THE APOLLO UNIVERSITY

Murukambattu, Chittoor (Dt) 517127, Andhra Pradesh
School of Health Sciences | Department of Biomedical Sciences

B.Sc. GENETICS AND MOLECULAR BIOLOGY

(B.Sc. GMB) – 3-Year Programme with 4-Year Option

Outcome-Based Education (OBE) Curriculum

Course Structure and Syllabi

Regulations R-26 | w.e.f. 2026-27 admitted batch

Prepared in the format required for NAAC accreditation and the UGC Credit Framework (CBCS / NEP-aligned)

PART A: PROGRAMME PROFILE

A1. Vision of the University

To be a global leader in health sciences education, research, and innovation, fostering interdisciplinary excellence to advance healthcare, improve patient outcomes, and address global health challenges through cutting-edge knowledge and technology.

A2. Mission of the University

To excel in interdisciplinary education, pioneering research, skill development, and technology-driven healthcare solutions while fostering global collaboration, community engagement, and lifelong learning to advance health sciences and improve patient outcomes.

A3. Programme Educational Objectives (PEO)

ID	Programme Educational Objective
PEO1	**Prepare graduates for careers in genetic research and biotechnology:** graduates will possess the knowledge, skills, and practical experience necessary to pursue careers in academic research, biotechnology companies, healthcare industries, or governmental agencies focused on genetics and molecular biology.
PEO2	**Equip graduates with advanced knowledge and skills in genetic analysis and molecular techniques:** graduates will be proficient in applying molecular techniques, genetic analysis tools, and bioinformatics to investigate genetic mechanisms, analyse data, and contribute to advancements in the understanding and treatment of genetic disorders and diseases.
PEO3	**Develop graduates' abilities for lifelong learning and professional growth:** graduates will have the foundation to engage in lifelong learning, keeping abreast of advancements in genetics and molecular biology, and adapting to evolving technologies and methodologies in the field.

A4. Programme Outcomes (PO)

ID	Programme Outcome	Description
PO1	Demonstrate proficiency in genetic terminology and concepts	Articulate and apply key genetic principles, including inheritance patterns, gene expression regulation, and genetic variation.
PO2	Apply molecular techniques	Proficiently use laboratory techniques such as PCR, DNA sequencing, gene cloning, and gel electrophoresis to analyse genetic material.
PO3	Analyse genetic data	Interpret and analyse genetic data from experiments or databases using bioinformatics tools and statistical methods.
PO4	Evaluate genetic research	Critically evaluate current genetic research literature, including experimental methodologies, data interpretation, and scientific conclusions.
PO5	Design genetic experiments	Design and execute experiments to test genetic hypotheses, with proficiency in experimental design, data collection, and analysis.
PO6	Understand genetic disease	Comprehend the molecular basis, inheritance patterns, and societal implications of genetic diseases and disorders.
PO7	Apply ethical principles in genetics	Recognise and address ethical considerations in genetics research, genetic testing, gene therapy, and genetic engineering.
PO8	Communicate scientific findings	Communicate genetic concepts and experimental findings through written reports, oral presentations, and scientific posters.
PO9	Collaborate in scientific settings	Collaborate effectively in teams to solve genetic and molecular biology problems, demonstrating teamwork and leadership skills.

ID	Programme Outcome	Description
PO10	Apply genetics knowledge to biotechnological applications	Apply genetic principles to biotechnological applications such as GMOs, gene editing technologies (for example CRISPR), and personalised medicine.
PO11	Explain evolutionary genetics	Explain the mechanisms of evolutionary change at the genetic level, including natural selection, genetic drift, and gene flow.
PO12	Synthesise interdisciplinary knowledge	Integrate knowledge from genetics, molecular biology, bioinformatics, and related disciplines to address complex biological questions and challenges.

A5. Programme Specific Outcomes (PSO)

ID	Programme Specific Outcome
PSO1	Graduates will be proficient in performing and interpreting molecular biology techniques such as PCR, cloning, DNA sequencing, and gene expression analysis, applying them effectively in research and laboratory settings.
PSO2	Graduates will demonstrate the ability to analyse genetic data using bioinformatics tools and statistical methods, interpreting results to draw meaningful conclusions about genetic variations, evolutionary relationships, and gene function.
PSO3	Graduates will apply foundational principles of genetics to design and conduct experiments that address biological questions, elucidating genetic mechanisms underlying inheritance, gene regulation, and adaptation in organisms.

A6. Mapping of PEOs and PSOs to Programme Outcomes (proposed)

3 = high, 2 = medium, 1 = low, - = none. Proposed mapping for Board of Studies approval.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PEO1	2	3	2	1	3	2	1	2	2	3	1	3
PEO2	3	3	3	2	2	3	1	1	1	3	2	2
PEO3	1	1	1	3	1	1	2	3	3	2	1	3
PSO1	-	3	1	-	2	-	-	-	-	2	-	1
PSO2	-	-	3	2	-	-	-	-	-	-	2	2
PSO3	3	-	-	-	3	1	-	-	-	-	2	1

PART B: ACADEMIC REGULATIONS APPLICABLE TO THE PROGRAMME (EXTRACT)

The following provisions are extracted from the Academic Regulations of The Apollo University as printed in the source document.

B1. Programme Details, Eligibility and Duration

Item	Provision
Programme	B.Sc. Genetics and Molecular Biology (B.Sc. GMB), Bachelor's level, Department of Biomedical Sciences, School of Health Sciences; offered from the academic year 2026-27
Eligibility (Annexure 1)	Candidates must secure 50% in Botany, Zoology, Physics and Chemistry of Intermediate, or in the diploma course, or must have appeared for Class 12 or equivalent with Physics, Chemistry and Biology as major subjects from a recognised board. Candidates who completed or qualified the final year of Intermediate should attain 17 years as on 31 December of the preceding calendar year.
Admission	Convener quota (Government of Andhra Pradesh) and University quota (marks in the qualifying examination and rank in the TAU entrance exam or a recognised national-level examination)
Minimum duration (N)	3 years
Maximum duration	N + 2 years (the Vice-Chancellor may extend in extenuating circumstances)
Medium of instruction	English
Attendance	Minimum 80% in the semester to be eligible for the Semester End Examination; students short of 80% are detained and repeat the semester
Degree eligibility	Minimum credits specified in the curriculum within the stipulated time; Provisional Certificate cum Memorandum of Grades (PCMG) issued on completion

B2. Assessment Procedure

Component	Marks	Scheme of evaluation
Theory (Continuous Evaluation)	40	20 marks for mid examinations (three mid examinations of 20 marks each; average of the best two); 10 marks for quizzes, assignments and presentations; 10 marks for periodic evaluation, case studies and projects
Theory (Semester End Examination)	60	Comprehensive 3-hour examination; minimum 24 marks (40%) in the semester-end examination and 40% aggregate to pass
Laboratory	100	Continuous evaluation: 80 marks with equal weightage to all experiments (minimum of 10 experiments); 20 marks for the end examination with an external examiner from the University other than the course teacher; minimum 50% to pass
Project work	100	80 marks for periodic evaluation and technical report by the supervisor; 20 marks for final report presentation and viva-voce before a panel of internal examiners
Internship	100	80 marks for periodic evaluation of the internship report; 20 marks for final presentation and viva-voce; two internships, evaluated in the final semester
Seminar	100	Seminar on a topic chosen with the faculty in charge; detailed report submitted

For courses having both theory and practical components, 60% weightage is given to theory and 40% to practical; the student must secure 40% (theory plus practical) with at least 24 marks in theory.

B3. Grading System

Grade	Grade points	Absolute marks
O (Outstanding)	10	90 and above
A+ (Excellent)	9	80 to 89
A (Very Good)	8	70 to 79
B+ (Good)	7	60 to 69
B (Above Average)	6	50 to 59
C (Average)	5	45 to 49
P (Pass)	4	40 to 44
F (Fail)	0	Less than 40
Ab (Absent)	0	-

SGPA = $\Sigma(C \times G) / \Sigma C$, where C is the credits of a course and G the grade points obtained. CGPA is computed in the same way across all semesters.

Class	CGPA required
First Class with Distinction	Above 8.0 (and all courses of every semester passed in the first attempt)
First Class	Above 6.5
Second Class	Above 5.5
Pass Class	Above 5.0

PART C: CREDIT FRAMEWORK AND OBE RULES

C1. Credit Norms (as per Academic Regulations)

Mode of instruction	Contact hours per week	Credits	Hours per semester (15 weeks)
Lecture (L)	1 hour	1 credit	15
Tutorial (T)	1 hour	1 credit	15
Laboratory (P)	2 hours	1 credit	30

Applied to this programme:

- Core courses carry 3 or 4 credits and electives 3 credits. A **4-credit theory course (3L + 1T)** has **60 teaching hours**, or **12 hours per unit** across 5 units; a **3-credit theory course (3L)** has **45 hours**, or **9 hours per unit**. University Core Communicative English follows the source split of 10, 10, 10, 10 and 5 hours.
- A **2-credit laboratory course (4 hours per week)** has **60 practical hours**; a **1.5-credit laboratory course (3 hours per week)** has **45 practical hours**. Experiments share the hours equally unless stated.
- The Mini Project (6 hours per week, 3 credits) and Major Project (32 hours per week, 16 credits in Semester VI) follow the 2 practical hours = 1 credit rule used in the course structure. The regulations text lists project work at 1 hour per week = 1 credit; see Appendix B.
- Non-credit components (Soft Skills, Mentoring, Technical Seminar, Library, Physical Activity, Extra-curricular, Co-curricular, Self-Learning, Journal Club and Publication Writing) are scheduled as per the semester structure.

C2. Credit Summary

Semester	Credits as printed	Credits computed from the course list	Remarks
I	22	22	Induction programme
II	22	21	3-week induction; labs at 1.5 credits and 3 hours; see note
III	26	26	
IV	26	26	
V	24	25	Precision Medicine (GMBT3518) is 4 credits in the course list; see note
VI (B.Sc. 3-year exit)	20	20	Includes Major Project (16 credits)
Total, B.Sc. (3 years)	**140**	**140**	Printed and computed totals agree because the two differences offset
VI (extended option)	16	16	Replaces Semester VI of the 3-year exit route
VII and VIII (extended option)	18 (VII and VIII)	36 (18 per semester)	Major Project; see note
Total, extended 4-year option	**172**	**172**	

Note: *Semester II lists 12 + 3 + 3 + 1.5 + 1.5 = 21 credits against a printed 22, and 6 practical periods against a printed 8. Semester V lists 16 + 3 + 3 + 3 = 25 credits and 4 tutorial periods against a printed 24 and 3, while the printed 36 hours per week matches the 25-credit reading. The Semester VII and VIII entry shows 18 credits and 36 periods once; it is read here as per semester. Please confirm and correct before submission.*

C3. Course Categories and Code Convention

Prefix	Meaning
GMBT	B.Sc. GMB Theory course
GMBL	B.Sc. GMB Laboratory course
GMBP	B.Sc. GMB Project
TAUT	The Apollo University Core / Elective course

C4. Bloom's Taxonomy Levels Used for Course Outcomes

Level	Cognitive domain	Typical verbs
K1	Remember	define, list, state, name
K2	Understand	explain, describe, classify, summarise
K3	Apply	apply, demonstrate, perform, calculate
K4	Analyse	analyse, compare, interpret, differentiate
K5	Evaluate	evaluate, justify, assess, critique
K6	Create	design, develop, formulate, propose

C5. CO-PO-PSO Mapping Scale

Each Course Outcome (CO) is mapped to the twelve POs and three PSOs on a 3-point scale. A dash means no correlation. The "Avg." row of each course is the average of the non-zero values in that column, and Appendix A consolidates these averages across all courses.

Value	Meaning
3	Substantial (high) correlation
2	Moderate (medium) correlation
1	Slight (low) correlation
-	No correlation

C6. CO Attainment Framework (proposed, to be ratified by the Board of Studies)

Assessment weightages follow the Academic Regulations (theory 40:60, laboratory and project as in B2). The attainment rules below are proposed because the source does not give them.

Component	Provision
Direct attainment (80% weight)	CO-wise marks from mid examinations, quizzes, assignments, semester end examination, laboratory and project evaluation
Indirect attainment (20% weight)	Course-exit survey of students
Target	60% of students scoring at least 60% of the marks mapped to the CO
Attainment levels	Level 3: at least 70% of students meet the target; Level 2: 60 to 69%; Level 1: 50 to 59%
Review	Every semester; action plan recorded for any CO below Level 2; PO and PSO attainment computed from CO attainment using the mapping tables

PART D: SEMESTER-WISE COURSE STRUCTURE

L = Lecture, T = Tutorial, P = Practical (periods per week), C = Credits.

Semester I

Code	Course	L	T	P	C	Hrs/week	Category
GMBT1501	Cell Biology and Genetics	3	1	0	4	4	Core
GMBT1502	Biochemistry	3	1	0	4	4	Core
GMBT1503	Data Science	3	1	0	4	4	Core
TAUT1101	University Core 1: Communicative English	3	0	0	3	3	University Core
TAUT1201	University Elective 1	3	0	0	3	3	University Elective
GMBL1501	Data Science Lab	0	0	4	2	4	Laboratory
GMBL1502	Biochemistry Lab	0	0	4	2	4	Laboratory
	Non-credit components (Soft Skills, Mentoring, Technical Seminar, Library, Physical Activity, Extra-curricular, Co-curricular, Self-Learning)	0	0	0	0	10	Non-credit
	Total	**15**	**3**	**8**	**22**	**36**	

Semester II (3-week induction programme)

Code	Course	L	T	P	C	Hrs/week	Category
GMBT1504	Molecular Biology and Genetic Engineering	3	1	0	4	4	Core
GMBT1505	Microbiology	3	1	0	4	4	Core
GMBT1506	Bioanalytical Techniques	3	1	0	4	4	Core
TAUT1102	University Core 2: Environmental Studies	3	0	0	3	3	University Core
TAUT1202	University Elective 2	3	0	0	3	3	University Elective
GMBL1503	Molecular Biology and Genetic Engineering Lab	0	0	3	1.5	3	Laboratory
GMBL1504	Microbiology Lab	0	0	3	1.5	3	Laboratory
	Non-credit components (Soft Skills, Mentoring, Technical Seminar, Library, Physical Activity, Extra-curricular, Co-curricular, Self-Learning)	0	0	0	0	10	Non-credit
	Total	**15**	**3**	**8 (as printed)**	**22 (as printed)**	**36**	

Semester III

Code	Course	L	T	P	C	Hrs/week	Category
GMBT2507	Immunology	3	1	0	4	4	Core
GMBT2508	Molecular Pathogenesis	3	1	0	4	4	Core
GMBT2509	Enzyme Technology	3	1	0	4	4	Core
GMBT2510	Nanobiotechnology	3	1	0	4	4	Core

Code	Course	L	T	P	C	Hrs/week	Category
TAUT2101	University Core 3: Health and Wellness	3	0	0	3	3	University Core
TAUT2201	University Elective 3	3	0	0	3	3	University Elective
GMBL2503	Immunology Lab	0	0	4	2	4	Laboratory
GMBL2504	Enzyme Technology Lab	0	0	4	2	4	Laboratory
	Non-credit components (Technical Seminar, Library, Physical Activity, Extra-curricular)	0	0	0	0	6	Non-credit
	Total	**18**	**4**	**8**	**26**	**36**	

Semester IV

Code	Course	L	T	P	C	Hrs/week	Category
GMBT2511	Animal Cell Culture and Techniques	3	1	0	4	4	Core
GMBT2512	Molecular Diagnostics	3	1	0	4	4	Core
GMBT2513	Genomics, Proteomics and Computational Drug Design	3	1	0	4	4	Core
GMBT2514	Biosafety and Bioethics	3	1	0	4	4	Core
GMBT2601	Program Elective 1	3	0	0	3	3	Program Elective
GMBT2602	Program Elective 2	3	0	0	3	3	Program Elective
GMBL2505	Genomics and Proteomics Lab	0	0	4	2	4	Laboratory
GMBL2506	Molecular Diagnostics Lab	0	0	4	2	4	Laboratory
	Non-credit components (Technical Seminar, Library, Physical Activity, Extra-curricular)	0	0	0	0	6	Non-credit
	Total	**18**	**4**	**8**	**26**	**36**	

Semester V

Code	Course	L	T	P	C	Hrs/week	Category
GMBT3515	Metabolic Engineering and Systems Biology	3	1	0	4	4	Core
GMBT3516	Cancer Biology	3	1	0	4	4	Core
GMBT3517	Pharmacology and Pharmacovigilance	3	1	0	4	4	Core
GMBT3518	Precision Medicine and Genomic Therapeutics	3	1	0	4	4	Core
GMBT3603	Program Elective 3	3	0	0	3	3	Program Elective
GMBT3604	Program Elective 4	3	0	0	3	3	Program Elective
GMBP3501	Mini Project	0	0	6	3	6	Project
	Non-credit components (Technical Seminar, Library, Physical Activity, Extra-curricular: 2 hours each)	0	0	0	0	8	Non-credit
	Total	**18**	**3 (as printed)**	**6**	**24 (as printed)**	**36**	

Semester VI: B.Sc. (3-year exit)

Code	Course	L	T	P	C	Hrs/week	Category
GMBT3605	MOOCs Course 1	2	0	0	2	2	MOOC
GMBT3606	MOOCs Course 2	2	0	0	2	2	MOOC
GMBP3502	Major Project	0	0	32	16	32	Project
	Total	**4**	**0**	**32**	**20**	**36**	

Semester VI: extended programme (4-year option)

Code	Course	L	T	P	C	Hrs/week	Category
GMBT3519	Clinical Biochemistry	3	1	0	4	4	Core
GMBT3520	Structural Biology	3	1	0	4	4	Core
GMBT3521	Neuroscience	3	1	0	4	4	Core
GMBT3605	MOOCs Course 1	2	0	0	2	2	MOOC
GMBT3606	MOOCs Course 2	2	0	0	2	2	MOOC
	Non-credit components (Technical Seminar 4, Library 4, Physical Activity 4, Extra-curricular 4, Journal Club and Publication Writing 4)	0	0	0	0	20	Non-credit
	Total	**13**	**3**	**0**	**16**	**36**	

Semesters VII and VIII: extended programme (4-year option), per semester

Code	Course	L	T	P	C	Hrs/week	Category
GMBP4502	Major Project	0	0	36	18	36	Project
	Total	**0**	**0**	**36**	**18**	**36**	

Program Elective Baskets

Basket	Option A	Option B	Option C
Program Elective 1 (GMBT2601)	Biomedical Applications of Advanced Materials	Clinical Research and Trial Design	Bioelectronics and Biosensors
Program Elective 2 (GMBT2602)	cGMP Facilities and Manufacturing	Regulatory Affairs in Biopharmaceuticals	Virology and Vaccine Technology
Program Elective 3 (GMBT3603)	Molecular Cytogenetics	Scientific Writing and Research Ethics	Systems Biology and Network Analysis
Program Elective 4 (GMBT3604)	Research Methodology and Biostatistics	Single-Cell Genomics and Transcriptomics	Clinical Data Management and Real-World Evidence

PART E: COURSE SYLLABI (OBE FORMAT)

Each course sheet follows one format: (1) Title, Code and L-T-P-C; (2) Course Description; (3) Course Objectives; (4) Unit-wise Syllabus with Teaching Hours (or List of Experiments with Hours); (5) Course Outcomes with Bloom's level; (6) CO-PO-PSO Mapping with course average; (7) Text Books and Reference Books. Course sheets follow in semester order. The source document contains no syllabi for the University Electives or the twelve Program Electives; these appear as listed entries and a blank template (see the end of Part E).

SEMESTER I

GMBT1501: Cell Biology and Genetics

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	I	Core

Course Description

In this course we will examine many different areas of cellular biology including: the synthesis and function of macromolecules such as DNA, RNA, and proteins; control of gene expression; membrane and organelle structure and function; bioenergetics; and cellular communication.

Course Objectives

1. Students will understand the basic principles of different types of Microscopes, and its application.
2. Students will understand the cellular structure and function of all cell organelles.
3. Students will understand the mechanism of cell division, cellular aging and cell death and its regulation
4. Students will apply their knowledge of cell biology to selected examples of changes or losses in cell function. These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.
5. Students will be equipped with a thorough understanding of the molecular and cellular mechanisms that govern genetic inheritance and cellular functions, and how these principles apply to the study of complex biological systems and diseases.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Microscopy.** History, Principle and Optical Components of microscope: Eye piece, Eye piece tube, Objective lenses, Coarse and Fine Focus knobs, Stage and stage clips, Aperture, Illuminator, Condenser, Focus Knob, Iris Diaphragm. Types of Microscopes: Light microscopes -Simple, Compound and Stereo zoom. Phase Contrast: Fluorescent microscope, Electron microscope- TEM and SEM, Confocal and Optical pathway in different microscopes. Applications of Microscopy: High resolution imaging, immune histochemistry, high-content screening and high throughput imaging. Clinical and Forensic applications.	12
2	**Cell Structure and Function.** Concept of cell: Discovery of cell, cell theory, Cell as a basic unit, Classification of cell types – Virus, Prokaryotes, Eukaryotes, Comparison between plant and animal cells. Plasma membrane: Fluid mosaic model, chemical composition, functions of plasma membrane. Ultrastructure and functions of Cytoplasmic organelles: Mitochondria, Endoplasmic reticulum, Golgi bodies, Lysosomes, and Peroxisomes. Chloroplast, Nucleus: Morphology, nuclear envelope, nucleoplasm, nucleolus.	12

Unit	Title and contents	Hours
3	**Cell Division and Cell Cycle.** Cell division in Bacteria and Archaea: Process of Binary fission. Cell Cycle Regulation: Cell cycle, Interphase-G1, S, G2 and M phase, Checkpoints. Mitosis: Stages, Mitotic apparatus, Role of cyclins and Cdks. Mitogens and Inhibitors, Significance. Meiosis: Stages, Synaptonemal complex, Crossing over and Chiasma formation, Significance. Cytokinesis in plant and animal cells. Endocycle and Endomitosis. Programmed cell death and its significance. Necrosis	12
4	**Introduction to Genetics.** Introduction, Genetical Terminology, Mendel and His Work, Genetic Interaction and Lethal Genes, Quantitative Genetics, Inbreeding, Outbreeding and Hybrid Vigour	12
5	**Linkage, Mapping and Human Genetics.** Linkage, Crossing Over, Genetic and Cytological Mapping of Chromosomes, Multiple Alleles, Fine Structure of Gene, Sex-linked Inheritance, Determination of Sex and Sex Differentiation, Chromosomal Mutations, Gene Mutation, Cytoplasmic or Extra-Nuclear Inheritance, Pedigree Analysis, Human Genetics, Eugenics and Genetic Engineering, Transposable Genetic Elements	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level	Unit
CO1	Explain the principles, types and applications of microscopes in biological and clinical research	K2	1
CO2	Describe the structure and function of the cell, the plasma membrane and cell organelles	K2	2
CO3	Explain the stages and regulation of the cell cycle, cell division, and programmed cell death	K2	3
CO4	Apply the principles of Mendelian and quantitative genetics to solve inheritance problems	K3	4
CO5	Analyse linkage, genetic mapping, mutations and pedigrees to interpret inheritance patterns in humans	K4	5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	1	-	-	-	1	-	-	1
CO2	3	1	-	-	-	-	-	-	-	-	-	1	-	-	1
CO3	3	-	-	1	1	-	-	-	-	-	-	1	-	-	2
CO4	3	-	1	-	2	1	-	-	-	-	1	-	-	-	2
CO5	2	-	2	1	2	2	-	-	-	-	1	-	-	1	3
Avg.	**2.8**	**1.0**	**1.5**	**1.0**	**1.7**	**1.5**	**-**	**1.0**	**-**	**-**	**1.0**	**1.0**	**-**	**1.0**	**1.8**

Text Books

1. Essential Cell Biology, 7th edition (2009), Alberts, Bray, Hopkin, Johnson, Lewis, Raff, Roberts and Walter. Garland Science. ISBN-13:978-0815341291.
2. Molecular Cell Biology, 7th edition (2012), Lodish, Berk, Kaiser, Krieger, Bretscher, Ploegh, Amon and Scott. W. H. Freeman. ISBN-13: 978-1429234139

Reference Books

1. Cell and Molecular Biology: Concepts and Experiments, 6th edition (2009), Gerald Karp, Wiley. ISBN-978-0470483374.

2. Physical Biochemistry: Applications to Biochemistry and Molecular Biology, David Freifelder, 2nd edition (1983), W. H. Freeman and Company.
3. An Introduction to Radiobiology, 2nd edition (1998), A. H. W. Nias, Wiley Blackwell, ISBN- 13: 978-0471975908.

