



**Shiromani Gurudwara Prabandhak Committee's
Guru Nanak Khalsa College of Arts, Science and Commerce
(Autonomous)**

Matunga, Mumbai – 400 019, Maharashtra

Program: Bachelor of Science

Course: Second year Biotechnology

Semester III and IV

(As per NEP guidelines-DSC model)

With effect from Academic Year 2025 - 2026

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

SYBSC BIOTECHNOLOGY

Program Structure

Semester-III

Course Code	Course Name	Teaching Hours		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
GNKUSBTMJ1103	(Major) Paper-I	45	30	3	1	4
GNKUSBTMJ2103	(Major) Paper-II	45	30	3	1	4
GNKUSBTMI103	(Minor) Paper	45	30	3	1	4
GNKUSBTOE103	Open elective (OE)	30	--	2	--	2
GNKUSBTVSC103	Vocational Skill Course (VSC)	--	60	--	2	2
GNKUSBTAEC103	Ability Enhancement Course (AEC)	30	--	2	--	2
	Co-curricular (CC)	--	--	--	--	2
GNKUSBTOJT/F P/ RP/CEP103	On job training (OJT)/ Field project (FP)/Research project (RP)/ Community engagement & service (CEP)	--	--	--	--	2
Total		195	150	13	05	22

SYBSC BIOTECHNOLOGY

Program Structure

Semester-IV

Course Code	Course Name	Teaching Hours		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
GNKUSBTMJ1104	(Major) Paper-I	45	30	3	1	4
GNKUSBTMJ2104	(Major) Paper-II	45	30	3	1	4
GNKUSBTMI104	(Minor) Paper	45	30	3	1	4
GNKUSBTOE104	Open elective (OE)	30	--	2	--	2
GNKUSBTSEC104	Skill Enhancement Course (SEC)	--	60	--	2	2
GNKUSBTVEC104	Value Education Course (VEC)	30	---	2	--	2
	Co-curricular (CC)	--	--	--	--	2
GNKUSBTOJT/ FP/RP/CEP10 4	On job training (OJT)/ Field project (FP)/Research project (RP)/ Community engagement & service (CEP)	--	--	--	--	2
Total		195	150	13	05	22



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

PROGRAMME OUTCOMES (PO)

BACHELOR OF SCIENCE (B.Sc.)

Undergraduate Science Program Outcomes:

PO1	Foundational Understanding: Develop a foundational understanding of core scientific principles and theories across various disciplines of science.
PO2	Analytical Skills: Develop analytical and problem-solving skills to critically analyse scientific problems and apply scientific methodologies.
PO3	Global Perspective: Gain a global perspective by understanding diverse scientific issues and incorporating ethical considerations in scientific practices.
PO4	Research Awareness: Gain awareness of research methodologies and techniques, preparing for future research endeavours.
PO5	Holistic Development: Experience holistic development by embracing values of humanism, empathy, and social responsibility in scientific pursuits.
PO6	Communication Skills: Enhance communication skills to effectively convey scientific concepts to diverse audiences.
PO7	Continuous Learning: Develop a commitment to lifelong learning and staying updated with advancements in science.
PO8	Ethical Practices: Understand and adhere to ethical standards in scientific research and practice.

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

Department of Biotechnology

Programme: SYBSc BIOTECHNOLOGY

Programme Specific Outcomes (PSOs) for BSc in Biotechnology

Sr. No.	A student completing BSc in Biotechnology will be able to:
PSO 1	Develop proficiency in basic sciences alongside a comprehensive understanding of biotechnology and chemical science principles, establishing a strong foundation for advanced studies through an interdisciplinary perspective
PSO 2	Demonstrate comprehensive understanding of fundamental concepts in biotechnology, including molecular biology, microbiology, biochemistry, genetics, and cell biology, and apply this knowledge in academic, industrial, and research settings.
PSO 3	Apply knowledge of fundamental biological processes across molecular, cellular, industrial, and environmental contexts.
PSO 4	Acquire proficiency in standard laboratory techniques such as DNA/RNA isolation, gel electrophoresis, PCR, spectrophotometry, chromatography, microbial culturing, and aseptic techniques essential for biotechnological applications.
PSO 5	Analyze, interpret, and reflect on information or data to address problems in the field of biotechnology and acquire scientific and entrepreneurial skills to devise sustainable solutions to current real-world issues.
PSO 6	Integrate concepts from allied sciences including chemistry, physics, mathematics, and computer science with biotechnology to strengthen problem-solving and research capabilities.
PSO 7	Understand the principles of industrial biotechnology, bioprocess engineering, and intellectual property rights, developing skills necessary for employment in biotechnology industries, quality control laboratories, or for pursuing entrepreneurial ventures.
PSO 8	Develop effective communication skills and the ability to work both independently and in teams within the scope of scientific research writing, while demonstrating the capacity to present innovative ideas and research findings effectively.
PSO 9	Demonstrate awareness of ethical, legal, and social aspects of biotechnology research and applications, and commit to responsible and sustainable practices for the betterment of society and the environment.

