REGULATIONS AND CURRICULUM GOVERNING

MSc BIOSCIENCE PROGRAM

(Academic year from which the curriculum is implemented: 2017; revised: 2019; amended: 2025)

Yenepoya (Deemed to be University)

University Road, Deralakatte

Mangalore - 575018



NOTIFICATION FROM THE UNIVERSITY

Faculty 18th July 2017.

YENEPOYA UNIVERSITY

(Recognized under Section 3A of the UGC Act 1956)
Accredited by NAAC with 'A' grade
FACULTY OF ALLIED HEALTH & BASIC SCIENCES

MINUTES OF THE MEETING

Minutes of the meeting of the Faculty of Allied Health and Basic Sciences held on 18/07/17 at 11.45am in the Lecture hall IV of Yenepoya Physiotherapy College

Agenda

1. Action taken report of the last meeting held on 15th May 2017- Approved
2. Discuss and approve the recommendations of BOS in Physiotherapy.

BOS in Physiotherapy in its meeting held on 4/7/2017 had made following recommendations.

2.1). **Increasing the intake of MPT seats from 10 to 20** from the academic year 2017-18. There are no additional expenses to the university in terms of faculty recruitment, infrastructure, and Clinical facilities

Principal, YPC explained the need to increase the PG seats

- ***It was resolved to approve the proposal to increase the intake from 10 to 20 for the MPT course from the academic year 2017-18 onwards. There are no additional expenses to the university with regard to the infrastructure and recruitment of Faculty.***

2.2). Proposal to start a **Certificate course in integrated manual therapy** in association with Institute of, Orthopaedic Manual Therapy (IOMT), Doha, Kathar.

Dean presented the course details, and the same was discussed. After detailed discussion, ***it was resolved to approve the proposed Certificate Course in "Integrated Manual Therapy". It was also resolve to approve the academic partnership with Institute of Orthopaedic manual Therapy. However, a MoU to be signed with IOMT as per university norms.***

- ***The physiotherapists/PGs/interns/Final years will be the beneficiaries.***

3. To discuss and approve the proposal of **BOS in Basic sciences to start M.Sc in Biosciences**

Dr. Rekah PD, Presented the course details, it was considered that there is adequate infrasturucte, faculty and laboratory facility and there is no additional expenses for the university to start this course.

- **It was resolved to approve the proposed course titled " M.Sc in Biosciences" from the year 2017-18.**

4. **Approval of pre PhD syllabus of following students.**

BOS in Physiotherapy has approved the pre Ph.D syllabus of the following four students in its meeting conducted on 04. 07 .2017, at 2.00 pm , in the lecture hall IV.

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Regulations, Scheme and Syllabus

Master of Science (M.Sc.) in Bioscience

Choice Based Credit System (CBCS)

1. Preamble

The broad goal of teaching and training postgraduate students in Bioscience is to enable students to acquire sound knowledge in the subject and develop practical skills to contribute effectively in the fields of research in academics and industry. Yenepoya Research Centre (YRC) has established several research facilities and has accumulated expertise in the fundamental and applied areas of life sciences, such as Stem cells and tissue engineering, Proteomics, Genomics and Metabolomics, Bioinformatics, Molecular biology and Nanobiotechnology. The M.Sc. program is envisaged under the Centre's vision to disseminate skills and knowledge in the broad area of Biological Sciences.

Definitions of Keywords

i. Academic Year: Two consecutive (one odd + one even) semesters constitute one academic year.

ii. Choice Based Credit System: The CBCS provides choice for students to select from the prescribed courses (core, elective or minor or soft skill courses).

iii. Course: Usually referred to, as 'papers' is a component of the program. The courses shall define learning objectives and learning outcomes. A course shall comprise lectures/tutorials/laboratory work/field work/outreach activities/project work/vocational training/viva/seminars/term papers/assignments/presentations/self-study etc. or a combination of some of these.

iv. Credits: Credit defines the quantum of contents/syllabus prescribed for a course and determines the number of hours of instructions required per week. Thus, normally in each of the courses, credits will be assigned on the basis of the number of lectures/tutorial, laboratory work and other forms of learning required, to complete the course contents in a 16–20-week schedule: One credit=1 hour of lecture per week/two hours of laboratory or practical/three hours of clinical rotation, field work/posting. All courses need not carry the same credits.

v. Grade Point: It is a numerical weight allotted to each letter grade on a 10-point scale.

vi. Credit Point: It is the product of grade point and number of credits for a course.

vii. Cumulative Grade Point Average (CGPA): It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the ratio of total credit points

secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.

viii. Letter Grade: It is an index of the performance of students in a said course. Grades are denoted by letters: O, A+, A, B+, B, C, P and F.

ix. Semester Grade Point Average (SGPA): It is a measure of the performance of work done in a semester. It is the ratio of total credit points secured by a student in various courses registered in a semester and the total course credits taken during that semester. It shall be expressed up to two decimal places.

x. Transcript or Grade Card or Certificate: Based on the grades earned, a grade certificate shall be issued to all the registered students after every semester. The grade certificate will display the course details (code, title, number of credits, grade secured) along with the SGPA of that semester.

2. Eligibility for admission:

Graduates (B.Sc./B.Tech) from any branch of Biological Sciences with an aggregate mark of 50% or equivalent CGPA scores. Selection will be based on merit.

3. Duration of the program:

Two years with four semesters.

4. Maximum period for completion of the program

A candidate shall complete the four semesters (two years) program within five years from the date of admission. Students who wish to take a career break can re-enroll. The period of reentry should not be more than three consecutive years.

5. Aim of the program

The primary aim of the M.Sc. Bioscience program is to provide students with an extensive and advanced understanding of the diverse aspects of biological science along with developing a strong foundation in fundamental concepts of Genetics, Molecular Biology and Biochemistry. Another fundamental aim of this program is to cultivate critical thinking and problem-solving skills among students through rigorous coursework and research projects where students will learn how to critically analyze complex biological problems, evaluate scientific literature and develop innovative approaches to tackle challenges in the field of Bioscience. Integrating knowledge from a variety of related fields, such as

Environmental Science, Biotechnology and Bioinformatics, is another aim of this program. Along with theoretical knowledge, this program aims to enhance technical abilities and familiarity with modern laboratory equipment.

6. Objectives/Outcomes of the program (Knowledge/ Skill/ Attitude/ Communication)

Knowledge:

• The graduates must be familiar with good theoretical knowledge in frontier areas of Life Sciences, such as Microbiology, Immunology, Biochemistry, Stem cells and Tissue Engineering, Proteomics, Genomics and Metabolomics, Bioinformatics, Molecular Biology and Nanobiotechnology.

• Graduates must be able to develop self-learning tools to allow for continued education throughout their careers.

• The graduates must be familiar with the frequently used instruments and their handling procedures in these disciplines.

• The graduates are expected to have practical exposure and to understand the contemporary issues that need focused research.

• The graduates are expected to be familiar with the research methodologies and best practices employed in academic research.

• The graduates are expected to be familiar with basic concepts of research ethics and intellectual property.

Skills:

• Discipline-based skills: The graduates are expected to develop a strong footing in the fundamentals and specialize in the disciplines of his/her liking and abilities.

• Critical thinking skills: The graduates are expected to be proficient critical thinkers to examine, develop and critically evaluate scientific questions that are required to perform research.

• Personality traits: Graduates are expected to develop basic personality traits that enable them to develop strong interpersonal relationships, such as time management, emotional intelligence, stress management, etc.

• Problem-solving skills: Graduates must be able to think critically and solve problems and have expected to design and carry out experiments, analyze data, and make informed decisions in their specific sectors.

• Research skills: The graduates are expected to leverage the critical thinking skills to effectively

perform research projects in the field of Biological Sciences.

• Collaboration skills: Graduates will be able to work in a team on group projects and collaborate with other researchers.

Attitudes:

• Curiosity/Inquisitiveness: The graduates are expected to nurture their curiosity and apply it in the context of Biological Sciences.

• Teamwork: The graduates are expected to effectively collaborate and work as a team with other individuals through group projects and seminars.

• Ethics: The graduates must have a strong moral and ethical foundation to be responsible citizens of the country.

• Leadership: The graduates are expected to have basic leadership traits that will enable them to successfully lead a team during the course of their careers.

• Lifelong learning: The graduates will troubleshoot and develop experiential learning attributes as part of the training.

Communication skills:

• Communication skills: The graduates are expected to effectively communicate their ideas/arguments to a wider audience, including those who are not familiar with the discipline. This includes general communication skills as well as the ability of the graduate to clearly communicate the concepts associated with the Biological Science.

- **Program outcomes (POs)**
  - i. Demonstrate the basic concepts of fundamental and applied areas of Biological Sciences and laboratory skills as applicable to the Life Science sector.
  - ii. Apply the learning skills in the emerging areas of Biological Sciences being used in both academia and industry.
  - iii. Build appropriate skills, attitude, values and ethics needed for holistic development of an individual and employability. Able to analyze the gaps and design a research project.
  - iv. Apply the knowledge gained to analyse and solve problems with key concepts of research methodology including regulatory and ethical issues and application of statistics.

- **Program specific outcomes**
  i. Inculcates foundations of core interdisciplinary knowledge and the integration of new knowledge in Life Sciences and its applications.
  ii. Necessitates students to acquire analytical skills, apply the scientific method in analysing and interpreting data and scientific literature, and generate data and draw appropriate inferences.
  iii. Nurture students with high integrity in their attitude and communications suitable for professional setup exhibiting confidence, competence, respectfulness, empathy and social responsibility.
  iv. Demonstrate proficiency in the core concepts of different divisions of biology, including Biochemistry, Cell and Molecular Biology, Microbiology, Genetics, Toxicology, Nanobiotechnology, Stem Cell and Developmental Biology, Immunology, Omics Technology and System Biology and Statistics.
  v. Demonstrate ability to apply research skills in a real-life professional set-up through an industrial or academic internship in different areas of Bioscience.
  vi. Be able to effectively communicate scientific information in written and oral form and learn ethical considerations in scientific research.
  vii. Solve complex biological questions by applying knowledge gained in interdisciplinary aspects of the program.

Program Structure				
Course code	**Type of Course**	**Course name**	**Max marks**	**Credits**
FS02BS-1C1	Core -Theory	Biochemistry	100	4
FS02BS-1C2	Core -Theory	Cell and Molecular Biology	100	4
FS02BS-1C3	Core -Theory	Microbiology	100	4
FS02BS-1C4	Core -Theory	Genetics	100	4
FS02BS-1C5	Core -Practical	Biochemistry	50	2
FS02BS-1C6	Core -Practical	Cell and Molecular Biology	50	2
FS02BS-1C7	Core -Practical	Microbiology	50	2
FS02BS-1C8	Core -Practical	Genetics	50	2
Total	600			24
FS02BS-2O1	Open Elective	Environment and Health	100	3
FS02BS-2C1	Core -Theory	Toxicology	100	4
FS02BS-2C2	Core -Theory	Stem cell and Developmental Biology	100	4
FS02BS-2C3	Core -Theory	Immunology	100	4
FS02BS-2C4	Core -Theory	Nanobiotechnology	100	3
FS02BS-2C5	Core -Practical	Nanobiotechnology and Toxicology	50	2
FS02BS-2C6	Core -Practical	Stem Cell and Developmental Biology	50	2
FS02BS-2C7	Core -Practical	Immunology	50	2
Total			650	24

FS02BS-3O1	Open Elective	Scientific Communication	100	3
FS02BS-3C1	Core -Theory	Research Methodology	100	4
FS02BS-3C2	Core -Theory	Omics Technology & Systems Biology	100	4
FS02BS-3C3	Core -Theory	Genetic Engineering	100	4
FS02BS-3C4	Core -Theory	Neurobiology	100	3
FS02BS-3C5	Core -Practical	Omics Technology & Systems Biology	50	2
FS02BS-3C6	Core -Practical	Biostatistics	50	2
FS02BS-3C7	Core -Practical	Neurobiology	50	2
Total			550	24
FS02BS-4PR	Project work		400	

7. Attendance

Each course (theory, practical, etc.) shall be treated as an independent unit for the purpose of attendance. A student shall attend a minimum of 80% of the total instruction hours in a course including tutorials and seminars in each semester.