GMBT1502: Biochemistry

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	I	Core

Course Description

This course delves into the chemical processes and substances that occur within living organisms. Students will study the structure and function of biomolecules, metabolic pathways, and the regulation of biochemical processes. Emphasis is placed on understanding the molecular basis of life and the application of biochemistry in health, disease, and biotechnology.

Course Objectives

1. To explain the structure, classification, properties and functions of carbohydrates, amino acids, proteins and lipids.
2. To describe the nature, classification, mechanism and regulation of enzymes and the role of coenzymes.
3. To explain the major pathways of carbohydrate metabolism and their regulation.
4. To describe protein and amino acid metabolism, including nitrogen disposal.
5. To explain lipid and nucleic acid metabolism and associated inborn errors of metabolism, and to provide the chemical foundation for careers in medicine, research and biotechnology.

Note: *Objectives 1 to 4 in the source sheet referred to Microbiology and nursing infection control (carried over from another programme). They have been replaced with objectives that match the Biochemistry syllabus.*

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Biomolecules.** Classification of carbohydrates, properties of mono-, Di-, and Polysaccharides, functions of carbohydrates. Proteins and amino acids, classification of amino acids, peptide bond, different structure and properties of proteins and their functions. Fats/lipids classification, properties, and functions.	12
2	**Enzymes and Co enzymes.** Nature and properties of enzymes, classification of enzymes, mode of action of enzymes, active site, mechanism and action of enzymes, factors affecting enzyme activity, Regulation of enzyme activity, industrial and commercial applications of enzymes. Coenzymes: classification, various types and function, structure of NAD+, NADP+, FAD and FMN.	12
3	**Carbohydrates metabolism.** Carbohydrate metabolism- Glycolysis, Gluconeogenesis, Tricarboxylic acid cycle, Electron transport chain, Oxidative phosphorylation, Hexose monophosphate shunt, Glycogen metabolism and its regulation.	12
4	**Proteins and amino acid metabolism.** Protein metabolism- General overview, Protein turnover, Nitrogen balance, Amino acid pool, sources for body amino acid pool, transamination, mechanism of transamination, deamination-oxidative and non-oxidative deamination, ammonia and its toxicity, Urea cycle.	12
5	**Lipid and nucleic acid metabolism.** Lipid metabolism- Mobilization of triglycerides, metabolism of glycerol, biosynthesis, and β- oxidation of saturated fatty acids (palmitic acid), ketone bodies. Nucleic acid metabolism- General overview, Outline of purine and pyrimidine metabolism. Introduction to metabolic inborn error diseases: Gout and Lesch-Nyhan syndrome.	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level	Unit
CO1	Describe the chemistry, classification and structural organisation of carbohydrates, lipids, amino acids and proteins	K2	1
CO2	Explain the classification, mechanism and regulation of enzyme action and the role of coenzymes	K2	2
CO3	Describe the catabolic and regulatory reactions of carbohydrate metabolism	K2	3
CO4	Explain amino acid and protein catabolism, including the urea cycle and ammonia toxicity	K2	4
CO5	Analyse lipid and nucleic acid metabolism and relate metabolic inborn errors to enzyme defects	K4	5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	-	-	-	3	-	-	1
CO2	2	1	-	-	-	-	-	-	-	-	-	3	1	-	1
CO3	2	-	-	-	1	1	-	-	-	-	-	2	-	-	2
CO4	2	-	1	-	1	2	-	-	-	1	-	2	-	-	2
CO5	2	-	-	1	-	3	1	-	-	1	-	2	-	-	2
Avg.	**2.0**	**1.0**	**1.0**	**1.0**	**1.0**	**2.0**	**1.0**	**-**	**-**	**1.0**	**-**	**2.4**	**1.0**	**-**	**1.6**

Text Books

1. Lehninger Principles of Biochemistry, 5thedition (2012), David L. Nelson and Michael M. Cox; W. H. Freeman, ISBN-13: 978-0716771081.
2. Principles and Techniques of Practical Biochemistry, 5thedition (2000), Keith Wilson and John Walker; Cambridge University Press, ISBN -13: 978-0521799652..

Reference Books

1. "Biochemistry" by Jeremy M. Berg, John L. Tymoczko, and Lubert Stryer ISBN: 978- 1319114657

GMBT1503: Data Science

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	I	Core

Course Description

This course provides a comprehensive introduction to computing, starting from binary representation and progressing to programming, data manipulation, linear algebra, and operating system concepts. It equips students with a deep understanding of the computational underpinnings of data science.

Course Objectives

1. To introduce the history and evolution of computing and the binary, octal and hexadecimal number systems.
2. To explain how numbers, characters and data are represented, stored and manipulated in a computer.
3. To develop proficiency in Python programming fundamentals, including control structures, functions and modules.
4. To develop advanced Python skills: generators, comprehensions, file handling, error handling and algorithm design.
5. To apply linear algebra concepts (vectors, matrices, transformations, eigenvalues) to data science problems in biology.

Note: *The source sheet listed objectives on statistics, machine learning, data mining and visualisation, and learning outcomes on calculus and polynomial roots, none of which appear in the five units. Objectives and outcomes here are aligned to the syllabus as printed. If the Board of Studies wants those topics, a unit on statistics and visualisation should be added.*

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Computing.** Early history of computing; Evolution of computing devices and current trends; Understanding binary representation; Hexadecimal and octal numbering systems; Programming Languages and Hardware Abstraction	12
2	**Data Representation.** Integer and floating-point representation; Character encoding (ASCII and Unicode); Data structures and memory allocation; Data manipulation and storage	12
3	**Programming Fundamentals.** Introduction to Python functions and modules; Programming paradigms (imperative, procedural, object-oriented); Control structures (if statements, loops); Functions, scope, and lifetime of variables	12
4	**Advanced Python Programming.** More advanced Python topics (generators, comprehensions, decorators); File handling and I/O operations; Error handling and debugging techniques; Algorithm design and analysis	12
5	**Linear Algebra for Data Science.** Vectors and matrices; Matrix operations (addition, multiplication); Linear transformations; Eigenvalues and eigenvectors; Applications of linear algebra in data science	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level	Unit
CO1	Explain the evolution of computing and convert between binary, octal, decimal and hexadecimal number systems	K2	1
CO2	Describe how integers, floating-point numbers, characters and data structures are represented and stored	K2	2
CO3	Write Python programs using control structures, functions and modules to solve computational problems	K3	3
CO4	Apply advanced Python features, file handling and error handling to process data and design simple algorithms	K3	4
CO5	Apply vector, matrix and eigenvalue concepts to model and interpret biological datasets	K3	5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	2	-	-	-	-	-	-	-	-	2	-	2	-
CO2	1	-	3	-	-	-	-	-	-	-	-	2	-	3	-
CO3	-	-	3	1	1	-	-	-	-	-	-	2	1	3	-
CO4	-	-	3	2	2	-	-	-	-	1	-	2	1	3	1
CO5	-	-	2	3	2	1	-	-	-	2	-	3	-	3	2
Avg.	**1.5**	**-**	**2.6**	**2.0**	**1.7**	**1.0**	**-**	**-**	**-**	**1.5**	**-**	**2.2**	**1.0**	**2.8**	**1.5**

Text Books

1. Python Data Science Handbook: Tools and Techniques for Developers, by Jake Vander Plas publishers O'Reilly Media, Inc. November 2016
2. Python for Data Analysis - Data Wrangling with Pandas, NumPy, and IPython by Wes McKinney was published by O'Reilly Media, Inc 2017

Reference Books

1. "Think Python - How to Think Like a Computer Scientist" by Allen B. Downey and was published by O'Reilly Media, Inc. 2012
2. "Learning Python" by Mark Lutz and David Ascher published by O'Reilly Media, Inc. 2003.

TAUT1101: University Core 1: Communicative English

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	I	University Core

Course Description

The creation of the Course is to facilitate Stakeholders in productively using the Language to functional advantage to form meaningful engagements in a social context and influence their professional dynamic.

Course Objectives

1. Improve speaking ability in English both in terms of fluency and comprehensibility. Enlarge vocabulary by maintaining a Vocabulary Journal. Increase reading speed and comprehension of academic articles.
2. Heighten awareness of the correct usage of English grammar in Writing and Speaking.
3. Strengthen ability to write academic papers, essays and summaries using "Mind Mapping'.
4. Develop skills that enable them to communicate effectively in English. To present ideas clearly and logically to achieve a specific purpose and to be appropriate for an intended audience
5. Give Oral Presentations and receive Feedback on their performance.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Vocabulary and Reading.** Special Features of English Vocabulary, Reading With Purpose; Understanding What is Read; Drawing a Conclusion Based on Inferences, Deduction, Reading Between the Lines, Context, Connotation, Higher Order Thinking; How to Explain Specific Information with Clarity; Defining and Giving Reasons; Giving Directions; Professional Vocabulary	10
2	**Basic Grammar.** Subject-Verb Agreement; Verb Tenses; Active-Passive Voice; Direct and Indirect Speech; Question Tags; Degrees of Comparison; Articles; Avoiding Jargon.	10
3	**Writing.** Letter Writing; Report Writing; E-Communication, Drafting and Collating Key Information, Taking Notes from Lectures, Reading Materials, Reporting on Minutes of the Meeting, Precis Writing.	10
4	**Basics of Communication.** Role of Communication, Purpose of Communication, Barriers of Communication, Verbal and Non-Verbal Communication, Communication at the workplace, Human Needs and Communication, Mind Mapping and E-Communication.	10
5	**Presentations.** Self-Introduction, Individual Presentation, Group Discussions, Debates.	5
	Total	45

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level	Unit
CO1	Read academic and professional texts for intensive information, paraphrase and summarise them accurately, and use professional vocabulary	K3	1
CO2	Use English grammatical structures correctly in speaking and writing across communicative contexts	K3	2
CO3	Plan, draft, revise and edit letters, reports, notes and precis, and avoid plagiarism by citing sources ethically	K3	3
CO4	Analyse communication processes, barriers and verbal and non-verbal messages, and recognise the effects of diversity and power in communication	K4	4

CO	Statement	Bloom level	Unit
CO5	Deliver professional presentations and take part in group discussions and debates with fluency and confidence	K3	5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	-	3	1	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	3	1	-	-	-	-	-	-
CO3	-	-	-	1	-	-	2	3	1	-	-	-	-	-	-
CO4	-	-	-	1	-	-	-	3	2	-	-	1	-	-	-
CO5	-	-	-	-	-	-	-	3	3	-	-	1	-	-	-
Avg.	**-**	**-**	**-**	**1.0**	**-**	**-**	**2.0**	**3.0**	**1.6**	**-**	**-**	**1.0**	**-**	**-**	**-**

Text Books

1. Quirk, Randolph, Sidney Greenbaum, Geoffrey Leech & Jan Svartvik. A Comprehensive Grammar of the English Language. London: Longman, 1989
2. Communicative English for Engineers and Professionals by Nitin Bhatnagar & Mamta Bhatnagar New Delhi: Pearson / Longman

Reference Books

1. Sharma, Sangeeta and Binod Mishra. Communication Skills for Engineers and scientists. Delhi: PHI, 2009
2. A Textbook of English for Engineers and Technologists (combined edition, Vol. 1 & 2); Orient Black Swan 2010.
3. English Communications Skills for Professionals, by Gregory A. Barnes, ISBN13: 978- 0844208589, 2nd Edition

Academic Resources

Scholarly journals; newspapers and magazines; professional sources; conference proceedings; government documents; Wren and Martin, High School English Grammar and Composition; Raymond Murphy, English Grammar in Use; Zoeller, Watkins and Lampman, Speaking Effective English.

TAUT1201: University Elective 1

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	I	University Elective

The syllabus for this course is drawn from the University Elective basket and is not part of the GMB source document. The elective sheet issued by the University (in the same OBE format) is to be attached here before submission.

GMBL1501: Data Science Lab

L	T	P	C	Total practical hours	Semester	Category
0	0	4	2	60	I	Laboratory

Course Description

This laboratory course introduces students of Genetics and Molecular Biology to the fundamentals of computing for data science using the Linux operating system and the Python programming language. Students learn command-line file management, Python scripting, control structures, functions, data structures and file handling with error handling. The course builds the computational foundation needed for bioinformatics and genetic data analysis.

Course Objectives

1. To train students in Linux command-line operations for navigation, file management and file permissions.
2. To develop Python programming skills using variables, control structures, functions and modules.
3. To teach the use of Python data structures (lists, tuples, dictionaries) and list comprehensions.
4. To enable reading, writing and processing of files in Python with exception handling.
5. To apply computational skills to introductory problems in genetics and molecular biology.

List of Experiments with Hours

Expt.	Experiment	Hours
1	Introduction to Python and Linux: Introduction to Python and its applications; Overview of the Linux operating system; Setting up a Linux environment (virtual machine or cloud instance)	8
2	Introduction to Linux Command Line: Basic Linux commands for navigation and file management; File system hierarchy and paths; Creating, copying, moving, and deleting files and directories	8
3	Linux File Permissions and Ownership: Understanding file permissions; Changing file permissions and ownership; Managing user accounts	8
4	Python Basics: Writing and running Python scripts; Variables, data types, and assignments; Basic input and output	8
5	Control Structures: Conditional statements (if, elif, else); Loops (for, while); Combining control structures	7
6	Functions and Modules: Defining and calling functions; Function parameters and return values; Importing and using Python modules	7
7	Data Structures: Lists, tuples, and dictionaries; Operations on data structures; List comprehensions	7
8	File Handling in Python: Reading and writing files; File input/output operations; Error handling with try-except	7
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Demonstrate proficiency in Linux command-line operations for file and directory management and file permissions	K3
CO2	Write and run Python programs using variables, control structures, functions and modules	K3
CO3	Use Python data structures and comprehensions to organise and manipulate data	K3

CO	Statement	Bloom level
CO4	Perform file reading and writing in Python with exception handling	K3
CO5	Apply computational skills to solve introductory problems in genetics and molecular biology	K3

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	1	2	-	-	-	-	-	-	-	-	2	-	2	-
CO2	-	-	3	-	1	-	-	-	-	-	-	2	-	3	-
CO3	-	-	3	-	1	-	-	-	1	-	-	2	-	3	1
CO4	-	-	3	2	2	-	-	1	-	-	-	2	-	3	1
CO5	-	-	2	2	2	-	-	3	2	1	-	3	-	2	2
Avg.	**-**	**1.0**	**2.6**	**2.0**	**1.5**	**-**	**-**	**2.0**	**1.5**	**1.0**	**-**	**2.2**	**-**	**2.6**	**1.3**

Text Books and Laboratory Manuals

1. Eric Matthes. Python Crash Course, 3rd Edition, No Starch Press, 2023.
2. Wes McKinney. Python for Data Analysis, 3rd Edition, O'Reilly Media, 2022.
3. Allen B. Downey. Think Python: How to Think Like a Computer Scientist, 2nd Edition, O'Reilly Media.
4. Evi Nemeth, Garth Snyder, Trent R. Hein & Ben Whaley. UNIX and Linux System Administration Handbook, 5th Edition.
5. Jake VanderPlas. Python Data Science Handbook, O'Reilly Media.

Note: *The source sheet lists the experiments (and, for some laboratories, reference books). The description, objectives and outcomes are drafted here for the Board of Studies to confirm; for laboratories shared with the Biotechnology programme they are adapted from that programme's sheets. Reference books were not given in the source for this laboratory; the recommended reading is carried over from the corresponding Biotechnology sheet.*

GMBL1502: Biochemistry Lab

L	T	P	C	Total practical hours	Semester	Category
0	0	4	2	60	I	Laboratory

Course Description

This laboratory course provides foundational training in biochemical techniques commonly employed in biotechnology laboratories. Students will gain practical experience in the qualitative and quantitative analysis of biomolecules, enzyme assays, chromatography, and isolation of biological macromolecules. The course emphasizes laboratory safety, accurate experimentation, data interpretation, and the biochemical principles underlying biological systems.

Course Objectives

1. To train students in laboratory safety and good laboratory practice in a biochemistry laboratory.
2. To enable qualitative identification of carbohydrates, amino acids, proteins and lipids.
3. To develop skills in quantitative estimation of biomolecules.
4. To study the effect of temperature and pH on enzyme activity and to apply chromatographic separation.
5. To develop the ability to record, analyse and interpret experimental data accurately.

List of Experiments with Hours

Expt.	Experiment	Hours
1	Qualitative test for carbohydrates	6
2	Qualitative analysis of amin acids/proteins	6
3	Qualitative analysis of lipids	6
4	Hydrolysis of sucrose and starch	6
5	Saponification Value	6
6	Isolation of casein from milk	5
7	Estimation of glucose by benedicts method	5
8	Estimation of proteins by Lowry's method	5
9	Separation of amino acids and sugars by paper/thin layer chromatography	5
10	Study the effect of temperature on the activity of enzyme	5
11	Study the effect pH on the activity of enzyme	5
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Perform qualitative identification of carbohydrates, proteins, amino acids, and lipids using standard biochemical tests.	K3
CO2	Carry out quantitative estimation of biomolecules using established biochemical methods.	K3
CO3	Investigate the effects of environmental factors such as temperature and pH on enzyme activity.	K4
CO4	Apply chromatographic techniques for the separation and identification of biomolecules.	K3
CO5	Analyze experimental observations, interpret biochemical results, and maintain accurate laboratory records.	K4

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3	-	-	1	-	-	1	-	-	-	-	3	-	-
CO2	-	3	-	-	1	-	-	1	1	-	-	-	3	-	1
CO3	-	3	1	-	2	-	-	-	1	-	-	-	3	-	2
CO4	-	2	2	1	2	-	-	1	1	-	-	-	2	1	2
CO5	-	-	2	2	2	-	1	3	2	-	-	-	1	1	2
Avg.	**1.0**	**2.8**	**1.7**	**1.5**	**1.6**	**-**	**1.0**	**1.5**	**1.2**	**-**	**-**	**-**	**2.4**	**1.0**	**1.8**

Text Books and Laboratory Manuals

1. Plummer, D. T. An Introduction to Practical Biochemistry. McGraw-Hill Education.
2. Jayaraman, J. Laboratory Manual in Biochemistry. New Age International Publishers.
3. Sadasivam, S. & Manickam, A. Biochemical Methods. New Age International Publishers.
4. Wilson, K. & Walker, J. Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.

Note: *The source sheet lists the experiments (and, for some laboratories, reference books). The description, objectives and outcomes are drafted here for the Board of Studies to confirm; for laboratories shared with the Biotechnology programme they are adapted from that programme's sheets. Reference books were not given in the source for this laboratory; the recommended reading is carried over from the corresponding Biotechnology sheet.*

SEMESTER II

GMBT1504: Molecular Biology and Genetic Engineering

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	II	Core

Course Description

This course provides a comprehensive understanding of the molecular basis of life and the principles of genetic engineering. It covers the structure, organization, replication, expression, regulation, and repair of genetic material in prokaryotic and eukaryotic systems. The course also introduces recombinant DNA technology, cloning strategies, vectors, DNA libraries, polymerase chain reaction (PCR), gene transfer techniques, and molecular diagnostic tools. Students will gain theoretical knowledge and practical insights into modern molecular biology techniques and their applications in biotechnology, medicine, agriculture, environmental science, and genetic engineering.

Course Objectives

1. To understand the structure, organization, and function of genetic material in prokaryotic and eukaryotic organisms.
2. To explain the molecular mechanisms of DNA replication, transcription, translation, and regulation of gene expression.
3. To understand bacterial genetics, mutations, DNA damage, and DNA repair mechanisms.
4. To introduce the principles, tools, and techniques of recombinant DNA technology and genetic engineering.
5. To develop knowledge of cloning vectors, DNA libraries, PCR, gene transfer methods, and their applications in biotechnology, medicine, agriculture, and research.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Chemical Basis of Heredity and Genome Organization.** Introduction to Molecular Biology and Genetic Engineering; Experimental proof of DNA and RNA as genetic material; Structure and functions of DNA and RNA; Watson and Crick model of DNA; A, B and Z forms of DNA; Ribozymes and catalytic RNA; Organization of prokaryotic genome (chromosome and plasmids); Organization of eukaryotic genome (chromatin, nucleosomes and chromosomes); Gene and gene expression.	12
2	**DNA Replication, Transcription and Translation.** DNA replication in prokaryotes and eukaryotes; Enzymes and proteins involved in DNA replication; Mechanism of transcription—initiation, elongation and termination; RNA polymerases, promoters and transcription factors; Post-transcriptional modifications—5′ capping, polyadenylation and mRNA splicing; Transcriptional inhibitors; Genetic code and Wobble hypothesis; Mechanism of translation in prokaryotes and eukaryotes; Post- translational modifications; Regulation of gene expression—Operon concept, Lac operon and Tryptophan operon.	12
3	**Recombinant DNA Technology and Cloning Vectors.** Principles and requirements of recombinant DNA technology; Isolation and purification of DNA; Restriction endonucleases, DNA ligases, DNA polymerases, reverse transcriptase and nucleases; Restriction–modification systems; Cohesive and blunt ends; Cloning vectors— Plasmids, Bacteriophages, Cosmids, BACs and YACs; Expression vectors; Promoters (lac, tac, T7 and λPL); Mammalian vectors (SV40); Plant vectors (Ti and Ri plasmids); Site-directed mutagenesis.	12

Unit	Title and contents	Hours
4	**Gene Cloning and Molecular Techniques.** Gene cloning strategies; Construction of genomic and cDNA libraries; cDNA synthesis; DNA hybridization and DNA probes; Southern, Northern and Western blotting; Gene transfer methods—Transformation, Transduction, Transfection, Electroporation, Microinjection, Particle bombardment and Liposome-mediated gene transfer; Screening and selection of recombinant clones; PCR—Principle, components, primer design and Taq DNA polymerase; Types of PCR—Multiplex PCR, Inverse PCR and Real-Time PCR; RFLP, RAPD and AFLP.	12
5	**Bacterial Genetics, and Applications of Genetic Engineering.** Bacterial recombination—Conjugation (F+, F−, Hfr and F′ strains), Transformation and Griffith's experiment, Generalized and Specialized Transduction, Bacterial Transposons; DNA repair mechanisms—Mismatch repair, Photoreactivation, Base excision repair, Nucleotide excision repair and SOS repair; Beneficial and harmful effects of mutations; Applications of genetic engineering in medicine, agriculture, industry, environmental biotechnology, forensic science and gene therapy.	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the structure, organization, replication, expression, regulation, and repair of genetic material in prokaryotic and eukaryotic organisms.	K2
CO2	Describe the molecular mechanisms of gene expression and bacterial genetic recombination, and their significance in cellular processes.	K2
CO3	Demonstrate an understanding of recombinant DNA technology, cloning vectors, DNA libraries, PCR, and other molecular biology techniques.	K2
CO4	Apply molecular biology and genetic engineering principles to solve problems in biotechnology, medicine, agriculture, environmental science, and genetic research.	K3
CO5	Perform and interpret fundamental molecular biology techniques, including DNA isolation, cloning, PCR, blotting, and gene transfer methods used in research and diagnostics.	K4

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	-	-	-	-	-	-	-	-	-	1	2	-	-
CO2	2	3	-	-	1	-	-	-	-	-	-	1	3	-	-
CO3	1	3	1	-	2	-	-	-	-	-	-	-	3	-	1
CO4	-	2	2	1	2	-	-	-	-	-	-	2	2	1	2
CO5	-	2	2	2	3	-	-	1	-	-	-	2	2	2	3
Avg.	**1.7**	**2.6**	**1.7**	**1.5**	**2.0**	**-**	**-**	**1.0**	**-**	**-**	**-**	**1.5**	**2.4**	**1.5**	**2.0**

Text Books

1. Griffiths, A. J. F., Miller, J. H., Suzuki, D. T., Lewontin, R. C. &Gelbart, W. M.(2000) An Introduction to Genetic Analysis (7th Ed.), Freeman, New York.
2. Hartwell, L. H., Hood, L., Goldberg, M. L., Reynolds, A. E., Silver, L. M. & Veres, R. C. (2000) Genetics: From Genes to Genomes,Tata McGraw Hill, New Delhi.
3. Brown, T. A. (2021). Gene Cloning and DNA Analysis: An Introduction (8th Ed.). Wiley- Blackwell.
4. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2014). Molecular Biology of the Gene (7th Ed.). Pearson.