Semester III

MAJOR I

Immunology and Cytogenetics

Course Objectives:

Sr. No.	Course objectives
The course aims :	
1.	To introduce and explore the concepts of immunology, immune-techniques and classical cytogenetics
2.	To familiarize, explore and the Immune Effector Mechanisms and various Immuno techniques and its applications
3.	To explore, understand and to analyze the fundamentals of cytogenetics and chromosomal aberrations with respect to structure and function
4	To understand the importance of pedigree analysis and study its applications
5	To understand and solve problems related to sex linked and recessive traits
6	To solve problems related to genetic linkage, cross over and tetrad analysis

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 the components and mechanisms of immune response.	PO 1,2	PSO 1	R,U
CO 2	Recognise the <i>in vitro</i> immune techniques including various precipitation and agglutination reactions.	PO 1,2,7	PSO 1,3	R,U,Ap
CO 3	Differentiate the different types of antigen antibody reactions	PO 1, PO 2	PSO 3	R,U
CO 4	Describe and organize the various chromosomal aberrations, sex determination	PO 1,2	PSO 3	R,U,An,Ap
CO 5	Explain the mechanisms and various genetic crosses and study their applications.	PO 1, 2	PSO 1,2,3	R,U,Ap

Course Code		Credits	No of lectures	Marks	
GNKUSBTMJ1103		03	45	75	
Unit		Immunology and Cytogenetics		No. of lectures	CO Mapping
Unit 1	1.1	Effectors of Immune Response		15	CO 1
	1.2	Haematopoiesis; Cells of the Immune System; Primary and Secondary Lymphoid Organs			CO 1
	1.3	Complement System: Classical, Alternate and Lectin Pathway; Regulation Cell Receptors: TCR, BCR – Structure, maturation and activation MHC Classes – General organization			CO 1
Unit 2		Immuno-techniques		15	
	2.1	Precipitation Reactions: Precipitin Curve, Immuno diffusion (Mancini and Ouchterlony), Immuno electrophoresis, Rocket electrophoresis.			CO 2
	2.2	Agglutination Reactions: Hemagglutination, Bacterial Agglutination, Passive Agglutination, Agglutination Inhibition.			CO 2
	2.3	Immunoassays: Coomb's Test, Complement Fixation Tests, RIA, ELISA			CO 2, 3
Unit 3		Cytogenetics		15	
	3.1	Variation in Chromosomal Structure: Structure: Deletion, Duplication, Inversion, Translocation Number: Aneuploidy, Euploidy and Polyploidy Syndromes: Klinefelter, Turner, Cri-du-Chat, Down syndrome, Edward's syndrome and Patau syndrome.			CO 4
	3.2	Sex Determination and Sex Linkage: Mechanisms of Sex Determination (XX-XY, ZZ-ZW, XX-XO), Dosage Compensation and Barr Body.			CO 4,5
	3.3	Genetic Linkage, Crossing Over and Tetrad analysis, Chromosomal Mapping: Two-point Cross; Three-point Cross; Pedigree Analysis- Dominant and Recessive traits for Autosomal and Sex Chromosome.			CO 4,5

References:

1. Immunology by Janis Kuby (8th Edition)
2. Immunology by C V Rao
3. iGenetics – Peter J Russel

Examination:

- **Internal Examination (15 Marks):** 10 Marks exam (MCQ and short answer question) with 20% completed syllabus. Duration of exam: 20 minutes. And 5 Marks for either Quiz/Assignments /Class Participation etc.
- **End Semester theory examination (60 Marks):** Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2 hours
- **Combined passing of 40% with minimum 20% in Internal Component.**

MAJOR II - Molecular Biology**Course Objectives:**

Sr. No.	Course objectives
The course aims :	
1	To introduce the molecular tools and enzymes used in molecular biology and its applications
2	To introduce the concept of biomarkers and molecular markers and barcoding
3	To explore the mechanisms involved in gene expression and regulation in prokaryotes
4	To introduce cytoskeletal components in prokaryotes
5	To give an insight in membrane transport system with 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	Discuss the fundamentals of enzymes and vectors used in recombinant DNA technology.	PO 1, 2	PSO 1,2	R , U

CO 2	Explain the importance of biomarkers and molecular markers	PO 1,2	PSO 1,2	R,U
CO 3	Recall and characterize vectors used in molecular biology. Explain the components and mechanism of gene expression in prokaryotes	PO 1,2	PSO 1,2	R,U,Ap
CO 4	Discuss the process of translation in prokaryotes and eukaryotes along with regulation	PO 1,2	PSO 1,2,5	R , U

Course Code		Credits	No of lectures	Marks	
GNKUSBTMJ2103		03	45	100	
Unit		Molecular Biology		No. of lectures	CO Mapping
Unit 1		Enzymes and Vectors		15	
	1.1	Enzymes: DNA Polymerases, Restriction Endonucleases, Ligases, Reverse Transcriptase, Nucleases, Terminal Transferases, Kinases, Phosphatases, Taq polymerase.			CO 1
	1.2	Introduction to Biomarkers: Visual markers, Biochemical markers and molecular markers and its correlation with enzymes , Characteristics of Barcode, Examples: CoxII and Rbcl			CO 2
	1.3	Classification and Characteristics of Vectors, Example: Plasmid Vectors (pBR322, pUC), Phage based vectors, Cosmids			CO 1,2
Unit 2		Transcription		15	
	2.1	Transcription in prokaryotes: mRNA Synthesis, Promoters; Structure of ribosome (70S); Initiation of Transcription; Elongation and Termination of an mRNA Chain.			CO 3
	2.2	Transcription in Eukaryotes: Eukaryotic RNA Polymerases; Eukaryotic Regulatory elements: Promoters, Enhancer and Activators; Structure of Ribosome (80S); Transcription of Protein Coding Genes by RNA Polymerases (mRNA); Structure and			CO 3

