Pre-PhD Syllabus
Department of Biotechnology
Guru Ghasidas Vishwavidyalaya, Bilaspur (CG)

Research scholars of Department of Biotechnology have to undergo a pre-Ph.D. course work of 3 papers to be completed in one semester (Six month). The Departmental Courses comprise of three theory papers, the paper I is research methodology and scientific communication, paper II comprises analytical and separation techniques. Paper III is optional in nature and comprise of five Elective papers and therefore student can select one paper based on his/her research interest area.

Code	Subject	End Semester Total Marks	Credit
101	**Research Methodology and Research Publication Ethics**	100	4
102	**Analytical and Separation Techniques**	100	4
103	**Elective paper (Student need to select only one as per their research interest)**	100	4
	103A: Advances in Animal Cell Culture Technology **103B: Advances in Cancer Biology** **103C: Advances in Immunology** **103D: Microbial Resources and Products** **103E: Enzyme and fermentation technology**		
	Total	**300**	**12**

The Seminar will be mandatory but qualifying on the recommendation of the member of the DRC and approval of the chairman of DRC. The minimum passing marks in each paper will be 55%.

- The programme outcomes for Ph.D programs will remain same as decided by the University (Dean and Heads).
- The Programme specific outcome will be specific for Ph.D Biotechnology.
- The Course outcome for specific theory and practical papers are to be prepared. It can be 3 or more as per course.
- The matrix to be prepared will give weightage to each course outcome against the Programme outcome and Programme specific outcome.
- An example is given in this document

- Each teacher may prepare their specific course outcomes and matrix.
- All such outcomes and matrix will be compiled together to assess achievement of programme and Programme specific objectives.
- The weightage is as follows
- 3: Strongly achieves
- 2: Moderately achieves
- 1: Slightly achieves

Programme Outcomes (POS)

PO1	**Knowledege:** To meet the professional requirements Knowledege will be provided on basics and advance fields of the core and applied fields
PO2	**Critical Thinking:** Special skill for critical thinking on contextual knowledge of living beings/ organisms, non-living components and environmental basis of life, enabling the students for critical analysis of day-to-day problems.
PO3	**Skill & Application Development**: Understanding of application of biological materials in food, health, medicine & Environment for sustainable development of the society, development of skill-based knowledge on theory and methodology for use in descriptive and inferential statistical tools and techniques.
PO4	**Ethics:** Internalisation of and sensitiveness to sound professional ethics for use to solve societal problems**.**
PO5	**Inter-disciplinary & Multi-disciplinary Approach:** Understanding of the vital connections within and among the flora, fauna and the physical environment so is to enable to integrate and synthesized
PO6	**Problem Solving & Employability:** Special skill through vocational trainings, field visits, entrepreneurial and career development approach in research and development issues in the society.

Program Specific Outcomes

PSO 1	**Disciplinaryknowledgeandskills:**Capableofdemonstrating(i)comprehensivek nowledge and understanding of major concepts, principles and applications of different areas of biotechnology suchas Molecular Biology, Recombinant DNA technology, Bioinformatics, Microbiology,Immunology, Plant and Animal Biotechnologyand Environmental Biotechnology (ii) ability to use moderninstrumentation/techniques for separation, purification and

	identification of biologicallyimportantmolecules and its application in human welfare.
PSO 2	**Skilled communicator:** Ability to convey complex technical information relating toBiotechnologyinaclearandconcise mannerbothinwritingaswell asorally.
PSO 3	**Critical thinker and problem solver:** Ability to employ critical thinking and efficientproblem solving skills in different areas related to Biotechnologylike Protein andNucleic Acid Chemistry, Cell Biology, Molecular Biology, Genetics, Microbiology,AnimalBiotechnology, Plant Biotechnologyand Bioprocess engineering.
PSO 4	**Teamplayer/worker:**Capableofworkingeffectivelyindiverseteamsinbothclass room,laboratoryaswell as in field-based situations improving knowledge anddevelopingskill.
PSO 5	**Ethicalawareness/reasoning:**Avoidingunethicalbehaviorsuchasfabrication,falsificationormisrepresentationofdataorcommittingplagiarism,andsensitivetowardsenvironmentaland sustainabilityissues.
PSO 6	**Lifelong learners:** Capable of making conscious efforts to achieve self-paced and self-directed learning aimed at personal development and for

Paper I

101: Research Methodology and Research Publication Ethics

Unit - 1

Literature Review, Defining the research questions, Approaches and Methodology for Scientific research, Documentation and presentation of data, Analysis and interpretation of data, manuscript preparation.

