechnology research. The instructor shall allot each student a topic. Student will have to understand the topic, collect literature and prepare the presentation. Through this the students will develop habit of reading newer topics, will become inquisitive and develop confidence of presentation and discussion before audience.
The students shall submit a project report on the allotted topic, which shall be evaluated by the concerned internal faculty. He/She then would present a seminar on the concerned topic. The students will be encouraged to explore all available literature as well as the internet to prepare the seminar report and present the same using informative slides made using Power Point or projectors.

Seminar Contents:
Students will present their work on a selected topic with the following headings:
• Title
• Objectives
• Review of Literature
• Materials and Methods
• Results
• Conclusion/recommendations

Assessment

Mid Semester Examination (MSE)- 25 Marks,
Written Quiz (Objective Type MCQs)- 10 Marks
Assignment/ Project Work/Seminar (evidence based) -10 Marks
End Semester Examination (ESE)- 50 Marks
Attendance- 5 Marks

Question paper formats for mid semester exam (MSE) and end semester exam (ESE)

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Term-

MSE

Name: …….. **Regd. No.: ……**

Course Code: MIC000 **Roll No.: …….**

Time: 1 Hour30 Minutes

Maximum Marks: 25

Course Name: ……

Section – A **(Maximum Marks: 1 x 5 = 5)**

All Questions are compulsory.

Very Short Answer Type: Each question should be answered within 5-8 lines.

Q.1

i.

ii.

iii.

iv.

v.

Section – B **(Maximum Marks: 4 x 3 = 12)**

Attempt any **3 Questions out of 5 Questions** and each question should be answered in maximum 2 pages.

Q.2

Q.3

Q.4

Q.5

Q.6

Section – C **(Maximum Marks: 8 x 1 = 8)**

Attempt **1 Question out of 2 Questions** and each question should be answered in maximum 4 pages.

Q.7

Q.8

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(Term---------)

ETE

Name: …….. **Regd. No.: …….**

Course Code: MIC000 **Time: 3 Hours**

Course Name: …….. **Maximum Marks: 50**

Section – A **(Maximum Marks: 1 x 10 = 10)**

All Questions are compulsory.

Very Short Answer Type: Each question should be answered within 5-8 lines.

Q.1

i.

ii.

iii.

iv.

v.

vi.

vii.

viii.

ix.

x.

Section – B **(Maximum Marks: 4 x 6 = 24)**

Short Answer Type: Attempt any **6 Questions out of 8 Questions** and each question should be answered in maximum 2 pages.

Q.2

Q.3

Q.4

Q.5

Q.6

Q.7

Q.8

Q.9

Section – C **(Maximum Marks: 8 x 2 = 16)**

Long Answer Type: Attempt **2 Questions out of 4 Questions** and each question should be answered in maximum 4 pages.

Q.10

Q.11

Q.12

Q.13