		Transcription of other genes: rRNA and tRNA. Capping, Polyadenylation.		
	2.3	Regulation of gene expression in Bacteria: lac Operon of <i>E. coli</i> ; trp Operon of <i>E. coli</i> , Arabinose operon Regulation of gene expression in viruses: Lytic / Lysogenic regulation		CO 3
Unit 3		Translation	15	
	3.1	Nature and Characteristics of Genetic Code. Wobble Hypothesis. Translation in Prokaryotes: Process of Protein Synthesis (Initiation-Shine Dalgarno Sequence, Initiation factors, Charging of tRNA molecule, Attachment of amino-acid to tRNA molecule and Methylation of first amino-acid, Elongation- EF-Tu and Ts cycle, Peptide bond formation and Translocation, Termination)		CO 4
	3.2	Translation in Eukaryotes: Process of Protein Synthesis (Initiation- Initiation factors, 43S and 48S Pre-initiation complex, 30S and 70S Initiation complex, Charging of tRNA molecule, Attachment of amino-acid to tRNA molecule, Elongation- EF-Tu (eEF1) and Ts (eEF2) cycle, Peptide bond formation and Translocation, Termination Regulation of Translation: Prokaryotes and Eukaryotes.		CO 4
	3.3	Regulation of gene expression in Eukaryotes: Operons in Eukaryotes; Control of Transcriptional Initiation; Gene Silencing and Genomic Imprinting; Post Transcriptional Control		CO 4

References:

1. Cell and Microbiology biology by Gerald Karp
2. iGenetics by Peter J. Russell- 2nd Edition
3. Cell Biology by Cooper
4. Molecular Biology of Gene by Watson- 5th Edition

Examination:

- **Internal Examination (15 Marks):** 10 Marks exam (MCQ and short answer question) with 20% completed syllabus. Duration of exam: 20 minutes. And 5 Marks for either Quiz/Assignments /Class Participation etc.

- **End Semester theory examination (60 Marks):** Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2hours
- **Combined passing of 40% with minimum 20% in Internal Component.**

MINOR - Instrumentation and Applied chemistry

Course Objectives:

Sr. No.	Course objectives
The course aims :	
1	To understand and recollect the various techniques in electro[phoresis a firm foundation of the fundamentals and applications of electrophoretic techniques
2	To study the applications of electrophoresis and centrifugation in biological research
3	To understand the principle, instrumentation and application of different microscopic techniques
4	To understand the fundamentals and applications of Organic and Green Chemistry.
5	To introduce the concept of green chemistry and its impact in the environment

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Explain the principles of biophysical techniques in the field of Biology such as Electrophoresis	PO 1,2	PSO 1 ,PSO2	R,U,A
CO 2	Demonstrate the applications of electrophoretic and centrifugation techniques in biological research	PO 1,2	PSO 1,2	R,U,Ap
CO 3	Discuss the applications of microscopy and its significance in research	PO 1,2	PSO 2,3	R,U,Ap
CO 4	Discuss the role of Organic Compounds in Biology and Synthesis of Organic Compounds.	PO2,PO3	PSO 1	R,U

CO 5	Memorize the different aspects of Organic chemistry	PO2,PO3	PSO1, PSO 3	U,An,Ap
CO 6	Express an understanding toward the impact of green chemistry	PO 7	PSO 9	R,U

Course Code		Credits	No of lectures	Marks	
GNKUSBTMI103		03	45	100	
Unit		Instrumentation and Applied Chemistry		No. of lectures	CO Mapping
Unit 1		Electrophoresis & Microscopy		15	
	1.1	Electrophoresis: Migration of Ions in an applied electric field; Factors affecting Electrophoretic Mobility; Moving Boundary Electrophoresis; Principle of Electrophoresis; Supporting Matrix; Paper Electrophoresis; Native and SDS PAGE (reducing and non-reducing, continuous and discontinuous); IEF and 2D PAGE. Staining and Detection Methods; Gel-Documentation Applications in Biology.			CO 1
	1.2	Centrifugation :Basic principles of centrifugation, Types of centrifuges, Design and types of rotors, Applications			CO 2
	1.3	Microscopy: Types of Microscopy; Phase Contrast Microscopy, Electron Optics; Electron Microscopy-Preparation of Specimen, SEM, TEM, Fluorescence Microscopy.			CO 3
Unit 2		Organic chemistry: Introduction and synthesis		15	
	2.1	Introduction to Types of Organic Reactions: Addition, Elimination and Substitution Reactions. Essential and Non-essential Elements in Biological Systems. Role of Metal Ions in Biological Systems. Biological Role of Metallo-enzymes (Myoglobin, Haemoglobin)			CO 4
	2.2	Criteria for Ideal Synthesis; Selectivity and Yield, Linear and Convergent Synthesis and multicomponent Reactions			CO 4,5

	2.3	Microwave Assisted Organic Synthesis, Ultrasound in Synthesis and Polymer supported Synthesis.		CO 4,5
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Unit 3		Green chemistry and synthesis	15	
	3.1	Introduction: Green Chemistry; Need and Relevance of Green Chemistry; Principles of Green Chemistry		CO 6
	3.2	Green Synthesis in Industry: Green Materials, Green Reagents, Green Solvents and Green Catalysts		CO 6

References:

- 1. Advanced Organic Chemistry- Reinhard Brucker**
- 3. Organic Synthesis (Special Techniques) - V. K. Ahluwalia**
- 5. College Organic Chemistry for T.Y.B.Sc (Himalaya Publishing House)**

Examination:

- **Internal Examination (15 Marks):** 10 Marks exam (MCQ and short answer question) with 20% completed syllabus. Duration of exam: 20 minutes. And 5 Marks for either Quiz/Assignments /Class Participation etc.
- **End Semester theory examination (60 Marks):** Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2 hours
- **Combined passing of 40% with minimum 20% in Internal Component.**

OPEN ELECTIVE

HUMAN HEALTH AND DISEASES - I

Course Objectives:

Sr. No.	Course objectives
The course aims :	
1	To Introduce concepts related to community health, health and environmental impact
2	To familiarize the different sources of pollutions and it's impact on health
3	To relate the importance of nutrition and balanced diet and its significance in maintenance of health