8. Syllabus/Course contents

SEMESTER-I						
Course code	**Type of course**	**Course name**	**Hrs/ Week**	**Exam hours**	**IA**	**SE**
FS02BS-1C1	Core -Theory	Biochemistry	4	4	50	50
FS02BS-1C2	Core -Theory	Cell and Molecular Biology	4	4	50	50
FS02BS-1C3	Core -Theory	Microbiology	4	4	50	50
FS02BS-1C4	Core -Theory	Genetics	4	4	50	50
FS02BS-1C5	Core - Practical	Biochemistry	4	2	25	25
FS02BS-1C6	Core - Practical	Cell and Molecular Biology	4	2	25	25
FS02BS-1C7	Core - Practical	Microbiology	4	2	25	25
FS02BS-1C8	Core - Practical	Genetics	4	2	25	25
Total			32	24	300	300

Course code	Type of Course	Course name	Hours/Week	Credits
FS02BS-1C1	**Core - Theory**	**Biochemistry**	**4**	**4**

Course Outcomes (COs)

CO 1	Demonstrate the classification, structure and significance of biological macromolecules
CO 2	Outline the acid-base concepts and modern techniques used in analytical Biochemistry
CO 3	Explain the basic concepts and mechanisms of metabolism in living organisms
CO 4	Demonstrate the basic concepts, mechanisms and significance of the biological catalysts
CO 5	Outline the basics of nutritional biochemistry and diseases related to nutrition

Unit I: Chemistry of Biomolecules (10 hrs)

- Carbohydrates [Classification, basic chemical structures, biological reactions and properties, biological significance]
- Lipids [Classification, structure and function of major lipid subclasses, formation of micelles, monolayer, bilayer]
- Amino acids [Classification, biological reactions and properties (N/C terminal reactions, ninhydrin reaction), digestion and absorption]
- Vitamins and Coenzymes [Classification, water-soluble and fat-soluble vitamins, coenzyme forms and their significance]
- Nutritional aspects of proteins, carbohydrates, lipids, vitamins and minerals. Definition of Balanced diet

Unit II: Analytical Biochemistry (12 hrs)

- Concept of pH, dissociation and ionization of acids and bases, pKa, buffers and buffering mechanism
- Henderson-Hasselbalch's equation, ionization of amino acids and proteins, measurement

of pH

- General principle and different types of chromatography
- Sedimentation velocity, preparative and analytical ultracentrifugation techniques, differential and density gradient centrifugation, subcellular fractionation
- Spectrophotometry: Beer-Lambert law, extinction coefficient and its importance, design of colorimeter and spectrophotometer, applications of UV-Vis spectrophotometer

Unit III: Metabolism (12 hrs)

- Concepts of metabolism [Carbohydrate metabolism, Lipid metabolism, Amino acid metabolism]
- Metabolic pathways [Catabolic and anabolic, regulation of metabolic pathways, glycolysis, energetics and its regulation]
- Gluconeogenesis carbohydrate metabolism [Glycogen biosynthesis and its regulation, role of enzymes in synthesis and degradation of glycogen, role of cAMP]
- Citric acid cycle [Energetics, regulation and significance, role of pyruvate dehydrogenase]
- Electron Transport Chain and Oxidative Phosphorylation, Biological Oxidation, high energy compounds, structure and function of ATP
- Heme Metabolism, Purine and Pyrimidine metabolism
- Disorders of carbohydrate metabolism, Postprandial and Glucose tolerance test

Unit IV: Enzymology (14 hrs)

- Classification and nomenclature of enzymes
- Isolation and purification of enzymes
- Enzyme catalysis: Enzyme specificity and the concept of active site, determination of active site
- Enzyme kinetics: Factors affecting rates of enzyme catalyzed reactions, Uni-substrate reactions, Concept of Michaelis – Menten, catalytic rate constant and specificity constant, limitations of Michaelis-Menten Kinetics, reversible and irreversible inhibition, competitive, non-competitive and uncompetitive inhibition
- Mechanism of enzymes action: lysozyme, chymotrypsin, carboxypeptidase, multienzyme system, allosteric enzymes

Unit V: Nutritional & Clinical Biochemistry (8 hrs)

- Food calories, Respiratory quotient, Basal metabolic rate, Calorie requirement, Adult

consumption unit

- Disorders related to the nutrition [Protein energy malnutrition, Starvation, Obesity]
- Collection and preservation of biological fluids and their significance, chemical analysis of CSF and its significance, biochemical changes in Diabetes mellitus, Hypoglycemia, Ketone bodies

Course code	Type of Course	Course name	Hours/ Week	Credits
FS02BS-1C5	**Core - Practical**	**Biochemistry**	**4**	**2**

Sl. No.	Laboratory Exercises	Hours
A	**Cell culture experiments**	
1	Semi-quantitative estimation of reducing sugar by Benedict's test	6
2	Precipitation reaction of proteins	2
3	Estimation of amino acids by Ninhydrin Method	4
B	**Clinical Experiments**	
1	Estimation of total protein and albumin in serum by Biuret Method	4
2	Estimation of serum urea by diacetyl monoxime method	4
3	Estimation of serum and urine creatinine by Jaffe's method	4
4	Estimation of serum direct and indirect bilirubin	4
C	**Urine Analysis**	
1	Urine Collection	2
2	Urine analysis of normal constituents	4
3	Analysis of abnormal constituents C	4
D	**Enzyme kinetics**	
1	Effect of substrate concentration on the rate of enzyme reaction	4
2	Effect of pH on the rate of enzymatic reaction	4
C	**Techniques/Demonstration**	
1	Colorimeter and Spectrophotometer	2
2	Agarose gel electrophoresis of serum proteins	2
3	ELISA	2
D	**Biomedical waste management**	4

Course code	Type of Course	Course name	Hours/Week	Credits
FS02BS-1C2	**Core - Theory**	**Cell and Molecular Biology**	**4**	**4**

Course outcomes (COs)

CO 1	Define the subcellular organelles and the molecular players for sustaining and functioning of the smallest unit- The Cell
CO 2	Illustrate the concepts of the central dogma. They will have a clear idea on replication, transcription and translation, post-translation and functionality of the genetic material
CO 3	Explain the importance and maintenance of the genetic material and code through several divisions and the players involved in this function
CO 4	Identify the significance and specificity in the process of translation and the functional importance of the post-translational modifications
CO 5	Distinguish and differentiate the gene regulation in prokaryotic and eukaryotic cell and will be able to explain the roles of repressors and inducers in gene regulation
CO 6	Explain the modulation of gene expression via the transmission of signal from the receptor to the intracellular regions

Unit 1: Cell Biology (10 hrs)

- The Cell- an overview: plant cell, animal cell
- Cell organelles: Cell membrane (transport, cell communication and cellular respiration), Ribosome, Mitochondria
- Types of cells (Stem cells/quiescent cells, blood cells, bone cells), cellular differentiation
- Different phases of cell cycle, regulation of cell cycle by Cyclins and CDKs, cell cycle arrest (Checkpoints-S-phase, G2 phase, M phase)

- Apoptosis, necrosis, senescence, cytokines, growth factors.
- Cell division-Mitosis and Meiosis.

Unit 2: Genetic material and its replication (11 hrs)

- Introduction to Molecular Biology (Experiments on- Semi-conservative DNA, DNA as the genetic material, discovery of the structure of DNA double helix)
- Overview on Central Dogma
- Cell Biology and Molecular Biology techniques: Subcellular fractionation- Ultra centrifugal analysis, flow cytometry, FISH, PCR (Conventional and Real-time PCR)
- Replication: its mechanism in prokaryotes, enzymes and protein factors
- Replication: its mechanism in eukaryotes, enzymes and protein factors
- DNA damage and repair
- Eukaryotic gene, gene dosage, genome size, C-value paradox, Repetitive DNA contents of genome-Centromeres, Telomeres, LINEs, SINE, gene families, non-coding genes, mobile DNA elements
- Genome organization: Genome overview at the chromosome level-Eukaryotic and bacterial chromosomes, nucleus, nucleolus, chromatin, histones and nucleosomes

Unit 3: Transcription (7 hrs)

- Transcription-prokaryotes, its regulation, RNA polymerase, transcription factors
- Transcription-eukaryotes, its regulation, RNA polymerase, transcription factors
- Post-transcriptional modification: RNA tailing, Capping, UTRs, RNA splicing, Spliceosome machinery, types of splicing, exon shuffling, RNA editing
- Post-transcriptional modification of mRNA, tRNA, rRNA

Unit 4: Translation (7 hrs)

- Genetic codes and its properties, reading frames, incorporation of novel amino acid
- Translation in prokaryotes: Initiation, elongation, termination of protein synthesis, components required at each stage, sequence of reaction
- Translation in eukaryotes: Initiation, elongation, termination of protein synthesis, components required at each stage, sequence of reaction
- Inhibitors of protein synthesis, post-translational modifications of proteins

Unit 5: Regulation of gene expression (14 hrs)

- Regulation of gene expression in prokaryotes: Overview of gene organization
- Definition of inducible and constitutive genes, regulatory system components of inducible genes: Structural gene, regulatory gene and operator gene
- Operon models: Inducible operon, repressible operon, regulation of lac operon, tryptophan operon and arabinose operon
- Regulation of gene expression in Eukaryotes: Overview of gene organization, levels of gene regulations in eukaryotes: Chromatin remodeling, transcription and translational levels
- Chromatin remodeling: Acetylation, deacetylation and methylation.
- Transcriptional regulatory sequence: Transcriptional Factors: An overview, introduction to RNAs involved in transcription and post-transcriptional regulation: Post-transcriptional gene silencing by RNA interference (RNAi), microRNAs (miRNA) and small interfering RNA (siRNA) (2h)
- Elements that influence translation of mRNA: Upstream Open reading frames (uORFs), 3'-UTR, Secondary structures- Hairpins internal ribosome entry Sequences

Unit 6: Cell Signaling (7 hrs)

- Introduction to cell signaling: Types of signaling, types of receptors, cellular response
- G protein coupled receptors: Heterotrimeric G protein
- Secondary messengers cAMP, lipid derived second messengers
- Receptor tyrosine kinase: Insulin receptors, Ras and the MAP kinase cascade
- Ion-exchange receptor

Course code	Type of Course	Course name	Hours/ Week	Credits
FS02BS-1C6	**Core - Practical**	**Cell and Molecular Biology**	**4**	**2**

