Shiromani Gurudwara Prabandhak Committee's

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Matunga, Mumbai – 400 019, Maharashtra

Program: Master of Science

Course: MSc-II Biotechnology

Syllabus for

Semester III and IV

(Major paper- I/II/Elective)

Name of the paper: Biostatistics

(As per NEP guidelines-DSC model)

With effect from Academic Year 2024 - 2025)

Program outcomes

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

PROGRAMME OUTCOMES (PO)

MASTERS IN SCIENCE (MSc)

Postgraduate Science Program Outcomes:

PO1	**Advanced Understanding:** Attain an advanced understanding of specialized scientific areas and theories, building upon undergraduate knowledge.
PO2	**Advanced Analytical Skills:** Develop advanced analytical and problem-solving skills for complex scientific issues.
PO3	**Research Proficiency:** Acquire proficiency in scientific research, contributing significantly to the advancement of knowledge.
PO4	**Leadership Skills:** Develop leadership skills to lead scientific initiatives and contribute to the scientific community.
PO5	**Interdisciplinary Collaboration:** Collaborate effectively with interdisciplinary teams for comprehensive scientific solutions.
PO6	**Innovation and Creativity:** Foster innovation and creativity in scientific research and practice.
PO7	**Professionalism:** Demonstrate professionalism and excellence in all scientific endeavours.
PO8	**Quality Improvement:** Embrace self-evaluation and continuous improvement for achieving excellence in scientific pursuits.

Program specific outcomes

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)
Department of Biotechnology

Programme: MSc -II Biotechnology

Programme Specific Outcomes (PSOs) for M.Sc. in Biotechnology

Sr. No.	A student completing a M.Sc. in Biotechnology will be able to:
PSO 1	Introduction to basics of protein structure and function with emphasis on hemoglobin, MHC, and myosin structure. Introduction to structure and biosynthesis of nucleic acids and their degradation pathways. Comprehensive understanding of advanced immunological concepts like organization and inheritance of MHC proteins and genes as well as hypersensitivity reactions, generation of immunoglobulin diversity and its regulation, and advanced immunological techniques Introduction to the concepts of RNA processing and protein folding followed by understanding the concepts of protein sorting and mobile DNA elements. Introduction to protein crystallography and x-ray diffractometer as well as spectroscopic techniques like NMR, MS, and CD/ORD for biomedical applications.
PSO 2	Introduction to membrane biochemistry and trafficking, autoimmunity/ transplantation, and cancer immunology and vaccines. Introduction to basic concepts of fermentation (and their reactors), biotransformation reactions, and downstream processing of proteins from recombinant microorganisms. Introduction to basics of intellectual property rights and basics of the patenting process, IP issues, and IP filling process.
PSO 3	Comprehend and demonstrate proficiency in statistical methods and their applications in biomedical research. Understand the principles and methods of medical microbiology in health and disease and molecular diagnostic techniques. Introduction to basics of nanotechnology, and their varied applications in biological sciences and tissue engineering.

PSO 4	**Understand the various concepts of GMOs and their role in bioremediation as well as assessment of safety in food and feed. Comprehend and demonstrate proficiency in various bioinformatics resources and their applications and introduction to fundamentals of clinical studies and their regulatory processes.**

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Program Structure

Semester-III

Course Code	Course Name	Teaching Hours		Credits Assigned		
		Theory	**Practical**	**Theory**	**Practical**	**Total**
GNKPSBTMJ1503	(Major) Paper-I	60	60	4	2	6
GNKPSBTMJ2503	(Major) Paper-II	60	60	4	2	6
GNKPSBTEL1503	(Elective) Paper	45	30	3	1	4
GNKPSBTRP503	Research project (RP)	--	--	--	--	4
Total		**165**	**150**	**11**	**05**	**20**

Semester-IV

Course Code	Course Name	Teaching Hours		Credits Assigned		
		Theory	**Practical**	**Theory**	**Practical**	**Total**
GNKPSBTMJ1504	(Major) Paper-I	60	60	4	2	6
GNKPSBTMJ2504	(Major) Paper-II	60	60	4	2	6
GNKPSBTEL1504	(Elective) Paper	45	30	3	1	4
GNKPSBTRP504	Research project (RP)	--	--	--	--	4
Total		**165**	**150**	**11**	**05**	**20**

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)
Department of Biotechnology

Course: MSc-II Biotechnology
Semester-III
Major Paper-I
Course Title: M.Sc. -II (Biotech) Paper Title - Biostatistics
Course Code: GNKPSBTMJ1503
Credits: 4
No of lectures (Hours): 60
Marks: 100 (75:25)