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to :	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Explain the significance and the role of various environmental factors and its impact on health and disease prevention	PO 1	PSO 1	R,U
CO 2	Define and discuss the importance of balanced diet and health.	PO 1,2	PSO 2, PSO 3	U,E,Ap

Course Code		Credits	No of lectures	Marks	
GNKUSBTOE103		02	30	50	
Unit		Human Health and Diseases		No. of lectures	CO Mapping
Unit 1		Environment and health		15	
	1.1	Introduction - Prevention of diseases in the community, Health - Definition, Determinants of health, Health situation - past and present, One health concept, Disease - concept of control and prevention, modes of interventions, Health management			CO 1
	1.2	Water in relation of health and diseases (sources and uses, pollution), Air & health - sources, pollutants, effects, prevention and control			CO 1
	1.3	Radiation & health - Sources, types, biological effects, protection , Hazardous wastes & health - Planning and management of safe disposal of municipal, solid waste and biomedical waste			CO1
Unit 2		Nutrition and health		15	
	2.1	Chemistry & physiology of food, Nutritive value of food & planning of balanced diet			CO 2
	2.2	Nutritional problems - LBW, PEM, Xerophthalmia, Nutritional anaemia, IDD			CO 2

	2.3	Food hygiene - Food toxicants, food fortification, food adulteration		CO 2
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References:

Environmental pollution and control (4th edition) by Jeffrey Pierce

Environmental health - Global to local by Howard Frumpkin

The New Public Health by Theodore H. Tulkinsky & Elena A. Varavikova

Examination:

- **Internal Examination (20 Marks):** Continuous Internal assessment (CIA) of 20 Marks each (Quiz, Assignment, presentation).
- **End Semester theory examination (30 Marks):** Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 1hour.
- **Combined passing of 40% with minimum 20% in Internal Component.**

VOCATIONAL SKILL ENHANCEMENT COURSE (VSC)
(Bioprocess technology)

Course Objectives:

Sr. No.	Course objectives
The course aims :	
1	To introduce the concept of microbial fermentation and skills applied in Fermentation Technology
2	To build a strong foundation for more advanced studies in Bioprocess Technology.
3	To explore various microbial techniques involved in isolation, selection and identification of microbes

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Develop an understanding of the various aspects of Bioprocess Technology.	PO1,PO2	PSO 1	R,U

CO 2	Develop skills associated with screening of Industrially Important Strains.	PO 1,2	PSO 1	R, Ap,An
CO 3	Recognize the principles underlying design of Fermenter and Fermentation Process.	PO 1,2	PSO 1	R,Ap,An
CO 4	Discuss specific techniques associated with the microbiology	PO 1,7	PSO 1,2	R,U,Ap

LIST OF EXPERIMENTS:

Course Code	Credits	No of lectures	Marks
GNKUSBTVSC103	02	30	50
Sr no	Experiments	Cognitive level addressed	
1.	Assignment on topics - of Fermenters/Types of fermenters/ Types of media/ Case studies based on fermentation.	R,U	
2.	Analyse a case-study and write a report on any one recent application of Biotechnology in fermentation technology (Not older than past 5 years)	C,An	
3.	Field visit/ Virtual visit (website) of National/ International research institutes for research in biotechnology and have a group discussion during the lab session.	R,U,C	
4.	Study of Microscope – Compound Microscope (Including Handling and storage), Dark Field Microscope, Phase Contrast, Fluorescent microscope, Electron Microscope and types	R,U	
5.	Isolation and Colony Characteristics of Microorganisms.	R	
6.	Isolation of industrially important organisms from different sources and optimization of conditions, Product purification and analysis (Eg. Penicillin production/Alcohol production)	R,C,E	
7.	Estimation of sugar in ethanol fermentation by Cole's ferricyanide method.	E,An	
8.	Estimation of Alcohol in ethanol fermentation by dichromate method	E,C	
9.	Demonstration of penicillin production - Process, extraction, separation	R,U,An	
10.	Analysis of products of fermentation - Bioassay of penicillin	R,U	

11.	Screening of antibiotic producers from soil by Crowded plate method.	R,U,An,E
12.	Comparative analysis of fermentation parameters- pH, Temperature, Oxygen requirements	R,U,E

References:

1. **Industrial Microbiology, L E Casida JR**
2. **Principles of Fermentation Technology by P. F. Stanbury, A. Whitaker and S. J. Hall (2nd Edition)**

Examination (Total Marks): 50

Experiment Marks: 40

Journal Marks: 05

Viva Marks: 05

<p><u>ABILITY ENHANCEMENT COURSE (AEC)</u></p> <p><u>(HINDI / MARATHI)</u></p> <p><u>Will be taken at College level</u></p>
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PRACTICAL'S BASED ON MAJOR I (IMMUNOLOGY AND CYTOGENETICS)

Course Objectives:

Sr. No.	Course objectives
The course aims:	
1	To equip the learner to correlate theoretical and experimental knowledge.
2	To analyze the various types of antigen-antibody reactions
3	To understand various chromosomal aberrations including structure and functions

4	To solve problems based of pedigree analysis , dominant and recessive traits
5	To analyse and solve problems based on tetrad analysis, two and three point testcross

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive levels
CO 1	Investigate antigen-antibody reaction and interpret the data	PO 1, 2	1, 2, 3	R, U, Ap, An, E