Reference Books

1. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2022). Molecular Biology of the Cell (7th Ed.). Garland Science.
2. Lodish, J. H & Baltimore, D. (1990).Molecular Cell Biology (2nd Ed.), Scientific American Books, New York.
3. Watson, J. D., Hopkins, N. H., Roberts, J. W., Steitz, J. A. & Weiner, A. M. (1987). Molecular Biology of the Gene (4th Ed.), Benjamin Cummins, Menlo Park.
4. Primrose, S. B., & Twyman, R. M. (2020). Principles of Gene Manipulation and Genomics (8th Ed.). Wiley-Blackwell.
5. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2017). Molecular Biotechnology: Principles and Applications of Recombinant DNA (5th Ed.). ASM Press. .

GMBT1505: Microbiology

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	II	Core

Course Description

This course will also focus on mechanisms of microbial pathogenesis and the host response, and the scientific approaches that are used to investigate these processes. The course deals with the problem of emerging antimicrobial resistance with reference to known pathogens.

Course Objectives

1. To provide students with a comprehensive understanding of microbial pathogens, including bacteria, viruses, fungi, and parasites, and their roles in infectious diseases.
2. To develop proficiency in laboratory techniques for the isolation, identification, and characterization of medically important microorganisms.
3. To explore the mechanisms of microbial pathogenesis, including virulence factors, host-pathogen interactions, and the immune response to infections.
4. To enable students to apply knowledge of medical microbiology to diagnose, treat, and prevent infectious diseases in clinical and public health settings.
5. To explore the role of microorganisms in gut health

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Fundamental Concepts.** INTRODUCTION, HISTORY & SCOPE OF MICROBIOLOGY 8 Introduction and history & developments of microbiology, scope of microbiology, general characteristics of prokaryotes and eukaryotes, classification of prokaryotes, introduction to mycology, virology and parasitology STERILIZATION AND DISINFECTION Introduction and its types, principle, procedure and its application, definition and types of disinfectant, quality control for sterilization and disinfection, biosafety in microbiology lab, biowaste management MICROBIAL NUTRITION AND GROWTH Different types of culture medium: continuous culture and synchronous growth cultures, aerobic & anaerobic culture and Growth kinetics.	12
2	**Bacteriology.** STRUCTURE OF BACTERIAL CELL structure and functions of gram positive and gram- negative bacteria, cell wall, cell membrane, cytoplasmic inclusions and mesosomes, flagella, capsule, ribosome, chromosome, plasmid and endospore, morphological classification of bacteria Introduction and its types, various affecting factors on microbial growth Bacterial Diseases (with reference to Etiology, clinical symptoms, virulence factors involved, detection and prevention) Respiratory tract infections: Diphtheria and Tuberculosis, Gastrointestinal tract infections, staphylococcal food poisoning and E. coli gastroenteritis, Urinary tract infections: gonorrhea and Syphilis.	12
3	**Medical Mycology.** Pathogenic Fungi: Pathogenicity, clinical picture, laboratory diagnosis, prevention; Introduction: Pathogenic and opportunistic fungi, classification, antifungal agents. Superficial mycoses: Piedra, tinea versicolor; Cutaneous mycoses: Dermatophytosis, candidiasis; Subcutaneous mycoses: Mycetoma, Systemic mycoses: Histoplasmosis; Opportunistic mycoses: Otomycosis, pulmonary aspergillosis General and detailed life cycle of Aspergillus and Candida albicans in relation to human diseasescaused by them. Classification of medically important parasites. Common protozoan disease: Malaria, Infectionscaused by Taenia Solium, Fasciola hepatica and Ascaris lumbricoides.	12

Unit	Title and contents	Hours
4	**Viruses, viroids, prions.** General characteristics of viruses, structure, isolation, cultivation and identification of viruses, viral multiplication, one step multiplication curve, lytic and lysogenic phages (lambda phage), Viroid's and prions. Pathogenic Viruses: RNA Viruses: Poliomyelitis virus, influenza virus, Rabies virus; DNA Viruses: Variola, adenoviruses, papilloma virus; Viral Hepatitis: Hepatitis viruses, A, B, C, D, E. Rota virus; SARS virus; Corona virus; Human Immuno Deficiency Virus (HIV). NOSOCOMIAL INFECTIONS Introduction and its types, pathogenicity and laboratory diagnosis of nosocomial infection, prevention and control of nosocomial infections	12
5	**Principles Of Diseases.** CHEMOTHERAPY AND CHEMOTHERAPEUTIC AGENTS Introduction, types of chemotherapeutic agents, mode of action and clinical importance of different chemotherapeutic agents, antibiotic sensitivity tests and its medical importance, introduction, types, mode of action and importance of multiple drugs resistance, mechanism of drug resistance NORMAL MICROBIAL FLORA AND PATHOGENIC MICROORGANISMS Normal microbial flora of the human body.	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Identify common infectious agents and the diseases that they cause.	K3
CO2	Evaluate methods used to identify infectious agents in the clinical microbiology.	K5
CO3	Recall microbial physiology including metabolism, regulation and replication.	K2
CO4	Explain general and specific mechanisms by which infectious agent causes disease.	K2
CO5	Recognize and diagnose common infectious diseases from the clinical presentation and associated microbiology.	K2

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	3	-	-	-	-	-	1	-	-	1
CO2	2	-	-	-	-	3	-	-	-	-	1	1	-	-	1
CO3	-	1	-	-	1	3	-	-	-	-	-	2	1	-	2
CO4	-	1	1	2	-	3	-	-	-	2	-	2	1	1	2
CO5	-	-	-	2	-	3	2	-	-	2	-	2	-	-	2
Avg.	**2.0**	**1.0**	**1.0**	**2.0**	**1.0**	**3.0**	**2.0**	**-**	**-**	**2.0**	**1.0**	**1.6**	**1.0**	**1.0**	**1.6**

Text Books

1. Microbiology: An Introduction, 9th edition (2008), Gerard J. Tortora, Berdell R. Funke, Christine L. Case; Benjamin Cummings. ISBN-13: 978-0321733603.
2. Prescott, Harley, and Klein's Microbiology, 8th edition, (2011), Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton, McGraw Hill International. ISBN- 13:978- 0071313674.

Reference Books

1. Bailey and Scott's Diagnostic Microbiology, 12th edition (2007), Betty A. Forbes, Daniel F. Sahm and Alice S. Weissfeld; Mosby Elsevier Publishers, ISBN-13: 978-0808923640.
2. Microbiology, 6th edition (1993), Pelczar, Chan and Krieg; McGraw Hill International, ISBN-13: 978-0070492585.
3. Brock Biology of Microorganisms, 13th edition (2010), Michael T. Madigan, John M. Martinko, David Stahl and David P. Clark, Pearsons, Benjamin Cummings, ISBN-13: 978- 0321649638.

GMBT1506: Bioanalytical Techniques

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	II	Core

Course Description

This course focuses on the principles and applications of modern bioanalytical techniques used in biological and pharmaceutical sciences. Students will learn theoretical foundations and practical skills in spectroscopy, chromatography, mass spectrometry, electrophoresis, and immunoassays. Emphasis is placed on method development, validation, and data analysis for quantifying biomolecules and understanding their interactions in biological systems.

Course Objectives

1. Understand the principles and instrumentation of bioanalytical techniques commonly used in biological and pharmaceutical research.
2. Develop proficiency in experimental design, sample preparation, and calibration methods for quantitative analysis of biomolecules.
3. Learn to troubleshoot and optimize bioanalytical methods to enhance sensitivity, accuracy, and precision.
4. Explore the application of bioanalytical techniques in drug discovery, pharmacokinetics, and biomarker research.
5. Understand regulatory guidelines and ethical considerations in bioanalytical method development and validation.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Centrifugation.** Principles. Types of centrifugations. Differential centrifugation. Density gradient centrifugation. Electrophoresis: General principles. Polyacrylamide and agarose gel electrophoresis. Isoelectric focusing. 2DGE. Pulse field gel electrophoresis. Capillary electrophoresis. Radioisotope techniques: Principles, measurement and applications of radioactivity.	12
2	**Chromatography.** General Principles. Modes of chromatography. Principles, chromatographic media and applications of the following types of chromatography: Ion exchange, Gel permeation, Affinity, Gas-Liquid, HPLC. UV-Visible Spectroscopy: Principles, instrumentation and applications. Turbidimetry and Nephelometry: Principles and applications. Infrared and Raman Spectroscopy: Principles, instrumentation and applications.	12
3	**Spectro-fluorimetry.** Basic principles. Uses of Fluorescence parameters, intensity, wavelength dependence, quantum yield, lifetime, polarization and rate of resonance energy transfer with emphasis on DNA sequencing, Fluorescence Immunoassays, and Molecular beacons. Mass spectrometry: Basic Principles. Ionization techniques with emphasis on EI, FAB, Electrospray and MALDI. Analysers with emphasis on Magnetic sector, quadrupole and TOF. FTICRMS. Applications of MS– determination of relative molecular mass, empirical formula, small molecule structural analysis, peptide sequencing and protein identification for proteomic studies.	12
4	**ESR spectroscopy.** Principles and applications. NMR spectroscopy: Principles of magnetic resonance. Use of NMR parameters chemical shift, coupling constants and areas for structural elucidation. Nuclear Overhauser effect. Principles of FTNMR and 2D-NMR. Introduction to Protein structure determination by NMR. Principles of MRI and MR-spectroscopy.	12
5	**Electrochemical methods.** Principles of potentiometry. Clark's oxygen electrode. Biosensors: Principles and applications of electrochemical, thermometric, optical and piezoelectric biosensors. Glucose biosensors. Microarrays: Basic principles. Introduction to different types. Methods of manufacture. Applications – differential expression, SNP analysis.	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level	Unit
CO1	Explain the principles, instrumentation and applications of bioanalytical techniques used in biological research	K2	1
CO2	Use bioanalytical instruments and methods for the analysis of biological samples	K3	2
CO3	Analyse biological samples qualitatively and quantitatively using appropriate bioanalytical methods	K4	3
CO4	Interpret bioanalytical data and draw valid conclusions	K4	4
CO5	Apply quality control measures and good laboratory practices in bioanalytical work	K3	5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	-	-	-	-	-	-	-	-	-	1	2	-	-
CO2	2	3	-	-	1	-	-	-	-	-	-	1	3	-	-
CO3	1	3	1	-	2	-	-	-	-	-	-	-	3	-	1
CO4	-	2	2	1	2	-	-	-	-	-	-	2	2	1	2
CO5	-	2	2	2	3	-	-	1	-	-	-	2	2	2	3
Avg.	**1.7**	**2.6**	**1.7**	**1.5**	**2.0**	**-**	**-**	**1.0**	**-**	**-**	**-**	**1.5**	**2.4**	**1.5**	**2.0**

Text Books

1. Practical biochemistry. Principles and Techniques. Keith Wilson and John Walker. 1994. 5th ed. Cambridge University Press.
2. Biophysical chemistry. Principles and Techniques. Upadhyay, Upadhyay and Nath. 11th ed. Himalaya Publishing House.
3. Molecular biology and biotechnology. Walker and Rapley. (for Biosensors). 4th ed. 2003.

TAUT1102: University Core 2: Environmental Studies

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	II	University Core

Course Description

This course examines the complex relationships between humans and their environment, focusing on ecological principles, sustainability, and the impact of human activities on natural systems. Students explore environmental issues such as climate change, biodiversity loss, pollution, and resource management, and examine solutions for promoting environmental conservation and sustainable development.

Course Objectives

1. To Gain in-depth knowledge on natural processes that sustain life, and govern economy.
2. To Predict the consequences of human actions on the web of life, global economy and quality of human life
3. To educate students about the fundamental concepts of ecology, environmental science, and sustainability.
4. To raise awareness about global environmental issues, including climate change, biodiversity loss, pollution, and resource depletion.
5. To foster critical thinking and problem-solving skills for addressing environmental challenges through interdisciplinary approaches.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Multidisciplinary nature of environmental studies.** Definition, scope and importance, Need for public awareness. Natural Resources: Renewable and non-renewable resources: Natural resources and associated problems. a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. e) Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.	9
2	**Ecosystems.** Concept of an ecosystem ; Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem:- a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)	9
3	**Biodiversity and its conservation.** Introduction – Definition: genetic, species and ecosystem diversity. Biogeographical classification of India ; Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values ; Biodiversity at global, National and local levels. India as a mega-diversity nation	9

Unit	Title and contents	Hours
4	**Environmental Pollution.** Definition ; Cause, effects and control measures of:- a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. Nuclear hazards ; Solid waste Management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Disaster management: floods, earthquake, cyclone and landslides. Human Population and the Environment ; Population growth, variation among nations. Population explosion – Family Welfare Programme. Environment and human health. Human Rights. Value Education. HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health. Case Studies.	9
5	**Social Issues and the Environment.** From Unsustainable to Sustainable development ; Urban problems related to energy ; Water conservation, rain water harvesting, watershed management ; Resettlement and rehabilitation of people; its problems and concerns. Case Studies ; Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act ; Wildlife Protection Act ; Forest Conservation Act ; Issues involved in enforcement of environmental legislation. Public awareness. Field work (10 Hours) ; Visit to a local area to document environmental assets river/ forest/ grassland/ hill/ mountain ; Visit to a local polluted site-Urban/Rural/Industrial/Agricultural ; Study of common plants, insects, birds. Study of simple ecosystems-pond, river, hill slopes, etc.	9
	Total	45

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Develop critical thinking for shaping strategies (scientific, social, economic and legal) for environmental protection and conservation of biodiversity, social equity and sustainable development.	K3
CO2	Acquire values and attitudes towards understanding complex environmental- economicsocial challenges, and participating actively in solving current environmental problems and preventing the future ones.	K2
CO3	Adopt sustainability as a practice in life, society and industry.	K2
CO4	Understand and evaluate the global scale of environmental problems; and.	K5
CO5	Reflect critically on their roles, responsibilities, and identities as citizens, consumers and environmental actors in a complex, interconnected world.	K2

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	-	-	-	-	-	2	-	-	-	1	2	-	-	-
CO2	-	-	-	-	-	-	2	-	-	-	2	2	-	-	-
CO3	-	-	-	1	-	-	3	-	-	-	-	2	-	-	-
CO4	-	-	-	1	-	-	3	-	-	1	-	2	-	-	-
CO5	-	-	-	-	-	-	3	1	2	-	-	2	-	-	-
Avg.	**1.0**	**-**	**-**	**1.0**	**-**	**-**	**2.6**	**1.0**	**2.0**	**1.0**	**1.5**	**2.0**	**-**	**-**	**-**

Text Books

1. Textbook for Environmental Studies for Undergraduate Courses of all Branches of Higher Education, Erach Bharucha for University Grants Commission, 2004

2. Odum, E.P., Odum, h.T. & Andrews, J.1971. Fundamentals of Ecology. Philadelphia: Saunders.

Reference Books

1. Singh, J.S., Singh, S.P. and Gupta, S.R. 2017. Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.
2. Sodhi, N.S., Gibson, L. andRaven, P.H. (Eds). 2013. Conservation Biology: Voices from the Tropics. John Wiley & Sons.
3. McNeil, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century

TAUT1202: University Elective 2

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	II	University Elective

The syllabus for this course is drawn from the University Elective basket and is not part of the GMB source document. The elective sheet issued by the University (in the same OBE format) is to be attached here before submission.

GMBL1503: Molecular Biology and Genetic Engineering Lab

L	T	P	C	Total practical hours	Semester	Category
0	0	3	1.5	45	II	Laboratory

Course Description

This laboratory course provides hands-on training in fundamental molecular biology and genetic engineering techniques used in modern biotechnology. Students will develop practical skills in nucleic acid isolation, quantification, electrophoresis, restriction enzyme analysis, PCR, and recombinant DNA technology. The course emphasizes laboratory safety, good laboratory practices, accurate data interpretation, and the applications of molecular techniques in biological research.

Course Objectives

1. To train students in laboratory safety, good laboratory practice and preparation of reagents and buffers.
2. To enable isolation, quantification and quality assessment of genomic DNA.
3. To develop skills in agarose gel electrophoresis, restriction digestion and PCR.
4. To explain the principles of bacterial transformation and recombinant DNA technology.
5. To interpret molecular biology data and use basic bioinformatics tools for sequence analysis and primer design.

List of Experiments with Hours

Expt.	Experiment	Hours
1	Preparation of laboratory reagents, buffers, and sterilization techniques (Autoclaving and aseptic handling)	5
2	Isolation of genomic DNA from plant or bacterial samples and qualitative analysis	5
3	Quantification and purity assessment of DNA using UV spectrophotometry (A260/A280) or NanoDrop (demonstration)	5
4	Separation of DNA by Agarose Gel Electrophoresis and interpretation of DNA banding patterns	5
5	Restriction digestion of DNA using restriction endonucleases and analysis of restriction fragments by agarose gel electrophoresis	5
6	Polymerase Chain Reaction (PCR) – Preparation of PCR reaction mixture and demonstration of DNA amplification	5
7	Analysis of PCR products using agarose gel electrophoresis	5
8	Bacterial transformation using plasmid DNA (demonstration or simulation) and selection of transformants on antibiotic-containing medium	5
9	Demonstration/Virtual experiment on recombinant DNA technology – Cloning strategy, plasmid vector map analysis, restriction mapping, and screening of recombinant clones	5
	Total	45

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Demonstrate laboratory safety practices and prepare reagents and buffers, with sterilisation and aseptic handling	K3
CO2	Isolate genomic DNA and assess its quantity and purity	K3

CO	Statement	Bloom level
CO3	Perform agarose gel electrophoresis, restriction digestion and PCR, and analyse the products	K3
CO4	Explain the principles of bacterial transformation and recombinant DNA technology	K2
CO5	Interpret experimental results and analyse cloning strategies using vector maps and restriction maps	K4

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3	-	-	1	-	-	1	-	-	-	-	3	-	-
CO2	-	3	-	-	1	-	-	1	1	-	-	-	3	-	1
CO3	-	3	1	-	2	-	-	-	1	-	-	-	3	-	2
CO4	-	2	2	1	2	-	-	1	1	-	-	-	2	1	2
CO5	-	-	2	2	2	-	1	3	2	-	-	-	1	1	2
Avg.	**1.0**	**2.8**	**1.7**	**1.5**	**1.6**	**-**	**1.0**	**1.5**	**1.2**	**-**	**-**	**-**	**2.4**	**1.0**	**1.8**

Text Books and Laboratory Manuals

1. Green, M. R., & Sambrook, J. (2019). Molecular Cloning: A Laboratory Manual (4th Ed.). Cold Spring Harbor Laboratory Press.
2. Brown, T. A. (2021). Gene Cloning and DNA Analysis: An Introduction (8th Ed.). Wiley-Blackwell.
3. Primrose, S. B., & Twyman, R. M. (2020). Principles of Gene Manipulation and Genomics (8th Ed.). Wiley-Blackwell.
4. Wilson, K., & Walker, J. (2018). Principles and Techniques of Biochemistry and Molecular Biology (8th Ed.). Cambridge University Press.

Note: *The source sheet lists the experiments (and, for some laboratories, reference books). The description, objectives and outcomes are drafted here for the Board of Studies to confirm; for laboratories shared with the Biotechnology programme they are adapted from that programme's sheets.*

GMBL1504: Microbiology Lab

L	T	P	C	Total practical hours	Semester	Category
0	0	3	1.5	45	II	Laboratory

Course Description

This laboratory course provides practical training in fundamental microbiological techniques used in research, clinical, industrial, and environmental laboratories. Students will develop skills in microscopy, aseptic techniques, sterilization, microbial cultivation, growth analysis, and antimicrobial susceptibility testing. The course emphasizes good laboratory practices, biosafety, accurate observation, and interpretation of microbiological data.

Course Objectives

1. To train students in microbiological laboratory safety, aseptic technique and equipment handling.
2. To enable preparation and sterilisation of culture media and glassware.
3. To develop skills in isolation, staining and identification of bacteria.
4. To analyse bacterial growth and the effect of environmental factors on growth.
5. To perform antimicrobial susceptibility testing and interpret microbiological data.

List of Experiments with Hours

Expt.	Experiment	Hours
1	Microscopy and Staining Techniques	5
2	To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory	4
3	Preparation of culture media for bacterial cultivation	4
4	Sterilization of medium using Autoclave and assessment for sterility	4
5	Sterilization of glassware using Hot Air Oven and assessment for sterility	4
6	Isolation of pure cultures of bacteria by streaking method	4
7	Study and plot the growth curve of E. coli by turbidometric and standard plate count methods	4
8	Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data	4
9	Effect of temperature, pH, salt, carbon and nitrogen sources on growth of E.coli	4
10	Antibiotic Susceptibility Testing by Kirby–Bauer Disc Diffusion Method	4
11	Demonstration of the thermal death time and decimal reduction time of E. coli	4
	Total	45

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Demonstrate microbiological laboratory safety, aseptic techniques, and proper handling of laboratory equipment.	K3
CO2	Prepare, sterilize, and evaluate culture media and laboratory materials for microbial cultivation.	K5
CO3	Isolate, stain, and identify bacterial cultures using standard microbiological techniques.	K3

CO	Statement	Bloom level
CO4	Analyze bacterial growth characteristics and evaluate the influence of environmental factors on microbial growth.	K5
CO5	Perform antimicrobial susceptibility testing and interpret microbiological experimental data.	K4

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3	-	-	1	-	-	1	-	-	-	-	3	-	-
CO2	-	3	-	-	1	-	-	1	1	-	-	-	3	-	1
CO3	-	3	1	-	2	-	-	-	1	-	-	-	3	-	2
CO4	-	2	2	1	2	-	-	1	1	-	-	-	2	1	2
CO5	-	-	2	2	2	-	1	3	2	-	-	-	1	1	2
Avg.	**1.0**	**2.8**	**1.7**	**1.5**	**1.6**	**-**	**1.0**	**1.5**	**1.2**	**-**	**-**	**-**	**2.4**	**1.0**	**1.8**

Text Books and Laboratory Manuals

1. Cappuccino, J. G., & Welsh, C. T. Microbiology: A Laboratory Manual. 12th Edition. Pearson.
2. Aneja, K. R. Experiments in Microbiology, Plant Pathology and Biotechnology. New Age International Publishers.
3. Harley, J. P., & Prescott, L. M. Laboratory Exercises in Microbiology. McGraw-Hill Education.
4. Forbes, B. A., Sahm, D. F., & Weissfeld, A. S. Bailey & Scott's Diagnostic Microbiology. Elsevier.
5. Benson, H. J. Microbiological Applications: Laboratory Manual in General Microbiology. McGraw-Hill Education.

Note: *The source sheet lists the experiments (and, for some laboratories, reference books). The description, objectives and outcomes are drafted here for the Board of Studies to confirm; for laboratories shared with the Biotechnology programme they are adapted from that programme's sheets. Reference books were not given in the source for this laboratory; the recommended reading is carried over from the corresponding Biotechnology sheet.*

SEMESTER III

GMBT2507: Immunology

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	III	Core

Course Description

This course delves into the study of the immune system, its components, functions, and interactions with pathogens and diseased cells. Students will explore the molecular and cellular basis of immune responses, immune regulation, immunodeficiencies, and immunotherapy. Practical aspects include laboratory techniques for studying immune cells and molecules, with an emphasis on understanding how immunobiology impacts health and disease.

Course Objectives

1. Understand the fundamental principles of immunology, including the structure and function of immune cells, tissues, and molecules.
2. Analyze the mechanisms of immune responses to pathogens, allergens, and cancerous cells.
3. Evaluate the roles of genetics, environment, and immunological memory in shaping immune responses.
4. Explore the applications of immunobiology in vaccine development, immunotherapy, and personalized medicine.
5. Critically assess current research and emerging trends in immunobiology and their implications for healthcare.