Sl. No.	Laboratory Exercises	Hours
1	Introduction to liquid handling systems and calibration	3
2	To study the parts of phase contrast microscope and its maintenance	3
3	Mammalian cell enumeration using Trypan blue staining	3
4	Live and dead mammalian cell enumeration using live/dead cell staining dyes in live mammalian cell cultures	3
5	To study the cells under phase contrast microscope	2
6	Plasmid DNA isolation	4
7	Designing of primers for conventional and qRT-PCR	2
8	PCR set up-Conventional	4
9	Agarose gel electrophoresis of DNA and PCR products	3
10	RNA isolation and quantification from the cell pellet	4
11	c-DNA synthesis	2
12	qRT-PCR set up using GAPDH or beta actin	3

Course code	Type of Course	Course name	Hours/ Week	Credits
FS02BS-1C3	**Core - Theory**	**Microbiology**	**4**	**4**

Course Outcomes (COs)

CO 1	Distinguish between major types of microorganisms belonging to Prokaryotes (Bacteria and Archaea) and Eukaryotes based on cell structure and general characteristics
CO 2	List the microbial codes in the modern microbiology for classification and naming of microorganisms as per taxonomic hierarchy
CO 3	Practice the microbial culturing methods, different sterilization and growth kinetics
CO 4	Demonstrate the important metabolic pathways of different groups of microorganisms
CO 5	Demonstrate a comprehensive understanding of microbiota, microbiome, antibiotics, drug resistance, and beneficial effects of microbes

Unit I: Characteristic features of microbes (12 hr)

- Ultrastructure of the prokaryotic cell (Size, shape, arrangement, membrane, cell wall, cytoplasmic inclusions, mesosomes, flagella and motility, slime, capsule, pili, chemotaxis and endospore)
- Cell wall organization in prokaryotes (Bacteria and Archaea) and eukaryotes
- General identification features of bacteria, fungi, protozoa, and virus

Unit II: Techniques for microbial identification (12 hr)

- Systematics, concept of species in microbiology, the new tree of life
- Polyphasic approach to taxonomy- Phenotype, genotype and phylogenetics.
- Numerical taxonomy
- Tools for microbial systematics - Phylogenetics-16S rRNA gene sequencing, MALDI-TOF, DNA-DNA hybridization, Multilocus Sequence Typing (MLST), Average Nucleotide Identity (ANI) and Average Amino Acid Identity (AAI), Genome-based taxonomy

Unit III: Microbial growth and nutrition (10 hr)

- Nutritional classification of microorganisms
- Types of culture media and microbial culture techniques
- Microbial growth kinetics
- Batch and continuous cultures
- Physical and chemical methods of sterilization
- Preservation and maintenance of microbial cultures

Unit IV: Microbial metabolism (10 hr)

- Overview of metabolic diversity of microbes
- Microbial metabolic cycles: Aerobic (Glycolysis, Krebs Cycle, Electron transport and Oxidative phosphorylation) and Anaerobic respiration (Fermentation)
- Alternative metabolic pathways in microorganisms (Phosphoketolase, Bifidium pathway, Entner-Doudoroff pathway and Glyoxylate shunt)

Unit V: Host-microbe interactions (12 hr)

- Overview and evolution of normal flora, factors contributing colonization of microbes
- Concepts and role of microbiome in health and disease
- Antibiotics and drug resistance: Overview, role of quorum sensing antimicrobial resistance (AMR) and biofilm
- Diseases: Causative agent, virulence factors involved, clinical symptoms, diagnosis and prevention (Tuberculosis, Leptospirosis, Hepatitis, Dengue, Malaria and Candidiasis).

Course code	Type of Course	Course name	Hours/ Week	Credits
FS02BS-1C7	**Core - Practical**	**Microbiology**	**4**	**2**

Sl. No.	Laboratory Exercises	Hours
1	Safety and occupational health in a Microbiology Laboratory: Principles of safety; Safety cabinets–Use and maintenance, Incident report and action	4
2	Isolation and cultivation of microorganisms - Serial dilution, spread and pour plate methods	8
3	Isolation and culturing of bacteria and fungi from food samples	4
4	Simple staining and Gram staining of bacteria	4
5	Endospore and capsule staining for bacteria	4
6	Staining techniques for fungi – Lactophenol cotton blue	4
7	Kirby-Bauer disc diffusion method	4
8	Demonstration of broth micro-dilution test for MIC determination	4
9	Evaluation of bacterial growth in liquid media-Sigmoid curve and diauxic curve	8
10	Culturing of fungi of industrial importance and downstream processing of the metabolites	4
11	Extraction of bacterial genomic DNA	4
12	Identification of microbial sequences using bioinformatics tools	4

Course code	Type of Course	Course name	Hours/ Week	Credits
FS02BS-1C4	**Core - Theory**	**Genetics**	**4**	**4**

Course outcomes (COs)

CO 1	Compare the model systems for genetic studies. Learn about transmission genetics, mutations & chromosomal aberrations
CO 2	Classify key components of Human molecular genetics, historical facts, genome analysis and mapping, mutations, transgenics
CO 3	Illustrate the genetics of diseases, cytogenetics, syndromes, prevalence, epigenetics
CO 4	Explain population quantitative genetics, genetic variation, allele frequency, genetic Drift, Hardy-Weinberg, migration
CO 5	Outline diagnostics genetics, genetic inheritance, variation at genetic level, pedigree, forensics, treatment options.

Unit 1: Transmission Genetics (10 hrs)

- Model systems in Genetic analysis (Bacteriophage, *E. coli*, Yeast, *Drosophila*, *C. elegans*, Zebra fish, Mouse
- Homo sapiens (General outline of life cycle, importance in genetic analysis). Laws of inheritance, Allelic and non-allelic interactions, Autosomal, Sex-linked inheritance, non-Mendelian inheritance, Cytoplasmic inheritance
- Mutation (Classification, mechanism, repair, role in genetic analysis and evolution)
- Changes in chromosome number and structure (Polyploidy, aneuploidy, chromosomal rearrangements- Deletion, duplication, inversion, and translocation)
- Properties and evolution of genetic material flow of genetic information.

Unit 2: Molecular and Human Genetics (12 hrs)

- Introduction to Human Genetics (History; Early perception, development and documentation; Genome organization; Chromosome structure, function and implications for disease)
- Study tools in Human Genetics: Mendelian inheritance and exceptions; Gene identification using positional and functional cloning approach
- Somatic cell genetics (Somatic cell hybrids, monochromosome hybrid panels, gene mapping)

- Human genome analysis: Cloning and sequencing, Outcome-Generation of 'OMICS' era, Human genome mapping methods: Physical mapping: Introduction to physical map markers-Chromosomal, G/Q-banding, radiation hybrid mapping
- Functional genomics and animal models in human disease: An overview; cDNA/gene cloning; Site-directed mutagenesis; Mammalian tissue culture; Cell line transfections
- Functional assays; Use of model organisms, methods for generation of transgenic animals/knock-in, knock out models (Microinjection, ES cell transformation); ENU mutagenesis; RNAi approach; Some examples

Unit 3: Genetic Diseases (12 hrs)

- Congenital and common genetic diseases, prevalence and databases. Single gene and disease: In born errors of metabolism, Haemoglobinopathies; Multifactorial disorders
- Common syndromes due to numerical chromosome changes (Downs, Patau, Edwards, Turner, Klinefelter, Jacobs syndromes), Common syndromes due to structural alterations (Translocations, Duplications, Deletions, Microdeletion, Fragile sites)
- Pedigree analysis, Diseases and disorders: Autosomal/sex chromosomal/sex reversal; Mechanisms – mitotic/meiotic non-disjunction/chromosomal rearrangements; Some examples (Syndromes/Cancer/Infertility)
- Methods of study (Epidemiological, Twin/adoption and Family studies); Etiology genetic and non-genetic determinants; Common examples
- Epigenetics and disease: Mechanisms (Imprinting/methylation; chromatin remodeling); Current understanding
- Mitochondrial myopathies, Personalized medicine, Pharmacogenomics

Unit 4: Population Genetics (12 hrs)

- Variation at the genetic level: DNA markers-VNTR, STR, Microsatellite, SNP and their detection techniques-RFLP, genotyping, RAPD, AFLP, etc
- Organization and measure of genetic variation: Random mating population, Hardy-Weinberg principle, complications of dominance, special cases of random mating– multiple alleles
- Different frequencies between sexes (Autosomal and X-linked). Linkage and linkage disequilibrium
- Sources responsible for changes in gene frequencies: Mutation, selection, migration and isolation; Random genetic drift; Insights into human migration, natural selection and

evolution

- Population substructure: Hierarchical population, isolate breaking, Inbreeding, Assortative mating
- Quantitative Genetics: Johannsen pure-line theory, multiple factor hypotheses, type of quantitative traits, components of phenotypic variation and genetic models for quantitative traits, Concept of heritability, artificial selection and realized heritability

Unit 5: Medical Genomics (10 hrs)

- Identification and Isolation of disease genes: Single gene disorders-Characterization
- Mutation detection, diagnosis and therapy (with examples from autosomal dominant, autosomal recessive, X-linked dominant, X-linked recessive and complex disease conditions)
- Multifactorial disorders: Familial forms- Genetic polymorphism and disease susceptibility
- Whole genome association (Single nucleotide polymorphism, CNVs); Gene dosage, gene amplification, molecular combing/fibre analysis
- Diagnostic genetics: Cytogenetics/Molecular Cytogenetics/Biochemical/Molecular methods; Screening for mutation/chromosomal anomaly
- Adult/Prenatal/Newborn screening; Preimplantation screening (Assisted reproductive technology-in vitro fertilization and Embryo transfer)
- Fluorescence in-situ hybridization, Comparative genome hybridization
- Forensic testing - DNA fingerprinting, paternity testing, individual identification
- Treatment of genetic disorders: Methods of therapy - Drug (recombinant proteins); Diet; Gene (Viral vectors, delivery methods, efficacy); Some examples (Thalassemia, Phenylketonuria, Cystic fibrosis, DMD, etc)
- Genetic counselling

Course code	Type of Course	Course name	Hours/ Week	Credits
FS02BS-1C8	**Core - Practical**	**Genetics**	**4**	**2**

Sl. No.	Laboratory Exercises	Hours
1	Crude isolation of the chromatin from Onions, chromosomal analysis	4
2	Cytogenetics – Study of chromosomes, sex chromatin in somatic cells, Barr body analysis in cheek epithelium	4
3	Metaphase preparation and Karyotyping	8
4	Genetic model organism: Budding yeast (*Saccharomyces cerevisiae*) Life cycle, genetic experiments	4
5	Mendelian genetics: Monohybridism, Dihybridism and Polyhybridism	4
6	Determining the segregation of trait through Chi-Square Test (use in genetics)	4
7	Branching methods: Determining the segregation of traits through Punnett Square	4
8	Analyzing the segregation pattern of polymorphic genes and gene interactions	4
9	Population genetics: Determining allele frequency, genotype, frequency, Hardy-Weinberg equilibrium with two or multiple alleles	4
10	PCR-RFLP	8

SEMESTER-II					
Course code	**Type of Course**	**Course name**	**IA**	**SE**	**Credits**
FS02BS-2O1	Open Elective	Environment and Health	50	50	3
FS02BS-2C1	Core -Theory	Nanobiotechnology	50	50	3
FS02BS-2C2	Core - Theory	Stem cell and Developmental Biology	50	50	4
FS02BS-2C3	Core- Theory	Immunology	50	50	4
FS02BS-2C4	Core- Theory	Toxicology	50	50	4
FS02BS-2C5	Core -Practical	Nanobiotechnology and Toxicology	25	25	2
FS02BS-2C6	Core -Practical	Stem Cell and Developmental Biology	25	25	2
FS02BS-2C7	Core - Practical	Immunology	25	25	2
Total			325	650	24