CO 2	Inspect the antigen antibody interaction via DOT ELISA strip method and interpret the result	PO 2	1, 3	R, U, Ap, An, E
CO 3	Recall the fundamentals of chromosomal abnormalities	PO 1, 2	1, 3	R, U, Ap, An, E
CO 4	Recognize and interpret a karyotype of normal and abnormal chromosomes.	PO 1,2	3	Ap, An, E
CO 5	Solve problems related to pedigree analysis	PO 1,2	2,3	An,Ap
CO 6	Solve problems on tetrad analysis	PO 1,2	2,3	An,Ap

Course Code	Credits	No of lectures	Marks
GNKUSBTMJ1P103	01	15	25
Sr no	Experiment		Cognitive level addressed
1.	DOT-ELISA		U, Ap
2.	Mancini method		U,Ap
3.	Ouchterlony method		An,Ap
4.	Demonstration of flow cytometer- Principle, working and applications		U, Ap
5.	Detection of Barr bodies from Buccal mucosa.		U,Ap

6.	Study of karyotype / Ideogram for chromosomal abnormalities – Normal and abnormal	R,U,E
7.	Chromosomal aberrations in syndromes: Down syndrome, Klinefelter syndrome, Turner syndrome, Cri-du-chat.	An,E
8.	Problems based on Tetrad analysis and three point cross.	E
9.	Problems based on Pedigree analysis- Autosomal and Sex linked	E

PRACTICAL'S BASED ON MAJOR II (MOLECULAR BIOLOGY)

Course Objectives:

Sr. No.	Course objectives
The course aims:	
1	To equip the learner to correlate theoretical and experimental knowledge.
2	To teach the learner various techniques in molecular biology like AGE, PAGE
	To teach the learner gene expression and estimation techniques
3	To describe the growth pattern of organisms in the presence of different sugars .
4	To analyse and solve problems based on restriction enzymes

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive levels
CO 1	Solve problems involved in constructing a restriction map	1, 2	1, 2	R, U, Ap, An, E
CO 2	Apply molecular biology techniques involved in isolation of DNA from different sources and visualization using UV light	2, 7	1, 2,5	R, U, Ap, An, E

CO 3	Recall the basic principles of transformation in <i>E coli</i> and interpret of result	1, 2	1, 3	R, U, Ap, An, E
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Course Code	Credits	No of lectures	Marks
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GNKUSBTMJ2P103	01	15	25
Sr no	Experiment	Cognitive level addressed	
1.	Enzymes used in molecular biology - Demonstration	R,U,An	
2.	Problems based on restriction enzymes	R,U,An, C	
3.	Demonstration of ligation reaction	An, C	
4.	Extraction of genomic DNA from <i>E coli</i>	R,U	
5.	Separation of proteins by PAGE	An	
6.	Demonstration of Blue white screening	R,E	
7.	Expression of β -galactosidase activity in <i>E.coli</i>	R,E,An	
8.	Demonstration of Diauxic growth curve in <i>E.coli</i>	R,An	

PRACTICALS BASED ON MINOR (INSTRUMENTATION AND APPLIED CHEMISTRY I)

Course Objectives:

Sr. No.	Course objectives
The course aims:	
1	To equip the learner to correlate theoretical and experimental knowledge.
2	To teach concepts related to instrumentation and application of AGE, PAGE and interpretation of gel
3	To purify organic compounds and estimation of organic compounds

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive levels
CO 1	Recognize and interpret data of DNA/Protein bands on AGE/PAGE gel	PO 1, 2	PSO 1, 2,7	R, U, Ap, An, E
CO 2	Estimate the concentration and amount of DNA/Protein by spectrophotometer.	PO 2,	PSO 2,7	R,U,Ap
CO 3	Estimate organic compounds using various methods	PO 2, 7	PSO 1, 3, 4	R, U, Ap, An, E

Course Code	Credits	No of lectures	Marks
GNKUSBTMIP103	01	15	25
<u>Sr No</u>	<u>Experiment</u>		<u>Cognitive level addressed</u>
1.	AGE – Demonstration of gel making and apparatus		R,U
2	Isolation of plasmid DNA and separation by AGE		U,C
3	Quantification of DNA by spectrophotometer		U,An
4	PAGE – Continuous and SDS PAGE - Demonstration		R,U
5.	Purification of any two organic compounds by recrystallization selecting suitable solvent.		R,U
6.	Organic estimation: Acetone		R,U
7.	Organic estimation: Amide		R,U
8	Organic estimation: Benzoic acid		R,U

Practical Examination for Major I/II/Minor (Total Marks): 25M each

Experiment Marks: 20

Journal Marks: 05



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

Semester IV

MAJOR I

MEDICAL MICROBIOLOGY

Course Objectives:

Sr. No.	Course objectives
The course aims :	
1	To introduce concepts in medical microbiology with respect to causative agent, epidemiology and disease.
2	To study the importance of clinical pathogens, pathogenesis prevention and treatment of a range of diseases caused by bacteria, fungi and protozoans.

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 factors playing a role in causing a disease.	PO 1	PSO 1, 2	R,U,An
CO 2	Discuss the various aspects of Systemic Infections including Causative Agents, Symptoms and Prophylaxis.	PO 1, PO2	PSO 1, 3	R,U
CO 3	Inspect the technical capability of handling, isolating and identifying various Bacteria.	PO 1, PO 2	PSO 1,2	R,U