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	**Comprehensive understanding and applications of probability, its types, and applications in the field of biomedical sciences.**
2	**Introduction and exploration of Gaussian and Poisson distribution and their applications.**
3	**Introduction to non-parametric tests and their types.**
4	**Introduction to ANOVA and multiple regression models along with their applications.**

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Discuss and apply the concepts of Probability, its types, and applications in biological sciences	PO-1,2,3,5	3	U, Ap, An
CO 2	Discuss and apply the concepts of Test of Significance, Poisson and Gaussian distribution and their applications.	PO-1,2,3,5	3	U, Ap, An
CO 3	Explain Non–Parametric test and its type with examples	PO-1,2,3,5	3	U, Ap, An

CO 4	Interpret and analyze ANOVA and multiple regression models with examples.	`PO-1,2,3,5	3	U, Ap, An

MAJOR I – BIOSTATISTICS

Course Code	Credits	No of lectures	Marks
GNKPSBTMJ1503	**04**	**60**	**100**

Unit		Title	No. of lectures	CO Mapping
Unit 1		**Probability**	**15**	
	1.1	Probability and Bayes Theorem: Introduction, Definition and Theorems.		**CO 1**
	1.2	Complementary events, Definition of probability in terms of odds in favor/ against, Application of permutations and combination		**CO 1**
	1.3	Conditional probability and Bayes theorem		**CO 1**
Unit 2		**Test of significance**	**15**	
	2.1	Gaussian Distribution and testing for normality		**CO 2**
	2.2	Poisson distribution, Binomial distribution and Skew-ness		**CO 2**
	2.3	Test of Significance. Steps in Hypothesis testing: Theory of errors-Type I and Type II errors, Null hypothesis, P values-one v/s two tail P values, Confidence intervals		**CO 2**
Unit 3		**Non-parametric tests**	**15**	
	3.1	Non-parametric tests: Introduction, Types, Advantages, Disadvantages and uses.		**CO 3**
	3.2	Sign test (One sample and Matched pairs), Wilcoxon test, Mann-Whitney Test, Krushkal Wallis test, Kolmogorov-Smirnov Test		**CO 3**
				C0 3

Unit 4		**Comparing three or more groups by ANOVA**	**15**	
	4.1	Introduction to ANOVA, One way ANOVA, repeated measures ANOVA, Two way ANOVA		**CO 4**
	4.2	Friedman Test		**CO 4**
	4.3	Multiple Regression		**C0 4**

References:
1. Biostatistics: A foundation For Analysis in Health Sciences (1999) Wayne W. Daniel (9th Edition) John Wiley & Sons Inc.
2. Biostatistics by Arora and Malhan- 2nd Edition

Course: MSc Biotechnology
Semester-III
Course Title: Practical Paper-I
Course Code: GNKPSBTMJ1P503
Credits: 02
No of Practical (Hours): 60
Marks: 75

Course Objectives:

Sr. No.	**Course objectives**
The course aims at: Practical applications of statistics in biomedical sciences with multiple examples.	

Course Outcomes (COs):

Sr. No.	**On completing the course, the student will be able to:**	**POs addressed**	**PSOs addressed**	**Cognitive Levels addressed**
CO 1	Apply and demonstrate the concepts of probability with real-life applications from biomedical sciences.	1,2,3,5	3	U, Ap, An
CO 2	Apply and demonstrate concepts of various Tests of significance, Gaussian and Poisson distribution from biomedical sciences.	1,2,3,5	3	U, Ap, An
CO 3	Discuss and apply the concepts of various non-parametric tests to real-world applications in biomedical sciences.	1,2,3,5	3	U, Ap, An

CO 4	Discuss and apply the concepts of ANOVA to real-world applications in biomedical sciences	1,2,3,5	3	U, Ap, An

Course Code	Credits	No of lectures	Marks
GNKPSBTMJ1P503	**02**	**60**	**75**

List of practical:
Biostatistics problem will be covered in practicals.