Note: *The source learning outcomes referred to laboratory work (flow cytometry, ELISA), communication and teamwork, none of which are taught in the five theory units (the practical component is in GMBL2503). Course Outcomes here are rewritten to match the units.*

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Overview of Immunity.** Overview of the immune system, Historical perspective on immunology, Components of the immune system (innate and adaptive), Barrier Immunity, Antigens and antibodies, Haptens.	12
2	**Innate Immunity & Adaptive Immunity.** Immune cells and their functions, Phagocytosis and macrophages, Complement system, Natural killer (NK) cells, Inflammation and its role in innate immunity, B-cells and T-cells, Immune response types, Antibody structure and function, Major Histocompatibility Complex (MHC) and antigen presentation	12
3	**Adaptive Immunity.** B cells and antibody-mediated immunity, B cell development and activation, T cells and cell- mediated immunity, T cell development and activation, Types of T cells (CD4+ and CD8+), Cytotoxic T cells and helper T cells.	12
4	**The recognition of antigen and Immune regulation.** Humoral Immune response, Cell mediated immune response, Antigen Recognition by B-cell and T-cell Receptors, The Generation of Lymphocyte Antigen Receptors, Antigen Presentation to T Lymphocytes, development of mature lymphocyte receptor, Lymphocyte Receptor Signaling	12
5	**The Immune System in Health and Disease.** Immunodeficiency disorders, Autoimmunity and autoimmune diseases, Allergies and hypersensitivity reactions, Vaccination and immunization, Failures of Host Défense Mechanisms, Allergy and Allergic Diseases, Transplantation immunology - Manipulation of the Immune Response, Infectious diseases and immunology, Emerging trends in immunology research	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level	Unit
CO1	Explain the components of the innate and adaptive immune systems, antigens, antibodies and haptens	K2	1
CO2	Describe the functions of immune cells, the complement system, inflammation and the MHC in antigen presentation	K2	2
CO3	Explain B cell and T cell development, activation and effector functions in humoral and cell-mediated immunity	K2	3
CO4	Analyse antigen recognition, lymphocyte receptor generation and signalling in immune regulation	K4	4
CO5	Apply immunological principles to immunodeficiency, autoimmunity, allergy, vaccination and transplantation	K3	5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	3	-	-	-	-	-	1	-	-	1
CO2	2	-	-	-	-	3	-	-	-	-	1	1	-	-	1
CO3	-	1	-	-	1	3	-	-	-	-	-	2	1	-	2
CO4	-	1	1	2	-	3	-	-	-	2	-	2	1	1	2
CO5	-	-	-	2	-	3	2	-	-	2	-	2	-	-	2
Avg.	**2.0**	**1.0**	**1.0**	**2.0**	**1.0**	**3.0**	**2.0**	**-**	**-**	**2.0**	**1.0**	**1.6**	**1.0**	**1.0**	**1.6**

Text Books

1. "Kuby Immunology" by Judy Owen, Jenni Punt, and Sharon Stranford
2. "Immunobiology" by Charles Janeway, Paul Travers, Mark Walport, and Mark Shlomchik
3. "Basic Immunology: Functions and Disorders of the Immune System" by Abul K. Abbas, Andrew H. Lichtman, and Shiv Pillai

GMBT2508: Molecular Pathogenesis

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	III	Core

Course Description

This course provides a comprehensive understanding of the molecular mechanisms underlying the development and progression of infectious and non-infectious diseases. Students will explore host–pathogen interactions, virulence factors, microbial pathogenesis, immune evasion strategies, molecular mechanisms of disease, and the role of genetics in pathogenesis. The course also introduces molecular diagnostic techniques, emerging infectious diseases, antimicrobial resistance, and therapeutic strategies. Emphasis is placed on integrating molecular biology with disease mechanisms to understand the diagnosis, prevention, and treatment of human diseases.

Course Objectives

1. To understand the molecular basis of disease pathogenesis and host–pathogen interactions.
2. To explain the mechanisms of microbial virulence and immune evasion.
3. To understand the molecular mechanisms involved in bacterial, viral, fungal, and parasitic infections.
4. To introduce molecular diagnostic techniques used in disease detection and monitoring.
5. To explore antimicrobial resistance and recent advances in molecular therapeutics.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to molecular pathogenesis.** Concepts of infection, disease, and pathogenicity; Host–pathogen interactions; Normal microbiota and opportunistic pathogens; Stages of microbial infection—entry, adhesion, colonization, invasion, dissemination, and transmission; Host defense mechanisms; Innate and adaptive immune responses; Inflammation and molecular basis of disease development.	12
2	**Molecular Mechanisms of Microbial Pathogenesis.** Virulence factors; Adhesins and colonization factors; Invasins; Exotoxins and endotoxins; Biofilm formation; Secretion systems (Types I–VI, overview); Quorum sensing; Molecular mechanisms of bacterial pathogenesis; Mechanisms of viral entry, replication, and persistence; Molecular basis of fungal and parasitic infections.	12
3	**Host Immune Response and Immune Evasion.** Host immune recognition; Pattern Recognition Receptors (PRRs), Toll-like Receptors (TLRs); Cytokines and chemokines; Antigen presentation; Molecular mechanisms of immune evasion by pathogens; Antigenic variation; Intracellular survival; Molecular basis of chronic infections; Inflammation-mediated tissue damage; Apoptosis and pathogen-induced cell death.	12
4	**Molecular Diagnostics and Antimicrobial Resistance.** Principles of molecular diagnostics; Polymerase Chain Reaction (PCR); Real-Time PCR (qPCR); DNA sequencing (overview); ELISA and rapid molecular diagnostic techniques; Biomarkers in infectious diseases; Mechanisms of antimicrobial resistance; Drug resistance genes; Horizontal gene transfer; Multidrug-resistant pathogens; Molecular epidemiology and disease surveillance.	12
5	**Molecular Basis of Human Diseases and Therapeutic Approaches.** Molecular pathogenesis of selected bacterial diseases (Tuberculosis, Cholera); Viral diseases (COVID-19, Influenza, HIV/AIDS); Cancer as a molecular disease (overview of oncogenes and tumor suppressor genes); Emerging and re-emerging infectious diseases; Vaccines and molecular vaccine development; Monoclonal antibodies; Gene therapy (overview); Precision medicine and future prospects in molecular pathogenesis.	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the molecular mechanisms involved in the development and progression of infectious diseases.	K2
CO2	Describe host–pathogen interactions, microbial virulence factors, and immune evasion strategies.	K2
CO3	Understand the molecular basis of bacterial, viral, fungal, and parasitic pathogenesis.	K2
CO4	Apply molecular diagnostic techniques for the detection and monitoring of infectious diseases.	K3
CO5	Evaluate antimicrobial resistance mechanisms and recent advances in molecular therapeutics and precision medicine.	K5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	3	-	-	-	-	-	1	-	-	1
CO2	2	-	-	-	-	3	-	-	-	-	1	1	-	-	1
CO3	-	1	-	-	1	3	-	-	-	-	-	2	1	-	2
CO4	-	1	1	2	-	3	-	-	-	2	-	2	1	1	2
CO5	-	-	-	2	-	3	2	-	-	2	-	2	-	-	2
Avg.	**2.0**	**1.0**	**1.0**	**2.0**	**1.0**	**3.0**	**2.0**	**-**	**-**	**2.0**	**1.0**	**1.6**	**1.0**	**1.0**	**1.6**

Text Books

1. Mims, C., Dockrell, H. M., Goering, R. V., Roitt, I., Wakelin, D., & Zuckerman, M. Medical Microbiology. Elsevier.
2. Murray, P. R., Rosenthal, K. S., & Pfaller, M. A. Medical Microbiology. Elsevier.

Reference Books

1. Abbas, A. K., Lichtman, A. H., & Pillai, S. Basic Immunology: Functions and Disorders of the Immune System. Elsevier.
2. Brooks, G. F., Carroll, K. C., Butel, J. S., Morse, S. A., & Mietzner, T. A. Jawetz, Melnick & Adelberg's Medical Microbiology. McGraw-Hill.
3. Ryan, K. J., & Ray, C. G. Sherris Medical Microbiology. McGraw-Hill.
4. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. Brock Biology of Microorganisms. Pearson.

GMBT2509: Enzyme Technology

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	III	Core

Course Description

This course provides a comprehensive understanding of enzymes, their structure, classification, kinetics, mechanisms of action, production, purification, immobilization, and industrial applications. Students will explore enzyme assay techniques, factors affecting enzyme activity, enzyme engineering, and the role of enzymes in biotechnology, medicine, food processing, agriculture, environmental biotechnology, and pharmaceutical industries. The course integrates theoretical concepts with practical applications, preparing students for careers in biotechnology, industrial microbiology, and life sciences.

Course Objectives

1. To understand the structure, classification, properties, and catalytic mechanisms of enzymes.
2. To explain enzyme kinetics, inhibition, regulation, and factors influencing enzyme activity.
3. To understand the production, extraction, purification, and characterization of enzymes.
4. To introduce enzyme immobilization techniques and enzyme engineering for industrial applications.
5. To explore the applications of enzymes in biotechnology, medicine, food, agriculture, environmental science, and pharmaceutical industries.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Enzymes and Enzyme Kinetics.** Introduction to enzymes; Historical background; Nomenclature and classification of enzymes (EC classification); Structure and properties of enzymes; Active site; Lock-and-key and induced-fit theories; Cofactors, coenzymes and prosthetic groups; Isoenzymes and ribozymes; Enzyme specificity; Factors affecting enzyme activity (temperature, pH, substrate concentration, enzyme concentration); Michaelis–Menten kinetics; Lineweaver– Burk plot; Enzyme inhibition—competitive, non-competitive, uncompetitive and irreversible inhibition.	12
2	**Enzyme Production, Extraction and Purification.** Sources of enzymes—Plant, animal and microbial; Microbial production of industrial enzymes; Fermentation methods—Submerged and solid-state fermentation; Extraction of intracellular and extracellular enzymes; Enzyme purification techniques—Precipitation, dialysis, ultrafiltration, centrifugation, chromatography (ion-exchange, gel filtration and affinity chromatography); Electrophoresis; Enzyme assays; Specific activity; Purity and characterization of enzymes.	12
3	**Enzyme Immobilization and Enzyme Engineering.** Principles of enzyme immobilization; Advantages and limitations of immobilized enzymes; Methods of immobilization—Adsorption, covalent binding, entrapment, encapsulation and cross-linking; Immobilized enzyme reactors; Enzyme engineering—Protein engineering and directed evolution (overview); Site-directed mutagenesis (basic concept); Biosensors and enzyme-based diagnostics.	12
4	**Industrial Applications of Enzymes.** Industrial enzymes and their production; Applications in food and dairy industries; Brewing and baking industries; Detergent enzymes; Textile and leather industries; Paper and pulp industries; Pharmaceutical and fine chemical industries; Agricultural applications; Environmental biotechnology—Bioremediation and waste management; Clinical and diagnostic applications of enzymes.	12
5	**Recent Advances and Applications of Enzyme Technology.** Enzymes in molecular biology—DNA polymerases, restriction enzymes, ligases and reverse transcriptase; Therapeutic enzymes; Enzymes in nanobiotechnology; Enzyme-based biosensors; Immobilized enzymes in bioprocessing; Green chemistry and biocatalysis; Enzyme applications in personalized medicine; Recent advances in enzyme technology and future prospects.	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the classification, structure, properties, kinetics, and catalytic mechanisms of enzymes.	K2
CO2	Evaluate the factors affecting enzyme activity and interpret enzyme kinetic data.	K5
CO3	Describe methods for enzyme production, extraction, purification, characterization, and immobilization.	K2
CO4	Apply enzyme technology principles in biotechnology, food processing, pharmaceuticals, agriculture, environmental management, and diagnostics.	K3
CO5	Demonstrate knowledge of modern enzyme engineering approaches and recent advances in industrial enzyme technology.	K2

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	-	2	-	2	-	-	1
CO2	1	1	-	-	-	-	-	-	-	2	-	2	1	-	1
CO3	-	2	-	-	1	-	-	-	-	3	-	2	2	-	1
CO4	-	-	1	1	2	1	-	-	-	3	-	3	1	1	2
CO5	-	-	-	2	1	2	2	-	-	3	-	3	-	-	2
Avg.	**1.5**	**1.5**	**1.0**	**1.5**	**1.3**	**1.5**	**2.0**	**-**	**-**	**2.6**	**-**	**2.4**	**1.3**	**1.0**	**1.4**

Text Books

1. Rastogi, S. C. (2020). Biochemistry (4th Ed.). McGraw Hill Education.
2. Dixon, M., & Webb, E. C. (1979). Enzymes (3rd Ed.). Academic Press.

Reference Books

1. Nelson, D. L., & Cox, M. M. (2021). Lehninger Principles of Biochemistry (8th Ed.). W. H. Freeman.
2. Chaplin, M. F., & Bucke, C. (1990). Enzyme Technology. Cambridge University Press.
3. Bisswanger, H. (2019). Enzyme Kinetics: Principles and Methods (3rd Ed.). Wiley-VCH.
4. Palmer, T., & Bonner, P. L. (2007). Enzymes: Biochemistry, Biotechnology and Clinical Chemistry (2nd Ed.). Woodhead Publishing.

GMBT2510: Nanobiotechnology

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	III	Core

Course Description

This course introduces the fundamental principles of nanotechnology and its applications in biological systems. It provides an understanding of nanomaterials, their synthesis, characterization, functionalization, and interactions with biological molecules and cells. The course emphasizes the applications of nanobiotechnology in medicine, drug delivery, diagnostics, biosensors, agriculture, environmental biotechnology, and tissue engineering. Students will gain knowledge of the interdisciplinary nature of nanobiotechnology and its emerging role in healthcare and biotechnology industries. The syllabus is designed specifically for undergraduate students and is aligned with current nanobiotechnology curricula.

Course Objectives

1. To understand the fundamental concepts, principles, and scope of nanobiotechnology.
2. To explain the properties, synthesis, and characterization of nanomaterials used in biological systems.
3. To understand the interactions between nanomaterials and biological molecules, cells, and tissues.
4. To introduce nanobiotechnology applications in medicine, agriculture, environmental science, and diagnostics.
5. To familiarize students with recent advances, ethical issues, and future prospects in nanobiotechnology.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Nanobiotechnology.** Introduction to nanotechnology and nanobiotechnology; Historical development; Scope and interdisciplinary nature; Nanoscale and size-dependent properties; Classification of nanomaterials (0D, 1D, 2D and 3D); Physical, chemical and biological properties of nanomaterials; Natural and synthetic nanomaterials; Applications of nanobiotechnology in life sciences	12
2	**Synthesis and Characterization of Nanomaterials.** Top-down and bottom-up approaches; Physical methods of nanoparticle synthesis; Chemical methods; Biological (green) synthesis of nanoparticles using plants and microorganisms; Functionalization of nanoparticles; Characterization techniques—UV-Visible spectroscopy, Dynamic Light Scattering (DLS), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), X-ray Diffraction (XRD).	12
3	**Nanomaterials in Biological Systems.** Carbon nanotubes; Quantum dots; Gold and silver nanoparticles; Liposomes; Dendrimers; Polymeric nanoparticles; Nanocomposites; Nanomaterial–cell interactions; Cellular uptake of nanoparticles; Biocompatibility; Toxicity and biosafety of nanomaterials; Nano biomaterials for tissue engineering.	12
4	**Applications of Nanobiotechnology.** Nanomedicine; Targeted drug delivery systems; Nanoparticles in cancer diagnosis and therapy; Nano biosensors; Nano-based diagnostic tools; DNA and protein nanotechnology; Agricultural applications; Food nanotechnology; Environmental applications including water purification, biosensing and bioremediation.	12
5	**Recent Advances and Future Perspectives.** Nano vaccines; Gene delivery using nanoparticles; Nanozymes; Smart nanomaterials; Nanorobotics (overview); Personalized medicine; Regulatory aspects and biosafety; Ethical and environmental concerns; Commercial applications; Future prospects of nanobiotechnology.	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the basic concepts, classification, and properties of nanomaterials used in biotechnology.	K2
CO2	Describe various methods of synthesis, functionalization, and characterization of nanomaterials.	K2
CO3	Understand the interactions between nanomaterials and biological systems, including their biocompatibility and toxicity.	K2
CO4	Apply the principles of nanobiotechnology to medicine, diagnostics, agriculture, food technology, and environmental biotechnology.	K3
CO5	Evaluate recent developments, ethical issues, and future applications of nanobiotechnology in research and industry.	K5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	-	2	-	2	-	-	1
CO2	1	1	-	-	-	-	-	-	-	2	-	2	1	-	1
CO3	-	2	-	-	1	-	-	-	-	3	-	2	2	-	1
CO4	-	-	1	1	2	1	-	-	-	3	-	3	1	1	2
CO5	-	-	-	2	1	2	2	-	-	3	-	3	-	-	2
Avg.	**1.5**	**1.5**	**1.0**	**1.5**	**1.3**	**1.5**	**2.0**	**-**	**-**	**2.6**	**-**	**2.4**	**1.3**	**1.0**	**1.4**

Text Books

1. Niemeyer, C. M., & Mirkin, C. A. (2011). Nanobiotechnology: Concepts, Applications and Perspectives. Wiley-VCH.
2. Goodsell, D. S. (2004). Bionanotechnology: Lessons from Nature. Wiley-Liss.

Reference Books

1. Bhushan, B. (2017). Springer Handbook of Nanotechnology (4th Ed.). Springer.
2. Kumar, C. S. S. R. (Ed.). (2006). Nanotechnologies for the Life Sciences. Wiley-VCH.
3. Salata, O. V. (Ed.). (2007). Applications of Nanotechnology in Biology and Medicine. Humana Press.
4. Ratner, B. D., Hoffman, A. S., Schoen, F. J., & Lemons, J. E. (2020). Biomaterials Science: An Introduction to Materials in Medicine (4th Ed.). Academic Press.
5. Rai, M., & Duran, N. (Eds.). (2011). Metal Nanoparticles in Microbiology. Springer.

TAUT2101: University Core 3: Health and Wellness

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	III	University Core

Course Description

This course helps students learn about human health: how current health knowledge helps future generations become stronger and healthier.

Course Objectives

1. To help students understand the importance of a healthy lifestyle.
2. To familiarise students with physical and mental health.
3. To create awareness of lifestyle-related diseases.
4. To create awareness of metabolic diseases.
5. To introduce functional foods and their role in health.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Health, Wellness and Genetics.** Define and differentiate health and wellness, Importance of health and wellness, Basic concepts of genetics, including genes, DNA, chromosomes, and inheritance patterns. Genetic factors affecting macronutrient (carbohydrates, proteins, and fats) digestion. Genetic variations associated with micronutrient (vitamins and minerals) digestion; malnutrition, under nutrition and over nutrition	9
2	**Human Body Systems.** Brief overview of Body systems – Skeletal system, Muscular system, Circulatory System, Lymphatic system, Cardiovascular system, Respiratory system, Nervous system (Central nervous system, Peripheral nervous system, Somatic and Autonomic nervous systems), Digestive system, Urinary system, Endocrine system, Reproductive system, Integumentary system	9
3	**Lifestyle, Mental Health and Vital Signs.** Sedentary lifestyle and its risk of disease, Lifestyle Disease and its Management, Factors affecting mental health - Stress, anxiety, and depression, Identification of suicidal tendencies, Substance abuse (Drugs, Cigarette, Alcohol), de-addiction, counselling and rehabilitation. Four Vital signs- Pulse rate, Respiratory rate, Blood pressure, Body temperature, other measurements-Body mass index, Waist-Hip Ratio, Basal Metabolic Rate	9
4	**Lifestyle and Metabolic Diseases.** Risk factors and Pathology of the following Diseases and their Management – - Diabetes - Hypertension - Coronary Heart Disease - Obesity - Osteoporosis - Osteoarthritis - Rheumatoid-arthritis - Cancers (Blood, Breast, Brain, Lung, Liver and Kidney) - Polycystic ovarian syndrome (PCOS) - Pain (including Low Back pain)	9
5	**Functional Foods and Yoga.** Introduction to Functional Foods; Nutrients and Bioactive Compounds in Functional Foods; Functional Foods for Cardiovascular Health, Weight Management, Immune Function, Cognitive Health, Chronic Disease Prevention; Yoga and its importance in Health and Wellness	9
	Total	45

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level	Unit
CO1	Differentiate health and wellness and explain the role of genetics and nutrition in wellbeing	K2	1

CO	Statement	Bloom level	Unit
CO2	Describe the organisation and functions of the major human body systems relevant to health	K2	2
CO3	Evaluate lifestyle, mental health and substance use risks and apply basic vital-sign monitoring and preventive practices	K5	3
CO4	Explain the risk factors, pathology and management of major lifestyle and metabolic diseases	K2	4
CO5	Explain the role of functional foods and yoga in weight management and disease prevention	K2	5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	2	-	-	-	-	-	2	-	-	-
CO2	-	-	-	-	-	2	-	-	-	-	-	2	-	-	-
CO3	-	-	-	-	-	3	1	1	-	-	-	2	-	-	-
CO4	-	-	-	-	-	3	-	-	-	1	-	2	-	-	-
CO5	-	-	-	-	-	2	1	1	-	-	-	2	-	-	-
Avg.	**2.0**	**-**	**-**	**-**	**-**	**2.4**	**1.0**	**1.0**	**-**	**1.0**	**-**	**2.0**	**-**	**-**	**-**

Text Books

1. Physical Activity and Health by Claude Bouchard, Steven N. Blair, William L. Haskell.
2. Mental Health Workbook by Emily Attached & Marzia Fernandez, 2021.
3. Mental Health Workbook for Women: Exercises to Transform Negative Thoughts and Improve WellBeing by Nashay Lorick, 2022

Reference Books

1. Lifestyle Diseases: Lifestyle Disease Management, by C. Nyambichu & Jeff Lumiri, 2018.
2. Physical Activity and Mental Health by Angela Clow & Sarah Edmunds, 2013.

TAUT2201: University Elective 3

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	III	University Elective

The syllabus for this course is drawn from the University Elective basket and is not part of the GMB source document. The elective sheet issued by the University (in the same OBE format) is to be attached here before submission.

GMBL2503: Immunology Lab

L	T	P	C	Total practical hours	Semester	Category
0	0	4	2	60	III	Laboratory

Course Description

This laboratory course provides practical training in fundamental immunological and serological techniques used in clinical diagnostics and biomedical research. Students will develop skills in blood grouping, hematological analysis, antigen-antibody reactions, immunodiffusion, and immunoassays. The course emphasizes laboratory safety, specimen handling, biosafety practices, quality control, and interpretation of immunological test results.

Course Objectives

1. To train students in laboratory safety, biosafety and handling of biological specimens.
2. To develop skills in basic haematological techniques, including blood grouping and blood cell analysis.
3. To enable serological assays based on antigen-antibody interactions for disease diagnosis.
4. To explain the principles of immunodiffusion, ELISA and other immunodiagnostic techniques.
5. To interpret laboratory results and apply quality control in a clinical immunology laboratory.

List of Experiments with Hours

Expt.	Experiment	Hours
1	Laboratory safety practices, preparation of reagents, and handling of biological specimens	5
2	Identification of Blood cells	5
3	Total count of Blood cells	5
4	ABO and Rh blood grouping by slide and tube methods	5
5	Widal test for the serological diagnosis of typhoid fever	5
6	VDRL (Venereal Disease Research Laboratory) test (demonstration) for syphilis screening	5
7	Latex agglutination test for detection of Rheumatoid Factor (RF) or C-Reactive Protein (CRP)	5
8	Ouchterlony Double Immunodiffusion (DID) for antigen-antibody precipitation	5
9	Single Radial Immunodiffusion (SRID) for quantitative estimation of immunoglobulins (demonstration)	5
10	Enzyme-Linked Immunosorbent Assay (ELISA) (demonstration) for detection of antigen or antibody	5
11	Preparation and staining of peripheral blood smear and differential leukocyte count (DLC)	5
12	Isolation of peripheral blood mononuclear cells (PBMCs) by density gradient centrifugation (demonstration) or Complement fixation test (demonstration), depending on laboratory facilities	5
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Demonstrate laboratory safety, biosafety practices, and proper handling of biological specimens.	K3
CO2	Perform basic hematological and immunological techniques, including blood grouping and blood cell analysis.	K3

CO	Statement	Bloom level
CO3	Carry out serological assays based on antigen-antibody interactions for disease diagnosis.	K3
CO4	Explain the principles and applications of immunodiffusion, ELISA, and other immunological diagnostic techniques.	K2
CO5	Interpret laboratory results and apply quality control measures in clinical immunology laboratories.	K4

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3	-	-	1	-	-	1	-	-	-	-	3	-	-
CO2	-	3	-	-	1	-	-	1	1	-	-	-	3	-	1
CO3	-	3	1	-	2	-	-	-	1	-	-	-	3	-	2
CO4	-	2	2	1	2	-	-	1	1	-	-	-	2	1	2
CO5	-	-	2	2	2	-	1	3	2	-	-	-	1	1	2
Avg.	**1.0**	**2.8**	**1.7**	**1.5**	**1.6**	**-**	**1.0**	**1.5**	**1.2**	**-**	**-**	**-**	**2.4**	**1.0**	**1.8**

Text Books and Laboratory Manuals

1. Turgeon, M. L. (2022). Immunology and Serology in Laboratory Medicine (7th Ed.). Elsevier.
2. Cheesbrough, M. (2018). District Laboratory Practice in Tropical Countries (Part 2). Cambridge University Press.