Course Code	Credits	No of lectures	Marks
GNKUSBTMJ1104	03	45	100

Unit		Medical Microbiology	No. of lectures	CO Mapping
Unit 1		Host and Parasite Interaction	15	
	1.1	Introduction: Pathology, Infection and Disease. Normal Microbiota and Transient Microbiota, Gnotobiotic animals. Factors affecting growth of Normal Microbiota		CO 1
	1.2	Distribution and occurrence of the normal flora: Skin, Eye, Mouth, Respiratory tract, Gastro-intestinal tract, Urinary and reproductive systems.		CO 1
Unit 2		Infectious Diseases	15	
	2.1	The Etiology of Infectious Diseases: Koch's Postulates		
	2.2	Classifying Infectious Diseases: Communicable and non-communicable, Occurrence of a disease, Severity or Duration of Disease, Extent of Host involvement		CO 2
	2.2	Patterns of Disease: Predisposing factors, Development of disease, The Spread of Infection: Reservoirs of infection, Transmission of disease		CO 2
	2.3	Nosocomial Infections: Microorganisms in the hospital, compromised host, chain of transmission, control of nosocomial infections.		
Unit 3		Bacterial and fungal infections	15	
	3.1	Morphology, Cultural characteristics, Resistance, Biochemical reactions, Pathogenesis, Epidemiology, Lab diagnosis, Treatment, Prophylaxis (Whichever applicable)		CO 3

	3.2	Bacterial Infections: 1. Typhoid (<i>Salmonella typhi</i> , <i>Salmonella paratyphi A</i> and <i>Salmonella paratyphi B</i>) 2. Tuberculosis		CO 3
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	3.3	Fungal Infection: Candidiasis, Tinea infections Protozoal infections : Malaria, Amoebiasis		CO 3

References:

Microbiology – an introduction by Tortora, Funke, Case- 9th Edition

2. Microbiology by Pelczar/ Chan/ Krieg- 5th Edition

3. Foundations in Microbiology by Talaro and Talaro- 8th Edition

4. Textbook of Microbiology by Ananthnarayan and Paniker's- 8th Edition

Examination:

- **Internal Examination (15 Marks):** 10 Marks exam (MCQ and short answer question) with 20% completed syllabus. Duration of exam: 20 minutes. And 5 Marks for either Quiz/Assignments /Class Participation etc.
- **End Semester theory examination (60 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.**

MAJOR II

Biochemistry and Biostatistics

Course Objectives:

Sr. No.	Course objectives
The course aims to:	
1	Discuss the the Metabolic Processes associated with Catabolism of Carbohydrates
2	Elaborate the metabolic pathways involved in catabolism of aminoacids and lipids
3	Describe the basic concepts of Biostatistics.

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 the Metabolic Pathways of Carbohydrates	PO1, PO 2	PSO 1	R,U
CO 2	Describe the various pathways involved in metabolism of amino acids and lipids	PO 1, PO 2, PO 3,	PSO 1, PSO 2	U, E
CO 3	Inspect the basic concepts and the statistical tools used in Biostatistics.	PO 1,PO 2,	PSO 1, PSO 2	E, An, Ap, C

Course Code	Credits	No of lectures	Marks
GNKUSBTMJ2104	03	45	100

Unit		Biochemistry & Biostatistics	No. of lectures	CO Mapping
Unit 1		Carbohydrate Metabolism	15	
	1.1	Carbohydrate Metabolism: Glycolytic Pathway and its Regulation; Citric Acid Cycle and its Regulation; Gluconeogenesis; Pentose Phosphate Pathway. (Sequence of Reactions, Regulation, Energy Yield and Metabolic Disorders of the above Pathways).		CO 1
	1.2	Biological Oxidation: Electron Transport System and Oxidative Phosphorylation. Inhibitors of ETS.		CO 1
	1.3	Photosynthesis, Intracellular Organization of Photosynthetic System. Fundamental Reactions of Photosynthesis, Photosynthetic Pigments, Role of Light. Hill Reaction and its Significance, Light Reactions, Cyclic and Non-Cyclic Photo induced Electron Flow, Energetics of Photosynthesis, Photorespiration, Dark Phase of Photosynthesis, Calvin Cycle, C-3, C-4 pathways		CO 1
Unit 2		Amino Acid and Lipid Metabolism	15	

	2.1	Amino Acid Breakdown: Deamination (Oxidative and non-oxidative), Transamination; Urea Cycle; Breakdown of Glucogenic and Ketogenic Amino Acids. (Sequence of Reactions, Regulation and Metabolic Disorders of the above Pathways)		CO 2
	2.2	Amino Acids as Biosynthetic Precursors: Biosynthesis and significance of Epinephrine, Dopamine, Serotonin, GABA, Histamine, Glutathione.		CO 2
	2.3	Lipid Metabolism: Mobilization, Transport of Fatty Acids, Beta, Alpha and Omega Oxidation of Saturated Fatty Acids; Oxidation of Unsaturated Fatty Acids; Oxidation of Odd Chain Fatty Acids, Energy Yield, Ketone Body Breakdown to Yield Energy. (Sequence of Reactions, Regulation, Energy Yield and Metabolic Disorders of the above Pathways)		CO 2
Unit 3		Biostatistics	15	
	3.1	Theory and Problems based on: Measures of Dispersion- Range, Interquartile range, Standard deviation, Variance		CO 3
	3.2	Theory and Problems based on: Correlation analysis Coefficient of correlation: Direct, Short-cut method, Spearson's Rank Correlation coefficient		CO 3

References:

- 1. Biochemistry by U. Satyanarayana and U. Chakrapani (3rd Edition)**
- 2. Lehninger- Principles of Biochemistry by David Nelson and Michael Cox (4th Edition)**
- 3. Biostatistics by P.N. Arora and P. K. Malhan**

Examination:

- **Internal Examination (15 Marks):** 10 Marks exam (MCQ and short answer question) with 20% completed syllabus. Duration of exam: 20 minutes. And 5 Marks for either Quiz/Assignments /Class Participation etc.
- **End Semester theory examination (60 Marks):** Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2hours

- Combined passing of 40% with minimum 20% in Internal Component.