References:
1. Biostatistics: A foundation For Analysis in Health Sciences (1999) Wayne W. Daniel (9th Edition) John Wiley & Sons Inc.
2. Biostatistics by Arora and Malhan- 2nd Edition

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)
Department of Biotechnology

Course: MSc-II Biotechnology
Semester-III Paper-II
Course Title: M.Sc. - II(Biotech) Paper Title-Medical Microbiology
Course Code: GNKPSBTMJ2503
Credits: 4
No of lectures (Hours): 60
Marks: 100 (75:25)

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	**Introduction to advanced cytogenetics techniques like FISH, M-FISH, SKY, CGH, and different types of probes used in such techniques as well as applications for diagnosis of diseases.**
2	**Introduction to the microbial diagnosis of diseases including GIT, Skin, RTI, and fungal infections and their pathophysiology.**
3	**Introduction to molecular amplification techniques and molecular detection of microbial diseases.**
4	**Introduction to biofilms, their formation, occurrence, types, and control of biofilms in medicine.**

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Discuss various advanced cytogenetics techniques. probes and their applications in disease diagnosis	1,2,3	3	U, Ap, An

CO 2	Describe and compare the pathophysiology for various microbial diseases affecting the Gut, Respiratory tract, skin as well as nosocomial infections.	1,2,3	3	U, Ap, An
CO 3	Discuss various molecular diagnostic techniques for diagnosis of infectious diseases like TB, HIV and Hepatitis.	1,2,3	3	U, Ap, An
CO 4	Discuss and summarize the occurrence, composition formation and control of biofilms in medicine.	1,2,3	3	U, Ap, An

MAJOR II - MEDICAL MICROBIOLOGY

Course Code	**Credits**	**No of lectures**	**Marks**
GNKPSBTMJ2503	**04**	**60**	**100**

Unit		**Title**	**No. of lectures**	**CO Mapping**
Unit 1		**Advanced Cytogenetic techniques**	**15**	
	1.1	Introduction to chromosomal abnormalities		**CO 1**
	1.2	Advanced Cytogenetic techniques - FISH, M-FISH, SKY, CGH Types of probes: centromeric, telomeric, fusion whole chromosome painting		**CO 1**
	1.3	Applications for diagnosis of diseases: Molecular Approaches for Delineating Marker Chromosomes Prenatal and Preimplantation Diagnosis of Aneuploidies Cytogenetics in the diagnosis of cancers Cytogenetics in Pathology		**CO 1**
Unit 2		**Microbial diagnosis of diseases**	**15**	
	2.1	Pathogenesis, virulence factors, lab diagnosis and treatment of :		**CO 2**

		GITs Infections - Salmonella spp and Shigella spps Skin infections - Streptococcus pyogenes Respiratory tract Infection - Streptococcus pneumoniae Nosocomial infections - Pseudomonas spps, Proteus spp and Klebsiella spps		
	2.2	Viral infections-HIV, Hepatitis		**CO 2**
	2.3	Fungal infections -Candida spps		**CO 2**
Unit 3		**Molecular diagnostic Techniques for detection of organisms.**	**15**	
	3.1	Introduction Molecular amplification techniques - Target amplification systems, Probe amplification systems and Signal amplification Quantitation – internal controls, external standards, calibrators absolute and relative quantification.		**CO 3**
	3.2	Detection and identity of microbial diseases: Direct detection and identification of pathogenic organisms that are slow growing or currently lacking a system of in vitro cultivation as well as genotypic markers of microbial resistance to specific antibiotics E.g. TB and HIV Clinical utility of molecular diagnostics tests (NAAT) for Hepatitis and AIDS		**CO 3**
	3.3	Drug resistance in TB and HIV Molecular identification of fungal pathogens		**C0 3**
Unit 4		**Biofilms in medicine**	**15**	
	4.1	Introduction, Occurrence, Composition, Formation of Biofilms and Quorum Sensing.		**CO 4**
	4.2	Biofilm formation by *Pseudomonas aeruginosa, Helicobacter pylori* and *Streptococcus pyogenes.*		**CO 4**

	4.3	Control of Biofilms formation: Pilicides, Enzymes, Inhibition of Quorum-sensing, Electrical currents, Surface coating, Bacteriophages. Biofilms and Antibiotic resistance: Inactivation, Altering body's sensitivity, Reduction of drug concentration and Efflux system. Role of biofilms in device associated infections and pathogenesis		**C0 4**

References:
1. Human Molecular Genetics. Tom Strachan and Andrew Read, 2004, 3rd Edition, Garland Science.
2. Introduction to human molecular genetics. Jack Pasternak, 2005, 2nd Edition, Wiley publication.
3. Methods in Molecular Biology, Vol. 204: Molecular Cytogenetics: Protocols and Applications
Edited by: Y. S. Fan © Humana Press Inc., Totowa, NJ 2001
4. Molecular Microbiology diagnostic principles and practice third edition
David H. Persing and Fred C. Tenover Copyright _ 2016 by ASM Press
5. IGenetics by Peter Russel 4th Edition
6. Medical Microbiology by Anantnarayanan
7. Coleman, W. B., & Tsongalis, G. J. (2010). Molecular Diagnostics: for the Clinical Laboratorian. Totowa, NJ: Humana Press.
8. https://cmr.asm.org/content/15/2/167
9.http://www.rroij.com/open-access/bacterial-biofilm-its-composition-formation-and-role-in-human-infections.php?aid=61426
10. Biofilms: Importance and applications. CR Kokare et al. Indian Journal of Biotechnology vol 8 pg 159-168 (2009)

