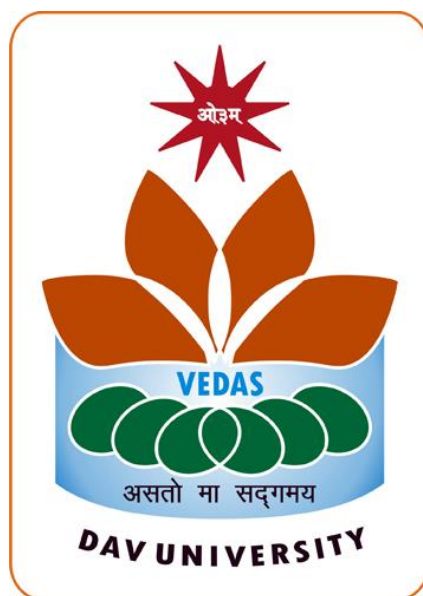


**DAV UNIVERSITY, JALANDHAR**  
**DEPARTMENT OF MICROBIOLOGY**



**Course Scheme & Syllabus**  
**For**  
**Doctor of Philosophy - Microbiology**  
**Examinations 2018–2019 Session Onwards**

**Course Scheme and Syllabus Applicable to Admissions in**  
**2018-2019**

**Scheme of Course  
Ph.D Microbiology**

**Semester 1**

<b>S.No.</b>	<b>Course Code</b>	<b>Course Title</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	<b>Course Type</b>
1.	BCH801	Research Methodology in Life Sciences	4	0	0	4	<b>Core</b>
2.	MIC802	Advances in Fermentation and Enzyme Technology	4	0	0	4	<b>Core</b>
3.	MIC803	Advances in Soil Microbiology	4	0	0	4	<b>Core</b>
5.	MIC804	Seminar	0	0	2	2	<b>Elective</b>
		<b>Total</b>	<b>12</b>	<b>0</b>	<b>2</b>	<b>14</b>	

**Additional Course:**

<b>S.No.</b>	<b>Course Code</b>	<b>Course Title</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	<b>Course Type</b>
1.	MIC805	Advanced Microbial Physiology and Biosynthesis	4	0	0	4	<b>Core</b>
		<b>Total</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>	

\*Choose any two theories from MIC802, MIC803 and MIC805

**L: Lectures T: Tutorial P: Practical Cr: Credits**

**Course Title: Research Methodology in Life Sciences**

L	T	P	Credits	Marks
4	0	0	4	100

**Course Code: BCH801**

**Objective:**

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

**Teaching Methodology:**

Class room Lectures, practicals, models, charts, power point presentations.

**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.

**UNIT-I (15 hours)**

**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-II (15 hours)**

**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-III (15 hours)**

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.

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.

#### **UNIT-IV**

**(15 hours)**

**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.

#### **Reference Books**

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.

## Course Title: Advances in Fermentation and Enzyme Technology

Course Code: MIC802

L	T	P	Credits	Marks
4	0	0	4	100

**Course 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 I

(15 hours)

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 II

(15 hours)

Stoichiometry of cell growth: Elemental balance, Electron balance, Theoretical calculation of oxygen demand, 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 III

(15 hours)

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 IV

(15 hours)

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.

### SUGGESTED READINGS

- (i) Stanbury PF, Whitaker A, Hall SJ. Principles of Fermentation Technology. 2<sup>nd</sup> edition., Elsevier Science. 1995. Print
- (ii) Glazer AN and Nikaido H. Microbial Biotechnology. 2nd edition, Cambridge University Press. 2007. Print
- (iii) Demain, A. L and Davies, J. E. Manual of Industrial Microbiology and Biotechnology. 2nd Edition, ASM Press. 1999. Print
- (iv) Swartz, J. R. Advances in Escherichia coli production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201. 2001. Print
- (v) Willey JM, Sherwood LM, Woolverton CJ. Prescott, Harley and Klein's Microbiology. 9th edition, McGraw Hill Publishers. 2014. Print

**Course Title: Advances in Soil Microbiology****Course Code: MIC803**

L	T	P	Credits	Marks
4	0	0	4	100

**Course Objective:** The aim of this course is to expose the students to some recent developments in the field of soil microbiology including the positive aspects 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 I****(15 hours)**