MINOR

INSTRUMENTATION AND APPLIED CHEMISTRY II

Course Objectives:

Sr. No.	Course objectives
The course aims :	
1	To describe and analyse the fundamentals of techniques like sampling and separation techniques
2	To understand important biophysical techniques like spectroscopy with their applications in biological research
3	To recall and demonstrate the principles and applications of advanced chromatographic techniques.

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Demonstrate various sampling , separation techniques used in modern chemistry	PO 1, 2	PSO 1, 2,7	R,U,An
CO 2	Discuss and apply various spectroscopic techniques in biological sciences	PO 1 , 2	PSO 1,2	R,U,Ap
CO 3	Apply various advanced chromatographic techniques in biological sciences	PO 1, 2,7	PSO 1, 2	R,U,Ap

Course Code	Credits	No of lectures	Marks
GNKUSBTMI104	03	45	100

Unit		Instrumentation and Applied Chemistry	No. of lectures	CO Mapping
Unit 1		Sampling and separation technique	15	
	1.1	Sampling: Importance of Sampling and Sampling Techniques Types of Sampling: Random and Non Random Sampling of Solids, Liquids and Gases.		CO 1
	1.2	Separation Techniques: Types of Separation Techniques: Filtration, Zone Refining, Distillation, Vacuum Distillation. Solvent Extraction: Partition Coefficient and Distribution Ratio, Extraction Efficiency, Separation Factor, Role of Complexing Agents,		CO 1

		Chelation, Ion Pair Formation, Solvation, and Soxhlation. Centrifugation: Basic Principles of Sedimentation.		
Unit 2		Spectroscopic techniques	15	
	2.1	Introduction to spectroscopic techniques, Properties of electromagnetic radiations		CO 2
	2.2	Lasers, principle and working of UV and Visible spectroscopy, Chromophores in proteins		CO 2
	2.3	Dual beam spectrophotometer, applications		CO 2
Unit 3		Advanced Chromatographic techniques	15	
	3.1	Principle, working, instrumentation and Applications of : HPLC, Adsorption chromatography, Partition chromatography, Ion Exchange and Affinity chromatography		CO 3
	3.2	Application of chromatographic techniques in biology		CO 3

References:

1. Advanced Organic Chemistry- Reinhard Brucker
2. Organic Synthesis (Special Techniques) - V. K. Ahluwalia
3. College Organic Chemistry for T.Y.B.Sc (Himalaya Publishing House)

4. Principles and techniques in Biochemistry and Molecular Biology - Wilson and Walker

5. Biophysical Chemistry By Upadhyay and Upadhyay

Examination:

- **Internal Examination (15 Marks):** 10 Marks exam (MCQ and short answer question) with 20% completed syllabus. Duration of exam: 20 minutes. And 5 Marks for either Quiz/Assignments /Class Participation etc.
- **End Semester theory examination (60 Marks):** Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2hours
- **Combined passing of 40% with minimum 20% in Internal Component.**

OPEN ELECTIVE

HUMAN HEALTH AND DISEASES 2

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	To gain firm knowledge in studies related to epidemiology and infectious epidemiology
2	To understand the significance of communicable and non communicable diseases and its impact on mental health

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 the importance of epidemiological diseases and spread of infections during an epidemic	PO 1, PO 2	PSO 1, PSO 2	R,U,Ap
CO 2	Recall communicable and non communicable diseases and appreciate its importance in mental health of humans	PO 1, PO 2	PSO 1, 2	R,U,Ap

Course Code	Credits	No of lectures	Marks
GNKUSBTOE104	02	30	50

Unit		Human health and diseases	No. of lectures	CO Mapping
Unit 1	1.1	Definition & aims, Epidemiological approach, Basic measurement in Epidemiology	15	CO 1
	1.2	Types of Epidemiological studies, Uses of Epidemiology		CO 1
	1.3	Infectious disease Epidemiology, Control of hospital acquired infections, Screening for diseases		

		Communicable and Non-communicable diseases	15	
Unit 2	2.1	Communicable diseases - Airborne infections, Contact infections, Water-borne & food borne disease, Vector borne diseases		CO 2
	2.2	Non-communicable diseases - Cardiovascular diseases, Cancer, Diabetes mellitus, Disasters, Obesity.		CO 2
	2.3	Mental Health - Health & diseases, Concept of Normality and Mental health, Magnitude of the problem, Prevention of mental diseases		CO 2

References:

1. An introduction to traditional and modern epidemiology (3rd Edition) B. Burt Gerstman
2. The New Public Health by Theodore H. Tulkinsky & Elena A. Varavikova

Examination:

- **Internal Examination (20 Marks):** Continuous Internal assessment (CIA) of 20 Marks each (Quiz, Assignment, presentation).
- **End Semester theory examination (30 Marks):** Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of

exam: 1hour.

- Combined passing of 40% with minimum 20% in Internal Component.

SKILL ENHANCEMENT COURSE (SEC)
(BIOINFORMATICS)

Course Objectives:

Sr. No.	Course objectives
The course aims at:	
1	To gain knowledge based on the tools and softwares available for visualization of biomolecules
2	To appreciate the importance of in silico analysis using a variety of softwares

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 the use of computers in understanding the structure and predict the functions of biomolecules	PO 1,PO 2	PSO 1,2	R,U,An
CO 2	Recognize different softwares for visualization of DNA, Proteins etc	PO 1, PO 2	PSO 1, 2	R,U,An

LIST OF EXPERIMENTS:

Course Code	Credits	No of lectures	Marks
GNKUSBTSEC104	02	60	50
Sr No	Experiment	COs addressed	
1.	Introduction to bioinformatics, databases and types, Specialized Genomic Resources. Protein Databases based on Composition, Motifs and Patterns.	CO 1	
2.	Assignment based on the use of specialized databases like KEGG, PIR etc	CO 1	