- **Internal Examination (25 Marks):** 20 Marks exam (Presentation). And 5 Marks for Class Participation etc.
- **End Semester theory examination (75 Marks):** Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2hours 30mins
- **Combined passing of 40% with minimum 20% in Internal Component.**

Course: MSc Biotechnology
Semester-III
Course Title: Practical Paper-II
Course Code: GNKPSBTMJ2P503

Credits: 02
No of Practical (Hours): 60
Marks: 75

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	**Perform and evaluate *in vitro* biofilm formation, antibiotic susceptibility tests and plaque assay technique.**

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Performance and evaluation of plaque assay	1,2,3	3	R , U & Ap
CO 2	Demonstration and evaluation of medical diagnostic (POC) kits	1,2,3	3	R & U
CO 3	Biofilm formation (*in vitro*) and its evaluation	1,2,3	3	R , U & Ap
CO 4	Antibiotics susceptibility testing using both macro and micro dilutions methods	1,2,3	3	R , U & Ap
CO 5	Demonstration of minimum biofilm inhibitory concentration of antibiotics/disinfectants.	1,2,3	3	R & U

Course Code	Credits	No of lectures	Marks
GNKPSBTMJ2P503	**02**	**60**	**75**

List of Experiments:

1. **Viral titration - Plaque assay**
2. **Molecular diagnosis - Detection kits Demo - Dengue,**
3. **Formation of biofilm - Quorum sensing**
4. **Antibiotics susceptibility testing by broth Macro dilution method & Micro broth dilution method**
5. **Study of microbial biofilm formation on various surfaces & Biofilm visualization by staining**

6. **Demonstration of minimum biofilm inhibitory concentration of antibiotics/disinfectants.**
7. **Medical diagnostic- Identification of organisms from specimens.**
   A. ***Salmonella typhimurium***
   B. ***Shigella dysenteriae***
   C. ***Streptococcus pyogens***
   D. ***Psuedomonas aeruginosa***
   E. ***Proteus mirabalis***
   F. ***Klebsiella pneumoniae***
   G. ***Candida albicans***

References:

1. Practical Medical Microbiology by R Panjarathinam Pub: Jaypee Brothers Medical Publishers (1st edition).

Examination (Total Marks): 75(Two practicals of 25 marks each)
Experiment Marks: 15
Journal Marks: 05
Viva Marks: 05

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)
Department of Biotechnology

Course: MSc-II Biotechnology
Semester-III Elective Paper
Course Title: Advanced Biotechnology – III (Nanobiotechnology)
Course Code: GNKPSBTEL1503
Credits: 3
No of lectures (Hours): 45
Marks: 100 (75:25)

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	**Introduction to nanomaterials, their synthesis, and analytical techniques employed to study nanomaterials.**
2	**Introduction, synthesis, and applications of Carbon nanotubes in biomedical sciences.**
3	**Applications of nanomaterials in food, pharmaceutical, cosmetic, and agricultural industries.**

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Describe the properties and synthesis of nanomaterials and introduction to analytical techniques.	1,2,3,5	3	R, U
CO 2	Describe the synthesis of Carbon Nanotubes and their applications in biomedical sciences.	1,2,3,5	3	R, U

CO 3	Discuss the various applications of nanomaterials in food, biopharmaceuticals, agriculture and cosmetics	1,2,3,5	3	R, U & Ap

Advanced Biotechnology-III (Nanobiotechnology)

