Department of Biotechnology

Proposed Syllabus
for
Pre-PhD Biotechnology
To be effective from Academic Session 2020-2021

Central University of Rajasthan
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Pre-Ph.D. Biotechnology - Revised Course Structure
(Proposed to be implemented from Academic Session 2020-2021 onwards)

Semester I				
Course Code	**Course Name**	**Course**	**Course Type**	**Credits**
BTY-701	Research Methodology	Core 1	T	4
BTY-702	**Elective I**	DSE 1	T	4
BTY-703	**Elective I**	DSE 2	T	4
	Total credits			**12**

List of Electives:

1. Cellular Responses to Stresses in Prokaryotes
2. Insect Genetics and Genomics
3. Stress Biology of Plants
4. Drug and Gene Delivery Systems
5. Molecular Microbial Ecology and Metagenomics
6. Diseases of Protein Misfolding and Aggregation
7. Parasitology
8. Vaccine Biology

BTY 701 Research Methodology Credits 4

Syllabus:

Name of Topic	No. of Classes (60*)
UNIT I - Research Basics	
Research Basics: definition, purpose and types and Significance of research	3
Process and tools of Research	3
Methods of research	3
Research Ethics, Impact Factor	4
Structuring the Ph.D. Thesis	2
UNIT II - Statistical Techniques	
Basic Statistical Concepts	3
Inference for Means	4
Inference for Categorical data	3
Modelling Relationships	3
Design and Analysis Techniques for Epidemiologic Studies	2
UNIT III – Analytical Techniques	
Optical Microscopy	3
Super Resolution Microscopy	2
Electron Microscopy	3
Chromatographic Techniques, Electrophoresis and Centrifugation	7
UNIT IV	
Tools and Techniques in Molecular Diagnosis	4
ELISA and Western blotting	2
PCR and Real Time PCR	2
Flow cytometry	2
Immunohistochemistry and Hybridization	4
Sequencing Techniques	1

***The total classes includes 2 classes for internal assessment**

Books recommended

- Endnote user manual
- Mount D. Bioinformatics: Sequence and Genome Analysis (2004), Cold Spring
- Harbor Laboratory Press.
- Total training video tutorials
- Imaging: A Laboratory Manual (2011); Cold Spring Harbor Laboratory Press.

BTY 702 Elective I Credits 4

BTY 703 Elective II Credits 4

List of Electives - Syllabus

Cellular Responses to Stresses in Prokaryotes **Credits 4**

Learning objectives: To understand the basic principles involved in bacterial stress responses, types of stress responses and their role - in bacterial host interactions, in different microorganisms and environmental conditions.

Prerequisites: Basic biology course at Master's level

Learning Outcomes: Understanding the area of microbial stress responses and knowledge about cellular mechanisms and regulations at the molecular level for clinical and other biotechnological applications.

Syllabus:

Name of Topic	**No. of Classes (60*)**
UNIT I - General stress responses	
Introduction and General Principles	3
Responses in gram-negative and gram-positive bacteria	5
Stringent responses, Biofilm, Persister bacteria	7
UNIT II - Specific stress responses	
Osmotic stress, Envelop stress	4
DNA damage, Oxygen deprivation,	4
Heat- and cold-shock tolerance	4
Reactive oxygen and nitrogen species response	3
UNIT III - Regulation of Stress Responses	
Two-component signaling systems	4
Small RNAs in regulating mRNA translation	4
Regulatory roles of Small molecules, alternative sigma factors, Proteolysis and chaperones	7
UNIT IV	
Pathogenic bacterial responses within host	6
Bacteria living in different Extreme environments	5
Importance and applications of stress response studies in biotechnology	4

***The total classes includes 2 classes for internal assessment**

Books recommended

- Stress Response in Microbiology by J M Requena (Ed.); Caister Academic Press.
- Bacterial Stress Response by G Storz and R Hengge (Ed); ASM Press; 2nd Edition.
- Stress Response in Pathogenic Bacteria by Stephen Kidd; CABI.
- Prescott's Microbiology by J Willey, L Sherwood and C J Woolverton; McGraw-Hill Education.

Insect Genetics and Genomics **Credits 4**

Learning objectives: To understand about the basic biology of insect pest and disease vectors. Also, pest and vector control strategies focusing genome manipulation will be taught.