3.	Use of FASTA and BLAST, Sequence alignment using BLAST	CO 2
3.	Protein Visualization tools: RasMol using Raswin	CO 2
4.	Classification of proteins using CATH / SCOP	CO 2
5.	Multiple sequence alignment for proteins/DNA using CluswalW	CO 2
7.	Assignment / problems based on sequence alignment using BLAST/MSA	CO 2
8.	Case studies involving bioinformatics applications	CO 2

References:

1. Bioinformatics- methods and S. C. Rastogi, N. Mendiratta, PHL learning Pvt. Ltd. applications Genomics, Proteomics P. Rastogi 3rd edition and Drug discovery 2. Bioinformatics - A practical Guide to analysis of genes and proteins by Andreas and Francis

Examination (Total Marks): 50

Experiment Marks: 40

Journal Marks: 05

Viva Marks: 05

ABILITY ENHANCEMENT COURSE (AEC)

(HINDI / MARATHI)

Will be taken at College level

PRACTICAL'S BASED ON MAJOR I (MEDICAL MICROBIOLOGY)

Course Objectives:

Sr. No.	Course objectives
The course aims:	
1	To teach the importance of medically important microbes
2	To understand the principle and techniques involved in isolating, characterization and identification of causative organisms
3.	To perform special staining techniques like capsule, metachromatic granules

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive levels
CO 1	Apply techniques involved in medical microbiology for identification of pathogenic organisms	PO 1, 2	1	R, U, Ap
CO 2	Recall, identify and interpret result compared to standard biochemical tests	PO 2	1	R, U, Ap
CO 3	Investigate special staining techniques using various methods	PO 1, 2	1	R, U, Ap

Course Code	Credits	No of lectures	Marks
GNKUSBTMJ1P104	01	30	25M

Sr no	Experiment	Cognitive level addressed
1.	Introduction to medical microbiology	R,U
2.	Techniques in medical microbiology, Types of diseases	R,U

3.	Selective and differential media for isolation of pathogenic organisms	R,U
4.	Isolation, characterization and Identification of <i>E. coli</i>	R, U, Ap
5.	Isolation, characterization and Identification of <i>K. pneumoniae</i>	R, U,Ap
6.	Isolation and Identification of <i>S. aureus</i>	An,Ap
7.	Isolation and Identification of <i>P. aeruginosa</i>	An,Ap
8.	Motility testing(Hanging drop method, stab method)	R,U,Ap
9.	Permanent slide – Mycobacterium tuberculosis	R
10.	Special staining – Capsule staining	R,U
11.	Special staining – Metachromatic granules	R,U

PRACTICALS BASED ON MAJOR II (BIOCHEMISTRY AND BIOSTATISTICS)

Course Objectives:

Sr. No.	Course objectives
The course aims:	
1	To equip the learner to correlate theoretical and experimental knowledge.
2	To teach the learner various instruments used for analysing solutes/biomolecules
3	To learn biostatistics formula and apply in research and solving problems

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive levels
CO 1	Apply use of instruments like colorimeter for estimation of biomolecules	1, 2	1, 2	R, U, Ap, An

CO 2	Estimate the concentration of biomolecules for organ functions tests for organs like liver, kidney etc	2, 7	1, 2	R, U, Ap, An
CO 3	Recall and solve statistical problems related to biological systems	1, 2	1,2	R, U, Ap

Course Code	Credits	No of lectures	Marks
GNKUSBTMJ2P104	01	30	25M

Sr no	Experiment	Cognitive level addressed
1.	Organ function tests : LFT,KFT,Blood tests, Urine tests	R,U,An
2.	Organ function tests: liver - SGPT	R,U,An
3.	Organ function tests: liver SGOT	An,Ap
4.	Organ function tests: kidney (Urea in urine)	R,U
5.	Estimation of uric acid in urine	An
6.	Estimation of creatinine in blood/urine	R,U,Ap
7.	Qualitative detection for ketone bodies in urine	R,U,Ap
8.	Estimation of proteins by Folin-Lowry method.	R,An
9.	Problems based on standard deviation	R,An
10.	Problems based on correlation and regression	R,An

PRACTICALS BASED ON MINOR (INSTRUMENTATION AND APPLIED CHEMISTRY II)

Course Objectives:

Sr. No.	Course objectives
The course aims:	

1	To equip the learner to correlate theoretical and experimental knowledge.
2	To teach concepts related to instrumentation and application of Spectrophotometer, chromatographic techniques
3	To teach learners the principle, instrumentation , working and interpretation of HPLC,GC

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive levels
CO 1	Interpret result based on chromatographic techniques	PO 1, 2	PSO 1, 2,7	R, U, Ap, An
CO 2	Recognize data based on HPLC/GC chromatogram	PO 1,2	PSO 2	R,U,Ap

Course Code	Credits	No of lectures	Marks
GNKUSBTMIP104	01	30	25M

<u>Sr No</u>	<u>Experiment</u>	<u>Cognitive level addressed</u>
1.	Demonstration of affinity chromatography	R,U
2	Separation of plant pigments by solvent extraction	U,C
3	Separation of sugars in coconut water by paper chromatography	U,An
4	Separation of biomolecules by TLC	R,U

5.	Demonstration of principle, working , instrumentation and application of spectrophotometer in biology	R,U
6.	HPLC analysis and interpretation of any one secondary metabolite from plants.	R,U
7.	Analysis of essential oils from any plant source using GC.	R,U
8	Identification of phytochemicals from any two plants.	R,U

Practical Examination of major I/II/Minor : 25 M each

Experiment Marks: 20 M

Journal Marks: 05