Course code	**Type of Course**	**Course name**	**Hours/Week**	**Credits**
AP02BS-2O1	**Open Elective**	**Environment and Health**	**3**	**3**

Course outcomes (COs)

CO 1	Define environment, biodiversity and natural resources
CO 2	Outline biodiversity, biogeochemical cycle, natural resources and impact of toxicants on health and environment
CO 3	Enumerate the different types of air pollutants and associated health risks
CO 4	Describe sources and types of water pollution, epidemiology, infectious diseases and water treatment technology

Unit 1: Fundamentals of Environmental Health (12 hrs)

- Global environmental change: Introduction, biodiversity loss, human impact on environment
- Basic concept in Environmental Toxicology [Important environmental toxicants: Pesticides, Heavy metals, Organic pollutants, Endocrine disruptor, Carcinogenesis, Mutagenesis and Genotoxicity, Ionizing and Nonionizing Radiation, Fluoride and Thoron toxicity, Health impact]
- Environmental pollution [Solid waste and hazardous waste]
- Biogeochemical cycles and health impacts
- Environmental and biological indicators
- Natural resources, conservation and sustainable development

Unit 2: Air pollution and health (10 hrs)

- Chemical composition of Air [Classification of elements, impact of air quality, aeroallergens and degraded air quality, respiratory diseases, thermochemical and photochemical reactions in the atmosphere]
- Air pollution [Indoor and outdoor air pollution, Climate change epidemiology: Problems and Challenges, Health exposures: Weather, Thermal extremes and their health impacts]
- Global warming and climate change [Stratospheric ozone depletion and public health, Photochemical smog]

Unit 3: Water pollution and health (10 hrs)

- Water pollution [Types, sources and consequences]

- Physico-chemical and bacteriological sampling and analysis of water quality [Water quality standards]
- Environmental Epidemiology and infectious diseases [Climate and its impacts on vector-borne and zoonotic Diseases, food- and water-borne diseases]
- Food security [Challenges of climate change to food security, safety, and nutrition]
- Marine pollution and control [Criteria employed for disposal of pollutants in marine system– coastal management]
- Conventional and advanced water treatment technology [Biotechnological approaches and steps involved]

Unit 4: Land pollution and health (10 hrs)

- Soil pollution [sources - Industrial waste effluents and heavy metals, their interactions with soil components. Different kinds of synthetic fertilizers and their interactions with different components of soil]
- Physico-chemical and bacteriological assessment of soil quality
- Effects of heavy metals on human health [Mercury, lead, chromium, cadmium, arsenic]
- Radioactive pollution
- Microbiological management of hazardous waste and wastelands
- Biomagnification
- Bio-degradation [Insecticides, fungicides and weedicides in soil]
- Environmental laws

Course code	Type of Course	Course name	Hours/ Week	Credits
AP02BS-2C1	**Core - Theory**	**Toxicology**	**3**	**4**

Course Outcomes (COs)

CO 1	Outline the basic concepts, different forms of toxicity and biotransformation mechanisms
CO 2	Illustrate the common pollutants and their mechanism of action
CO 3	Summarize key concepts of pharmacokinetics and pharmacodynamics, also understand the various forms of drug toxicity
CO 4	Assess the applications of toxicology in various fields - Food toxicology, Forensic toxicology, Cosmetic toxicology and Occupational toxicology
CO 5	Elaborate the various techniques of toxicity evaluation and learn the guidelines for regulatory requirements

Unit 1: Introduction to Toxicology (10 hrs)

- History, introduction, basic principles and scope of toxicology
- Dose response relationships: LD50, ED50, LC50, EC50; Dose Response Assessment
- General mechanisms of toxicity, Disposition of toxicants - Adsorption, distribution and elimination of toxicants
- Biotransformation of xenobiotics- Basic properties, categories and distribution of xenobiotic bio transforming enzymes
- Risk Assessment

Unit 2: Health effects and indicators of toxic agents (12 hrs)

- Toxic effects of pesticides with special reference to DTT, lindane and cyclodienes
- Toxic effects of lead, arsenic, mercury and cadmium
- Health effects of radiation and radioactive materials: Deterministic and Stochastic effects
- Overview of rules and regulations on radiation safety
- Introduction to International nuclear event scale, Important radiation episodes – Chernobyl disaster, The Three Mile Island Accident, Fukushima Daichi Nuclear Disaster
- Bioindicators: Overview of bioindicators and biomonitoring – theory, practices and problems, key indicators of environmental pollution

Unit 3: Drugs interactions and toxicity (12 hrs)

- Classification of drug interactions
- Drug interactions with Vitamins (Interactions of Retinoids with Vitamin A, levodopa with Vitamin B6, Warfarin with Vitamin E and Vitamin K, Methotrexate with folic acid)
- Drug interactions with minerals (Interactions of Tetracyclines and Fluoroquinolones with Calcium, Aluminium and Magnesium, Methyldopa and proton pump inhibitors with Iron, Angiotensin receptor blockers and Diuretics with Potassium)
- Drug-nutrient interactions - Mechanism based classification system (Ex-vivo bioinactivations, absorption phase associated interactions, physiological action associated interactions, elimination phase associated interactions).
- Drug - dietary supplement interactions (Interactions of coenzyme Q10, fish oil and herbal supplements with drugs)

Unit 4: Applications in various fields (10 hrs)

- Food toxicology: Introduction, safety standards for food, food ingredients and contaminants
- Forensic toxicology: Analytic role, toxicologic investigations of poison death, criminal poisoning of the living
- Clinical toxicology: Strategy for treatment of the poisoned patient
- Cosmetic toxicology: Overview and principles
- Occupational toxicology: Introduction, occupational diseases, worker health surveillance, exposure monitoring

Unit 5: Toxicity evaluation and guidelines (12 hrs)

- In vitro toxicity assays: MTT assay, Neutral red uptake assay, Mitochondrial membrane potential detection assay
- Assessment of genetic toxicity: COMET assay, Micronucleus assay
- Mutagenicity testing: Ames's test, Mouse lymphoma thymidine kinase assay
- In vivo toxicity testing: Acute, subchronic, chronic
- Teratogenicity testing: Pre-natal, developmental and teratology
- Carcinogenicity testing: Transgenic mice models, chemical carcinogenesis models
- OECD guidelines for the acute and chronic toxicity testing of chemicals

Course code	Type of Course	Course name	Hours/Week	Credits
AP02BS-2C5	**Core - Practical**	**Nanobiotechnology and Toxicology**	**4**	**2**

Sl. No.	Laboratory Exercises	Hours
1	Fabrication of nanomaterials	4
2	Synthesis of nanoparticles using biological processes	4
3	Detection of nanoparticles in colloidal solutions using UV-vis absorption technique	4
4	Radical polymerization of functional monomers	4
5	Synthesis of hydrogels	8
6	Fabrication of bio-nano composites	4
7	Fluorescent nanomaterials for bioimaging	4
8	GHS pictograms for hazard identification	4
9	Genotoxicity testing by COMET assay	8
10	Chemical toxicity testing by Micronucleus assay	8
10	Toxicity of nanomaterials using MTT assay	4
11	Estimation of chlorine in drinking water	4
12	Detection of food adulterants	4

Course code	Type of Course	Course name	Hours/ Week	Credits
AP02BS-2C2	**Core - Theory**	**Nanobiotechnology**	**3**	**3**

Course outcomes (COs)

CO 1	Explain the concept of nanomaterials and their preparative methods
CO 2	Illustrate the synthesis and characterization methods of nanomaterials
CO 3	Categorize the application of nanomaterials in different domains such as Drug Delivery and Medical Diagnostics
CO 4	Describe the application and advantages of nano biomaterials in tissue engineering

Unit 1: Introduction to Nanomaterials (10 hrs)

- Definition of nanomaterials
- Materials classification by bonding, amorphous and crystalline nanomaterials
- Type of Nanomaterials-polymeric nano materials, metallic nanomaterials, ceramic nanomaterials carbon nanomaterials, composite nano materials
- Properties of nanomaterials- Optical, mechanical, electrical, and magnetic properties

Unit 2: Synthesis and Characterization of Nanomaterials (10 hrs)

- Top-down and bottom-up approaches for synthesis of nanomaterials: Milling method, colloidal, sol-gel, microemulsion, hydrothermal and electrodeposition methods
- Green synthesis of nanomaterials using microbes and plant metabolites
- Bio-responsive nanomaterials based on natural and synthetic polymers, nanohydrogel, nanofibers, polymer nanocomposites
- Characterization of nanomaterials: UV-visible and fluorescence spectroscopy, FT-IR spectroscopy, and Dynamic light scattering
- Shape and structural analysis- Scanning electron microscopy, Transmission electron microscopy, Atomic force microscopy

Unit 3: Nanomaterials Drug Delivery and Medical Diagnostics (12 hrs)

- Basic concepts in the design of nanomedicine, specification and desired features of nanomedicine
- Strategies for advanced drug delivery: Concept of drug targeting, nanoscale drug delivery systems and advantages
- Nanocarriers for drug delivery- Lipid based nanocarriers, Polymeric nanocarriers, Inorganic nanoparticles
- Nanomedicines for various disease conditions and different types of drug delivery systems
- Nano systems in medical diagnostics: Biomarkers to cells and tissues, Nano biosensors in diagnosis, Enzymatic and non-enzymatic sensors, Electrochemical biosensors, Lab-on-a-chip concept, Bio-microelectromechanical systems and Microfluidics

Unit 4: Nano biomaterials in tissue engineering (10 hrs)

- Fundamentals of tissue engineering, structure-function-properties of biomaterials, extracellular matrix, cells, growth factors, biomaterials-cell interactions
- Definition and requirements of a scaffold; biomimetic materials, decellularized scaffolds and role of nanomaterials in tissue engineering
- Scaffold fabrication and characterizations: Salt leaching method, freeze-drying method, design of medical devices, 3D printing, bioreactors and organoids
- Applications of nanomaterials in tissue engineering: Bioengineering of human skin, bone and cartilage regeneration

Course code	Type of Course	Course name	Hours/Week	Credits
AP02BS-2C3	**Core - Theory**	**Stem Cells and Developmental Biology**	**4**	**4**

Course outcomes (COs)

CO 1	Define mammalian developmental biology from the right perspective and understand the developmental biology in the model organism, *Drosophila*
CO 2	Explain the importance of energetics in mammalian development
CO 3	Discuss the cellular potencies
CO 4	Examine the regenerative potential and translational aspect using regenerative stem cells and for cancer therapeutics
CO 5	Adapt the national/international guidelines on the ethical issues involved in the use of stems cells in research and clinical applications

Unit 1: Developmental biology and Introduction, origin of stem cells and types (12 hrs)

- Importance of studying developmental biology for understanding stem cell biology
- Mammalian development with special emphasis to pre-embryonic mouse human and model organism-*Drosophila*
- Vertebrate developmental patterning, axis and body plans, germ layers (ecto, meso and endoderm)
- Mechanisms of differentiation and crosstalk between various cell lineages during mammalian development
- Cell potency during mammalian development
- Concepts of regenerative and cancer stem cells in correlation to development and/or developmental imbalance, pre and post-embryonic perspective

Unit 2: Stem Cell metabolism, Metabolic differences between somatic cells, stem cells and cancer cells, Stem Cell Energetics (10 hrs)