Unit – 2

Statistics in Research, Measures of Central Tendency, Dispersion, Asymmetry, Relationship. Regression Analysis, Multiple correlation and Regression, Partial Correlation, Association in case of Attributes. Testing of Hypothesis. Chi-Square test: Applications, Steps, characteristics, limitations. Analysis of Variance and Covariance.

Unit - 3

Basic knowledge of computers, hardware and software, Generation of Computers and information storages devices. MS-OFFICE, MS-WORD, MS-EXCEL, MS-POWER POINT Application of Different computer software in handling the bio-statistical problems and Data-management, R Programme, SPSS, Origin, Prism, .

Unit - 4

Philosophy And Ethics: Introduction to philosophy : definition, nature and scope, concepts, branches; Ethics : definition, moral philosophy, nature of moral judgments and reactions; Scientific Conduct: Biosafety and Bioethics and IPR, Ethics with respect to science and research, Intellectual honesty and research integrity, Scientific misconducts : Falsification, fabrication, and plagiarism (FFP), Redundant publications: duplicate and overlapping publications, salami slicing, Selective reporting and misrepresentation of data;

Unit - 5

Publication Ethics: Publication ethics: definition, introduction and importance, Best practices/ standard setting initiatives and guidelines: COPE, WAME, etc., Conflicts of interest, Publication misconduct: definition, concepts, problems that lead to unethical behaviour and vice versa, types, Violation of publication ethics, authorship and contributor ship, Identification of publication misconduct, complaints and appeals, Predatory publishers and journals.

PRACTICE

- **OPEN ACCESS PUBLISHING (4 hrs.)**

1. Open access publication and initiatives.
2. SHERPA/RoMEO online resouice to check publisher copyright & self-archiving policies-
3. Software tool to identifu predatory publications developed by SPPU.
4. Journal finder / Journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

.

- **OPEN ACCESS PUBLISHING (4 hrs.)**

A. Group Discussions (2hrs,)

1. Subject specific ethical issues, FFP, authorship.
2. Conflicts of interest.
3. 3- Complaints and appeals : examples and fraud from India and abroad-

B. Software tools (2hrs,)

Use ofplagiarism software like Tumitin, Urkund and other open source software tools.

A.

OPEN ACCESS PUBLISHING (4 hrs')

Data base (4 hrs.)

1. Indexing databases
2. Citation databases : Web of Science, Scopus, etc.

Research Metrics (3 hrs.)

1. Impact Factor ofjoumal as per Journal Citation Report, SNIP, SJR' IPP' Cite Score'
2. Metrics : h-inden, g index, i10 index, altnretrics'

Suggested Readings

1. Kothari, C.R., Research Methodology (Methods and Techniques), New Age Publisher
2. Fundamentals of modern statistical methods By Rand R. Wilcox
3. Power Analysis for Experimental Research A Practical Guide for the Biological, Medicaland Social Sciences by R. Barker Bausell, Yu-Fang Li Cambridge University Press
4. Design of Experiments: Statistical Principles of Research Design and Analysis, by Robert O. Kuehl Brooks/Cole
5. Study and Communication Skills for the Biosciences by Stuart Johnson and JonScott, Oxford University Press
6. Write and Publish a Scientific Paper by Robert A. Day Oryx Press
7. Scientific Easy when you know how by Jennifer Peat BMJ Books
8. Research Projects and Research Proposals A Guide for Scientists Seeking Funding by Paul G. Chapin Cambridge.
9. Critical conversation about Plagiarism: Ed: Michael Donnelly et al, Parler press 2012