Course Code	Credits	No of lectures	Marks
GNKPSBTEL1503	**03**	**45**	**100**

Unit		Title	No. of lectures	CO Mapping
Unit 1		**Nanomaterial Properties and synthesis**	**15**	
	1.1	Introduction, General properties of nanomaterial.		**CO 1**
	1.2	Characterization of nanomaterial by AFM, XRD, SEM TEM, analysis techniques, properties of nano-mechanical, optical, magnetic properties, electrical conductivity, thermal conductivity.		**CO 1**
	1.3	Synthesis of nanomaterial, biological methods, use of microbial system & plant extracts, use of proteins & templates like DNA.		**CO 1**
Unit 2		**CNT and Nanomachines**	**15**	
	2.1	Carbon nanotubes: Introduction, types and synthesis		**CO 2**
	2.2	Nano-bio machines in nature: ATP synthase, myosin, flagella, dynein.		**CO 2**
Unit 3		**Applications**	**15**	
	3.1	Biopharmaceutics, implantable materials, implantable chemicals, surgical aids, diagnostic tools, nanosensors, nano scanning		**CO 3**
	3.2	Nano enabled drug delivery system		**CO 3**
	3.3	Food, cosmetics and agriculture		**CO 3**

References:

1. The Nanoscope encyclopedia of nanoscience and nanotechnology, Vol. I , V VI (2005) Dr. Parag Diwan and Ashish Bharadwaj Pentagon Press New Delhi

2. Nano forms of carbon and its applications (2007) Prof. Maheshwar Sharon and Dr. Madhuri Sharon Monad Nanotech Pvt. Ltd.
3. Biotech nanotechnology lessons from Nature (2004) David Goodsell Wiley-Liss A John Wiley and sons
4. Nanotechnology- Basic science and emerging technologies (2005) Willson Kannangava, Smith, Simmons, Raguse Overseas Press
5. Textbook of Biotechnology (2005) R. C. Dubey S. Chand and Co.
6. Nanotechnology- Principles and practices S. K. Kulkarni Capital Publishing Co.

Examination:

- **Internal Examination (25 Marks):** 20 Marks exam (Presentation). And 5 Marks for Class Participation etc.
- **End Semester theory examination (75 Marks):** Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2hours 30mins
- **Combined passing of 40% with a minimum 20% in Internal Component**

Course: MSc Biotechnology Practical
Semester-III
Course Title: Elective Practical
Course Code: GNKPSBTEL1P503
Credits: 01
No of Practical (Hours): 30
Marks: 50

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	**Performing and evaluating basic protein chemistry techniques like PAGE (SDS & Native) and protein estimation technique (Folin Lowry method)**
2	**Biosynthesis and evaluation of eco-friendly nanoparticles using plant products**

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed

CO 1	Perform protein electrophoretic techniques (native/SDS/Reducing/Non-reducing) and evaluate the results	1,2,3	3	R,U & Ap
CO 2	Protein Estimation using Folin Lowry methodology	1,2,3	3	R,U & Ap
CO 3	Undertake biosynthesis and evaluation of eco-friendly plant-based silver nanoparticles	1,2,3	3	U & Ap
CO 4	Perform anti-microbial assay testing of various nanoparticles/nanomaterials in vitro	1,2,3	3	U & Ap

Course Code	Credits	No of lectures	Marks
GNKPSBTEL1P503	**01**	**30**	**50**

List of Experiments:

1. **Characterization of proteins by Electrophoresis {PAGE (native, SDS, reducing, non-reducing)}**
2. **Determine concentration of proteins by Folin Lowry method.**
3. **Biosynthesis and characterization of eco-friendly silver nanoparticles by using plant/leaf extracts/green tea**
4. **Antimicrobial activity testing of Nanoparticles/nanocomposites**

References:

1. An Introduction to Practical Biochemistry by David T. Plummer (3rd Edition) Pub: McGraw Hill Education

Examination (Total Marks): 50
Experiment Marks: 40
Journal Marks: 05
Viva Marks: 05

SEMESTER IV

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)
Department of Biotechnology

Course: MSc-II Biotechnology
Semester-IV Paper-I/II
Course Title: GMO and Environment
Course Code: GNKPSBTMJ1504
Credits: 4
No of lectures (Hours): 60
Marks: 100 (75:25)

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	Comprehensive understanding of GMOs and bioremediation and waste management strategies using biotechnology
2	Evaluation and exploration of bioinformatics databases and tools in genomics, transcriptomics and proteomics
3	Introduction and understanding of the drug discovery process and its regulatory processes

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed

CO 1	Describe the various methods for generating GMOs including crop plants as well as bioremediation and detoxification of industrial wastes	1,2,3,5	4	R, U & Ap
CO 2	Discuss and explore the vast bioinformatics databases and web-based tools on genomics and proteomics	1,2.3,5	4	R, U & Ap
CO 3	Discuss and learn about the basics of the drug discovery process, regulatory protocols in drug discovery, and preclinical toxicology	1,2,3,5,6	4	R, U & Ap
CO 4	Outline the various bioremediation and biological detoxification of wastes from textile, petrochemicals, and food industries	1,2,3,5	4	R,U,& Ap