- Cellular metabolism in mammalian system
- Somatic versus cancer stem cell metabolism
- Reactive Oxygen species (ROS) generation management by somatic and cancer stem cells
- Stem cell niche and energetics
- Naïve versus primed stem cell energetics
- Oxidative phosphorylation versus glycolysis as stem cell energetics

- Mitochondrial biogenesis and mitophagy as cellular energetic machinery governing respective differentiated and undifferentiated stem cell states

Unit 3: Basics and applications of stem cells (12 hrs)

- Embryonic stem (ES) cells, discovery and importance
- Use of ES cells for alleviating human diseases
- Induced pluripotent stem cells (iPSCs), generation and uses
- Role of iPSCs for alleviating human diseases
- Advantages and disadvantages of using ESC and iPSC for research
- Adult stem cells (ASC) and their importance in the scientific community
- Advantages and disadvantages of using ASC for research
- Ground breaking application of adult stem cell (ASC) in human disease

Unit 4: Clinical applications and status of clinical research/trials using regenerative stem cells: Embryonic/pluripotent and adult stem cells; Regenerative stem cell based cancer therapeutics (10 hrs)

- Status of translational research for regenerative applications of stem cells
- Various steps need to be followed in order for stem cells usage from bench-to-bedside
- The basic principles of cancer therapeutics using stem cells
- Pre-clinical and clinical trials using stem cells
- Kinds of stem cell products gone into clinical trials and their status
- Stem Cell manufacturing under C-GMP facility, overview of various stem cell products

Unit 5: Ethical considerations for research and clinical use of various kinds of stem Cells (12 hrs)

- Ethical considerations for research and clinical use of various kinds of stem cells
- Regulatory requirements as per Indian (ICMR guidelines) and global standards for carrying out stem cell research
- Regulatory requirements for clinical use of stem cells as per Indian and global standards
- Safety issues related to various stem cell therapies
- Stem cell banking, informed consent and regulatory issues
- Stem cell products obtained from PSC, ASC for regenerative applications versus applications for cancer therapeutics - similarities differences and ethical considerations

Course code	Type of Course	Course name	Hours/Week	Credits
AP02BS-2C6	**Core - Practical**	**Stem Cells and Developmental Biology**	**4**	**2**

Sl. No.	Laboratory Exercises	Hours
A	**Cell culture experiments**	
1	Basic mammalian stem cell culture-Media preparation	4
2	Thawing and seeding of cells and cell passaging	8
3	Cell counting	4
4	Isolation of mouse bone marrow mesenchymal stem cells (MSC)	4
5	Harvesting of tissues, digestion and processing for pre plate culture	8
6	Isolation of adipose stem cells/muscle stem cells from mouse tissue Isolation of mouse bone marrow mesenchymal stem cells and human Wharton's jelly mesenchymal stem cells	8
7	Cancer stem cells	4
B	**Characterization experiments**	
1	Analytical flow cytometry for stem cell Immunophenotyping	4
2	Human MSC as per International Society for Cell Therapy (ISCT) guidelines, Immunofluorescence staining of MSCs	4
3	Fluorescent Assisted Sorting (FACS) of Stem Cells	4
C	**Cell Imaging and Quantification**	

4	Cell imaging using fluorescent imagers (EVOS M5000- Thermo Fisher Scientific, USA) and ZOE (Bio-Rad, USA), Image Quantification for various parameters such as nuclei and positively stained cells using ImageJ	4

Course code	Type of Course	Course name	Hours/Week	Credits
AP02BS-2C4	**Core - Theory**	**Immunology**	**4**	**4**

Course outcomes (COs)

CO 1	Define and outline the various component of immune system
CO 2	Illustrate with mechanism of immune effecter system
CO 3	List the importance of immunological response
CO 4	Explain applications of immunological tests and animal models used for immunological studies
CO 5	Practice evaluation of immune response

Unit 1: Introduction to Immune system (8 hrs)

- Introduction to immune system
- Cells, organs and tissues of immune system
- Types of Immunity - Innate immunity, Acquired immunity
- Mechanisms of barrier to entry of microbes/pathogens (Protective and Destructive)

Unit 2: Immune Effecter mechanism (14 hrs)

- Hematopoiesis and its regulation
- Cytokines in immunity, Interferons, Interleukins, Tumor Necrosis Factors, Transforming Growth Factor, Chemokines and Adhesion molecules.
- Complement system: (Classical and Alternative pathways)
- Cytotoxic T cells, Natural Killer Cells, ADCC, NK cell receptors, Inverse correlation with target

MHC expression, Missing self-hypothesis, Cytotoxicity reaction), Leukocyte activation and Migration, Phagocytosis and Microbicidal mechanisms

- Hypersensitivity, Immediate hypersensitivity; Asthma, IgE receptor, Prostaglandins and Leukotrienes
- Antibody structure and function, Antibody mediated effector functions
- Antibody classes and biological activities: Monoclonal antibody, Immunotoxins, Abzymes

Unit 3: Cell mediated immunity (14 hrs)

- Antigens, antigenicity, and immunogenicity; B and T cell epitopes
- Generation, activation and differentiation of B-lymphocyte, Differentiation and activation of B cells, BCR and pre BCR, Receptor editing
- Immunoglobulin superfamily, Expression of Immunoglobulin genes (Genetic model compatible with immunoglobulin structure, Antibody diversity, VDJ recombination)
- Class switching of Ig: Class switching, somatic hypermutation, N-and P-nucleotide addition
- Antigen-Antibody reactions
- Major Histocompatibility Complex (Genetic organization of H2 and HLA complexes; Class I and class II MHC molecules, structure and function), Antigen processing and presentation
- T-cell help, T-cell receptor, and T-cell antigen recognition; T-cell maturation, activation and differentiation, Th1/Th2 cells
- Cytokines– Applications in diagnostics

Unit 4: Immune system in health and disease (10 hrs)

- Auto immunity and immunodeficiency, Molecular mimicry, Immune therapy
- Tumor and Transplant immunology, Parasitic immunology, Phage display
- Animal models and transgenic animals and their use in immunological studies; Routes of Inoculation transgenic animals
- Experimental immunology: Vaccine development (Recombinant, Combined and Polyvalent vaccines) Immuno - Diagnostics, CAR T - Cell Therapy and dendritic cell vaccines

Unit 5: Immunological Techniques (10 hrs)

- Hybridoma, Monoclonal antibodies and Antibody engineering: Antibody (mAb, pAb), Chimeric antibodies
- Evaluation of immune response by using ELISA, RIA, Western blot, Immunoprecipitation, Flowcytometry, Immunofluorescence

- Qualitative, quantitative and kinetic modes of expression: Realtime PCR, Microarray, Immune-seq

Course code	Type of Course	Course name	Hours/Week	Credits
AP02BS-2C7	**Core - Practical**	**Immunology**	**4**	**2**

Sl. No.	Laboratory Exercises	Hours
1	Immune system and organs in a mammalian animal model	8
2	Hematoxylin and eosin staining of spleen	4
3	Lymphocyte isolation and staining	4
4	ELISA	8
5	Single Radial immuno-diffusion	4
6	Ouchterlony diffusion on gels	4
7	Counter current immune electrophoresis	4
8	Rocket immunoelectrophoresis	4
9	Latex agglutination kit	4
10	Blood typing	4
11	Immunocytochemistry (Light, Fluorescent Microscopy)	8

SEMESTER-III					
Course code	**Type of Course**	**Course name**	**IA**	**SE**	**Credits**
FS02BS-3O1	Open Elective	Scientific Communication	50	50	3
FS02BS-3C1	Core -Theory	Research Methodology	50	50	4
FS02BS-3C2	Core - Theory	Omics Technology and Systems Biology	50	50	4
FS02BS-3C3	Core -Theory	Genetic Engineering	50	50	4
FS02BS-3C4	Core -Theory	Neurobiology	50	50	3
FS02BS-3C5	Core -Practical	Omics Technology & Systems Biology	25	25	2
FS02BS-3C6	Core- Practical	Biostatistics	25	25	2
FS02BS-3C7	Core -Practical	Neurobiology	25	25	2
Total			650		24

Course code	**Type of Course**	**Course name**	**Hours/Week**	**Credits**
FS02BS-3O1	**Open Elective**	**Scientific Communication**	**4**	**3**

Course outcomes (COs)

CO 1	Explain the research practices and good laboratory practices
CO 2	Demonstrate the advanced software tools, and maintenance scientific record
CO 3	Practice presentations, effective communication, writing project proposals and manuscripts
CO 4	Outline innovations, entrepreneurship, start-up companies and product development

Unit 1: Research Practices and Applications (10 hrs)

- The review of the literature and approaches to research
- How to use search engines such as PubMed, Scopus and Science Direct
- Planning the research and development of hypothesis and research ideas
- Designing a research work or projects
- Selecting methods of data collection
- Organizing the research notes and logbooks and interpreting of results
- Ethics and integrity in research and Learning Good Laboratory Practices (GLP)

Unit 2: Effective Writing and Presentation Skills (10 hrs)

- Writing research and review papers and documenting the paper
- Drafting and revising, preparing the final draft and how to communicate the manuscript to journals
- How to make power point presentations
- How to present the scientific findings in front of scientific peers
- How to present the oral poster presentation in symposiums and conferences
- Attending the web-based webinar, TED talks and podcasts

Unit 3: Skill Advancement Programs (10 hrs)

- Learning and utilization of advanced software such as EndNote, Adobe Photoshop, Origin Lab, Sigma Plot, and Graph Pad Prism
- Development of quality figures for publications, research proposals, and presentations
- Introduction to Microsoft Offices (Word, Excel and PowerPoints)

- Creative writing and publishing
- How to write a research proposal

Unit 4: Personality and Career Development (12 hrs)

- Building a motivated research collaboration among the researchers and experts in similar research field and social interaction
- Developing self in work and career and dress code
- Management in health, mindfulness and time
- How to prepare and attend the interview
- How to make resumes, and do and don'ts
- Innovation and entrepreneurship and industrial visits
- How to do research-based projects
- How to develop startup companies

Course code	Type of Course	Course name	Hours/Week	Credits
FS02BS-3C1	**Core-Theory**	**Research Methodology**	**4**	**4**

Course Outcomes (COs)

CO 1	Explain research methodology, its significance and scientific methods used in research
CO 2	Analyse how to define a Research Problem under different contexts
CO 3	List different Ethical and regulatory bodies and their role in shaping research
CO 4	Elaborate Intellectual Property Rights and their issues in Research

Unit 1: Introduction to Research Methodology (14 hrs)

- Definition of Research and outcomes
- General Characteristics of Research
- Types of Research
- Research Approach: Qualitative and Quantitative

- Significance of Research, Research and Scientific Methods
- Important Research designs: Experimental (Randomized, non-randomized, single blind and double blind) and Observational (Cross-sectional, prospective, retrospective and case control)

Unit 2: Defining the Research Problem (14 hrs)

- Concept and Identification of Research problem
- Understanding lacunae in research
- Defining a research problem
- Literature review, types of research articles
- Search tools (Databases, PubMed, Google Scholar, Keyword search)
- Basis of Systematic review (Filtering criteria)
- Research Questions and Hypothesis
- Basis and characteristics for good hypothesis.