Course Outcome	COURSE: Research Methodology and Research Publication Ethics :101
CO1	The students should be well-versed with defining the research questions, Approaches and Methodology for Scientific research, Documentation and presentation of data, Analysis and interpretation of data, manuscript preparation
CO2	The students should understand the Statistics in Research, Measures of Central Tendency, Dispersion, Asymmetry and Relationship. Regression Analysis, Multiple correlation and Regression, Partial Correlation, Association in case of Attributes. Testing of Hypothesis. Chi-Square test: Applications, Steps, characteristics, limitations. Analysis of Variance and Covariance
CO3	The students should have knowledge of Philosophy And Ethics and Publication Ethics.

Program Matrix

	PO1	PO2	PO3	PO4	PO5	PO6		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	1	2	3	1	3		1	1	1	2	2	2
CO2	2	3	1	3	1	1		2	3	2	2	3	3
CO3	1	1	3	1	2	3		1	3	3	3	1	3

PAPER-II:

102: Analytical and Separation Techniques

Unit –1

Chromatographic technique: Types of chromatography used for bimolecular separations, HPLC, FPLC, GAS and instrumentation details of each, Application of chromatography in Biology.

Unit - 2

Electrophoretic techniques, Polyacrylamide gel electrophoresis (native and SDS), Agarose gel electrophoresis, 2-D electrophoresis. Immunoblotting, Southern, Western and Northern blotting, DNA finger printing and ELISA.

Unit - 3

Spectroscopy techniques, UV/VIS Spectrophotoinetry, Infrared spectroscopy, Atomic absorption spectroscopy, ESR and NMR spectroscopy. Mass spectroscopy (LC-MS, GC-MS). Fluorescent spectroscopy. Fourier Transform Infra-Red Spectrometer (FTIR), Applications of different Spectroscopic techniques in Biology.

Unit -4

PCR techniques, Real time PCR, DNAMicroarray,ProteinMicroarray.Next generation sequencing, Protein Sequencing. Microscopic techniques including Fluorescence microscopy, Confocal microscopy and live cell imaging FACS analysis, Histology and histochemistry: Fixation and sectioning of tissue, embryos and cells. Immunohistochemistry, immunofluorescence, histochemical staining for characterization of cell type.

Unit – 5

Introduction to bioinformatics, Bioinformatics resources, sequence database, sequence analysis and application of bioinformatics

Suggested Readings

1. Nuclear Magnetic Resonance:(2007)Williams
2. Biochemical Techniques theory and practice: (2009) WhiteR
3. Analytical Chemistry: (2000) Christion G.D.
4. A Biologist Guide to Principle and Techniques: (2009) Willson K. and GqundingK.H.
5. An Introduction to Practical Biochemistry:(2008) Plummer D.T.

Course Outcome	**COURSE: Analytical and Separation Techniques: 102**
CO1	The students should be well-versed with Chromatographic technique: Types of chromatography used for bimolecular separations, HPLC, FPLC, GAS and instrumentation details of each, Application of chromatography in Biology
CO2	The students should understand the Electrophoretic techniques, Polyacrylamide gel electrophoresis (native and SDS), Agarose gel electrophoresis, 2-D electrophoresis. Immunoblotting, Southern, Western and Northern blotting, DNA finger printing and ELISA and Spectroscopy techniques.
CO3	The students should have knowledge of PCR techniques, Real time PCR, DNAMicroarray,ProteinMicroarray.Next generation sequencing, Protein Sequencing. Microscopic techniques including Fluorescence microscopy, Confocal microscopy and live cell imaging FACS analysis, Histology and histochemistry: Fixation and sectioning of tissue, embryos and cells. Immunohistochemistry, immunofluorescence, histochemical staining for characterization of cell type and bioinformatics

Program Matrix

	PO1	PO2	PO3	PO4	PO5	PO6		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	3	2	3	1	3		3	1	2	2	3	2
CO2	2	1	1	3	1	3		2	3	1	2	3	3
CO3	2	3	2	1	3	1		3	3	2	2	3	2

Paper III Elective Paper

103A: Advances in animal Cell Culture Technology

Unit 1

Types of Tissue Culture, Types of Cell Culture-Primary and Secondary Cell Transformation Cryopreservation Contamination

Unit 2

Culture media, Base ingredients and nomenclature, Antibiotics, Fetal bovine serum, Sterility and storage.