MAJOR I - GMO AND ENVIRONMENT

Course Code	**Credits**	**No of lectures**	**Marks**
GNKPSBTMJ1504	**04**	**60**	**100**

Unit		**Title**	**No. of lectures**	**CO Mapping**
Unit 1		**Genetically modified organisms**	**15**	
	1.1	Examples and methods- Humulin and ice-minus bacteria		**CO 1**
	1.2	GM bacteria in bioremediation		**CO 1**
	1.3	GMO identification by protein and DNA based methods, Risks and controversies related to use of genetically modified microorganisms, Genetic Engineering Approval Committee (GEAC), Biosafety data of any two approved genes available on the database.		**CO 1**
Unit 2		**GE crops**	**15**	
	2.1	Introduction to GE crops - effects of genetic engineering on crop yield, environmental effects		**CO 2**
	2.2	Protocols on food and feed safety assessment		**CO 2**

	2.3	Acute oral safety study in rats and mice, Sub-chronic feeding studies in rodents, Protein thermal stability and Pepsin digestibility for Livestock feeding studies		**CO 2**
Unit 3		**Biotechnology in waste management**	**15**	
	3.1	Solid waste treatment		**CO 3**
	3.2	Pollution indicators & biosensors		**CO 3**
	3.3	Biodegradation of xenobiotic, pesticides, Phytoremediation		**C0 3**
Unit 4		**Biodegradation and Biological detoxification of industrial waste**	**15**	
	4.1	Biodegradation of waste from: Food and textile industries, Paper industries, Petrochem industries and dye industries		**CO 4**
	4.2	Biological detoxification: Removal of oil spillage & grease deposits		**CO 4**

References:

1. www.geac.in
2. Protocols for food and feed safety assessment of GE crops – DBT 2004
3. Genetically modified bacteria in agriculture- N Armager Biochemi vol 84 pg 1061-72, 2002
4. Detection of genetically modified organisms in food Farid E Ahmed Trends in biotechnology vol 20 pg 215-223, 2002
5. Biosafety and ethical issues related to genetically modified organism (GMO) and recombinant products by Amulya K. Panda
6. GE crops http://nap.edu/23395
7. Environmental Biotechnology (Basic concepts and application) Indu Shekar Thakur
8. Testing of genetically modified organisms in food by Farid E Ahmed (Food product press)

Course: MSc-II Biotechnology
Semester-IV Paper-I/II
Course Title: BIOINFORMATICS
Course Code: GNKPSBTMJ2504
Credits: 4
No of lectures (Hours): 60
Marks: 100 (75:25)

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Recognize and operate various primary and secondary bioinformatics databases and primer design tools on the internet	1,2,3.5	4	R,U & Ap
CO 2	Describe and explore various gene/motif finding tools as well as protein sequence and structure analysis software packages	1,2,3,5	4	R, U & Ap
CO 3	Explain the techniques employed in 'OMICS' like microarrays, chromatin immunopecipitation assays and pharmacogenomics	1,2,3,5	4	R, U & Ap
CO 4	Discuss and explore proteomics-based protein profiling, protein expression analysis and protein-protein interaction techniques	1,2,3,5	4	R,U & Ap

MAJOR II - BIOINFORMATICS

Course Code	Credits	No of lectures	Marks
GNKPSBTMJ2504	**04**	**60**	**100**

Unit		Title	No. of lectures	CO Mapping
Unit 1		**Databases and Tools**	**15**	

	1.1	Composite and specialized databases, Exploration of databases, retrieval of desired data and tools –Entrez, SRS, LinkDb, Db Get		**CO 1**
	1.2	Types of primers, parameters for primer designing, use of computers in primer designing.		**CO 1**
	1.3	Human genome Analysis/ Gateways to human genome- NCBI, UCSC, Encode, Hugo, GWAS		**CO 1**
Unit 2		**Gene and protein sequence analysis**	**15**	
	2.1	Gene finding for prokaryotes and eukaryotes: Approaches, Methods and tools, Motif finding: DNA and protein Approaches, Methods and tools multiple sequence alignment: Clustal W and algorithms.		**CO 2**
	2.2	Protein sequence analysis: theory, algorithms, Databases and tools, pairwise (FASTA and BLAST) and multiple sequence (Clustal W)		**CO 2**
	2.3	Protein structure analysis Databases and tools for Structure visualization, alignment and classification – CATH and SCOP, Applications of protein sequence and structure analysis. Protein modelling		**CO 2**
Unit 3		**Genomics**	**15**	
	3.1	Gene expression profiling by a) SAGE b) Microarrays - Microarray fabrications technology. Microarray analysis- Data collection and image analysis, Grouping of data and clustering methods.		**CO 3**
	3.2	Study of protein-DNA interactions-electrophoretic mobility shift assay; DNase footprinting; methyl interference assay, chromatin immunoprecipitation		**CO 3**
	3.3	Introduction to pharmacogenetics and pharmacogenomics		**C0 3**
Unit 4		**Proteomics**	**15**	
	4.1	Separation and Identification of Proteins 2D-PAGE, isoelectric focusing, Edman reaction Protein tryptic digestion and peptide mass fingerprinting		**CO 4**
	4.2	Protein Expression Profiling		**CO 4**