Unit 3: Ethical and regulatory aspects in Research (14 hrs)

- ICMR guidelines: National ethical guidelines for biomedical and health research involving human participants
- Declaration of Helsinki, Ethical Principles for Medical Research Involving Human Subjects
- CPCSEA guidelines for use of animals in research

Unit 4: IPR (Intellectual Property Rights) issues in Research (14 hrs)

- Patent, designs, trademarks
- Inventions and patents; key differences
- IPR- intellectual property rights and patent law, commercialization, Trade related aspects of intellectual property rights (TRIPS)
- Understanding the inventorship, ownership and rights, royalty
- Novelty, inventive step and industrial applicability
- Introduction to patent specifications; provisional and complete specifications
- Patent filling procedure, Patent granting organizations
- Geographical indications in patent
- Copy right and Plagiarism
- Start-up and entrepreneurship

Course code	Type of Course	Course name	Hours/Week	Credits
FS02BS-3C2	**Core-Theory**	**Omics Technology and Systems Biology**	**4**	**4**

Course Outcomes (CO)

CO 1	Explain the basics of gene expression analysis and genome sequencing technologies
CO 2	Illustrate the technologies to analyse transcriptome and epigenome
CO 3	Interpret the basics of proteomics experimental pipeline and data analysis
CO 4	Relationship with Multi-Omics data integration
CO 5	Relate with Basics of metabolomics experimental workflow and data analysis
CO 6	Make use of Mass spectrometry-based Metabolomics and Proteomics experiments

Unit 1: Genomics (12 hrs)

- Sanger sequencing-Principle, methodology and applications
- History of Genome sequencing
- Human Genome Sequencing Project
- Analysis of gene expression- qPCR, Northern blot, Southern blot
- Exome sequencing
- DNA microarrays
- Copy number variation
- Sequence repeats
- SNV, Haplotype and their relevance in diseases
- Next Generation Sequencing (NGS) technology
- Whole genome - de novo sequencing
- Comparative genomics

- Metagenomics

Unit 2: Transcriptomics (10 hrs)

- RNA-seq analyses
- Transcriptome profiling
- RNA sequencing
- Small RNA sequencing
- Differential expression
- Alternate splicing

Unit 3: Proteomics (12 hrs)

- Basics of Chromatography
- Mass Spectrometry – Ionization methods (MALDI, Electrospray)
- Mass Analysers
- Protease digestion
- Peptide mass fingerprinting
- Tandem mass spectrometry
- Sample preparation strategies
- Fractionation strategies
- Search algorithms/engines
- Proteomic data repositories
- Targeted proteomics

Unit 4: Metabolomics (12 hrs)

- Metabolomics - An overview
- Basic sample preparation strategies- Extraction, Derivatization
- Introduction to small molecules and lipidomics
- Targeted vs Untargeted Metabolomics
- Development of targeted assays for small molecules
- Metabolic pathways
- Metabolite profiling
- Inborn errors of metabolism

Unit-5: Data analysis and multi-omics data integration (10 hrs)

- Genomic, transcriptomic, proteomic and metabolomics data file format and standards
- Bioinformatics tools for data analysis
- Curation and gene accession mapping
- Quality control for data integration
- Analysis and visualization
- Gene set enrichment analysis
- Pathway analysis
- Network analysis

Course code	Type of Course	Course name	Hours/Week	Credits
AP02BS-3C3	**Core - Theory**	**Genetic Engineering**	**4**	**4**

Course outcomes (CO)

CO 1	Summarize the importance of enzymes and vectors in gene cloning
CO 2	Illustrate different cloning methods used in genetic engineering
CO 3	Outline the different library construction and screening methods
CO 4	Identify different gene manipulation and transformation techniques
CO 5	Justify the translational value of genetic engineering

Unit 1: Enzymes and vectors in gene cloning (10 hrs)

- T4 DNA ligase, Reverse transcriptase
- Restriction enzymes
- Methylase
- DNA polymerases
- Terminal transferase, Alkaline phosphatase
- DNase and RNase

- Polynucleotide kinase
- Topoisomerases
- Lambda bacteriophage
- Cosmids, M13 vectors
- Cloning vectors (TA, TOPO), Plasmids
- Expression vectors (pET28a, TOPO)
- BACs, YACs, Super Vectors

Unit 2: Introduction to cloning (10 hrs)

- Designing gene specific primers, gene amplification by PCR
- Cloning with added restriction sites (Cohesive and blunt-end cloning)
- Cloning using adapters, linkers and homopolymer tailing
- Nested primers and PCR
- PCR based Site Directed Mutagenesis
- Degenerate primers and PCR
- TOPO cloning
- GATEWAY cloning
- Transformation and Colony PCR

Unit 3: Library construction and screening (8 hrs)

- Construction of genomic DNA and cDNA libraries
- Subtractive cDNA library
- Normalized cDNA library
- Methods of screening the libraries using nucleic acid and antibody probes
- Functional screening
- Screening by complementation

Unit 4: Gene manipulation of living organisms (8 hrs)

- Expression and purification of recombinant proteins in *E. coli*, Yeast, Baculovirus, Animal cell lines, Transgenic plants and Transgenic animals.
- Gene manipulation (Silencing, types of small non translated RNA)
- Use of Phage display techniques to facilitate the selection of mutant peptides
- Gene shuffling

- Production of chimeric proteins

Unit 5: Translational value for genetic engineering (10 hrs)

- Recombinant enzymes as diagnostic tool
- Vectors for gene therapy
- GMO and food security
- Environmental bioremediation
- Genetically modified drugs
- Genetically altered biomaterials
- Biosensors, and biochips
- Ethics in genetic engineering

Unit 6: Demonstration and experimental protocols (10 hrs)

- Target gene amplification by PCR
- Isolation and purification of plasmid construct
- Restriction digest of construct
- Ligation and Transformation
- Colony PCR
- SDS-PAGE of over expressed proteins

Course code	Type of Course	Course name	Hours/Week	Credits
FS02BS-3C4	**Core - Theory**	**Neurobiology**	**3**	**3**

Course Outcomes (COs)

CO 1	Explain the concept of neuronal organization and communications in animals
CO 2	Compare the functional and structural differences in the organization of the nervous system in vertebrates and invertebrates
CO 3	Identify the pathophysiological mechanisms of acute and chronic neurological disorders
CO 4	Model the human neurological disorders in a simple vertebrate and invertebrate system
CO 5	Analyze the normal and altered states of neurological conditions using various neural techniques

Unit I: Structure and Function of the Nervous System (10 hrs)

- Structural organization of the vertebrate and invertebrate brain
- Structure and functions of the Neuron: Cytology of the neurons, classification and types of the neurons, Dendrites structure and function, Axons structure and functional aspects, Myelination and Synapses
- Structure and function of the Glial cells: Different types of glial cells: Astrocytes, Oligodendrocytes and Schwann cells, Microglia
- Electrical properties of excitable membranes, generation and propagation of action potential

Unit II: Neurochemistry (10 hrs)

- Synaptic transmission and cellular signaling: Structure and function of the chemical/electrical synapses
- Synaptic transmission between neurons
- Acetylcholine: Chemistry, synthesis, storage and release; Nicotinic and muscarinic receptors
- Catecholamine: Chemistry, synthesis, storage and release; Dopamine and adrenergic receptors
- Serotonin synthesis, action, distribution and the role of serotonergic receptors in the behavior
- Excitatory and Inhibitory neurotransmitters: Synthesis, metabolism, distribution and receptors subtypes; Neuropeptides as neurotransmitters

Unit III: Neural Disorders (12 hrs)

- Different types of neural disorders in humans
- Causes, neural mechanisms and behavioral phenotypes in some of the major neurological disorders (Alzheimer's, Parkinson's disease, Epilepsy)
- Diagnostic and possible therapeutic approaches for neural disorders
- Acute neurological disorders – Stroke and vascular dementia – Risk factor, epidemiology, etiology, pathophysiology and treatment

Unit IV: Preclinical Models and Neural Techniques (10 hrs)

- Different vertebrate, invertebrate and in vitro models for neurological studies (*Drosophila*, Mouse model for Alzheimer's, Parkinson's, Epilepsy and vascular dementia studies)
- Preclinical models of stroke (in vitro, in vivo models)
- Anatomical techniques - Golgi-silver staining, Nissl staining; Histological and Immunohistochemical techniques
- Imaging techniques: MRI, PET, SPECT, MRI/FMRI
- Transgenic techniques- Gal4-UAS and MARCM techniques in *Drosophila*
- Recording techniques – Patch clamp and extracellular recordings in neurons

Course code	Type of Course	Course name	Hours/Week	Credits
FS02BS-3C7	**Core - Practical**	**Neurobiology**	**4**	**2**

Sl. No.	Laboratory Exercises	Hours
1	Differentiation of mechanoreceptors and chemoreceptors in *Drosophila*	4
2	Golgi-staining technique	4
3	Campaniform sensilla in *Drosophila*	4
4	Olfactory discrimination in *Drosophila*	4
5	Gal4-UAS system to label neural circuits	4
6	Feeding preferences in *Drosophila*	4
7	Culture of secondary brain cells – differentiation (spine identification)	4
8	RT-PCR of cell-type specific markers of cultured brain cells	4
9	Oxygen-glucose deprivation – *in vitro* model of ischemic stroke	4
10	Isolation of rodent common carotid artery	4
11	Isolation of rodent brain – identification of substructures (cortex, hippocampus etc.)	4
12	TTC (2,3,5-triphenyltetrazolium chloride) staining of rodent brain	4
13	Slit sensilla in *Drosophila*	4
14	Dissection of *Drosophila* larval and adult brain	4

Course code	Type of Course	Course name	Hours/Week	Credits
FS02BS-3C5	**Core-Practical**	**Omics Technology and Systems Biology**	**4**	**2**

S. No.	Laboratory Exercises:	Hours
1	DNA sequence databases: Sequence Alignment and Searching, Data base similarity search-BLAST. Phylogenetics: Methods of tree construction	6
2	Next Generation Sequencing data–quality control, alignment, Phredscore; Fast QC and FastX toolkits, data analysis tools and pipeline, read length, read depth, sequence coverage	12
3	Molecular Docking and drug interaction	6
4	Protein sequence databases; PDB file formats	6
5	Protein extraction strategies for varied biological samples	3
6	Normalization techniques for quantitative proteomics	4
7	Liquid chromatography-based fractionation of proteins	4
8	Stop And Go Extraction (C18-based) for mass spectrometry	4
9	Proteomic data analysis- Search algorithms, False Discovery Rates, Parsimony rules	8
10	Extraction techniques for Metabolomics.	3
11	Metabolomics Data analysis – identification of molecular features, metabolite identification; structural confirmation of metabolites.	8
12	Biological interpretation of OMICS data- Gene Set Enrichment Analysis, Pathway analysis, Network analysis	8

Course code	Type of Course	Course name	Hours/Week	Credits
FS02BS-3C6	**Core - Practical**	**Biostatistics**	**4**	**2**

Course outcomes (COs)

CO 1	Identify methods to collect, organize and represent data
CO 2	Determine the range and variation in the data
CO 3	Develop statistical hypothesis to test using real-life biological data
CO 4	Differentiate statistical hypothesis from research Hypothesis