Prerequisites: Basic biology course at Master's level

Learning Outcomes: Understanding of techniques employed for genome manipulation of insects.

Syllabus:

Name of Topic	**No. of Classes (60*)**
UNIT I	
Insecta: Classification	3
Morphology and anatomy of Arthropods	3
Insect physiology	4
Introduction to endocrine organs, growth and molting	5
UNIT II	
Introduction to major pests of field crops	3
Mode of action of pesticides and molecular mechanism of pesticide resistance	4
Host pathogen interaction with respect to major Insect vectors of human diseases	4
Overview of management strategies for pest and human disease vectors	4
UNIT III	
Process of RNA interference and miRNA regulation in insects	5
Molecular mechanism of molting and metamorphosis	5
Molecular mechanism of Sex-determination in insects	5
UNIT IV	
Genetic principles, terminologies and overview of insect genome organization	5
Genetic modification techniques for the management of pests and disease vectors	4
Review of literature on Insect molecular biology and Biotechnology	6

***The total classes includes 2 classes for internal assessment**

Books recommended

- Insecta-An Introduction by K.N. Ragumoorthi, V. Balasubramani, M.R. Srinivasan
- Imms' General Textbook of Entomology, Volume 2: Classification and Biology by Imms, A.D., Richards, O.W., Davies,
- The Insects-Structure and Function by R.F Chapman and A.E Douglas
- A Textbook of Applied Entomology by K. P. Srivastava & G. S. Dhaliwal volume 2
- Toxicology of Insecticides by Matusmura, Fumio

Stress Biology of Plants **Credits 4**

Learning objectives: To understand the different environmental (abiotic and biotic) stresses encountered by plants and how they respond to counter such stress conditions.

Prerequisites: Basic biology course at Master's level

Learning Outcomes: Understanding the interaction between plants and the environment and gain an insight of the different physiological and molecular responses generated by plants to counter such environmental stresses.

Syllabus:

Name of Topic	**No. of Classes (60*)**
UNIT I	
Introduction to stress biology	3
Physiological and molecular level impact of different stresses on plants	3
Concept of 'growth-defense' equilibrium in plants	4
Key examples of the devastations caused by the environmental stresses	5
UNIT II	
Different abiotic stresses	3
Plant response to the stress conditions at the physiological level	4
Plant response to the stress conditions at the molecular level	4
Introduction to Abscisic acid (ABA) hormone signaling	4
UNIT III	
Different biotic stresses	3
Concept of plant defense response	3
Pathogen detection	5
Hormones and their involvement in biotic stress response	4
UNIT IV	
Role of post-translation modifications (PTMs) in plant stress response	5
SUMOylation and ubiquitination	4
PTMs regulating different signaling pathways	6

***The total classes includes 2 classes for internal assessment**

Books recommended

- Plant Responses to Abiotic stress, Editors: Hirt, Heribert, Shinozaki, Kazuo (Eds.), 2004.
- Plant Responses to Drought Stress: From Morphological to Molecular Features, Editors: Aroca, Ricardo (Ed.), 2012.
- Biotic and Abiotic Stress Responses in Crop Plants, Thomas Dresselhaus and Ralp Hückelhoven (Eds.), 2019.

Drug and Gene Delivery Systems **Credits 4**

Learning objectives: To understand the key concepts of nanotechnology and familiarize about nanotechnology mediated Drug and Gene delivery aspects.

Prerequisites: A course in nanobiotechnology at UG or PG level.

Learning Outcomes: Understanding of basic knowledge and concepts in nanotechnology and learn to manipulate various nanomaterials for drug/gene delivery.

Syllabus:

UNIT I	
Name of Topic	**No. of Classes (60*)**
UNIT I - Basic concepts of drug and gene delivery	
Introduction to drug/gene delivery	5
Biological barriers encountered during drug/gene delivery	5
Controlled and targeted drug/gene delivery	5
UNIT II - Delivery vectors	
Types of delivery vectors - Viral and non-viral vectors	2
Liposomes and lipid based vectors	3
Microparticles	5
Nanoparticles	5
UNIT III - Concepts of Nanomedicine	
Introduction to concepts of Nanomedicine	2
Nanoparticles types - Metallic and polymeric nanoparticles	3
Synthesis of Nanoparticles	5
Tools and techniques for characterization of nanoparticles- in vitro and in vivo	5
UNIT IV - Nanoparticles as drug/gene delivery vectors	
Nanoparticles for drug delivery	5
Nanoparticles for gene delivery	5
Nanoparticles for siRNA delivery	5