		Gel-based quantitative proteomics: DIGE (Difference in Gel Electrophoresis) Gel-free based quantitative proteomic: MS based used with stable-isotope tagging. *In vivo* labelling- SILAC *Invitro* labelling- ICAT: Protein chips: Types and applications		
	4.3	Protein-Protein Interaction Detection: Yeast 2 hybrid, TAP (tandem affinity purification, Phage display, and Mammalian system, Clinical and biomedical applications of proteomics Introduction to metabolomics		**C0 4**

References:

1. Lesk, A. M. (2002). Introduction to Bioinformatics. Oxford: Oxford University Press.

2. Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

3. Baxevanis, A. D., & Ouellette, B. F. (2001). Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins. New York: Wiley-Interscience.

4. Pevsner, J. (2015). Bioinformatics and Functional Genomics. Hoboken, NJ: Wiley-Blackwell.

5. Lesk, A. M. (2004). Introduction to Protein Science: Architecture, Function, and Genomics.
Oxford: Oxford University Press.

6. Philip Bourne and Helge Weissig Structural bioinformatics Wiley -Liss

7. Metabolomics: An introduction Reza Salek, Laura Emery, Stephan Beisken (https://www.ebi.ac.uk/training/online)

8. Proteomics in diagnosis: Past, present and future. Ahmad Y , Arya A et al Journal of proteomics and genomics vol 1, 2014.

9. Genomes 3rdEdition T.A. Brown.

10. Manolio TA (July 2010). "Genomewide association studies and assessment of the risk of disease". The
New England Journal of Medicine. 363 (2): 166–76. doi:10.1056/NEJMra0905980. PMID 20647212

11. The Human Genome Organisation (HUGO) Edison T. Liu HUGO J (2009) 3:3–4

12. Microarray Bioinformatics - DOV STEKEL 2003

Course: MSc Biotechnology

Semester-IV

Course Title: Practical Paper-I/II

Course Code: GNKPSBTMJ1P504 and GNKPSBTMJ2P504

Credits: 02

No of Practical (Hours): 60

Marks: 50

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	**Exploring free bioinformatic resources like BLAST, MSA, motif - finding/gene finding (eukaryotic/prokaryotic) tools and protein visualization tools like Rasmol and PyMol**
2	**Performing *in vitro* bioremediation and composting experiments using metal tolerant organisms**
3	**Demonstration of protein separation and purification techniques like PAGE and chromatography**

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Perform bioinformatics analysis for genomics, transcriptomics and proteomics applications using free web-based tools	1,2,3	4	U, Ap & An
CO 2	Bioremediation and composting experiments using various microbial/plant sources	1,2,3	4	U, Ap & An
CO 3	Protein separation and purification experiments like PAGE(Native/SDS/Reducing) and chromatography	1,2,3	4	U , Ap & An

Course Code	Credits	No of lectures	Marks
GNKPSBTMJ1P504 and GNKPSBTMJ2P504	**02**	**60**	**50**

List of Experiments:

1. **Multiple alignment - Phylogenetic tree**
2. **BLAST- orthologs and paralogs, homologs**
3. **Motif finding**
4. **KEGG**
5. **Structure of proteins – visualization – RASMOL and PyMol**
6. **Use of gene prediction methods (by any one tool)**
7. **Use of various primer designing and restriction prediction tools**

8. **Homology modelling of protein**
9. **Bioremediation- isolation of metal tolerant organisms & study their growth**
10. **Composting – physical & chemical parameters**
11. **GMO Validation - kit based/ demo**
12. **Case studies on GE crops**
13. **Demonstration of 2D PAGE**
14. **Demonstration of Affinity chromatography**
15. **Exploration of microarray database**

References:

1. An Introduction to Practical Biochemistry by David T. Plummer (3rd Edition) Pub: McGraw Hill Education

2. Baxevanis, A. D., & Ouellette, B. F. (2001). Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins. New York: Wiley-Interscience.