Sl. No.	Sessions	Hours
1	Understanding the data (Categorical vs. Continuous Variables), Arrangement of data in tabular formats using Microsoft Excel,	6
2	Presentation and visualization of data using Microsoft Excel/GraphPad Prism/SPSS (Histogram, Bar diagram, Pie chart etc.)	6
3	Calculation of the Measures of central tendencies and measures of dispersion (Mean, Median, Mode, Standard Deviation, Standard Error and Coefficient of Variation) using Microsoft Excel	6
4	Understanding and computing the Degrees of Freedom, estimate of parameters and their confidence intervals (CIs), Understanding and computing 95% Confidence Intervals	6
5	Hypothesis Testing Ia: Comparison of two groups using parametric statistics (Student's t-Test, paired t-Test) using Microsoft Excel/SPSS/GraphPad Prism, Computation of P-values and understanding its significance, Determination of Power for statistical analysis	6
6	Hypothesis Testing Ib: Comparison of two groups using non parametric statistics (Mann-Whitney U test, Wilcoxon signed rank test) manually and using MS Excel/SPSS/GraphPad Prism	6
7	Hypothesis Testing II: Comparison of more than two groups using parametric and non-parametric statistics (One-way ANOVA, Kruskal Wallis test) using Microsoft Excel/GraphPad Prism, Multiple comparisons using Tukey's, Bonferroni and Dunn's posthoc tests, Computation of *P*-values and Understanding its significance	12
8	Hypothesis Testing III: Goodness of Fit tests (Chi square test)	6

	using Microsoft Excel/SPSS/GraphPad Prism	
9	Understanding Covariance: Drawing scatter plots and Trend's line using Microsoft Excel/ SPSS/GraphPad Prism	6
10	Parametric and Nonparametric Correlation analysis (Karl Pearson's and Spearman's rank) and Simple Linear Regression analysis using Microsoft Excel-add ins/SPSS/GraphPad Prism	12

SEMESTER-IV			
Course code	**Details**	**Duration**	**Credits**
FS02BS-4PR	Project work	14 weeks	24

Postgraduate Internship Program

Aim

We offer a built-in 6-month internship program during the final semester of the curriculum. The primary aim of this program is to provide the students a hands-on experience of cutting-edge academic or industrial projects. Through this, the students can develop the right professional attitude, learn work ethics, and expand their domain of expertise as per their career goals. Further, this internship provides the opportunity to interact with potential employers in academia or industry before they formally apply for a job. It offers a platform for pro-active students to develop collaborative ventures between academia and industry or between two academic institutions.

Details

Students can opt for either an internal or external institution. They are free to work in any of the departments of any constituent college of Yenepoya (Deemed to be University) depending on the availability of suitable projects. For external internships, students can opt for industrial or academic institutions or any other organization of their choice. Due guidance is provided to the students to help them make contacts with the external organization.

Evaluation

At the end of the program, the students are expected to submit a thesis and defend their dissertation during a presentation in presence of a panel of examiners. An open presentation and/or poster session is arranged where students present their results and get feedback from peers and faculties of the institute.

- **Course specific outcomes:**

In the M.Sc., Biosciences program, diverse courses are designed covering various aspects of biological and allied sciences along with the cutting-edge omics techniques with systemic approach and bioinformatics. The integration of interdisciplinary schemes makes the outcome of this course very unique. The learning outcomes include knowledge in the core theoretical aspects as well as practical applications of the knowledge in all sections covered under the curriculum. The outcomes from each course are defined so that the students satisfying the course and program outcomes will be competitive in the current life sciences job market as well as in academia. Additionally, the elective courses and the supplementary courses on soft skills will broaden the multidisciplinary knowledge of the student and will prepare the student for a successful career in the industry as well as in academia.

9. Teaching methods:

To ensure that the students are imparted with the knowledge and skills in the diverse sections of biological sciences, a combination of both traditional learning as well as modern methods will be employed. These methods include:

- Illustrative learning using Smart boards.
- Lectures using audiovisual mode (PowerPoint presentations)
- Practical hands-on training using laboratory experiments.
- Seminars and group discussions by the students
- Attending the Guest lectures by experts from academia, industry, or research institutions to broader perspective of the field
- Field trips as a part of extracurricular activities
- Peer-teaching methods
- Research internships

11. Scheme of Examinations

- **Internal Assessment:** Marks for internal assessment shall be awarded on the basis of seminars, Journal paper presentations, tests, assignments etc. The assessment gives importance to continuous and comprehensive evaluation. The internal assessment marks shall be notified be communicated to the Controller of Examinations before the commencement of the University examinations. Internal assessment will be out of 50.

Components of CIA	Details	Weightage
Sessional Tests	Average of the two tests	60%
Seminar/Journal Cub/assignments	One Seminar/course One Journal paper relevant to the core courses	30%
Quiz/Viva-voce	Mock competitive exam preparation	10%

- **Semester End Examination:** There shall be examinations at the end of each semester, ordinarily during December/January for odd semesters and during June/July for even semesters. The SEE duration shall be three hours. Semester IV will be assessed on the project outcome.

- Pattern of question paper for semester-end examination (50 marks)

Sl. No.	Key Criteria	No. of questions and marks	Max marks
1	Questions to define or explain (5 out of 7 questions) (related to reasoning)	5 × 2	10
2	Problems/concepts (4 out of 5 questions) (related to applications)	4 × 5	20
3	Descriptive problems/questions (2 out of 3 questions) (related to understanding)	2 × 10	20
	TOTAL		50

- Pattern for Practical examination (25 marks)

Sl. No.	Key Criteria	No. of questions and marks	Max marks
1	Major experiment: Perform and report	1 × 10	10
2	Minor experiment: Perform and report	1 × 5	05
3	Spotters- Identify and report	5 × 1	05
4	Viva & Records	5	05
TOTAL			25

CIA shall be based on the quality of the records and performance in laboratory practical sessions during the semester (25 Marks).

- **Valuation of answer scripts**: Each theory examination shall be evaluated by one internal and one external examiner. There shall be a third evaluation if the difference is more than 15%.

  Practical examination shall be jointly conducted and evaluated by one internal examiner and one external examiner.

- **Evaluation of Project:** The internal assessment marks shall be allotted by the supervisor based on the work progress and attendance.

  Dissertation: Dissertation shall be evaluated by an external and internal examiner on the following criteria;

Sl. No.	Key Criteria	Max marks
1	Outline of the work and adequacy of the methodology	40
2	Rationale of the study and contribution to skill enhancement	40
3	Appropriateness of instruments and data analysis tools applied	60
4	Quality of data interpretations and reporting style	60
TOTAL		200

Viva-voce: Viva voce shall be conducted by a Common Viva-Board consisting of internal examiner and one external expert as approved by the Controller of Examinations. Viva duration shall be of one hour (40 minutes for presentation and 20 minutes for Q/A session) for 100 marks.

Sl. No.	Key Criteria	Max marks
1	Justification on the work done and its relevance	25
2	Clarity of presentation	25
3	Knowledge on the subject	25
4	Communication skills	25
TOTAL		100

- Internal assessment for the project work will be of 100 marks based as below:

Sl. No	Key Criteria	Max marks
1	Enthusiasm in research and punctuality	20
2	Approaches towards literature search and participation in scholarly discussion with mentors.	20
3	Ability to work independently and compliance to laboratory SoPs	30
4	Quality of the data generated	30
TOTAL		100

12.Eligibility to appear for University Examination

Candidates having ≥80% attendance in each of the courses and securing 50% in IA can only qualify to appear for the semester-end examinations. The candidate shall register for all the papers in the subject of a semester when he/she appears for the examination of that semester for the first time.

13. Criteria for passing

i. A candidate shall be declared to have passed the PG program if he/she secures at least a CGPA of 5.0 (Course letter Grade P) in the aggregate of both internal assessment and semester end examination marks.

ii. For each course the total of 100% is determined from the CIA evaluation and the SEE weighted at 40% and aggregate of CIA and SEE at 50% as minimum for pass.

iii. The candidates who pass all the semester examinations in the first attempt in two years are eligible for ranks provided they secure at least a CGPA of 6.0 (at least letter Grade B).

iv. The results of the candidates who have passed the fourth semester examination but not passed the lower semester examinations shall be declared as NCL (Not Completed Lower semester examinations). Such candidates shall be eligible for the degree only after completion of all the lower-semester examinations.

v. A candidate who passes the semester examinations in parts is eligible for only CGPA and letter Grade but not for ranking.

vi. Carry over shall be allowed for a candidate who failed in not more than two courses in a semester.

vii. A candidate who fails in any of the unit/project work/project report/dissertation shall reappear in that unit/project work/project report/dissertation and pass the examination subsequently.

14. Grading and Classification

The results of successful candidates at the end of each semester shall be declared in terms of Grade Point Average (GPA) and alpha sign grade. The results at the end of the fourth semester shall be classified based on the Cumulative Grade Point Average (CGPA) obtained in all four semesters and the corresponding overall alpha-sign grade. The letter grade, as described below, shall be adopted.

Letter Grade	Grade Point	Range of marks
O (Outstanding)	10	95-100
A (Very Good)	9	85-94
B (Good)	8	75-84
C (Average)	7	65-74
D (Below Average)	6	55-64
E (Poor)	5	50-54
F (Very poor)	0	Less than 50

The Cumulative Grade Point Average (CGPA) at the end of the fourth semester shall be calculated as the weighted average of the semester GPW. The CGPA is obtained by dividing the total of GPW

of all four semesters by the total credits for the programme.

The following is the sample illustration of computing semester grade point averages (GPA), cumulative grade point average (CGPA) and the letter grades assigned.

CGPA Range	Letter Grade
9.0-10.0	O (Outstanding)
8.0 – 8.99	A (Very Good)
7.0 - 7.99	B (Good)
6.0 - 6.99	C (Average)
5.5 - 5.99	D (Below Average)
5.0 – 5.49	E (Poor)
<5.0	F (Very poor)

15. Recommended books

Biochemistry

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5. Burtis and Edward R. Ashwood. Tietz Textbook of Clinical Chemistry (3rd Ed). W.B. Saunders Company. (1998).
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(Germany): Wiley-VCH. (2008).

Cell and Molecular Biology

1. Karp G., Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. (2016).
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4. Dubey, R. C. A text book of Biotechnology. (5th Ed). S Chand and Company Ltd. (2014).
5. Gerard J. Tortora, Berdell R. Funke and Christine L. Case Microbiology: An Introduction, Benjamin Cummings Publishing Company. (2018)
6. Jacquelyn Black and Laura J. Black. Microbiology: Principles and Explorations. (9th Ed). Wiley publications. (2014).
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York. (1993).
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9. Gibson G, Muse SV. A primer of genome science. Sinauer Associates Incorporated. (2004).

Environment and Health

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2. Spellman F. R and Bieber R. M. Environmental Health and Science Desk Reference. The Scarecrow Press, INC. (2012).
3. Robert Friis. Essentials of environmental health. Jones and Bartlett Publishers. (2018).
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Stem cells and Developmental biology

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16. Other information

General Regulations

1. Title of the program:

Master of Science in Bioscience (M.Sc. Bioscience)

2. The commencement of the program:

The program was introduced August 2018

3. Course pattern:

Choice based credit System with 4 semesters

Total Credits: 96 credits

Core courses: 66 credits

Open elective papers- 6 credits

Project: 24 credits

[1 credit=1 hour of lecture per week/2 hours of Laboratory]

4. Semesters

An academic year shall consist of two semesters;

Odd Semester 1st & 3rd	July/August to December/January
Even semester 2nd & 4th	January/February to June/July

5. Types of Courses

Core course: A course that should compulsorily be studied by a candidate as a requirement is termed as a core course. This can be hard core or soft core.

Open Elective: Generally, a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline or subject or domain or nurtures the candidate's proficiency skill is termed as an open elective course.

The open elective courses shall be offered in the second and third semesters only.

The list of open elective courses offered shall be displayed in the University website.

A student shall not take the courses offered by the department in which she/he is enrolled.