Unit 3

Preparation of single cell suspension , Trypsinization of cells, subculture or passaging of cells, Cryopreservation, freezing and cell thawing.

Unit 4

Cell counting using a hemocytometer, cell viability assay, mtt colorimetric proliferation assay, crystal violet assay,Immunofluorescent staining, flow cytometry, Methods of Gene Transfer :Viral and Non-Viral Vectors

Unit 5

Stem Cells, Reprogramming of Somatic Cells to induced pluripotent Stem cells, Application of iPS technology to Regenerative Medicine. Tissue Engineering, 3D printing.

Suggested Readings

1. Basic Biotechnology - Colin Ratlidge and Bjorn Kristiansen, Cambridge University, Press,2006
2. Biotechnology and Biopharmaceuticals -- Rodney J.Y. Ho and Milo Gibaldi, Wiley-Liss2003
3. Culmre of Animal Cells -- Ian Freshney Wiley-Liss2006
4. Microbial Biotechnology -- Alexander N Glazer and Hiroshi Nikaido, Cambridge University Press,2006

Course Outcome	COURSE: Advances in animal Cell Culture Technology : 103A
CO1	The students should be well-versed with Types of Tissue Culture and cell viability, Types of Cell Culture-Primary and Secondary Cell Transformation Cryopreservation Contamination
CO2	The students should understand the Cell counting using a hemocytometer, cell viability assay, mtt colorimetric proliferation assay, crystal violet assay,Immunofluorescent staining, flow cytometry, Methods of Gene Transfer :Viral and Non-Viral Vectors.
CO3	The students should have knowledge of Stem Cells.

Program Matrix

	PO1	PO2	PO3	PO4	PO5	PO6		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	2	3	3	2	2		2	2	2	1	3	1
CO2	3	3	3	2	1	2		1	2	3	3	2	3
CO3	1	1	3	1	2	1		2	1	1	1	1	1

103B: Advances in Cancer Biology

Unit 1

Introduction to Cancer Biology Tumor suppressors and oncogenes, Cancer growth and metastasis, Hallmarks of Cancer, Epithelial to Mesenchymal Transition (EMT), Angiogenesis, Escape Strategies against Apoptosis/Cell death and Autophagy

Unit 2

Tumor Microenvironment, Stroma Interaction, Infiltrating Immune cells, Animal models for cancer growth and metastasis, Cancer stem cells.

Unit 3

Signaling mechanisms: Cancer growth and metastasis, Abnormal cell signaling for cancer growth, Reprogramming metabolism and rewiring signaling,

Unit 4

Therapeutic Intervention Success and failure of present therapies, Micro-RNA mediated cancer treatment and targeted drug delivery, Drug resistance, Molecular diagnosis and stem cell therapy.

Unit 5

In vitro tools of cancer biology: Tissue Culture, Primary and Secondary Cell Culture, Cell Transformation, Cryopreservation, iPSCs, Generation and Reprogramming of Somatic Cells. Applications of iPSC technology to Regenerative Medicine and cancer biology. Microscopic techniques including Fluorescence microscopy, Confocal microscopy and live cell imaging FACS analysis, Histology and histochemistry: Fixation and sectioning of tissue, embryos and cells. Immunohistochemistry, immunofluorescence, histochemical staining for characterization of cell type.