3. Environmental Biotechnology (Basic concepts and application) Indu Shekar Thakur

4. Testing of genetically modified organisms in food by Farid E Ahmed

Examination (Total Marks): 50 (Two practicals of 25 marks each)
Experiment Marks: 15
Journal Marks: 05
Viva Marks: 05

Course: MSc-II Biotechnology
Semester-IV
Course Title: Advanced Biotechnology - IV (CLINICAL STUDIES)
Course Code: GNKPSBTEL1504
Credits: 4
No of lectures (Hours): 60
Marks: 100 (75:25)

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Discuss and explore new drug discovery processes including various phases of clinical trials	1,2,3,5,6	4	U, Ap & An
CO 2	Describe the regulatory protocols for carrying out clinical trials and various aspects of clinical data management	1,2,3,5,6	4	U, Ap & An
CO 3	Examine the various facets of preclinical toxicology including animal toxicity requirements	1,2,3,5,6	4	U, Ap & An

Advanced Biotechnology - IV (CLINICAL STUDIES)

Course Code	Credits	No of lectures	Marks
GNKPSBTEL1504	**04**	**60**	**100**

Unit		Title	No. of lectures	CO Mapping
Unit 1		**New drug discovery process**	**15**	
	1.1	Purpose, main steps involved, timeline for each step, advantages of steps		**CO 1**
	1.2	Introduction to clinical studies.		**CO 1**
	1.3	Phases of clinical research Phase I, II, III, IV		**CO 1**

Unit 2		**Regulatory protocols for clinical trials**	**15**	
	2.1	Ethics in clinical research, unethical trials – thalidomide tragedy ICH GCP- objective, steps and guidelines.		**CO 2**
	2.2	Types of clinical trials: single and double blinded, open access and randomized, interventional studies, cross over design. Examples for each.		**CO 2**
	2.3	Clinical study reports -Principle and software in clinical data management		**CO 2**
Unit 3		**Preclinical toxicology:**	**15**	
	3.1	General principles Systemic toxicology -single and repeat dose toxicity studies		**CO 3**
	3.2	Carcinogenicity, mutagenicity and teratogenicity studies, Reproductive toxicity, local toxicity and Genotoxicity studies, Animal toxicity requirements.		**CO 3**

References:

1. Clinical pharmacology by Peter N Bennett, Morris Brown and Pankaj Sharma 11th edition,
Churchill Livingstone Elsevier 2012
2. Basic clinical pharmacology by Katzung B Anthony Trevor 13th edition McGraw hill 2015
3. Practical guide to clinical data management Susanne Prokscha 3rd edition CRC press 2012
4. Basic and clinical pharmacology by Katzung B G Prentice hall
5. Clinical Pharmacology by Laurence DR and Bennett PN , Scientific book agency
6. Clinical pharmacokinetics by D R Krishna and V Koltz , Springer Verlag
7. Ramington pharmaceutical sciences by Williams and Wilkins Lippincott
8. Drug interaction by Hamster Kven Stockley
9. Drug interaction by J K Mehra Basic Business publication Bombay
10. Clinical pharmacology and drug therapy by Grahame Smith and Aronson

Examination:

- **Internal Examination (25 Marks):** 20 Marks exam (Presentation). And 5 Marks for Class Participation etc.
- **End Semester theory examination (75 Marks):** Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2hours 30mins
- **Combined passing of 40% with minimum 20% in Internal Component.**

Course: MSc Biotechnology Practical
Semester-IV
Course Title: Elective Practical
Course Code: GNKPSBTEL1P504
Credits: 01
No of Practical (Hours): 30
Marks: 50

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	**Understanding and comprehension of real-life case studies from drug discovery and regulatory aspects of various drugs/molecules**

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Understand the various aspects of clinical and regulatory framework involved in the discovery and manufacturing of drugs and devices	1,2,3,5	4	U, Ap & An

Course Code	Credits	No of lectures	Marks
GNKPSBTEL1P504	**01**	**30**	**50**

List of Experiments:

1. **Various case studies**

References:

1. **Practical guide to clinical data management Susanne Prokscha 3rd edition Pub:CRC press 2012**
2. **Basic and clinical pharmacology by Katzung B G Pub:Prentice Hall**

Examination (Total Marks): 50

Experiment Marks: 40

Journal Marks: 05

Viva Marks: 05