Note: *The source sheet lists the experiments (and, for some laboratories, reference books). The description, objectives and outcomes are drafted here for the Board of Studies to confirm; for laboratories shared with the Biotechnology programme they are adapted from that programme's sheets.*

GMBL2504: Enzyme Technology Lab

L	T	P	C	Total practical hours	Semester	Category
0	0	4	2	60	III	Laboratory

Course Description

This laboratory course provides practical training in enzyme technology, focusing on the isolation, characterization, purification, and analysis of enzymes. Students will perform enzyme assays, investigate factors influencing enzyme activity, and learn basic protein separation techniques used in biochemical and biotechnological laboratories. The course emphasizes laboratory safety, experimental accuracy, and interpretation of enzyme kinetics and analytical data.

Course Objectives

1. To prepare laboratory reagents and buffers and perform enzyme assays under good laboratory practice.
2. To evaluate enzyme activity by qualitative and quantitative methods.
3. To investigate the effect of environmental factors on enzyme activity and stability.
4. To perform basic enzyme purification and protein separation techniques.
5. To analyse enzyme kinetics and interpret experimental data.

List of Experiments with Hours

Expt.	Experiment	Hours
1	Laboratory safety, preparation of buffers, and calibration of laboratory instruments	6
2	Preparation of phosphate, acetate, and Tris buffers of different pH	6
3	Qualitative detection of amylase activity by starch hydrolysis	6
4	Quantitative estimation of amylase activity using the DNS method	6
5	Assay of catalase activity using hydrogen peroxide decomposition	6
6	Assay of urease activity by ammonia estimation	5
7	Assay of alkaline phosphatase activity	5
8	Determination of optimum pH for enzyme activity	5
9	Dialysis for enzyme purification	5
10	Serum electrophoresis by SDS PAGE	5
11	Western Blotting	5
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Prepare laboratory reagents and buffers and perform enzyme assays following good laboratory practices.	K3
CO2	Evaluate enzyme activity using qualitative and quantitative biochemical methods.	K5
CO3	Investigate the effects of environmental factors on enzyme activity and stability.	K4
CO4	Perform basic enzyme purification and protein separation techniques used in biotechnology laboratories.	K3
CO5	Analyze enzyme kinetics and interpret experimental data for biochemical and industrial applications.	K4

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3	-	-	1	-	-	1	-	-	-	-	3	-	-
CO2	-	3	-	-	1	-	-	1	1	-	-	-	3	-	1
CO3	-	3	1	-	2	-	-	-	1	-	-	-	3	-	2
CO4	-	2	2	1	2	-	-	1	1	-	-	-	2	1	2
CO5	-	-	2	2	2	-	1	3	2	-	-	-	1	1	2
Avg.	**1.0**	**2.8**	**1.7**	**1.5**	**1.6**	**-**	**1.0**	**1.5**	**1.2**	**-**	**-**	**-**	**2.4**	**1.0**	**1.8**

Text Books and Laboratory Manuals

1. Nicholas C. Price and Lewis Stevens, Fundamentals of Enzymology, Oxford University Press.
2. Satyanarayana U., Biochemistry, Elsevier.
3. Dixon, M. and Webb, E.C., Enzymes, Academic Press.
4. Bisswanger H., Enzyme Kinetics: Principles and Methods, Wiley-Blackwell.

Note: *The source sheet lists the experiments (and, for some laboratories, reference books). The description, objectives and outcomes are drafted here for the Board of Studies to confirm; for laboratories shared with the Biotechnology programme they are adapted from that programme's sheets.*

SEMESTER IV

GMBT2511: Animal Cell Culture and Techniques

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	IV	Core

Course Description

This course provides a comprehensive overview of techniques used to cultivate and manipulate animal cells in vitro. Students will learn principles and practices of cell culture, including media preparation, cell line establishment, maintenance, and characterization. Emphasis is placed on applications in biotechnology, drug development, and research in cell biology and medicine.

Course Objectives

1. Understand the principles of animal cell culture, including cell biology, growth kinetics, and culture environments.
2. Develop proficiency in sterile technique, media formulation, and maintaining cell viability and purity.
3. Learn techniques for cell line establishment, cryopreservation, and cell-based assays.
4. Explore the application of cell culture techniques in biopharmaceutical production and regenerative medicine.
5. Evaluate ethical considerations and regulatory guidelines in animal cell culture research and applications.

Note: *The source sheet listed only three outcomes, none matching the units. Five Course Outcomes aligned to the five units are given here.*

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Foundations of Animal Cell Culture.** History of Development of Cell Culture, Natural Surroundings of Animal Cell, Metabolic Capabilities of Animal Cell, Simulating Natural Conditions for Growing Animal Cells	12
2	**Media, Culture Systems and Cell Lines.** Serum and Serum Free Media, Cell Culture System, Secondary Culture: Transformed Animal cell, Commonly used Cell Lines and their Uses	12
3	**Growth Kinetics, Gene Expression and Transfection.** Growth Kinetics of Cells in Culture, Gene Expression and Application of Animal Cell Culture for Its Studies, Organ Culture, Transfection	12
4	**Cell Fusion, Hybridoma and Differentiation.** Cell Fusion, Selectable Marker and Antibiotic Resistance, Hybridoma and Monoclonal Antibodies, Transplantation of Cultured Cell, Differentiation of Cells	12
5	**Transgenic Animals, Cell Death and Embryo Transfer.** Transgenesis and Transgenic Animals, Apoptosis, Necrosis, Senescence and Quiescence, Embryo Transfer Technology	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level	Unit
CO1	Explain the history, natural surroundings and metabolic capabilities of animal cells and the principles of simulating them in vitro	K2	1

CO	Statement	Bloom level	Unit
CO2	Prepare and compare serum and serum-free media and culture systems, and identify commonly used cell lines	K3	2
CO3	Analyse growth kinetics of cultured cells and describe organ culture, gene expression studies and transfection	K4	3
CO4	Explain cell fusion, selectable markers, hybridoma technology, transplantation and differentiation of cultured cells	K2	4
CO5	Evaluate the applications and ethical aspects of transgenic animals, apoptosis, senescence and embryo transfer technology	K5	5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	-	-	-	-	-	-	-	-	-	1	2	-	-
CO2	2	3	-	-	1	-	-	-	-	-	-	1	3	-	-
CO3	1	3	1	-	2	-	-	-	-	-	-	-	3	-	1
CO4	-	2	2	1	2	-	-	-	-	-	-	2	2	1	2
CO5	-	2	2	2	3	-	-	1	-	-	-	2	2	2	3
Avg.	**1.7**	**2.6**	**1.7**	**1.5**	**2.0**	**-**	**-**	**1.0**	**-**	**-**	**-**	**1.5**	**2.4**	**1.5**	**2.0**

Text Books

1. Principles of Animal Cell Culture - Students Compendium, Basant Kumar Sinha and Rinesh Kumar M., International Book Distributing Co., First Edition, 2008
2. Freshney's Culture of Animal Cells A Manual of Basic Technique and Specialized Applications, Eighth Edition, Amanda Capes-Davis and R. Ian Freshney, Robert J. Geraghty and Raymond W. Nims, Wiley Blackwell, 2016
3. Introduction to Cell and Tissue Culture: Theory and Technique by Jennie P. Mather and Penelope E. Roberts

Reference Books

1. Tissue Culture Techniques: An Introduction by Paul F.A. Madson
2. Animal Cell Culture and Technology by Michael Butler and Kim Lee

GMBT2512: Molecular Diagnostics

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	IV	Core

Course Description

This course provides an in-depth exploration of the principles and applications of molecular diagnostics. Students will gain a comprehensive understanding of the techniques used in the detection and analysis of nucleic acids and proteins. The course will cover topics such as PCR, sequencing, microarrays, and the role of molecular diagnostics in personalized medicine, infectious disease, oncology, and genetic disorders. Laboratory sessions will offer hands-on experience with state-of-the-art diagnostic tools and techniques.

Course Objectives

1. To provide a thorough understanding of the principles underlying molecular diagnostics, including the chemistry and biology of nucleic acids and proteins.
2. To familiarize students with the various molecular diagnostic techniques such as PCR, sequencing, and microarrays.
3. To explore the clinical applications of molecular diagnostics in different fields such as oncology, infectious diseases, and genetic disorders.
4. To teach students how to analyze and interpret data generated from molecular diagnostic tests.
5. To discuss the ethical, legal, and regulatory issues surrounding molecular diagnostics.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Diagnostics and the Genetic Basis of Disease.** Introduction and History of diagnostics, Diseases- infectious, physiological and metabolic errors, genetic basis of diseases, inherited diseases. Infection – mode of transmission in infections, factors predisposing to microbial pathogenicity, types of infectious diseases- bacterial, viral, fungal, protozoans and other parasites. Philosophy and general approach to clinical specimens, Sample collection- method of collection, transport and processing of samples, Interpretation of results, Normal microbial flora of the human body, Host - Parasite relationships.	12
2	**Traditional Diagnostic Methods for Infectious and Fungal Diseases.** Traditional disease diagnosis methods and tools - diagnosis of infection caused by Streptococcus, Coliforms, Salmonella, Shigella, Vibrio, and Mycobacterium., Diagnosis of fungal infections. Major fungal diseases: Dermatophytosis, Candidiasis and Aspergillosis. Diagnosis of DNA and RNA viruses- Pox viruses, Adenoviruses, Rhabdo Viruses, Hepatitis Viruses and Retroviruses. Diagnosis of Protozoan diseases: Amoebiosis, Malaria, Trypnosomiosis, Leishmaniasis. Study of helminthic diseases- Fasciola hepatica and Ascaris lumbricoides. Filariasis and Schistosomiasis.	12
3	**Metabolic and Genetic Disorders and Cancer Genetics.** Major Metabolic disorders and its causes. Traditional methods for the diagnosis of metabolic errors. Disease due to genetic disorders - Identifying human disease genes, Cancer- different types of cancers, genetics of cancer- oncogenes, tumour suppressor genes. Methods available for the diagnosis of genetic diseases and metabolic disorders.	12
4	**Genetic Disorders and Prenatal Diagnostics.** Genetic disorders- Sickle cell anemia, Duchenne muscular Dystrophy, Retinoblastoma, Cystic Fibrosis and Sex – linked inherited disorders. Neonatal and Prenatal disease diagnostics. Gender identification using amelogenin gene locus. Amplification of Y chromosome specific Short Tandem Repeats (Y-STR). Analysis of mitochondrial DNA for maternal inheritance.	12

Unit	Title and contents	Hours
5	**Molecular Diagnosis of Disorders and Disorders of Blood and Muscle.** Molecular diagnosis for early detection of cerebral palsy, Down syndrome etc. Blood (formation, composition, function and pathology of blood disorders (haemoglobinopathies, sickle cell anemia, hemophilia), Muscle disorders (Duchene muscular dystrophy-DMD, Becker's muscular dystrophy-BMD, spinal muscular atrophy-SMA), Bone disorders (Osteogenesis imperfecta, Rheumatoid arthritis), Skin disorder (Albinism), Eye disorder (Retinitis pigmentosa	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Demonstrate a comprehensive understanding of the fundamental concepts in molecular diagnostics.	K3
CO2	Perform and troubleshoot various molecular diagnostic techniques in a laboratory setting.	K3
CO3	Analyze and interpret data from molecular diagnostic tests, understanding their implications in a clinical context.	K4
CO4	Apply knowledge of molecular diagnostics to case studies and real-world clinical scenarios.	K3
CO5	Critically evaluate the ethical, legal, and regulatory issues associated with molecular diagnostics and propose solutions to potential challenges.	K6

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	3	-	-	-	-	-	1	-	-	1
CO2	2	-	-	-	-	3	-	-	-	-	1	1	-	-	1
CO3	-	1	-	-	1	3	-	-	-	-	-	2	1	-	2
CO4	-	1	1	2	-	3	-	-	-	2	-	2	1	1	2
CO5	-	-	-	2	-	3	2	-	-	2	-	2	-	-	2
Avg.	**2.0**	**1.0**	**1.0**	**2.0**	**1.0**	**3.0**	**2.0**	**-**	**-**	**2.0**	**1.0**	**1.6**	**1.0**	**1.0**	**1.6**

Text Books

Reference Books

1. Medical Microbiology (1997), Edited by Greenwood, D, Slack, R and Peutherer, J, ELST Publishers.
2. Parasitology (1997), Chatterjee K.D, Chatterjee Medical Publishers.
3. Bailey & Scott's Diagnostic Microbiology (2002), Betty A. Forbes , Daniel F. Sahm, Alice S. Weissfeld , Ernest A. Trevino, Published by C.V. Mosby
4. Jawetz, Melnick, & Adelberg's Medical Microbiology (2004), Geo F. Brooks, Stephen A. Morse, Janet S. Butel.
5. Fundamentals of Molecular Diagnostics (2007). David E. Bruns, Edward R. Ashwood, Carl A. Burtis. Saunders Group.
6. Henry's Clinical Diagnosis And Management By Laboratory Methods (2007) Mcpherson
7. Molecular Diagnostics: Fundamentals, Methods & Clinical applications (2007). Lele Buckingham and Maribeth L. Flaws
8. Molecular Diagnostics for the Clinical Laboratorian 2Ed. 2006, W.B. Coleman. Humana Press.
9. Molecular Pathology in Clinical Practice (2007). D. G. B. Leonard.
10. Microbial Functional Genomics (2004) by J.Zhou, D.K. Thomson. Y.Xu. J.M. Tiedje. J.Wiley & Sons Publishers.

GMBT2513: Genomics, Proteomics and Computational Drug Design

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	IV	Core

Course Description

This course delves into the comprehensive fields of genomics, proteomics, and computational drug design. Students will explore the structure, function, and interactions of genomes and proteomes, and how these biological insights can be leveraged to design and optimize new therapeutic drugs. The curriculum covers high-throughput techniques, bioinformatics tools, and computational methods that are essential for modern drug discovery. Hands-on laboratory sessions and computational workshops will provide practical experience in genomic and proteomic analyses, as well as in silico drug design.

Course Objectives

1. To provide students with a solid foundation in the principles of genomics and proteomics.
2. To familiarize students with high-throughput technologies and bioinformatics tools used in genomics and proteomics research.
3. To develop skills in computational methods for drug design, including molecular modeling and virtual screening.
4. To integrate genomic and proteomic data in the context of drug discovery and development.
5. To enhance the ability to critically analyze and interpret scientific literature and data in genomics, proteomics, and computational drug design.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction.** Genomics Overview, Importance of genomics, DNA Sequencing Techniques, Sanger sequencing, Next-generation sequencing (NGS), Genomic Databases, Proteomics overview, Role of proteomics in biology	12
2	**Functional Genomics and Transcriptomics.** Functional Genomics, Gene function annotation, RNA interference (RNAi, si RNA & mi-RNA), Transcriptomics, RNA-Seq analysis, microarray analysis, Gene Expression Data Analysis, Analyzing gene expression profiles, Data visualization and interpretation	12
3	**Proteomics and Structural Biology.** Mass Spectrometry in Proteomics, Principles of mass spectrometry, Protein identification and quantification, Techniques for protein quantification, Applications in disease research, Structural Biology Techniques, Determining protein structures, X-ray crystallography and NMR, Structure-Based Drug Design, Molecular docking and dynamics simulations	12
4	**Computational Drug Design.** Drug Discovery Overview, Stages of drug development, Role of computational methods, Virtual Screening and Ligand-Based Design, Pharmacophore modeling, Docking and virtual screening, Structure-Based Drug Design, Homology modeling, Rational drug design techniques, Drug ADMET Analysis, Absorption, distribution, metabolism, excretion, and toxicity, In silico toxicity prediction	12
5	**Applications and Ethical Considerations.** Personalized Medicine and Biotechnology, Genomics and personalized medicine, Case studies in biotechnology, Ethical and Legal Aspects, Ethical considerations in genomics and drug design, Intellectual property and regulatory issues, Future Trends and Course Conclusion, Emerging trends in genomics, proteomics, and drug design.	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Demonstrate a comprehensive understanding of the core concepts in genomics, proteomics, and computational drug design.	K3
CO2	Employ high-throughput genomic and proteomic techniques, as well as bioinformatics tools, to analyze biological data.	K4
CO3	Apply computational methods for drug design, including molecular modeling, docking, and virtual screening.	K6
CO4	Analyze and interpret complex genomic and proteomic data, integrating these findings into the drug discovery process.	K4
CO5	Critically evaluate scientific literature in the fields of genomics, proteomics, and computational drug design, and effectively communicate findings.	K6

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	2	-	-	-	-	-	-	-	-	2	-	2	-
CO2	1	-	3	-	-	-	-	-	-	-	-	2	-	3	-
CO3	-	-	3	1	1	-	-	-	-	-	-	2	1	3	-
CO4	-	-	3	2	2	-	-	-	-	1	-	2	1	3	1
CO5	-	-	2	3	2	1	-	-	-	2	-	3	-	3	2
Avg.	**1.5**	**-**	**2.6**	**2.0**	**1.7**	**1.0**	**-**	**-**	**-**	**1.5**	**-**	**2.2**	**1.0**	**2.8**	**1.5**

Text Books

1. "Principles of Genetics" by D. Peter Snustad and Michael J. Simmons
2. "Genomes" by T.A. Brown
3. "Principles of Proteomics" by Richard Twyman
4. "Proteomics: From Protein Sequence to Function" by S. Pennington and P. Dunn
5. "Principles of Computer-Aided Drug Discovery" by D. D. Suri and Michael K. Gilson

GMBT2514: Biosafety and Bioethics

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	IV	Core

Course Description

This course introduces the fundamental principles of biosafety and bioethics in biological sciences, biotechnology, biomedical research, and healthcare. It covers laboratory biosafety practices, biosafety regulations, risk assessment, waste management, and safe handling of biological materials. The course also explores ethical principles in biological research, genetic engineering, stem cell research, clinical trials, animal experimentation, intellectual property rights, and regulatory frameworks. Students will develop an understanding of responsible scientific conduct and ethical decision-making in research and biotechnology.

Course Objectives

1. To understand the principles and importance of biosafety in biological laboratories and research.
2. To explain biosafety guidelines, laboratory risk assessment, and biological waste management practices.
3. To understand the ethical principles governing biological and biomedical research.
4. To familiarize students with national and international biosafety regulations and ethical guidelines.
5. To develop awareness of responsible conduct in research, intellectual property rights, and emerging ethical issues in biotechnology.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Biosafety.** Introduction to biosafety; Concepts and importance of biosafety; Laboratory hazards biological, chemical, physical and mechanical hazards; Risk groups of microorganisms (RG1– RG4); Biosafety Levels (BSL-1 to BSL-4) and their characteristics; Laboratory design and safety equipment; Personal Protective Equipment (PPE); Good Laboratory Practices (GLP); Biosafety symbols and signage.	12
2	**Biosafety Practices and Waste Management.** Laboratory risk assessment; Safe handling, transport and storage of biological materials; Sterilization and disinfection methods; Decontamination procedures; Biomedical waste management; Segregation, collection and disposal of biological waste; Spill management; Emergency response procedures; Occupational health and laboratory-acquired infections.	12
3	**Introduction to Bioethics.** Definition, principles and scope of bioethics; History and evolution of bioethics; Ethical principles Autonomy, Beneficence, Non-maleficence and Justice; Informed consent; Confidentiality and privacy; Research misconduct fabrication, falsification and plagiarism; Responsible conduct of scientific research.	12
4	**Ethical Issues in Biotechnology and Biomedical Research.** Ethical issues in recombinant DNA technology; Genetic testing and genetic counseling; Human genome research; Stem cell research; Gene editing (CRISPR-Cas9) and gene therapy (overview); Animal ethics and CPCSEA guidelines; Clinical trials and Institutional Ethics Committees (IEC); Biosafety regulations for genetically modified organisms (GMOs).	12
5	**Biosafety Regulations, Intellectual Property Rights and Emerging Issues.** National and international biosafety guidelines; Institutional Biosafety Committee (IBSC); Recombinant DNA safety guidelines; Cartagena Protocol on Biosafety; Intellectual Property Rights (IPR) Patents, copyrights, trademarks and geographical indications (overview); Biosafety in agriculture, food, healthcare and industry; Dual-use research; Emerging ethical issues in biotechnology, artificial intelligence in healthcare and future perspectives.	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the principles of biosafety, laboratory safety practices, and biological risk assessment.	K2
CO2	Apply appropriate biosafety measures, waste management procedures, and standard laboratory practices for handling biological materials.	K3
CO3	Demonstrate an understanding of ethical principles, responsible conduct of research, and professional integrity in life sciences.	K2
CO4	Evaluate ethical and biosafety issues related to genetic engineering, stem cell research, clinical trials, and genetically modified organisms.	K5
CO5	Interpret national and international biosafety regulations, intellectual property rights, and regulatory frameworks governing biological research and biotechnology.	K4

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	1	-	-	3	-	-	-	-	1	-	-	-
CO2	-	-	-	1	-	1	3	-	-	-	-	1	-	-	-
CO3	-	-	-	2	-	-	3	1	-	-	-	1	-	-	-
CO4	-	-	-	2	-	1	3	1	-	1	-	2	-	-	-
CO5	-	-	-	2	-	-	3	2	1	1	-	2	-	-	-
Avg.	**-**	**-**	**-**	**1.6**	**-**	**1.0**	**3.0**	**1.3**	**1.0**	**1.0**	**-**	**1.4**	**-**	**-**	**-**

Text Books

1. Sateesh, M. K. (2010). Bioethics and Biosafety. I.K. International Publishing House.
2. Fleming, D. O., & Hunt, D. L. (2006). Biological Safety: Principles and Practices (4th Ed.). ASM Press.

Reference Books

1. World Health Organization (WHO). Laboratory Biosafety Manual (4th Ed.).
2. National Academy of Sciences. On Being a Scientist: A Guide to Responsible Conduct in Research (3rd Ed.).
3. Indian Council of Medical Research (ICMR). National Ethical Guidelines for Biomedical and Health Research Involving Human Participants (Latest Edition).
4. Department of Biotechnology (DBT), Government of India. Recombinant DNA Safety Guidelines.
5. Prescott, L. M., Harley, J. P., & Klein, D. A. Microbiology. McGraw-Hill.

GMBT2601: Program Elective 1

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	IV	Program Elective

Code	Course title	L-T-P-C	Hours	Status
GMBT2601(A)	Biomedical Applications of Advanced Materials	3-0-0-3	45	Syllabus not in source document
GMBT2601(B)	Clinical Research and Trial Design	3-0-0-3	45	Syllabus not in source document
GMBT2601(C)	Bioelectronics and Biosensors	3-0-0-3	45	Syllabus not in source document

One option is chosen from the basket. The OBE course sheet for each option (description, objectives, five units with hours, outcomes, CO-PO-PSO mapping and text books) is to be attached using the blank template at the end of Part E.

GMBT2602: Program Elective 2

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	IV	Program Elective

Code	Course title	L-T-P-C	Hours	Status
GMBT2602(A)	cGMP Facilities and Manufacturing	3-0-0-3	45	Syllabus not in source document
GMBT2602(B)	Regulatory Affairs in Biopharmaceuticals	3-0-0-3	45	Syllabus not in source document
GMBT2602(C)	Virology and Vaccine Technology	3-0-0-3	45	Syllabus not in source document

One option is chosen from the basket. The OBE course sheet for each option (description, objectives, five units with hours, outcomes, CO-PO-PSO mapping and text books) is to be attached using the blank template at the end of Part E.

GMBL2505: Genomics and Proteomics Lab

L	T	P	C	Total practical hours	Semester	Category
0	0	4	2	60	IV	Laboratory

Course Description

This laboratory course introduces the computational tools and databases used in genomics and proteomics. Students retrieve sequence and structural records from NCBI, UniProt and PDB, perform pairwise and multiple sequence alignments, study the principles of X-ray crystallography and NMR, predict and validate protein structures, analyse differential gene expression with GEO2R, predict toxicity, and analyse metabolomic data to study metabolic pathways.