Suggested readings:

1. Basic Biotechnology - Colin Ratlidge and Bjorn Kristiansen, Cambridge University, Press,2006
2. Biotechnology and Biopharmaceuticals -- Rodney J.Y. Ho and Milo Gibaldi, Wiley-Liss2003
3. Culmre of Animal Cells -- Ian Freshney Wiley-Liss2006
4. Microbial Biotechnology -- Alexander N Glazer and Hiroshi Nikaido, Cambridge University Press,2006

Course Outcome	**COURSE: Advances in Cancer Biology: 103B**
CO1	The students should be well-versed with Introduction to Cancer Biology Tumor suppressors and oncogenes.
CO2	The students should understand the Signaling mechanisms: Cancer growth and metastasis, Abnormal cell signaling for cancer growth, Reprogramming metabolism and rewiring signaling.
CO3	The students should have knowledge of Therapeutic Intervention Success and failure of present therapies, Micro-RNA mediated cancer treatment and targeted drug delivery, Drug resistance, Molecular diagnosis and stem cell therapy and In vitro tools of cancer biology.

Program Matrix

	PO1	PO2	PO3	PO4	PO5	PO6		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	1	2	1	3	1		1	1	1	2	1	3
CO2	1	3	2	3	1	1		3	2	3	1	2	2
CO3	3	2	2	2	3	2		1	3	1	1	3	1

103C: Advances in Immunology

Unit – 1

Monoclonal Antibody and Antibody engineering, abzymes, Antigen-antibody interaction-based Assays (RIA, ELISA, Immuno-Microscopy, Immunohistochemistry, Immunoprecipitation and co-immunoprecipitation, Immunoblotting, ELISPOT, Flow-cytometer etc)

Unit – 2

Isolation and enrichment of specific immune cells, FACS for quantitative/qualitative analysis and sorting of different immune cell subsets, Cell functional assays- lymphoproliferation, Cell cytotoxicity, mixed lymphocyte reaction, methods for determination of cell deaths/apoptosis

Unit – 3

Immune response in infections, immunodeficiency; autoimmune diseases, Immunological tolerance Tumor Immunology.

Unit – 4

Manipulation of the immune response: Regulation of unwanted immune responses and immunomodulation against autoimmunity, Correction of immunodeficiency, transplantation rejections, cancer immune-therapy, Vaccination and vaccine design, Stem cell therapy; Immunoinformatics.

Unit – 5

Evaluation of immunomodulation and biological response modification, adoptive transfer of lymphocytes and HSCs: Transgenic mice and gene knockout by targeted disruption, Molecular diagnosis of immunological disorders.

Suggested Readings

1. Immunobiology: Kenneth Murphy
2. Cellular and Molecular Immunology: Abbas AK, Lichtman AH and Pillai S
3. Immunology: Kuby
4. Essential Immunology: Devlin and Roit
5. Zneway's Immunology
6. Fundamental Immunology: William Paul

Course Outcome	**COURSE: Advances in Immunology : 103C**
CO1	The students should be well-versed with Monoclonal Antibody and Antibody engineering, abzymes, Antigen-antibody interaction-based Assays.
CO2	The students should understand the Immune response in infections, immunodeficiency; autoimmune diseases, Immunological tolerance Tumor Immunology.
CO3	The students should have knowledge of Evaluation of immunomodulation and biological response modification, adoptive

	transfer of lymphocytes and HSCs: Transgenic mice and gene knockout by targeted disruption, Molecular diagnosis of immunological disorders.

Program Matrix

	PO1	PO2	PO3	PO4	PO5	PO6		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	2	3	3	2	2		2	3	1	2	2	1
CO2	3	3	2	3	1	3		1	2	2	2	1	2
CO3	1	1	3	1	1	2		3	1	3	3	1	2

103D: Microbial Resources and Products

Unit - 1

Microbial resources. Bacteria, Fungi and Viruses. Source of microorganism (Soil, Water and Air). Isolation, preservation and maintenance of industrial microorganisms.

Unit - 2

Microbial Identification: Morphological methods, Biochemical methods, Chemotaxonomy, Molecular taxonomy. Isoenzymes, ELISA and PCR based identification methods

Unit – 3

Bioprospecting, Major methods of bioprospecting. Screening of microorganisms for value added products and therapeutic molecules. Downstream processing: introduction, removal of microbial cells and solid matters, drying and crystallization

Unit - 4

Industrial production of chemicals: Antibiotics, Organic acids, Solvents, Polymers, Enzymes. Optimization of conditions for production, Scaleup of the process. Quality control parameters in Industry.