Soil Microbiology

(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 II****(30 hours)**

Beneficiary Microorganisms to plants

(a) Plant growth promoting Rhizobacteria, nitrogen fixation, phosphate mobilization and biocontrol of plant pathogens (b) Mycorrhiza – Ectomycorrhiza, Endomycorrhiza, VAM structure & significance (c) Plant growth promoting hormones from microbes viz. bacteria and fungi & their significance (d) Nitrogen Fixing Microbes – Free living N<sub>2</sub> fixing bacteria, symbiotic N<sub>2</sub>- fixers, Azolla, Cyanobacteria, Frankia. (e) 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. (f) Biofertilizers: An Overview (i) free living soil microbes fixing N<sub>2</sub> (*Azotobacter*, *Azospirillum*) (ii) *Rhizobium*, *Azorhizobium*, *Bradyrhizobium* in symbiotic association with leguminous plants. (iii) Free living cyanobacteria- Nostoc, Anabaena, Scytonema present in Rice fields. (iv) Associative cyanobacteria (symbionts)-*Anabaena azollae*, *Anabaena cicadae* (v) Azolla as Biofertilizer (vi) Compost as Biofertilizer (g) Microbial Pesticides-(Biocontrol agents for agriculturally important crop plants)-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 III****(15 hours)**

A. Plant Pathogens and Genetic basis of pathogenesis

(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

B. Pathogenesis in plants and Defense response

(i) Virulence in plant pathogens: biochemical and genetic basis of virulence (ii) Toxins as virulence factors (iii) Phytoalexins and their induction (iv) Plant Defense responses or mechanisms of control (anatomical changes and biochemical synthesis of toxins, alkaloids and other biocontrol molecules C. Other means of pathogen control (i) Application of Viral proteins in controlling viral diseases (ii)

Antisense RNA technology in disease control (iii) RNA in controlling plant pathogens (iv) Mycoviruses acting against fungal plant pathogens

### **SUGGESTED READINGS**

- (i) Soil Microbiology - Alexander
- (ii) Agricultural Microbiology Biotechnological approaches in soil microorganisms for sustainable crop production by Dadarwal 1997
- (iii) Agricultural Microbiology by N.S. Subba Rao
- (iv) Biology of Nitrogen fixing Cyanobacteria by N.G. Carr and B. A. Whitton
- (v) Fundamentals of Agricultural Microbiology by K. C. Mahanta
- (vi) Applied Soil Biology and Ecology by G.K. Veeresh and D. Rajagopal
- (vii) Biofertilizers edited by Somani et al.1990.
- (viii) Biofertilizers in Agriculture and Forestry by N.S. Subba Rao
- (ix) Plant Microbe Interactions - by K.S. Bilgrami, 2000
- (x) Biology of Microorganisms by M.T. Madigan and J.M. Martinko XIth edition

## Course Title: ADVANCED MICROBIAL PHYSIOLOGY AND BIOSYNTHESIS

Course Code: MIC805

L	T	P	Credits	Marks
4	0	0	4	100

### 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 I

(15 hours)

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 II

(15 hours)

Molecular biology of bioluminescence, bacterial virulence, Heat shock response- heat shock proteins, chaperones, amino acid starvation- stringent control, Oxidative stress control, SOS regulatory control.

#### UNIT III

(15 hours)

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 IV

(15 hours)

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.

### SUGGESTED READINGS

- (i) Lin E. C. C. and Lynch, A. S. Regulation of Gene Expression in *Escherichia coli*, 2<sup>nd</sup> edition, Springer, 2012, Print.
- (ii) Carter, J and Saunders, V. Virology: Principles and Applications, 2nd Edition, 2012, Print
- (iii) Maloy, S., Cronan, J. and Freifelder, D. Microbial Genetics, Jones and Bartlett, 1994 2<sup>nd</sup> Edition, Print
- (iv) Swartz, J. R. Advances in *Escherichia coli* production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201. 2001. Print
- (v) Moat, A. G and Foster, J. W. Microbial Physiology. 4th edition. John Wiley & Sons. 2002. Print
- (vi) Atlas, R. M. and Bartha R. Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing. 2000. Print.
- (vii) Current research articles and review articles related to microbial physiology and regulation of biosynthesis



**Course Title: Seminar**

L	T	P	Credits	Marks
0	0	2	2	100

**Course Code: MIC804**

**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

**Examination Scheme (Weightage in %):**

Literature study/ Fabrication/ Presentation: 50%

Written Report: 25%

Question answer session: 25%