Course Objectives

1. To retrieve nucleotide, protein and structural data from public biological databases.
2. To perform global, local and multiple sequence alignments with standard tools.
3. To explain structure-determination techniques and to predict and validate protein three-dimensional structures.
4. To analyse gene expression datasets and interpret functional genomic information.
5. To apply toxicity prediction and metabolomic data analysis to the study of metabolic pathways.

List of Experiments with Hours

Expt.	Experiment	Hours
1	Introduction to NCBI Databases and Sequence Retrieval	6
2	Introduction to UniProt and PDB Databases for Protein Analysis	6
3	Sequence Alignment: Global and Local Alignment	6
4	Multiple Sequence Alignment with ClustalW	6
5	Techniques for Studying Protein Structure: X-ray Crystallography and NMR Spectroscopy	6
6	Computational Prediction of Protein Structures Using SWISS-MODEL	6
7	Protein Structure Validation Using Ramachandran Plot	6
8	Differential Gene Expression Analysis Using GEO2R	6
9	Toxicity Prediction Using Protox 3	6
10	Analysis of Metabolomic Data to Study Metabolic Pathways and Their Regulation	6
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Retrieve and annotate nucleotide, protein and structural records from NCBI, UniProt and PDB	K3
CO2	Perform global, local and multiple sequence alignments and interpret the results	K4
CO3	Explain X-ray crystallography and NMR, and predict and validate protein structures using SWISS-MODEL and the Ramachandran plot	K3
CO4	Analyse differential gene expression datasets using GEO2R	K4
CO5	Apply toxicity prediction tools and analyse metabolomic data to interpret metabolic pathways	K4

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	1	2	-	-	-	-	-	-	-	-	2	-	2	-
CO2	-	-	3	-	1	-	-	-	-	-	-	2	-	3	-
CO3	-	-	3	-	1	-	-	-	1	-	-	2	-	3	1
CO4	-	-	3	2	2	-	-	1	-	-	-	2	-	3	1
CO5	-	-	2	2	2	-	-	3	2	1	-	3	-	2	2
Avg.	**-**	**1.0**	**2.6**	**2.0**	**1.5**	**-**	**-**	**2.0**	**1.5**	**1.0**	**-**	**2.2**	**-**	**2.6**	**1.3**

Text Books and Laboratory Manuals

1. Mount, D. W. Bioinformatics: Sequence and Genome Analysis. 2nd Edition. Cold Spring Harbor Laboratory Press.
2. Lesk, A. M. Introduction to Bioinformatics. 6th Edition. Oxford University Press.
3. Pevsner, J. Bioinformatics and Functional Genomics. 4th Edition. Wiley-Blackwell.
4. Rastogi, S. C., Mendiratta, N., & Rastogi, P. Bioinformatics: Methods and Applications. 4th Edition. PHI Learning.
5. Baxevanis, A. D., & Bader, G. D. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. 4th Edition. Wiley.

Note: *The source sheet lists the experiments (and, for some laboratories, reference books). The description, objectives and outcomes are drafted here for the Board of Studies to confirm; for laboratories shared with the Biotechnology programme they are adapted from that programme's sheets. Reference books were not given in the source for this laboratory; the recommended reading is carried over from the corresponding Biotechnology sheet.*

GMBL2506: Molecular Diagnostics Lab

L	T	P	C	Total practical hours	Semester	Category
0	0	4	2	60	IV	Laboratory

Course Description

This laboratory course gives practical training in PCR-based molecular diagnostics. Students amplify disease-associated genes, detect polymorphisms and point mutations by PCR-RFLP, ARMS-PCR and SNP assays, detect and identify pathogens by conventional, multiplex and 16S rRNA gene PCR, design and validate primers, analyse DNA sequences for mutations, and apply colony PCR and STR/VNTR fingerprinting.

Course Objectives

1. To amplify disease-associated genes and optimise PCR parameters.
2. To detect genetic polymorphisms and point mutations by PCR-RFLP, ARMS-PCR and PCR-based SNP methods.
3. To detect and identify pathogens by conventional PCR, multiplex PCR and 16S rRNA gene PCR.
4. To design and validate primers and analyse DNA sequences using bioinformatics tools.
5. To apply colony PCR and DNA fingerprinting (STR/VNTR) and interpret the results for diagnostic use.

List of Experiments with Hours

Expt.	Experiment	Hours
1	PCR Amplification of Disease-Associated Genes	5
2	Detection of Genetic Polymorphisms using PCR–Restriction Fragment Length Polymorphism (PCR-RFLP)	5
3	Detection of Pathogens by Conventional Polymerase Chain Reaction (PCR)	5
4	Detection of Point Mutations using Allele-Specific PCR (ARMS-PCR)	5
5	Multiplex PCR for Simultaneous Detection of Multiple Gene Targets	5
6	DNA Sequence Analysis and Mutation Identification using Bioinformatics Tools	5
7	Primer Design and Validation for Molecular Diagnostic Assays	5
8	Optimization of PCR Amplification Parameters	5
9	Colony PCR for Screening of Recombinant Clones	5
10	DNA Fingerprinting using Variable Number Tandem Repeat (VNTR)/Short Tandem Repeat (STR) Analysis	5
11	Detection of Single Nucleotide Polymorphisms (SNPs) using PCR-Based Methods	5
12	Molecular Identification of Microorganisms using 16S rRNA Gene PCR	5
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Perform PCR amplification of disease-associated genes and optimise amplification parameters	K3
CO2	Detect genetic polymorphisms and point mutations using PCR-RFLP, ARMS-PCR and PCR-based SNP detection	K3
CO3	Detect and identify pathogens using conventional PCR, multiplex PCR and 16S rRNA gene PCR	K3

CO	Statement	Bloom level
CO4	Design and validate primers and analyse DNA sequences to identify mutations using bioinformatics tools	K4
CO5	Apply colony PCR and STR/VNTR fingerprinting and interpret results for diagnostic and forensic use	K4

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3	-	-	1	-	-	1	-	-	-	-	3	-	-
CO2	-	3	-	-	1	-	-	1	1	-	-	-	3	-	1
CO3	-	3	1	-	2	-	-	-	1	-	-	-	3	-	2
CO4	-	2	2	1	2	-	-	1	1	-	-	-	2	1	2
CO5	-	-	2	2	2	-	1	3	2	-	-	-	1	1	2
Avg.	**1.0**	**2.8**	**1.7**	**1.5**	**1.6**	**-**	**1.0**	**1.5**	**1.2**	**-**	**-**	**-**	**2.4**	**1.0**	**1.8**

Text Books and Laboratory Manuals

1. Bruns, D. E., Ashwood, E. R., & Burtis, C. A. Fundamentals of Molecular Diagnostics (2007). Saunders.
2. Buckingham, L., & Flaws, M. L. Molecular Diagnostics: Fundamentals, Methods and Clinical Applications (2007).
3. Coleman, W. B., & Tsongalis, G. J. Molecular Diagnostics for the Clinical Laboratorian, 2nd ed. (2006). Humana Press.
4. Leonard, D. G. B. Molecular Pathology in Clinical Practice (2007).

Note: *The source sheet lists the experiments (and, for some laboratories, reference books). The description, objectives and outcomes are drafted here for the Board of Studies to confirm; for laboratories shared with the Biotechnology programme they are adapted from that programme's sheets.*

SEMESTER V

GMBT3515: Metabolic Engineering and Systems Biology

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	V	Core

Course Description

This course provides an integrated understanding of Metabolic Engineering and Systems Biology, focusing on the analysis, regulation, and engineering of cellular metabolic networks. It introduces the principles of metabolic pathway analysis, metabolomics, fluxomics, metabolic flux analysis, and computational modeling for studying complex biological systems. Students will gain hands-on knowledge of modern tools for metabolic network reconstruction, pathway engineering, and multi-omics data integration. The course explores strategies for improving cellular performance and designing microbial systems for the production of pharmaceuticals, biofuels, biomaterials, and other value-added products. It also highlights emerging applications in precision medicine, synthetic biology, industrial biotechnology, and sustainable bioprocess development, preparing students for research and innovation in modern life sciences.

Course Objectives

1. Understand the principles of metabolic engineering and systems biology.
2. Analyze metabolic pathways and their regulation using computational and experimental approaches.
3. Apply metabolomics and fluxomics for studying cellular metabolism.
4. Utilize systems biology tools for metabolic network reconstruction and engineering.
5. Design metabolic engineering strategies for industrial biotechnology, healthcare, and synthetic biology applications.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to Systems Biology and Cellular Metabolism.** Introduction to Systems Biology ; Components of biological systems: DNA, RNA, Proteins and Metabolites ; Properties and functions of biological molecules ; Overview of cellular metabolism ; Enzyme kinetics and metabolic pathways ; Online resources and databases for studying metabolism: KEGG, EcoCyc, MetaCyc and BioCyc	12
2	**Omics Technologies and Metabolomics.** Introduction to Omics technologies ; Biological networks: Genome, Transcriptome, Proteome, Metabolome and Fluxome ; Principles and applications of metabolomics ; Analytical methods for metabolite detection and quantification ; Workflow in metabolomics ; Statistical methods in metabolomics ; Pathway and metabolome databases ; Case studies in metabolomics	12
3	**Metabolic Networks and Constraint-Based Modeling.** Central and secondary metabolic pathways in microbes, plants and animals ; Reconstruction of metabolic networks ; Stoichiometric matrix and network representation ; Topological analysis of metabolic networks ; Elementary Flux Modes (EFMs) ; Extreme Pathways ; Constraint-based metabolic modeling ; Flux Balance Analysis (FBA) ; Software tools and online resources	12
4	**Metabolic Flux Analysis and Fluxomics.** Metabolic phenotypes ; Fundamentals of Metabolic Flux Analysis (MFA) ; Stable isotope (^13C) labeling ; Steady-state and non-stationary MFA ; Isotopomer analysis ; Carbon transition networks ; Mathematical modeling for in vivo flux estimation ; Flux maps ; Software tools for flux analysis	12

Unit	Title and contents	Hours
5	**Applications of Systems Biology and Metabolic Engineering.** Case studies on constraint-based metabolic modelling ; Applications of Flux Balance Analysis in metabolic engineering ; Applications of 13C Metabolic Flux Analysis ; Drug target identification using metabolic network models ; Metabolic engineering strategies for strain improvement ; Understanding metabolic alterations in diseases (e.g., cancer metabolism) ; Emerging trends in systems biology and metabolic engineering	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the principles of metabolic engineering and systems biology for understanding cellular metabolism.	K2
CO2	Analyze metabolic pathways, regulatory mechanisms, and biological networks using stoichiometric and computational approaches.	K4
CO3	Apply metabolomics, fluxomics, and metabolic flux analysis techniques to investigate cellular physiology and metabolic engineering problems.	K4
CO4	Design metabolic engineering strategies using computational models to enhance product yield, develop novel biosynthetic pathways, and optimize microbial cell factories.	K6
CO5	Evaluate contemporary applications of systems metabolic engineering in biotechnology, healthcare, synthetic biology, precision medicine, and industrial bioprocesses.	K5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	-	2	-	2	-	-	1
CO2	1	1	-	-	-	-	-	-	-	2	-	2	1	-	1
CO3	-	2	-	-	1	-	-	-	-	3	-	2	2	-	1
CO4	-	-	1	1	2	1	-	-	-	3	-	3	1	1	2
CO5	-	-	-	2	1	2	2	-	-	3	-	3	-	-	2
Avg.	**1.5**	**1.5**	**1.0**	**1.5**	**1.3**	**1.5**	**2.0**	**-**	**-**	**2.6**	**-**	**2.4**	**1.3**	**1.0**	**1.4**

Text Books

1. Systems Biology: Properties of Reconstructed Networks Edited by Bernhard O. Palsson, Cambridge University Press, 2006, ISBN: 978-0521859035
2. Introduction to Systems Biology, Edited by Choi, Sangdun, Springer Publishers, 2007

Reference Books

1. Metabolomics – A powerful Tool in Systems Biology, Edited by J.Nielsen and M.C. Jewett, Springer Publishers, 2007
2. Metabolic Flux Analysis-Methods and protocols Edited by Jens O. Krömer, Lars K. Nielsen, Lars M. Blank, Springer Publishers, 2014
3. Additional reference material and scientific papers will be provided.

GMBT3516: Cancer Biology

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	V	Core

Course Description

This course provides an integrated understanding of the molecular and cellular basis of cancer, focusing on the mechanisms underlying tumor initiation, progression, metastasis, and therapeutic response. It introduces the principles of cancer genetics, cell signaling, tumor immunology, cancer stem cells, and experimental models used in cancer research. Students will gain knowledge of the molecular alterations driving carcinogenesis, including oncogenes, tumor suppressor genes, epigenetic modifications, genome instability, and immune evasion. The course also explores modern diagnostic approaches and emerging therapeutic strategies such as chemotherapy, immunotherapy, targeted therapy, gene therapy, and precision oncology. It prepares students to understand current advances in translational cancer research and equips them with the knowledge required for careers in biomedical research, oncology, biotechnology, and precision medicine.

Course Objectives

1. Understand the fundamental concepts of cancer biology, including the mechanisms of carcinogenesis and tumor progression.
2. Analyze the molecular and cellular pathways involved in cancer development and metastasis.
3. Explain the role of oncogenes, tumor suppressor genes, epigenetic regulation, and the tumor microenvironment in cancer.
4. Evaluate experimental models, diagnostic approaches, and modern therapeutic strategies used in cancer research and clinical oncology.
5. Apply the principles of cancer biology to research in precision medicine, immuno- oncology, and translational cancer therapeutics.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Fundamentals of Cancer Biology.** Introduction to Cancer ; Hallmarks of Cancer ; Cancer initiation, promotion, and progression ; Causes of cancer: genetic, environmental, chemical, physical, and biological factors ; Classification of cancers ; Different cell types and their associated cancers ; Rare cancers ; Cancer epidemiology and cancer registries	12
2	**Molecular Mechanisms of Cancer.** Cellular proto-oncogenes and oncogenes ; Growth factors and growth factor receptors ; Transcription factors in cancer ; Retroviral oncogenes ; Tumor suppressor genes ; Cell signaling pathways in cancer ; DNA viruses and cellular immortalization ; DNA methylation and epigenetic regulation ; Epigenetic silencing of tumor suppressor genes	12
3	**Cellular Basis of Tumorigenesis.** Cell cycle regulation and checkpoints ; Genome instability ; DNA damage response and DNA repair mechanisms ; Apoptosis and cellular senescence ; Multistep tumorigenesis ; Cancer stem cells ; Tumour relapse and recurrence ; Cancer therapy-associated health complications	12
4	**Tumour Microenvironment and Experimental Models.** Introduction to tumour immunology ; Immune surveillance and immune evasion ; Tumour-associated macrophages (TAMs) ; Cancer-associated fibroblasts (CAFs) ; Cancers of immune cells and their molecular mechanisms ; Biological models in cancer research ; Cancer cell lines ; Tumour organoids ; Animal models for cancer research	12
5	**Cancer Diagnosis and Therapeutics.** Conventional and molecular diagnosis of cancer ; Cancer biomarkers ; Chemotherapy ; Radiation therapy ; Targeted therapy ; Immunotherapy ; Gene therapy ; Monoclonal antibody-based therapies ; Personalized medicine ; Mechanisms of therapeutic resistance ; Emerging trends in cancer diagnosis and treatment	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the fundamental principles of cancer biology, including carcinogenesis, tumour progression, and the hallmarks of cancer.	K2
CO2	Analyse the molecular and cellular mechanisms involved in cancer development, including oncogenic signalling, tumour suppressor pathways, and epigenetic regulation.	K4
CO3	Evaluate the role of the tumour microenvironment, immune system, cancer stem cells, and experimental models in cancer research.	K5
CO4	Apply knowledge of modern diagnostic techniques and therapeutic approaches, including targeted therapy, immunotherapy, gene therapy, and precision oncology.	K3
CO5	Assess current advances in translational cancer research and identify emerging opportunities in cancer prevention, diagnosis, and treatment.	K5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	3	-	-	-	-	-	1	-	-	1
CO2	2	-	-	-	-	3	-	-	-	-	1	1	-	-	1
CO3	-	1	-	-	1	3	-	-	-	-	-	2	1	-	2
CO4	-	1	1	2	-	3	-	-	-	2	-	2	1	1	2
CO5	-	-	-	2	-	3	2	-	-	2	-	2	-	-	2
Avg.	**2.0**	**1.0**	**1.0**	**2.0**	**1.0**	**3.0**	**2.0**	**-**	**-**	**2.0**	**1.0**	**1.6**	**1.0**	**1.0**	**1.6**

Text Books

1. Weinberg, R. A. (2023). The Biology of Cancer (3rd Edition). Garland Science, Taylor & Francis.
2. Pecorino, L. (2021). Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics (5th Edition). Oxford University Press.

Reference Books

1. Kumar, Abbas, & Aster. (2024). Robbins & Cotran Pathologic Basis of Disease (11th Edition). Elsevier.
2. DeVita, Hellman, & Rosenberg. (2023). Cancer: Principles & Practice of Oncology (12th Edition). Wolters Kluwer.
3. Croce, C. M., & Brenner, M. K. (Eds.). (2022). Molecular Basis of Cancer (5th Edition). Elsevier.
4. Hanahan, D., & Weinberg, R. A. Hallmarks of Cancer: The Next Generation. Cell.
5. Alberts, B., et al. Molecular Biology of the Cell. Garland Science.
6. Kufe, D. W., et al. Holland-Frei Cancer Medicine. Wiley-Blackwell.
7. National Cancer Institute (NCI). Cancer Biology Resources.
8. Recent review articles from Nature Reviews Cancer, Cancer Discovery, Cell, and The Lancet Oncology.

GMBT3517: Pharmacology and Pharmacovigilance

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	V	Core

Course Description

This course provides a comprehensive understanding of the principles of pharmacology and pharmacovigilance, emphasizing the safe, effective, and rational use of medicines. It introduces the mechanisms of drug action, pharmacokinetics, pharmacodynamics, adverse drug reactions, drug interactions, and principles of clinical pharmacology. Students will gain knowledge of pharmacovigilance systems, adverse event reporting, signal detection, risk assessment, regulatory requirements, and global drug safety practices. The course also explores modern approaches in pharmacoepidemiology, pharmacogenomics, real-world evidence, and artificial intelligence applications in drug safety monitoring. It prepares students for careers in pharmaceutical industries, clinical research, healthcare organizations, regulatory agencies, and drug safety management.

Course Objectives

1. Understand the fundamental principles of pharmacology, including pharmacokinetics and pharmacodynamics.
2. Explain the mechanisms of drug action, adverse drug reactions, and drug interactions.
3. Analyse the principles and practices of pharmacovigilance and drug safety monitoring.
4. Evaluate regulatory guidelines, pharmacovigilance systems, and risk management strategies for medicines.
5. Apply pharmacological and pharmacovigilance concepts in clinical research, healthcare, and pharmaceutical industries.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Fundamentals of Pharmacology.** Introduction to Pharmacology ; History and scope of pharmacology ; Drug nomenclature and classification ; Routes of drug administration ; Pharmacokinetics: Absorption, Distribution, Metabolism, and Excretion (ADME) ; Pharmacodynamics: Mechanisms of drug action ; Drug receptors and receptor theories ; Dose-response relationships ; Therapeutic index and therapeutic drug monitoring	12
2	**Principles of Clinical Pharmacology.** Autonomic pharmacology ; Pharmacology of the cardiovascular, respiratory, gastrointestinal, endocrine, and central nervous systems ; Chemotherapy and antimicrobial agents ; Drug interactions ; Adverse Drug Reactions (ADRs): Classification, mechanisms, and prevention ; Medication errors ; Rational use of medicines ; Pharmacogenomics and personalized medicine	12
3	**Fundamentals of Pharmacovigilance.** Introduction to Pharmacovigilance ; History and evolution of pharmacovigilance ; WHO Programme for International Drug Monitoring ; National Pharmacovigilance Programme of India (PvPI) ; Pharmacovigilance terminology and definitions ; Individual Case Safety Reports (ICSRs) ; Adverse Event Following Immunization (AEFI) ; Causality assessment methods ; Signal detection and signal validation	12
4	**Pharmacovigilance Systems and Regulatory Affairs.** Pharmacovigilance in clinical trials ; Post-marketing surveillance ; Risk Management Plans (RMPs) ; Periodic Safety Update Reports (PSURs) ; Benefit-risk assessment ; Good Pharmacovigilance Practices (GVP) ; International regulatory agencies: WHO, CDSCO, US FDA, EMA, MHRA, ICH ; Electronic reporting systems and pharmacovigilance databases (VigiBase, FAERS, EudraVigilance)	12

Unit	Title and contents	Hours
5	**Emerging Trends in Pharmacology and Pharmacovigilance.** Pharmacoepidemiology ; Real-world evidence in drug safety ; Artificial Intelligence and Machine Learning in pharmacovigilance ; Big data and pharmacovigilance analytics ; Pharmacovigilance for biologics, biosimilars, vaccines, and medical devices ; Medication safety in special populations (Paediatrics, Geriatrics, Pregnancy) ; Ethical and legal aspects of pharmacovigilance ; Case studies on major drug withdrawals and safety alerts	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the principles of pharmacology, including pharmacokinetics, pharmacodynamics, and mechanisms of drug action.	K2
CO2	Analyse adverse drug reactions, drug interactions, and factors influencing drug safety and efficacy.	K4
CO3	Apply the principles of pharmacovigilance for the detection, assessment, reporting, and prevention of adverse drug reactions.	K3
CO4	Evaluate pharmacovigilance systems, regulatory guidelines, and risk management strategies for ensuring patient safety.	K5
CO5	Assess emerging technologies, real-world evidence, and artificial intelligence applications in pharmacology and pharmacovigilance for improving healthcare outcomes.	K5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	-	2	-	2	-	-	1
CO2	1	1	-	-	-	-	-	-	-	2	-	2	1	-	1
CO3	-	2	-	-	1	-	-	-	-	3	-	2	2	-	1
CO4	-	-	1	1	2	1	-	-	-	3	-	3	1	1	2
CO5	-	-	-	2	1	2	2	-	-	3	-	3	-	-	2
Avg.	**1.5**	**1.5**	**1.0**	**1.5**	**1.3**	**1.5**	**2.0**	**-**	**-**	**2.6**	**-**	**2.4**	**1.3**	**1.0**	**1.4**

Text Books

1. Katzung, B. G., Vanderah, T. W. (2024). Basic and Clinical Pharmacology (16th Edition). McGraw-Hill Education.
2. Rang, H. P., Ritter, J. M., Flower, R. J., & Henderson, G. (2023). Rang & Dale's Pharmacology (10th Edition). Elsevier.

Reference Books

1. Brunton, L. L., Hilal-Dandan, R., & Knollmann, B. C. (2023). Goodman & Gilman's The Pharmacological Basis of Therapeutics (14th Edition). McGraw-Hill.
2. Mann, R. D., & Andrews, E. (Eds.). (2021). Pharmacovigilance (3rd Edition). Wiley- Blackwell.
3. Edwards, I. R., & Aronson, J. K. (Eds.). Meyler's Side Effects of Drugs: The International Encyclopedia of Adverse Drug Reactions and Interactions. Elsevier.
4. World Health Organization (WHO). The Importance of Pharmacovigilance: Safety Monitoring of Medicinal Products.
5. WHO. Safety Monitoring of Medicinal Products: Guidelines for Setting up and Running a Pharmacovigilance Centre.

6. ICH Guidelines (E2 Series) on Pharmacovigilance.
7. European Medicines Agency (EMA). Good Pharmacovigilance Practices (GVP).
8. Central Drugs Standard Control Organization (CDSCO). Pharmacovigilance Programme of India (PvPI) Guidance Documents.

GMBT3518: Precision Medicine and Genomic Therapeutics

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	V	Core

Course Description

This course explores the evolving landscape of precision medicine and genomic therapeutics, focusing on tailoring healthcare interventions based on individual genetic profiles, environmental influences, and lifestyle factors. It introduces the principles, tools, and applications of genomics, pharmacogenomics, gene therapy, RNA therapeutics, and emerging technologies such as CRISPR-based therapeutics. Case studies of monogenic and complex diseases are included to demonstrate translational approaches from bench to bedside.