***The total classes includes 2 classes for internal assessment**

Books recommended

- C.M. Niemeyer and C.A. Mirkin, Nanobiotechnology, Concepts, Applications and perspectives, WILEY-VCH, Verlag Gmb H&Co, 2004
- C.M. Niemeyer and C.A. Mirkin, Nanobiotechnology - II more concepts and applications, WILEY-VCH, Verlag Gmb H&Co, 2007
- Journals in the field of Gene delivery and Nanotechnology

Molecular Microbial Ecology and Metagenomics **Credits 4**

Learning objectives: To understand the molecular aspects of microbial diversity and metagenomics.

Prerequisites: A course in Microbiology at UG or PG level.

Learning Outcomes: Understanding the role of genomics and metagenomics in microbial diversity.

Syllabus:

Name of Topic	**No. of Classes (60*)**
UNIT I – Introduction to Molecular Microbial Ecology (15 Classes)	
Microbial Ecology (Background; pre molecular biology era)	3
Microbial Ecology (post molecular biology era)	4
Microbial Species Concept	4
Use of rRNA operon and Genomic Repetitive Sequences for identification of bacterial species	4
UNIT II – Experimental Methods in Molecular Microbial Ecology (15 Classes)	
Differential PCR primer based analyses for characterization of microbial species	2
Amplified rDNA Restriction Analyses (ARDRA) – Phylotype characterization	3
Denaturing Gradient Gel Electrophoresis (DGGE) –Phylotype characterization	3
Terminal Restriction Fragment Length Polymorphism (T-RFLP) – Phylotype characterization	3
Qualitative and quantitative Data analyses of DNA fingerprinting data	4
UNIT III – Metagenomics (15 Classes)	
Pitfalls of PCR-Based rRNA Gene Sequence Analysis	2
Metagenomic insight into bacterial species	3
Next Generation Sequencing and 3rd Generation Sequencing for Metagenomics	5
Functional Metagenomics – Generation and screening of Metagenomic Libraries	4
Gene Targeted Metagenomics (GT- Metagenomics)	2
UNIT IV – Metagenomic Databases & Computational Tool for Data Analyses (15 Classes)	
The Ribosomal Database Project (RDP): Sequences & Softwares for High Through put analyses	2
Metagenomic RAST Server: A public resource for automated annotation of metagenomes	3
The EBI Metagenomic Archive: Metagenomic Data integration and analyses tool	3
MEGAN: A LINUX based tool for Comparative Metagenomic Analyses	4
SILVA: Comprehensive Database of QC selected and aligned Ribosomal Sequence Data	3

***The total classes includes 2 classes for internal assessment**

Books recommended

- Handbook of Molecular Microbial Ecology (Volumes I & II): Metagenomics and Complementary Approaches – Ed By: Frans J. de Bruijn - John Wiley Publication
- Microbial Ecology: Current Advances from Genomics, Metagenomics and Other Omics. Ed by Diana Marco – Caister Academic Press
- Molecular Microbial Ecology: Osborn & Smith – CRC Press.

Diseases of Protein Misfolding and Aggregation **Credits 4**

Learning objectives: To understand advances in the field of amyloids in general, and amyloid related human diseases, particularly the neurodegenerative diseases such as, Alzheimer's and Parkinson's diseases etc.

Prerequisites: Basic course in Biology or Chemistry at the level of Post-Graduation.

Learning outcomes: After successful completion of the course students will have substantial understanding about the molecular basis of amyloid formation, pathological mechanisms and the strategies for therapeutic intervention.

Syllabus:

Name of Topic	**No. of Classes (60*)**
UNIT I	
Overview of Amyloids, Structure and Function	3
Description of amyloid conformers (monomer, oligomers, protofibrils and fibrils)	4
Structural determinant of amyloids	3
In silico prediction of amyloidogenic sequences in proteins and peptides.	3
Functional amyloids: microbial amyloids	2
UNIT II	
Techniques to study amyloids	10
Diagnostic markers of amyloid related diseases	5
UNIT III	
Amyloid-related human diseases	12
Cellular basis of neurodegenerative diseases-mitochondrial dysfunction	3
UNIT IV	
Amyloid based strategies-preventing amyloid aggregation and enhancing amyloid clearance	8
Modulating of cellular calcium homeostasis	7