Unit - 5

Application of microorganism: Novel products, Biofuel cell, Biodegradation of xenobiotics and pollutants, Biotransformation of drugs and metabolites, biosensors.

Suggested Readings

1. General Microbiology: Sullia SB and Shantharam S
2. Microbial Biotechnology: Glaser AN and Nilaido H
3. Industrial Microbiology : Prescott & Dunn
4. A text of Industrial Microbiology: Crueger W and Crueger A
5. Priciples of Fermentation Technology: Stanbury PF, Ehitaker H, Hall SJ
6. Industrial Biotechnology: SN Jogdan

Course Outcome	COURSE: Microbial Resources and Products: 103D
CO1	The students should be well-versed with Microbial resources. Bacteria, Fungi and Viruses.
CO2	The students should understand the Microbial Identification and Bioprospecting
CO3	The students should have knowledge of Industrial production of chemicals and Application of microorganism.

Program Matrix

	PO1	PO2	PO3	PO4	PO5	PO6		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	2	3	2		2	1	2	3	3	2
CO2	2	2	3	3	2	3		3	3	1	1	2	1
CO3	1	2	1	2	2	1		1	2	1	2	2	2

103E: Enzyme and fermentation technology

Unit - 1

General introduction to Enzymes: nomenclature, EC numbers, and classification. Enzyme activity, Specific activity and turn over number, Marker enzymes. Enzyme Kinetics: Steady state, pre-steady state, equilibrium kinetics, Michaelis-Menten, Lineweaver-Burk Equations and plots, Different methods to calculate the K_m and V_{max} and their significance.

Unit – 2

Factor affecting enzyme activity and catalysis: pH, subsrate and enzyme concentration, temperature, coenzyme and cofactors, Mechanism of bisubstrate and multi substrate reaction catalysis. Role of metal ions in enzyme catalysis. Enzyme inhibition and activators.

Unit - 3

Enzyme technology: Isolation and purification of enzymes, determination of molecular weight preparation of purification chart, limitations of microbial cells used as catalysts, Immobilization of enzymes, whole cell immobilization and their application, multi-enzyme reactors. Enzyme engineering: Design and construction of novel enzymes.

Unit - 4

Introduction to fermentation: Fermenter design, operation, measurement and control in fermentation. Aeration and agitation in fermentation, oxygen requirement, measurement of adsorption coefficients, Types of Bioreactors: Stirred tank, bubble columns, airlift bioreactors, submerged and solid state fermentation and immobilized cell reactors

Unit - 5

Upstream processing: methods for isolation of pure culture, measurement of microbial growth, nutritional and genetic parameters for over production of metabolites, Strain selection and improvement maintenance and preservation of pure culture. Design of production media, preparation of inoculum, alternative carbon and nitrogen sources, manipulation of environment and Sterilization techniques. Downstream processing – extraction, separation, concentration, recovery & purification operations of fermentation products.

Suggested Readings

1. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry: Trevor Palmer and Philip Bonner.
2. Biochemistry: Jeremy M. Berg, Lubert Stryer, John L. Tymoczko, Gregory J. Gatto
3. Lehninger's Principles of Biochemistry by Nelson, Cox
4. Enzyme kinetics: Dixon W. B.
5. Fundamentals of Enzymology : Nicholas C. Price and Lewis Stevens
6. A text of Industrial Microbiology: Crueger W. & Crueger A.
7. Principles of Fermentation Technology: Stanbury P.F, Ehitaker H, Hall S.J

Course Outcome	**COURSE: Enzyme and fermentation technology: 103E**
CO1	The students should be well-versed with General introduction to Enzymes and Factor affecting enzyme activity and catalysis.
CO2	The students should understand the Enzyme technology and fermentation technology
CO3	The students should have knowledge of Upstream processing and Downstream processing.

Program Matrix

	PO1	PO2	PO3	PO4	PO5	PO6		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	2	3	3	3	3		3	2	3	2	2	3
CO2	3	3	2	2	3	3		1	3	2	3	3	2
CO3	2	1	2	1	1	2		2	1	2	1	1	1