Course Objectives

1. To understand the foundations and scope of precision medicine in healthcare.
2. To explore genomic and multi-omics tools for disease diagnosis, prognosis, and treatment.
3. To analyze pharmacogenomic variations and their impact on drug efficacy and safety.
4. To examine gene-based and RNA-based therapeutic platforms.
5. To evaluate current clinical applications and ethical issues in genomic medicine.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Foundations of Precision Medicine.** Definition and historical evolution of precision medicine ; Personalized vs precision medicine ; Role of genomics, epigenomics, transcriptomics, and proteomics ; Clinical and translational research in precision medicine ; Biomarkers and companion diagnostics	12
2	**Genomics and Disease Stratification.** Whole genome and exome sequencing in clinical settings ; Rare and common genetic variants ; Molecular subtyping of diseases (e.g., cancer, neurological disorders) ; Integrative omics and systems biology in disease prediction ; Case studies: cancer genomics, rare genetic diseases, metabolic disorders	12
3	**Pharmacogenomics and Drug Response.** Genetic polymorphisms in drug metabolism (e.g., CYP450 enzymes) ; Genotype-guided drug dosing and adverse drug reactions ; Pharmacogenomic testing in clinical practice (e.g., warfarin, clopidogrel, antidepressants) ; Drug-gene interactions and regulatory frameworks (FDA, EMA guidelines) ; Clinical decision support tools and databases (PharmGKB, CPIC)	12
4	**Genomic Therapeutics and Gene Editing.** Gene therapy strategies: gene replacement, silencing, editing ; Viral and non-viral vectors for gene delivery ; RNA-based therapeutics: antisense oligonucleotides, siRNA, mRNA vaccines ; Genome editing platforms: ZFNs, TALENs, CRISPR-Cas systems ; Clinical applications and regulatory approvals (e.g., Luxturna, Zolgensma, Casgevy)	12
5	**Implementation, Challenges, and Future Directions.** Precision medicine initiatives: All of Us (USA), Genomics England, GenomeAsia 100K ; Integration into clinical practice and healthcare systems ; Bioinformatics tools and databases for precision medicine ; Ethical, legal, and social implications (ELSI) of genomic data ; Future directions: digital twins, AI in precision medicine, gene-environment interactions	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the principles and applications of precision medicine and its components.	K2

CO	Statement	Bloom level
CO2	Interpret genomic data for clinical decision-making and personalized therapy.	K4
CO3	Assess pharmacogenomic profiles and recommend individualized treatments.	K5
CO4	Evaluate the mechanisms, platforms, and applications of gene and RNA therapeutics.	K5
CO5	Critically analyze real-world case studies and ethical issues in genomic medicine.	K4

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	-	2	-	2	-	-	1
CO2	1	1	-	-	-	-	-	-	-	2	-	2	1	-	1
CO3	-	2	-	-	1	-	-	-	-	3	-	2	2	-	1
CO4	-	-	1	1	2	1	-	-	-	3	-	3	1	1	2
CO5	-	-	-	2	1	2	2	-	-	3	-	3	-	-	2
Avg.	**1.5**	**1.5**	**1.0**	**1.5**	**1.3**	**1.5**	**2.0**	**-**	**-**	**2.6**	**-**	**2.4**	**1.3**	**1.0**	**1.4**

Text Books

1. Ginsburg, G.S. & Willard, H.F. (2022). Genomic and Precision Medicine, 4th Ed., Elsevier.
2. Meyers, R.E. (2017). Precision Medicine: A Guide to Genomics in Clinical Practice, McGraw-Hill.

Reference Books

1. Kole, C., Kole, P. (2022). Genomic Therapeutics: Revolutionizing Medicine, Springer.
2. Turner, T.N., et al. (2023). Clinical Genomics: Practical Applications in Adult Patient Care, Oxford University Press.
3. Select peer-reviewed articles from journals like Nature Reviews Genetics, Trends in Pharmacological Sciences, The New England Journal of Medicine, and Genome Medicine.

GMBT3603: Program Elective 3

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	V	Program Elective

Code	Course title	L-T-P-C	Hours	Status
GMBT3603(A)	Molecular Cytogenetics	3-0-0-3	45	Syllabus not in source document
GMBT3603(B)	Scientific Writing and Research Ethics	3-0-0-3	45	Syllabus not in source document
GMBT3603(C)	Systems Biology and Network Analysis	3-0-0-3	45	Syllabus not in source document

One option is chosen from the basket. The OBE course sheet for each option (description, objectives, five units with hours, outcomes, CO-PO-PSO mapping and text books) is to be attached using the blank template at the end of Part E.

GMBT3604: Program Elective 4

L	T	P	C	Total teaching hours	Semester	Category
3	0	0	3	45	V	Program Elective

Code	Course title	L-T-P-C	Hours	Status
GMBT3604(A)	Research Methodology and Biostatistics	3-0-0-3	45	Syllabus not in source document
GMBT3604(B)	Single-Cell Genomics and Transcriptomics	3-0-0-3	45	Syllabus not in source document
GMBT3604(C)	Clinical Data Management and Real-World Evidence	3-0-0-3	45	Syllabus not in source document

One option is chosen from the basket. The OBE course sheet for each option (description, objectives, five units with hours, outcomes, CO-PO-PSO mapping and text books) is to be attached using the blank template at the end of Part E.

GMBP3501: Mini Project

L	T	P	C	Total hours	Semester	Category
0	0	6	3	90	V	Project

Course Description

The Mini Project gives students their first structured experience of independent investigation. Working individually or in small teams under a faculty guide, students take up a short laboratory, computational or survey-based problem in genetics and molecular biology and apply the knowledge gained in Semesters I to V.

Course Objectives

1. To enable students to identify a focused problem in genetics and molecular biology and review the relevant literature.
2. To train students to plan and carry out a short investigation using appropriate laboratory or computational methods.
3. To develop skills in data recording, analysis and interpretation.
4. To build skills in scientific writing and oral presentation.
5. To instil research ethics, data integrity and teamwork.

Note: *The source document gives no syllabus for the Mini Project. The description, objectives, hours and outcomes here are drafted for the Board of Studies to confirm.*

Project Phases with Hours

Phase	Activity	Hours
1	Problem identification, guide allocation and literature survey	15
2	Planning of methodology and approval by the department project committee	15
3	Execution of laboratory or computational work with regular guide review	40
4	Data analysis, interpretation and preparation of the project report	15
5	Final presentation and viva-voce	5
	Total	90

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Identify a researchable problem in genetics and molecular biology and review the literature on it	K3
CO2	Plan an investigation using appropriate laboratory or computational methods	K6
CO3	Carry out experiments or computations and record observations accurately	K3
CO4	Analyse and interpret results and draw justified conclusions	K4
CO5	Communicate the work through a structured report and presentation, observing research ethics	K3

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	2	2	-	-	1	-	-	-	2	-	-	2
CO2	-	1	-	-	3	-	2	-	-	-	-	2	2	-	3
CO3	-	2	3	-	2	-	-	-	2	-	-	-	2	3	2

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO4	-	-	2	3	2	1	-	-	-	-	1	3	-	2	2
CO5	-	-	-	-	-	-	2	3	3	-	-	2	-	-	1
Avg.	**-**	**1.5**	**2.5**	**2.5**	**2.2**	**1.0**	**2.0**	**2.0**	**2.5**	**-**	**1.0**	**2.2**	**2.0**	**2.5**	**2.0**

Text Books and Reference Resources

1. Guidelines issued by the department project committee.
2. Faculty-recommended primary literature and laboratory manuals relevant to the chosen topic.
3. Software tools: Python, R, Bioconductor (as applicable).

SEMESTER VI (B.SC. 3-YEAR EXIT)

GMBT3605: MOOCs Course 1

L	T	P	C	Total hours	Semester	Category
2	0	0	2	30	VI	MOOC

Course Description

A self-paced online course taken from an approved platform (SWAYAM, NPTEL or an equivalent recognised provider) in genetics and molecular biology or an allied discipline, chosen with the approval of the department. Credit is awarded on successful completion of the course assessments and submission of the certificate.

Course Objectives

1. To enable self-directed learning in an advanced or allied area of genetics and molecular biology.
2. To broaden the learner's knowledge beyond the core curriculum.
3. To develop the habit of lifelong learning through online platforms.

Note: *The source lists the MOOC courses by code and credit only. This sheet is a generic template; the title, platform and syllabus of the selected course are to be recorded for each batch.*

Course Structure

Component	Activity	Hours
Learning	Completion of the video lectures, readings and assignments of the approved MOOC	24
Assessment	Weekly quizzes and the proctored final examination of the platform	4
Mentoring	Course approval, progress review and credit transfer by the department mentor	2
	Total	30

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the core concepts of the chosen course	K2
CO2	Apply the concepts learned to genetics and molecular biology problems	K3
CO3	Complete the platform assessments and obtain certification	K3
CO4	Relate the course content to the programme outcomes and career interests	K4
CO5	Plan further self-directed learning in the area	K6

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	-	-	-	-	-	-	-	-	-	-	2	-	-	-
CO2	1	-	-	-	-	-	-	-	-	1	-	2	-	-	-
CO3	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-
CO4	-	-	-	1	-	-	-	-	-	-	-	2	-	-	-
CO5	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-
Avg.	**1.0**	**-**	**-**	**1.0**	**-**	**-**	**-**	**1.0**	**-**	**1.0**	**-**	**1.6**	**-**	**-**	**-**

Text Books and Reference Resources

1. As specified by the platform for the selected course.

GMBT3606: MOOCs Course 2

L	T	P	C	Total hours	Semester	Category
2	0	0	2	30	VI	MOOC

Course Description

A self-paced online course taken from an approved platform (SWAYAM, NPTEL or an equivalent recognised provider) in genetics and molecular biology or an allied discipline, chosen with the approval of the department. Credit is awarded on successful completion of the course assessments and submission of the certificate.

Course Objectives

1. To enable self-directed learning in an advanced or allied area of genetics and molecular biology.
2. To broaden the learner's knowledge beyond the core curriculum.
3. To develop the habit of lifelong learning through online platforms.

Note: *The source lists the MOOC courses by code and credit only. This sheet is a generic template; the title, platform and syllabus of the selected course are to be recorded for each batch.*

Course Structure

Component	Activity	Hours
Learning	Completion of the video lectures, readings and assignments of the approved MOOC	24
Assessment	Weekly quizzes and the proctored final examination of the platform	4
Mentoring	Course approval, progress review and credit transfer by the department mentor	2
	Total	30

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the core concepts of the chosen course	K2
CO2	Apply the concepts learned to genetics and molecular biology problems	K3
CO3	Complete the platform assessments and obtain certification	K3
CO4	Relate the course content to the programme outcomes and career interests	K4
CO5	Plan further self-directed learning in the area	K6

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	-	-	-	-	-	-	-	-	-	-	2	-	-	-
CO2	1	-	-	-	-	-	-	-	-	1	-	2	-	-	-
CO3	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-
CO4	-	-	-	1	-	-	-	-	-	-	-	2	-	-	-
CO5	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-
Avg.	**1.0**	**-**	**-**	**1.0**	**-**	**-**	**-**	**1.0**	**-**	**1.0**	**-**	**1.6**	**-**	**-**	**-**

Text Books and Reference Resources

1. As specified by the platform for the selected course.

GMBP3502: Major Project (B.Sc. 3-year exit)

L	T	P	C	Total hours	Semester	Category
0	0	32	16	480	VI	Project

Course Description

The Major Project provides an opportunity to apply knowledge and skills in Genetics and Molecular Biology to real-world problems through research, experimentation and innovation. The project focuses on health informatics, molecular diagnostics, bioinformatics or data science applications in healthcare. Students work individually or in small teams.

Course Objectives

1. To apply knowledge and skills in Genetics and Molecular Biology to solve real-world problems through research, experimentation and innovation.
2. To formulate a research question on a healthcare problem aligned with medical biotechnology (diagnostics and biomarkers, personalised medicine, computational biology and multi-omics, biopharmaceuticals, AI in healthcare).
3. To design experiments or data-driven studies with ethical compliance and data security.
4. To analyse and interpret data using appropriate bioinformatics, statistical and machine-learning tools.
5. To communicate findings through a comprehensive project report and a final presentation.

Note: *Hours per task are allocated here so that the tasks total the 480 hours of the semester (32 hours per week for 15 weeks). The source gives week-wise deadlines (reproduced below) but no hours.*

Project Tasks with Hours

Task	Activity	Hours
1	Identify a research problem: select a specific healthcare problem aligned with medical biotechnology (diagnostics and biomarker discovery, personalised medicine and pharmacogenomics, computational biology and multi-omics integration, biopharmaceutical development, AI and machine learning in healthcare)	30
2	Literature review and hypothesis development: review the current state of research; formulate a research question and hypothesis	50
3	Data acquisition and experimental design: identify datasets (genomic databases, clinical datasets, bioinformatics repositories) or design laboratory experiments; ensure ethical compliance and data security	90
4	Data preprocessing and analysis: clean, preprocess and integrate datasets; exploratory data analysis; use of bioinformatics or statistical tools	110
5	Feature engineering and model development (data-driven projects): feature selection; predictive models using machine learning; training and validation with suitable metrics	80
6	Results interpretation and discussion: interpret findings, compare with existing studies, discuss applications and limitations	60
7	Project report and presentation: comprehensive report on methodology, findings and conclusions; final presentation to faculty and peers	60
	Total	480

Evaluation Criteria (from the Major Project Guidelines)

Criterion	Excellent (5)	Good (4)	Fair (3)	Needs Improvement (2)	Inadequate (1)
Problem Definition	Clearly defined and highly significant	Well-defined and significant	Adequately defined, could be more significant	Somewhat unclear or lacks significance	Unclear or irrelevant
Literature Review	Comprehensive and well-referenced	Good coverage with relevant sources	Adequate review with minor gaps	Limited review with significant gaps	Minimal or no review
Experimental Design / Data Acquisition	Highly appropriate methodology with strong justification	Well-designed methodology	Adequate methodology with minor weaknesses	Poorly designed methodology	No clear methodology
Data Preprocessing and Analysis	Thorough and effective data processing	Effective preprocessing with minor issues	Somewhat effective but lacks completeness	Incomplete or ineffective	Missing or poorly done
Feature Engineering / Model Development	Highly relevant features and models with strong results	Relevant features and models with good results	Somewhat relevant features and models with moderate results	Poorly designed features and models	Features and models missing or ineffective
Results Interpretation	Insights are clear, significant and actionable	Clear and significant insights	Somewhat clear insights	Unclear or lacks significance	Missing or irrelevant insights
Project Report	Well-written, organised and comprehensive	Well-written and organised	Adequate but lacks clarity	Poorly written or lacks detail	Incomplete or missing
Presentation	Clear, engaging and well-communicated	Clear and well-communicated	Somewhat clear but lacks engagement	Unclear or lacks coherence	Missing or ineffective

Overall score	Grade
23 - 25	Exceptional
19 - 22	Good
15 - 18	Fair
11 - 14	Needs Improvement
0 - 10	Inadequate

Note: *The source rubric has eight criteria scored 1 to 5 (maximum 40) but the overall score bands stop at 25. Please confirm whether the bands should be scaled to 40 or whether five criteria are intended.*

Project Timeline (from the Major Project Guidelines)

Task	Deadline
Problem Selection	Week 2
Literature Review	Week 4
Experimental Design / Data Collection	Week 6
Data Analysis and Model Development	Week 10
Results and Interpretation	Week 12
Report Writing	Week 14
Final Presentation	Week 16

Resources

- Genomic and clinical datasets
- Software tools (Python, R, MATLAB, Bioconductor, etc.)
- Tutorials on data preprocessing, analysis and modelling
- Faculty mentorship and peer discussions

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Formulate a researchable problem and hypothesis in medical biotechnology after a critical literature review	K6
CO2	Design laboratory experiments or data-driven studies with ethical compliance and data security	K6
CO3	Acquire, preprocess and analyse biological or clinical data using appropriate tools	K4
CO4	Develop and validate models or experimental results and interpret them against existing studies	K5
CO5	Communicate the project through a comprehensive report and presentation	K3

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	2	2	-	-	1	-	-	-	2	-	-	2
CO2	-	1	-	-	3	-	2	-	-	-	-	2	2	-	3
CO3	-	2	3	-	2	-	-	-	2	-	-	-	2	3	2
CO4	-	-	2	3	2	1	-	-	-	-	1	3	-	2	2
CO5	-	-	-	-	-	-	2	3	3	-	-	2	-	-	1
Avg.	**-**	**1.5**	**2.5**	**2.5**	**2.2**	**1.0**	**2.0**	**2.0**	**2.5**	**-**	**1.0**	**2.2**	**2.0**	**2.5**	**2.0**

Text Books and Reference Resources

1. Major Project Guidelines for B.Sc. Genetics and Molecular Biology (as reproduced above).
2. Genomic and clinical datasets, bioinformatics repositories and tutorials on preprocessing, analysis and modelling made available by the department.

SEMESTER VI (EXTENDED PROGRAMME, 4-YEAR OPTION)

GMBT3519: Clinical Biochemistry

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	VI	Core (extended option)

Course Description

This course provides exploration of biochemical principles crucial for understanding human health and disease. It covers specimen collection techniques, blood disorders, and the mechanisms of blood clotting. Students will be able to understand carbohydrate and lipid metabolism disorders, including diabetes and atherosclerosis, and examine amino acid metabolism, clinical enzymology, and gastrointestinal tract disorders. The course also addresses cancer genetics, including oncogenes and tumour markers, and therapeutic interventions.

Course Objectives

1. To explain techniques for collecting and preserving biological specimens.
2. To understand blood clotting mechanism, identify common blood clotting disorders.
3. To enable students to diagnose and manage disorders related to carbohydrate and lipid metabolism.
4. To identify the significance of various diagnostic enzymes, their role in disease states. and how to interpret enzyme levels for accurate diagnosis
5. To understand genetic basis of cancer and use of tumour markers in cancer diagnosis and monitoring.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Specimen Collection and Blood Disorders.** Introduction and Maintenance of clinical Biochemistry laboratory. Collection, preparation and preservation of biological specimens such as blood, urine, CSF bile Saliva and faeces. Disorders of blood – Blood diseases (agranulocytosis, thrombocytopenia, haemolytic anaemia, haematuria, hemoglobinopathies and Thrombosis) Blood clotting mechanism and disorders. Anticoagulants. Tests to evaluate acid base status of blood and their significance.	12
2	**Disorders of Carbohydrate and Lipid Metabolism.** Disorders of carbohydrates metabolism Hyper and Hypoglycaemia, regulation of blood glucose, renal threshold, diabetes mellitus classification, metabolic abnormalities, diagnosis and management. Acute and long-term complications of diabetes. Glucose tolerance test, glycosylated haemoglobin, glycogen storage diseases. Galactosemia, fructosuria, pentosuria, keto bodies. Atherosclerosis- risk factors, biochemical findings and management. Plasma lipids and lipoproteins and heir functions. Hyper lipoproteinemia classification – primary and secondary, Cardiovascular disorders.	12
3	**Inborn Errors of Amino Acid Metabolism and Clinical Enzymology.** Nonprotein nitrogenous constituents of blood Urea, Uric acid and creatinine. Plasma protein abnormalities, deficiency agammaglobulinemia, phenylketonuria, albinism, Hartnup's disease and Maple syrup urine disease, multiple myeloma, homocystinuria, histidinuria, disorders of urea cycle. Clinical enzymology- Diagnostic applications of enzymes, clinical significance of Aspartate transaminase, Creatinine kinase, lactate dehydrogenase amylase, r-glutamyl transferase. Disorders of thyroid secretions and thyroid functional tests.	12
4	**Disorders of the Gastrointestinal Tract, Liver and Kidney.** Composition of gastric juice, gastric function. Stimulation of gastric secretion, Composition of gastric secretion, Composition of gastric secretion. Trest for gastric function- Fractional test meal, Penta gastrin test, hyperchlorhydria achlorhydria, achylia gastric. Liver function tests related to protein carbohydrate lipid, pigment metabolism detoxification and excretion. Jaundice – Classification and differential diagnosis. Kernicterus Renal Function tests- Glomerular and tubular functions. Tests for evaluation-concentration, dilution, excretion, creatinine clearance tests, nephritic syndrome.	12

Unit	Title and contents	Hours
5	**Cancer.** Genetic rearrangements in progenitor cells, Oncogenes, tumour suppressor genes, mechanism of protooncogene activation. Cancer and cell cycle, 2wtrVirus induced cancer, interaction of cancer cells with normal cells, therapeutic interventions of uncontrolled cell growth, cancer stem cells, embryonic signature in cancer stem cells, stem cell markers and factors. Apoptosis and Necrosis. Tumour markers- AFP (Alpha fetoprotein), CEA (Carcinoembryonic antigen), hcG (human chorionic gonadotropin) Carcinogenic agents.	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level	Unit
CO1	Explain the collection, preparation and preservation of biological specimens and interpret diagnostic tests for blood disorders	K4	1
CO2	Identify disorders of carbohydrate and lipid metabolism using appropriate diagnostic tests	K3	2
CO3	Interpret inborn errors of amino acid metabolism, plasma protein abnormalities and diagnostic enzyme profiles	K4	3
CO4	Explain gastric, liver and renal function tests and their use in disease diagnosis	K2	4
CO5	Describe the molecular basis of cancer, tumour markers and therapeutic interventions for cancer management	K2	5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	3	-	-	-	-	-	1	-	-	1
CO2	2	-	-	-	-	3	-	-	-	-	1	1	-	-	1
CO3	-	1	-	-	1	3	-	-	-	-	-	2	1	-	2
CO4	-	1	1	2	-	3	-	-	-	2	-	2	1	1	2
CO5	-	-	-	2	-	3	2	-	-	2	-	2	-	-	2
Avg.	**2.0**	**1.0**	**1.0**	**2.0**	**1.0**	**3.0**	**2.0**	**-**	**-**	**2.0**	**1.0**	**1.6**	**1.0**	**1.0**	**1.6**

Text Books

1. Textbook of Medical Biochemistry: A clinically oriented approach – Dinesh Puri living stone., India.
2. Varley's Practical clinical Biochemistry- Alan H Gowenlock, published by CBS Publishers and distributors, 2008,6th edition.
3. Mayne, Clinical Chemistry in Diagnosis and Treatment, ELBS.

Reference Books

1. Mosby, clinical Chemistry Marshall.
2. Willaims and Wilkins,2006, Biochemistry and Disease, Cohn and Roth.
3. Harpers 2013. Biochemistry, 26th ed. Mc Graw Hill.
4. Harrison's Principles of Internal Medicien. Vol1 and 2, 14thed. Mc Graw Hill.
5. Mosby, Biochemistry- A case Oriented Approach Montgomery et al.

GMBT3520: Structural Biology

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	VI	Core (extended option)

Course Description

This course provides a comprehensive understanding of the principles and applications of Structural Biology, focusing on the relationship between the three-dimensional structure of biological macromolecules and their functions. It introduces the structural organization of proteins, nucleic acids, carbohydrates, lipids, and biomolecular complexes, along with the forces governing molecular folding, stability, and interactions. Students will gain knowledge of modern experimental and computational techniques used to determine biomolecular structures, including X-ray crystallography, Nuclear Magnetic Resonance (NMR), Cryo-Electron Microscopy (Cryo-EM), molecular modeling, and bioinformatics tools. The course also explores structure-function relationships in enzymes, membrane proteins, nucleic acids, and supramolecular assemblies. It prepares students for research in structural biology, drug discovery, molecular medicine, biotechnology, and computational biology.