Registration for the open elective courses shall be at least one week prior to the commencement of the course with the CBCS coordinator.

SWAYAM from CBCS regulation revised curriculum.

Value added & Open Elective courses can be opted from Swayam.

6. **Annual intake:** 10 seats. 30% of Supernumerary seats can be accommodated on need basis.
7. **Reservation policy:** 2 seats are reserved for the SC/ST and PH candidates. If unfilled will be offered to the General category students.
8. **Assessment of a Course:**

Evaluation for a course shall be done on a continuous basis. Two continuous internal assessments (CIA) followed by one semester end university examination (SEE) for each course. The weightage of CIA shall be 50% and SEE shall be 50%.

9. Activities for different levels of students

Slow learners	Average learners	Advanced learners
Refer to prescribed books from library	Provide advanced books for subject preparation	Train them with research orientation
Request to approach faculties after class hours for any clarifications	Recent simple research articles for journal club and seminars	Recent research articles for journal club and seminars
Assign mentors to take special attention	Encourage them to use library digital resources of the university	Encourage them to use library digital resources of the university
Attend to those students by questioning them to gauge their aptitude		Advise them to join group discussions if interested in certain research groups of YRC.
		Motivate to prepare for National tests (CSIR, NET, GATE, DBT, ICMR)

Initiatives for advanced learners

• Students are identified based on the interaction from the classes being taken.

• They are encouraged to be more interactive.

• One of them is assigned to be the class representative.

• Properly counseled for career planning.

• Encouraging them to use the library and the digital resources available.

• Advising to participate in presentations and group discussions.

• Plan and prepare for competitive exams like the CSIR, NET and/or GATE.

Initiatives for slow learners

• Slow learners are again identified from the class performance, how they interact and involve with the faculties.

• They are advised to refer to text books from the library.

• Faculties arrange for special sessions with such students which act as remedial classes.

• Fellow advanced learner students are encouraged to help such slow learner students to discuss things which will make them more comfortable to understand.

• Faculties pay special attention to such students and ask appropriate questions to gauge the level of understanding.

• In addition, mentors are assigned to take special care of such slow learners. Students are treated equally and mentored in such a way that by the 2nd year the slow learners acquire skills that are required for them to be job ready. In fact, we have experienced tremendous improvement among our first batch slow learner and we are confident that the mechanism is working.

10. Qualification descriptors:

At the end of two years:

1. Demonstrate comprehensive knowledge and interdisciplinary skills in the fields of Biochemistry, Cell and Molecular Biology, Genetics, Immunology, Microbiology, Nanobiotechnology, Neurobiology, Cell culture, Stem cells and Developmental Biology, Toxicology and Omics Technology.
2. Graduates will be competent to critically analyse biological problems.
3. Graduates will be able to carry out research in diverse areas of life sciences.
4. Graduates will be competent to contribute to academia and the society.

11. Opportunities and employability:

The M.Sc. Bioscience program opens up a multitude of exciting opportunities and offers excellent employability prospects. To consider the technological advancements and to optimally equip the students for the interdisciplinary nature of the job profile in academia and industry of government or private sectors, this program combines diverse subject modules with a root in biology, chemistry, informatics, and statistics. The addition of various soft-skill training sessions on topics such as conflict resolution, teamwork, work ethics, and emotional intelligence provides with necessary management skills to prepare the students for job interviews and a demanding career.

The curriculum due to its presence of subjects such as Neuroscience, Toxicology, Biochemistry,

Immunology, and Microbiology with suitable hands-on/practical sessions prepares the students for Life science, Biotechnology, Biomedical, and Pharmaceutical industries. The presence of Nanobiotechnology with modules on drug delivery and tissue engineering tune the students for opportunities in Biomedical engineering and Biopharmaceutical industries. The incorporation of Proteomics, Bioinformatics, and Data science modules provides preliminary yet useful exposure to job profiles in various contract research organizations that deals with big data generation, storage, or analysis.

YRC is closely associated with Yenepoya Medical College & Hospital and various other centers and institutes such as the Centre for Integrative Omics Data Science (CIODS), Centre for Ethics, and Yenepoya Technology Incubator (YTI), all of which have created a vibrant ecosystem of basic, preclinical, clinical researchers, practicing clinicians, and engineers thriving with positive and innovative ideas. This has created additional employment opportunities for interested students in healthcare sectors and academia as clinical coordinators, tutors or lecturers, and junior research fellows in cutting-edge areas of biomedical research. Since its inception in 2018, our M.Sc. Bioscience graduates have proven the worth of this program in a very short span of 5 years and successfully transitioned to a range of challenging and exciting careers such as research scientists in life science, biotechnology, and the pharmaceutical industry and also opted for higher studies in foreign or Indian universities.

17. Annexures:

CO-PO mapping

Course Outcomes (COs)		**Program Outcomes (POs)**			
		PO 1	**PO 2**	**PO 3**	**PO 4**
Biochemistry	CO 1	Substantial	Slight	Slight	Substantial
	CO 2	Substantial	Slight	Slight	Substantial
	CO 3	Substantial	Slight	Slight	Substantial
	CO 4	Substantial	Slight	Slight	Substantial
	CO 5	Substantial	Slight	Slight	Substantial

Course Outcomes (COs)		Program Outcomes (POs)			
		PO 1	**PO 2**	**PO 3**	**PO 4**
Cell & Molecular Biology	CO 1	Substantial	Slight	Moderate	Substantial
	CO 2	Substantial	Slight	Moderate	Substantial
	CO 3	Substantial	Slight	Moderate	Substantial
	CO 4	Substantial	Slight	Moderate	Substantial
	CO 5	Substantial	Slight	Moderate	Substantial
	CO 6	Substantial	Slight	Moderate	Substantial
Course Outcomes (COs)		**Program Outcomes (POs)**			
		PO 1	**PO 2**	**PO 3**	**PO 4**
Microbiology	CO 1	Substantial	Slight	Slight	Substantial
	CO 2	Substantial	Slight	Moderate	Moderate
	CO 3	Substantial	Slight	Slight	Substantial
	CO 4	Substantial	Moderate	Moderate	Moderate
	CO 5	Moderate	Slight	Slight	Substantial
Course Outcomes (COs)		**Program Outcomes (POs)**			
		PO 1	**PO 2**	**PO 3**	**PO 4**
Genetics	CO 1	Substantial	slight	Moderate	Substantial
	CO 2	Substantial	slight	Moderate	Substantial
	CO 3	Substantial	slight	Moderate	Substantial
	CO 4	Substantial	Moderate	Moderate	Substantial
	CO 5	Substantial	slight	Moderate	Substantial

Course Outcomes (COs)		**Program Outcomes (POs)**			
		PO 1	**PO 2**	**PO 3**	**PO 4**
Environment and Health	CO 1	Slight	Slight	Moderate	Substantial
	CO 2	Slight	Slight	Moderate	Substantial
	CO 3	Slight	Slight	Moderate	Substantial
	CO 4	Slight	Slight	Moderate	Substantial
	CO 5	Slight	Slight	Moderate	Substantial

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Course Outcomes (COs)		Program Outcomes (POs)			
		PO 1	**PO 2**	**PO 3**	**PO 4**
NanoBiotechnology	CO 1	Slight	Substantial	moderate	moderate
	CO 2	Slight	Substantial	moderate	moderate
	CO 3	Slight	Substantial	moderate	moderate
	CO 4	Slight	Substantial	moderate	moderate
	CO 5	Slight	Substantial	moderate	moderate
Course Outcomes (COs)		**Program Outcomes (POs)**			
		PO 1	**PO 2**	**PO 3**	**PO 4**
Stem Cells & Developmental Biology	CO 1	Substantial	Slight	Moderate	Substantial
	CO 2	Substantial	Slight	Moderate	Substantial
	CO 3	Substantial	Slight	Moderate	Substantial
	CO 4	Substantial	Slight	Moderate	Substantial
	CO 5	Substantial	Slight	Moderate	Substantial
	CO6	Substantial	Slight	Moderate	Substantial
Course Outcomes (COs)		**Program Outcomes (POs)**			
		PO 1	**PO 2**	**PO 3**	**PO 4**
Immunology	CO 1	Substantial	Slight	Slight	substantial
	CO 2	Substantial	Slight	Slight	substantial
	CO 3	Substantial	Slight	Slight	substantial
	CO 4	Substantial	Slight	Slight	substantial
	CO 5	Substantial	Slight	Slight	substantial

Course Outcomes (COs)		Program Outcomes (POs)			
		PO 1	**PO 2**	**PO 3**	**PO 4**
Toxicology	CO 1	substantial	Slight	Slight	substantial
	CO 2	substantial	Slight	Slight	substantial
	CO 3	substantial	Slight	Slight	substantial
	CO 4	substantial	Slight	Slight	substantial
	CO 5	substantial	Slight	Slight	substantial
		Program Outcomes (POs)			
		PO 1	**PO 2**	**PO 3**	**PO 4**
Scientific Communications	CO 1	Slight	Slight	moderate	substantial
	CO 2	Slight	Slight	moderate	substantial
	CO 3	Slight	Slight	moderate	substantial
	CO 4	Slight	Slight	moderate	substantial
	CO 5	Slight	Slight	moderate	substantial
Course Outcomes (COs)		**Program Outcomes (POs)**			
		PO 1	**PO 2**	**PO 3**	**PO 4**
Research Methodology	CO 1	None	None	Substantial	Moderate
	CO 2	slight	slight	Substantial	Moderate
	CO 3	slight	slight	Substantial	Moderate
	CO 4	None	None	Substantial	Moderate
Course Outcomes (COs)		**Program Outcomes (POs)**			

		PO 1	PO 2	PO 3	PO 4
Systems Biology and Omics Technology	CO 1	Substantial	Substantial	slight	Moderate
	CO 2	Substantial	Substantial	slight	Moderate
	CO 3	Substantial	Substantial	slight	Moderate
	CO 4	Substantial	Substantial	slight	Moderate
	CO 5	Substantial	Substantial	slight	Moderate
Course Outcomes (COs)		**Program Outcomes (POs)**			
		PO 1	**PO 2**	**PO 3**	**PO 4**
Genetic Engineering	CO 1	CO 1	Slight	Substantial	Slight
	CO 2	CO 2	Slight	Substantial	Slight
	CO 3	CO 3	Slight	Substantial	Slight
	CO 4	CO 4	Slight	Substantial	Slight
	CO 5	CO 5	Slight	Substantial	Slight
		CO 6	Slight	Substantial	Slight
Course Outcomes (COs)		**Program Outcomes (POs)**			
		PO 1	**PO 2**	**PO 3**	**PO 4**
Bioinformatics	CO 1	None	Moderate	Slight	Slight
	CO 2	None	Moderate	Slight	Slight
	CO 3	None	Moderate	Slight	Slight
Course Outcomes (COs)		**Program Outcomes (POs)**			
		PO 1	**PO 2**	**PO 3**	**PO 4**
Biostatistics	CO 1	Slight	Slight	Substantial	Substantial

	CO 2	Slight	Slight	Substantial	Substantial
Course Outcomes (COs)		**Program Outcomes (POs)**			
		PO 1	**PO 2**	**PO 3**	**PO 4**
Neurobiology	CO 1	Substantial	Moderate	Substantial	moderate
	CO 2	Substantial	Moderate	Substantial	moderate
	CO 3	Substantial	Moderate	Substantial	moderate
	CO 4	Substantial	Moderate	Substantial	moderate
	CO 5	Substantial	Moderate	Substantial	moderate