***The total classes includes 2 classes for internal assessment**

Books recommended

- Methods in Enzymology, Volume 309, Amyloid, Prions, and Other Protein Aggregates by Ronald Wetzel (Ed), Publisher-Elsevier Inc.
- Amyloid Proteins: The Beta Sheet Conformation and Disease, by Jean D. Sipe (Ed), Publisher-WILEY-VCH Verlag GmbH & Co.
- Amyloid and Amyloidosis by Gilles Grateau, Robert A. Kyle & Martha Skinner Publisher CRC Press.
- Amyloid Proteins: Methods and Protocols, by Einar M. Sigurdsson, Miguel Calero & María Gasset (Eds.), Publisher Humana Press.

Parasitology **Credits 4**

Learning objectives: The present structure of the course will provide the basic information about parasite biology, which includes mode of infection, life cycle and immune responses generated against parasite in human body. It will also cover the available therapeutics approaches against the parasites by taking case studies of malaria and Leishmania parasites.

Prerequisites: M.Sc. in the field of Life Sciences

Learning Outcomes: Student will able to understand the mode of action of parasites in causing human diseases and would be able to understand and design the effective therapeutics for the same.

Syllabus:

Name of Topic	**No. of Classes (60*)**
Unit I	
Introduction to infectious diseases	3
Overview of parasitic diseases	4
Mode of transmission, vectors	4
Public health and management	4
UNIT II	
Molecular parasitology	5
Host-parasite interactions	5
Immuno-parasitology	5
UNIT III	
History of Malaria, Life cycle of *Plasmodium*	3
Key pathways of *Plasmodium*	3
Drug Resistance in *Plasmodium*	3
Life Cycle of *Leishmania*	3
Drug targets in *Leishmania*	3
UNIT IV	
Current diagnosis and control	4
Drugs and chemotherapy	3
Vaccine for parasitic diseases	3
Drugs and vaccines designing for parasitic diseases	5

***The total classes includes 2 classes for internal assessment**

Books recommended

- Irwin W. Sherman, Malaria Parasite Biology, Pathogenesis, and Protection, American Society for Microbiology, 1998. www.plasmodb.org
- WHO technical series-949; Control of the Leishmaniasis (ISBN 978 92 4 120949 6)
- Stefan H.E. Kaufmann, Novel Vaccination Strategies Ed. Wiley-VCH Verlag GmbH &Co., 2004

Vaccine Biology **Credits 4**

Learning Objectives: To understand the concepts, scope and impact of vaccines and their role in human health.

Prerequisites: Open to all

Learning Outcomes: Understanding the concepts, scope and impact of vaccines and their role in human health.

Syllabus:

Name of Topic	No. of Classes (60*)
UNIT I	
Principles of Epidemiology	3
Introduction to concept, scope of vaccines	3
Vaccine designs	4
Vaccine adjuvants	3
Vaccination strategies and autoimmune disease	3
UNIT II	
Antigen processing and presentation; mucosal immune system	3
Innate immunity & adjuvant designs	3
Immunological memory : T-cell, B-cells	6
Mouse and non-human primates in vaccine development	2
UNIT III	
Antigen discovery: high-throughput screening technologies	2
Anti-viral, bacterial and parasitic vaccines	6
Vaccine Production basics	3
Vaccine challenges: industrial perspective	2
Newly introduced vaccines	2
UNIT IV	
Vaccine testing paradigm	3
Good clinical practices and ethical issues	3
Phase-1, 2, 3 & 4 clinical trials	5
Vaccine safety	2
Regulatory approval and issues	2

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Books recommended

- Vaccinology: Principles and Practice, W. John W. Morrow, Nadeem A. Sheikh, Clint S. Schmidt, D. Huw Davies, C.M. Niemeyer and C.A. Mirkin, Blackwell Publishing Ltd, 2012
- The vaccine book, Barry R. Bloom Paul-Henri Lambert, Academic Press, 2016
- Epidemiology: An Introduction. Kenneth J. J. Rothman. Latest edition / Pub. Date: May
- 2002. Publisher: Oxford University Press
- Laboratory Biosafety Manual, WHO, http://www.who.int/csr/resources/publications/biosafety/who_cds_csr_l yo_20034/en/
- Subject related reviews and research articles
- WHO reports and case studies