Course Objectives

1. Understand the structural organization and functional significance of biological macromolecules.
2. Explain the principles governing protein folding, molecular interactions, and biomolecular stability.
3. Analyze the experimental and computational methods used for determining biomolecular structures.
4. Evaluate structure-function relationships of proteins, nucleic acids, and macromolecular complexes.
5. Apply structural biology concepts in drug discovery, protein engineering, and biomedical research.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Fundamentals of Structural Biology.** Introduction to Structural Biology ; Levels of protein structure: Primary, Secondary, Tertiary, and Quaternary ; Structure of nucleic acids ; Structural organization of carbohydrates and lipids ; Chemical bonds and molecular forces stabilizing biomolecular structures ; Protein folding and conformational stability ; Biomolecular interactions and molecular recognition	12
2	**Experimental Methods in Structural Biology.** Principles of X-ray crystallography ; Protein crystallization techniques ; Nuclear Magnetic Resonance (NMR) spectroscopy ; Cryo-Electron Microscopy (Cryo-EM) ; Small-angle X-ray scattering (SAXS) ; Circular Dichroism (CD) spectroscopy ; Fluorescence spectroscopy ; Mass spectrometry in structural biology ; Comparative advantages and limitations of structural techniques	12
3	**Computational Structural Biology.** Structural bioinformatics ; Protein structure databases (PDB, AlphaFold Database, SCOP, CATH) ; Sequence alignment and homology modeling ; Molecular visualization tools (PyMOL, Chimera, RasMol) ; Molecular docking ; Molecular dynamics simulations ; Protein structure prediction ; Artificial Intelligence in structural biology (AlphaFold and related tools)	12
4	**Structure–Function Relationships.** Enzyme structure and catalytic mechanisms ; Structure and function of membrane proteins ; Protein-ligand interactions ; Protein-DNA and protein-RNA interactions ; Molecular motors and cytoskeletal proteins ; Ribosomes and large macromolecular complexes ; Protein misfolding and conformational diseases ; Structural basis of inherited genetic disorders	12
5	**Applications of Structural Biology.** Structure-based drug discovery ; Rational drug design ; Protein engineering ; Antibody engineering ; Vaccine design ; Structural biology in infectious diseases and cancer research ; Structural genomics ; Emerging trends: Cryo-EM revolution, AI-driven protein structure prediction, Integrative Structural Biology, and Precision Medicine	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the structural organization and functional significance of biological macromolecules.	K2
CO2	Analyze protein folding, molecular interactions, and the structural basis of biomolecular function.	K4
CO3	Apply experimental and computational approaches for determining and analyzing biomolecular structures.	K3
CO4	Evaluate structure-function relationships for understanding biological processes, disease mechanisms, and therapeutic targets.	K5
CO5	Assess the applications of structural biology in drug discovery, protein engineering, biotechnology, and precision medicine.	K5

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	2	-	-	-	-	-	-	-	-	2	-	2	-
CO2	1	-	3	-	-	-	-	-	-	-	-	2	-	3	-
CO3	-	-	3	1	1	-	-	-	-	-	-	2	1	3	-
CO4	-	-	3	2	2	-	-	-	-	1	-	2	1	3	1
CO5	-	-	2	3	2	1	-	-	-	2	-	3	-	3	2
Avg.	**1.5**	**-**	**2.6**	**2.0**	**1.7**	**1.0**	**-**	**-**	**-**	**1.5**	**-**	**2.2**	**1.0**	**2.8**	**1.5**

Text Books

1. Branden, C., & Tooze, J. (2018). Introduction to Protein Structure (2nd Edition). Garland Science.
2. Rhodes, G. (2017). Crystallography Made Crystal Clear: A Guide for Users of Macromolecular Models (4th Edition). Academic Press.

Reference Books

1. Liljas, A., Liljas, L., Piskur, J., Lindblom, G., Nissen, P., & Kjeldgaard, M. (2017). Textbook of Structural Biology (2nd Edition). World Scientific.
2. Lesk, A. M. (2019). Introduction to Protein Science: Architecture, Function, and Genomics (3rd Edition). Oxford University Press.
3. Rupp, B. (2010). Biomolecular Crystallography: Principles, Practice, and Application to Structural Biology. Garland Science.
4. Petsko, G. A., & Ringe, D. (2004). Protein Structure and Function. Oxford University Press.
5. Bourne, P. E., & Weissig, H. (Eds.). (2003). Structural Bioinformatics. Wiley-Liss.
6. Gu, J., & Bourne, P. E. (Eds.). (2009). Structural Bioinformatics (2nd Edition). Wiley- Blackwell.
7. Lodish, H., et al. Molecular Cell Biology (Latest Edition). W.H. Freeman.
8. Alberts, B., et al. Molecular Biology of the Cell (Latest Edition). Garland Science.

GMBT3521: Neuroscience

L	T	P	C	Total teaching hours	Semester	Category
3	1	0	4	60	VI	Core (extended option)

Course Description

This course provides an introduction to the structure and function of the nervous system with emphasis on the cellular and molecular mechanisms underlying neural communication, sensory perception, motor control, learning, memory, and behavior. Students will explore the organization of the brain, neuronal signaling, neurotransmission, sensory and motor systems, and the molecular basis of neurological and psychiatric disorders. The course integrates concepts from neurobiology, physiology, and molecular neuroscience, providing a foundation for understanding normal brain function and diseases of the nervous system.

Course Objectives

1. To understand the structure and functional organization of the nervous system and the brain.
2. To explain the cellular and molecular mechanisms of neuronal communication and synaptic transmission.
3. To understand the organization and functions of sensory and motor systems.
4. To describe the neural basis of learning, memory, and behavior.
5. To familiarize students with the molecular basis of neurological and psychiatric disorders.

Unit-wise Syllabus with Teaching Hours

Unit	Title and contents	Hours
1	**Introduction to the Nervous System and Neuronal Communication.** Introduction to neuroscience; Organization of the nervous system; Structure and functions of the brain; The brain and behavior; Structure of neurons and neuroglia; Nerve cells and neuronal communication; Ion channels; Resting membrane potential and action potential; Synaptic transmission; Intracellular signaling pathways.	12
2	**Synaptic Function, Neurotransmitters and Higher Brain Functions.** Synaptic integration; Excitatory and inhibitory synapses; Neurotransmitters and neuromodulators; Neurotransmitter receptors; Cortical organization; Association cortices; Neural basis of learning and memory; Synaptic plasticity; Long-term potentiation (LTP) and long-term depression (LTD) (overview).	12
3	**Sensory Systems.** Overview of sensory systems; Somatic sensation; Pain and temperature sensation; Visual system—Structure of the eye, photoreceptors, visual pathway and visual cortex; Auditory system—Structure of the ear and auditory pathway; Chemical senses—Taste and smell; Integration of sensory information; Introduction to motor system organization.	12
4	**Motor Systems.** Organization of the motor system; Voluntary movement; Upper and lower motor neurons; Motor unit and muscle action; Neuromuscular junction; Spinal reflexes; Control of posture and locomotion; Control of eye movements (gaze); Basal ganglia and their functions; Cerebellum and motor coordination.	12
5	**Neurological and Psychiatric Disorders.** Introduction to neurological disorders; Alzheimer's disease; Parkinson's disease; Epilepsy; Stroke; Multiple sclerosis; Introduction to psychiatric disorders; Depression; Anxiety disorders; Schizophrenia; Autism spectrum disorder (overview); Neurodegenerative diseases; Principles of diagnosis, prevention, and management (overview).	12
	Total	60

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Explain the structure and functional organization of the nervous system and the molecular mechanisms of neuronal signaling.	K2
CO2	Describe synaptic transmission, neurotransmitter function, cortical organization, learning, and memory.	K2
CO3	Interpret the organization and physiological functions of sensory and motor systems.	K4
CO4	Explain the neural control of voluntary movement, posture, reflexes, and motor coordination.	K2
CO5	Describe the causes, pathophysiology, clinical features, and basic management of common neurological and psychiatric disorders.	K2

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	3	-	-	-	-	-	1	-	-	1
CO2	2	-	-	-	-	3	-	-	-	-	1	1	-	-	1
CO3	-	1	-	-	1	3	-	-	-	-	-	2	1	-	2
CO4	-	1	1	2	-	3	-	-	-	2	-	2	1	1	2
CO5	-	-	-	2	-	3	2	-	-	2	-	2	-	-	2
Avg.	**2.0**	**1.0**	**1.0**	**2.0**	**1.0**	**3.0**	**2.0**	**-**	**-**	**2.0**	**1.0**	**1.6**	**1.0**	**1.0**	**1.6**

Text Books

1. Bear, M. F., Connors, B. W., & Paradiso, M. A. (2020). Neuroscience: Exploring the Brain (4th Ed.). Jones & Bartlett Learning.
2. Purves, D., Augustine, G. J., Fitzpatrick, D., et al. (2018). Neuroscience (6th Ed.). Oxford University Press.

Reference Books

1. Kandel, E. R., Koester, J. D., Mack, S. H., & Siegelbaum, S. A. (2021). Principles of Neural Science (6th Ed.). McGraw-Hill.
2. Nolte, J. (2019). The Human Brain: An Introduction to its Functional Anatomy (8th Ed.). Elsevier.
3. Squire, L. R., Berg, D., Bloom, F. E., et al. (2018). Fundamental Neuroscience (5th Ed.). Academic Press.
4. Blumenfeld, H. (2021). Neuroanatomy through Clinical Cases (3rd Ed.). Oxford University Press.
5. Breedlove, S. M., & Watson, N. V. (2023). Behavioral Neuroscience (10th Ed.). Oxford University Press.

SEMESTERS VII AND VIII (EXTENDED PROGRAMME, 4-YEAR OPTION)

GMBP4502: Major Project (Semesters VII and VIII)

L	T	P	C	Total hours	Semester	Category
0	0	36	18	1080	VII and VIII	Project

Course Description

The Major Project of the extended (4-year) option is carried out over two semesters (18 credits in each semester) and gives students the opportunity to apply their knowledge and skills in Genetics and Molecular Biology to real-world problems through research, experimentation and innovation. The project focuses on health informatics, molecular diagnostics, bioinformatics or data science applications in healthcare. Students work individually or in small teams.

Course Objectives

1. To apply knowledge and skills in Genetics and Molecular Biology to solve real-world problems through research, experimentation and innovation.
2. To formulate a research question on a healthcare problem aligned with medical biotechnology (diagnostics and biomarkers, personalised medicine, computational biology and multi-omics, biopharmaceuticals, AI in healthcare).
3. To design experiments or data-driven studies with ethical compliance and data security.
4. To analyse and interpret data using appropriate bioinformatics, statistical and machine-learning tools.
5. To communicate findings through a comprehensive project report and a final presentation.

Note: *The source gives one set of guidelines and a structure entry of 36 periods and 18 credits for "VII and VIII Semester". It is read here as 18 credits in each semester (36 in all) so that 2 practical hours equal 1 credit, as in the Semester VI Major Project. Phases and hours (1080 in total) are drafted for the Board of Studies to confirm.*

Project Phases with Hours (two semesters)

Phase	Activity	Hours
1	Problem identification and research proposal, including ethical compliance	90
2	Literature review, hypothesis development and research design	150
3	Data acquisition and experimentation or laboratory work	300
4	Data preprocessing, analysis, modelling and validation	270
5	Interpretation of results, comparison with existing studies and manuscript preparation	150
6	Project report, final presentation and viva-voce	120
	Total	1080

Evaluation Criteria (from the Major Project Guidelines)

Criterion	Excellent (5)	Good (4)	Fair (3)	Needs Improvement (2)	Inadequate (1)
Problem Definition	Clearly defined and highly significant	Well-defined and significant	Adequately defined, could be more significant	Somewhat unclear or lacks significance	Unclear or irrelevant
Literature Review	Comprehensive and well-referenced	Good coverage with relevant sources	Adequate review with minor gaps	Limited review with significant gaps	Minimal or no review
Experimental Design / Data Acquisition	Highly appropriate methodology with strong justification	Well-designed methodology	Adequate methodology with minor weaknesses	Poorly designed methodology	No clear methodology

Criterion	Excellent (5)	Good (4)	Fair (3)	Needs Improvement (2)	Inadequate (1)
Data Preprocessing and Analysis	Thorough and effective data processing	Effective preprocessing with minor issues	Somewhat effective but lacks completeness	Incomplete or ineffective	Missing or poorly done
Feature Engineering / Model Development	Highly relevant features and models with strong results	Relevant features and models with good results	Somewhat relevant features and models with moderate results	Poorly designed features and models	Features and models missing or ineffective
Results Interpretation	Insights are clear, significant and actionable	Clear and significant insights	Somewhat clear insights	Unclear or lacks significance	Missing or irrelevant insights
Project Report	Well-written, organised and comprehensive	Well-written and organised	Adequate but lacks clarity	Poorly written or lacks detail	Incomplete or missing
Presentation	Clear, engaging and well-communicated	Clear and well-communicated	Somewhat clear but lacks engagement	Unclear or lacks coherence	Missing or ineffective

Overall score	Grade
23 - 25	Exceptional
19 - 22	Good
15 - 18	Fair
11 - 14	Needs Improvement
0 - 10	Inadequate

Note: *The source rubric has eight criteria scored 1 to 5 (maximum 40) but the overall score bands stop at 25. Please confirm whether the bands should be scaled to 40 or whether five criteria are intended.*

Project Timeline (from the Major Project Guidelines)

Task	Deadline
Problem Selection	Week 2
Literature Review	Week 4
Experimental Design / Data Collection	Week 6
Data Analysis and Model Development	Week 10
Results and Interpretation	Week 12
Report Writing	Week 14
Final Presentation	Week 16

Resources

- Genomic and clinical datasets
- Software tools (Python, R, MATLAB, Bioconductor, etc.)
- Tutorials on data preprocessing, analysis and modelling
- Faculty mentorship and peer discussions

Course Outcomes

Upon successful completion of the course, the student will be able to:

CO	Statement	Bloom level
CO1	Formulate a researchable problem and hypothesis in genetics and molecular biology after a critical literature review	K6

CO	Statement	Bloom level
CO2	Design laboratory experiments or data-driven studies with ethical compliance and data security	K6
CO3	Acquire, preprocess and analyse biological or clinical data using appropriate tools	K4
CO4	Develop and validate models or experimental results and interpret them against existing studies	K5
CO5	Communicate the project through a comprehensive report and presentation	K3

CO-PO-PSO Mapping (3 = high, 2 = medium, 1 = low, - = none)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	2	2	-	-	1	-	-	-	2	-	-	2
CO2	-	1	-	-	3	-	2	-	-	-	-	2	2	-	3
CO3	-	2	3	-	2	-	-	-	2	-	-	-	2	3	2
CO4	-	-	2	3	2	1	-	-	-	-	1	3	-	2	2
CO5	-	-	-	-	-	-	2	3	3	-	-	2	-	-	1
Avg.	**-**	**1.5**	**2.5**	**2.5**	**2.2**	**1.0**	**2.0**	**2.0**	**2.5**	**-**	**1.0**	**2.2**	**2.0**	**2.5**	**2.0**

Text Books and Reference Resources

1. Major Project Guidelines for B.Sc. Genetics and Molecular Biology (reproduced under GMBP3502).
2. Genomic and clinical datasets, bioinformatics repositories and tutorials made available by the department.

APPENDIX A: PROGRAMME ARTICULATION MATRIX (COURSE-LEVEL AVERAGE CO-PO-PSO MAPPING)

Each value is the average of the non-zero CO mappings of the course for that PO or PSO (the "Avg." row of each course sheet). A dash means the course does not address that outcome. Electives without syllabi are excluded until their sheets are attached.

Code	Course	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	S1	S2	S3
GMBT1501	Cell Biology and Genetics	2.8	1.0	1.5	1.0	1.7	1.5	-	1.0	-	-	1.0	1.0	-	1.0	1.8
GMBT1502	Biochemistry	2.0	1.0	1.0	1.0	1.0	2.0	1.0	-	-	1.0	-	2.4	1.0	-	1.6
GMBT1503	Data Science	1.5	-	2.6	2.0	1.7	1.0	-	-	-	1.5	-	2.2	1.0	2.8	1.5
TAUT1101	University Core 1: Communicative English	-	-	-	1.0	-	-	2.0	3.0	1.6	-	-	1.0	-	-	-
GMBL1501	Data Science Lab	-	1.0	2.6	2.0	1.5	-	-	2.0	1.5	1.0	-	2.2	-	2.6	1.3
GMBL1502	Biochemistry Lab	1.0	2.8	1.7	1.5	1.6	-	1.0	1.5	1.2	-	-	-	2.4	1.0	1.8
GMBT1504	Molecular Biology and Genetic Engineering	1.7	2.6	1.7	1.5	2.0	-	-	1.0	-	-	-	1.5	2.4	1.5	2.0
GMBT1505	Microbiology	2.0	1.0	1.0	2.0	1.0	3.0	2.0	-	-	2.0	1.0	1.6	1.0	1.0	1.6
GMBT1506	Bioanalytical Techniques	1.7	2.6	1.7	1.5	2.0	-	-	1.0	-	-	-	1.5	2.4	1.5	2.0
TAUT1102	University Core 2: Environmental Studies	1.0	-	-	1.0	-	-	2.6	1.0	2.0	1.0	1.5	2.0	-	-	-
GMBL1503	Molecular Biology and Genetic Engineering Lab	1.0	2.8	1.7	1.5	1.6	-	1.0	1.5	1.2	-	-	-	2.4	1.0	1.8
GMBL1504	Microbiology Lab	1.0	2.8	1.7	1.5	1.6	-	1.0	1.5	1.2	-	-	-	2.4	1.0	1.8
GMBT2507	Immunology	2.0	1.0	1.0	2.0	1.0	3.0	2.0	-	-	2.0	1.0	1.6	1.0	1.0	1.6
GMBT2508	Molecular Pathogenesis	2.0	1.0	1.0	2.0	1.0	3.0	2.0	-	-	2.0	1.0	1.6	1.0	1.0	1.6
GMBT2509	Enzyme Technology	1.5	1.5	1.0	1.5	1.3	1.5	2.0	-	-	2.6	-	2.4	1.3	1.0	1.4
GMBT2510	Nanobiotechnology	1.5	1.5	1.0	1.5	1.3	1.5	2.0	-	-	2.6	-	2.4	1.3	1.0	1.4
TAUT2101	University Core 3: Health and Wellness	2.0	-	-	-	-	2.4	1.0	1.0	-	1.0	-	2.0	-	-	-
GMBL2503	Immunology Lab	1.0	2.8	1.7	1.5	1.6	-	1.0	1.5	1.2	-	-	-	2.4	1.0	1.8
GMBL2504	Enzyme Technology Lab	1.0	2.8	1.7	1.5	1.6	-	1.0	1.5	1.2	-	-	-	2.4	1.0	1.8
GMBT2511	Animal Cell Culture and Techniques	1.7	2.6	1.7	1.5	2.0	-	-	1.0	-	-	-	1.5	2.4	1.5	2.0
GMBT2512	Molecular Diagnostics	2.0	1.0	1.0	2.0	1.0	3.0	2.0	-	-	2.0	1.0	1.6	1.0	1.0	1.6
GMBT2513	Genomics, Proteomics and Computational Drug Design	1.5	-	2.6	2.0	1.7	1.0	-	-	-	1.5	-	2.2	1.0	2.8	1.5
GMBT2514	Biosafety and Bioethics	-	-	-	1.6	-	1.0	3.0	1.3	1.0	1.0	-	1.4	-	-	-
GMBL2505	Genomics and Proteomics Lab	-	1.0	2.6	2.0	1.5	-	-	2.0	1.5	1.0	-	2.2	-	2.6	1.3
GMBL2506	Molecular Diagnostics Lab	1.0	2.8	1.7	1.5	1.6	-	1.0	1.5	1.2	-	-	-	2.4	1.0	1.8
GMBT3515	Metabolic Engineering and Systems Biology	1.5	1.5	1.0	1.5	1.3	1.5	2.0	-	-	2.6	-	2.4	1.3	1.0	1.4
GMBT3516	Cancer Biology	2.0	1.0	1.0	2.0	1.0	3.0	2.0	-	-	2.0	1.0	1.6	1.0	1.0	1.6
GMBT3517	Pharmacology and Pharmacovigilance	1.5	1.5	1.0	1.5	1.3	1.5	2.0	-	-	2.6	-	2.4	1.3	1.0	1.4
GMBT3518	Precision Medicine and Genomic Therapeutics	1.5	1.5	1.0	1.5	1.3	1.5	2.0	-	-	2.6	-	2.4	1.3	1.0	1.4
GMBP3501	Mini Project	-	1.5	2.5	2.5	2.2	1.0	2.0	2.0	2.5	-	1.0	2.2	2.0	2.5	2.0
GMBT3605	MOOCs Course 1	1.0	-	-	1.0	-	-	-	1.0	-	1.0	-	1.6	-	-	-
GMBT3606	MOOCs Course 2	1.0	-	-	1.0	-	-	-	1.0	-	1.0	-	1.6	-	-	-
GMBP3502	Major Project	-	1.5	2.5	2.5	2.2	1.0	2.0	2.0	2.5	-	1.0	2.2	2.0	2.5	2.0
GMBT3519	Clinical Biochemistry	2.0	1.0	1.0	2.0	1.0	3.0	2.0	-	-	2.0	1.0	1.6	1.0	1.0	1.6
GMBT3520	Structural Biology	1.5	-	2.6	2.0	1.7	1.0	-	-	-	1.5	-	2.2	1.0	2.8	1.5
GMBT3521	Neuroscience	2.0	1.0	1.0	2.0	1.0	3.0	2.0	-	-	2.0	1.0	1.6	1.0	1.0	1.6
GMBP4502	Major Project (VII-VIII)	-	1.5	2.5	2.5	2.2	1.0	2.0	2.0	2.5	-	1.0	2.2	2.0	2.5	2.0

Programme-level average (all courses listed above):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Average	1.56	1.70	1.62	1.67	1.50	1.88	1.75	1.49	1.59	1.72	1.04	1.88	1.61	1.49	1.66

APPENDIX B: CORRECTIONS AND POINTS FOR BOARD OF STUDIES CONFIRMATION

Items 1 to 8 were corrected or completed in this document; items 9 to 20 need a decision before submission.

1. Biochemistry (GMBT1502): objectives 1 to 4 referred to Microbiology and nursing infection control; replaced with Biochemistry objectives. Outcomes aligned to the units.
2. Data Science (GMBT1503): objectives (statistics, machine learning) and outcomes (calculus, polynomial roots) did not match the five units; aligned to the syllabus.
3. Immunology (GMBT2507): outcomes on flow cytometry, communication and teamwork did not match the units; rewritten.
4. Animal Cell Culture (GMBT2511): only three outcomes were given; five aligned outcomes written. Cell Biology and Genetics (GMBT1501), Bioanalytical Techniques (GMBT1506), Clinical Biochemistry (GMBT3519) and Health and Wellness (TAUT2101): outcomes reworded and aligned; TAUT2101 objectives separated from the description.
5. Molecular Diagnostics (GMBT2512) and Genomics, Proteomics and Computational Drug Design (GMBT2513): the bold labels at the start of objectives and outcomes were removed; the reference list of GMBT2512 was separated from its outcomes.
6. Laboratory sheets: the source gives experiment lists only. Descriptions, objectives and outcomes were drafted (adapted from the Biotechnology programme sheets where the laboratory is shared) and experiment hours allocated equally.
7. Hours per unit were added to every theory course (12 hours per unit for 4-credit courses, 9 for 3-credit courses) and the Mini Project, Major Project and MOOC sheets were drafted.
8. Course Outcomes carry Bloom's levels assigned from the action verb; for courses with a single "Recommended Text Books" list, the list is shown as Text Books.

Items needing confirmation:

9. Credits: Semester II (printed 22, computed 21) and Semester V (printed 24, computed 25; Tutorial periods printed 3, computed 4). The 3-year and extended totals (140 and 172) agree either way. Confirm lab credits in Semester II and the credit of GMBT3518.
10. Semester VII and VIII: one entry of 18 credits and 36 periods is printed for both semesters; confirm whether this is per semester (36 credits in all) or for the pair.
11. Project credits: the regulations state 1 project hour per week = 1 credit, whereas the course structure gives the Major Project 32 hours and 16 credits (2 hours = 1 credit). Align the two.
12. Duration: the regulations and annexures state a 3-year programme, but the structure includes a second Semester VI and a Semester VII and VIII Major Project. State the entry, exit and award rules for the 4-year option (the programme title, Honours or Research designation and credit total).
13. Program Electives 1 to 4 (12 courses) and University Electives 1 to 3: no syllabi in the source. Attach OBE sheets using the blank template.
14. MOOC courses (GMBT3605, GMBT3606): only credits are given; record the approved courses for each batch.
15. Mini Project (GMBP3501) and the Semester VII and VIII Major Project (GMBP4502): no syllabus in the source; the drafts here need approval.
16. Major Project rubric: eight criteria scored 1 to 5 give a maximum of 40, but the overall bands end at 25.
17. CO-PO-PSO mappings, PEO and PSO to PO mappings and the attainment thresholds are proposed values; the source gives none.
18. Text Books: several references in the source are old or lack edition details (for example, Essential Cell Biology 7th edition is cited with a 2009 date; Molecular Diagnostics references date from 2006 and 2007). Verify editions before submission.
19. Introduction in the source (Preamble, programme demand and career outlook) is not given for this programme; add if NAAC criteria documentation requires it.
20. Typographical points in the source: course code printed twice for GMBT1504 on one page, Biosafety titled "Biosafety and Bioethics" (retained), and the two lab sheets GMBL2505 and GMBL2506 give "LTPC 0042" without spacing.