UNIVERSITY OF
SRI JAYEWARDENEPURA,
GANGODAWILA, SRI LANKA

GENETICS AND MOLECULAR BIOLOGY UNIT

Message from the Coordinator of the Unit

Dear Students,

Welcome to the Genetics and Molecular Biology Unit. We contribute to three degree programmes offered by the Faculty of Applied Sciences; the BSc, BSc (Honours) in Genetics and Molecular Biology and BSc (Honours) in Applied Sciences degrees. These dynamic programmes have been designed to produce bio-centered molecular specialists to fill the void of manpower in biotechnology-based industries in Sri Lanka and to provide those aspiring to pursue higher studies with the opportunity to engage in cutting-edge research in Molecular Biology and Biotechnology.

Our mission is to arm our graduates with knowledge of molecular components of life and to provide them with opportunities to develop their skills, positive attitudes and mindset, producing competent individuals for the betterment of science and society.

Our curricula are enriched with course units that will strengthen your employability upon graduation. Furthermore, you will get the opportunity to visit laboratories in the industry and other academic institutes, work in one for a short period, develop solutions to current issues and conduct experiments using basic molecular biology techniques during your time here. I encourage you to take advantage of all the opportunities available to you, including the co and extracurricular activities.

This handbook includes information on the undergraduate programmes conducted by our unit and the resources, facilities and opportunities available to our students. This will serve as a guide as you decide which path to pursue during your time at our university.

Our team of dedicated lecturers will be available to address any questions or concerns you may have. Our goal is to see you succeed! The staff of the unit eagerly await to see what the future unfolds, and I invite you all to be part of this exciting journey.

Sincerely,

Dr. Hiruni Harischandra

Coordinator of Genetics and Molecular Biology Unit,

Faculty of Applied Sciences

University of Sri Jayewardenepura,

Gangodawila, Nugegoda

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About Genetics and Molecular Biology Unit

The Genetics and Molecular Biology Unit was established under the Dean's Office of FAS in 2018. The dearth of local, bio-centered molecular specialists is the bottleneck for the snail's-pace progress in the natural sciences-based industries in the country and triggered the initiation of the Genetics and Molecular Biology Unit. The objective of establishing this unit was to introduce a new programme dedicated to the study of Genetics and Molecular Biology to produce graduates to fill this void in the country. The achievements and steady progress in all aspects over the short time since its inception demonstrate the capabilities and dedication of the staff of the unit and the support of academics in other departments in fulfilling this objective. Initiated as a Unit in 2018, we are now in the process of upgrading to a department as our inaugural batch of students has graduated and strive to develop into a complete department with all the facilities for teaching and conducting high-quality research.

Mission:
To arm our graduates with knowledge of molecular components of life and to provide them with opportunities to develop their skills, positive attitudes and mindset, producing competent individuals for the betterment of science and society.

Why Study Genetics and Molecular Biology?

Genetics is pivotal to all biological sciences; thus, the programme is designed to provide basic and practical knowledge on Genetics and Molecular Biology which is a subject scarce in Sri Lanka. Genetics and Molecular Biology (GMB) is offered as a subject combination along with the Biology and Chemistry subject combinations. This is an excellent combination of subjects because Biology provides a broad overview of all life forms while GMB allows the students to explore these life forms at the molecular level, introducing many layers of intricacy. Chemistry on the other hand adds value to this combination by introducing an applicational aspect to these fundamental sciences, providing our graduates with a comprehensive learning experience.

We take pride in ensuring career preparedness and enhanced employability of the students in our programme. At the end of the second year, we discuss with the students their next step upon graduation and how they should prepare for it to maximize the probability of entering the next phase within a short time after graduation. We also offer many courses that allow the students to explore various avenues related to the degree to expand their scope and prepare them for their careers upon graduation. Some of them are,

- **Occupational competence** – Students work in laboratories at universities, hospitals and industries around the country for a few weeks applying their theoretical knowledge and gaining experience in the real world.

- **Mini project –** This course provides the students with an opportunity to apply their knowledge to address the Sustainable Development Goals set forth by the United Nations for the betterment of society. They work in small groups to identify current issues or ways to improve the quality of life, critically analyze the current situation, and propose a feasible solution to the identified issue in the form of a product or service. A few such projects are biscuits made from banana flour as a healthier alternative for biscuits and to minimize wastage of ripe banana, a local Potato Dextrose Agar (PDA) from potatoes found in the wild as an alternative for standard PDA, and a safer alternative for primary water treatment using *Moringa* as an alternative for the heavy metals currently used in the process.

- **Science communication** – the students work closely with professionals in media to explore how to deliver scientific findings and knowledge to the public.

- **Career skills development** – the students engage in activities such as mock interviews. They also generate a portfolio at the end of the semester.

- **Entrepreneurship** – the students get an understanding of the basics of entrepreneurship and how to apply the knowledge gained in such a venture.

Graduates of this field can be employed as scientists in a vast variety of areas such as crop production, insecticide development, animal well-being and production, and identification of genetic disorders. As the necessity for introducing Genetics and Molecular Biology to schools and other institutions is being recognized, the need for qualified personnel to teach the curriculum will arise, and graduates of this programme will be well suited for the role. The design of the programme and the professional network of the academics of the programme make those interested in pursuing higher studies in related fields well-positioned to do so at renowned institutions worldwide.

Organization of the Unit

ACADEMIC STAFF MEMBERS

COORDINATOR OF THE UNIT

Dr. Hiruni Harischandra
Senior Lecturer
BSc (ISU, USA), PhD (USA)
Phone: 076-4985603
Email: *hirunih@sci.sjp.ac.lk*

Areas of Specialty & Research Interests:

- Host-parasite and vector-parasite interactions of Lymphatic Filariasis (LF) causing nematodes.
- Developing diagnostics for LF, Biotechnological solutions for current issues.

PROFESSORS

Prof. B. G. D. Nissanka K. de Silva

Senior Professor
BSc (Hons), PhD (USJ)
Email: *nissankakolitha@gmail.com*, *nissanka@sci.sjp.ac.lk*

Areas of Specialty & Research Interests:

- Insecticide-resistant studies of disease vectors.
- Dengue vectors and sand flies.
- Transmission dynamics of Dengue and Leishmaniasis.
- Development of molecular assays for the identification of malaria vectors and sand flies.
- Population genetic structure analysis and phylogenetic studies of malaria vectors.

Prof. L. Dinithi C. Peiris
Senior Professor
BSc (Colombo), PhD (UK)
Email: *dinithipeiris@sci.sjp.ac.lk*

Areas of Specialty & Research Interests:

- Toxicology
- Alternative medicine
- Molecular mechanisms and pathways

ACADEMIC STAFF

Dr. D. Helani H. Munasinghe
Senior Lecturer
BSc (Colombo), MSc (Cheju National University), PhD (UK)
Email: *hmunasinghe@yahoo.com*

Areas of Specialty & Research Interests:

- Effects of plant metabolites on *Caenorhabditis elegans* with special emphasis on life span.

Dr. D. Pamoda W. Jayatunga
Senior Lecturer
BSc (Colombo), MPhil (USJ) PhD (Australia)
Email: *pamoda@sci.sjp.ac.lk*

Areas of Specialty & Research Interests:

- Molecular neuroscience
- Neuroprotective agents
- Alzheimer's disease
- Bioactive compounds
- Nutraceuticals

Dr. Kasun M. Thambugala
Lecturer
BSc (Kelaniya), PhD (Thailand)
Email: *kasun@sci.sjp.ac.lk*

Areas of Specialty & Research Interests:

- Molecular phylogenetics and systematics
- Plant pathology
- Biological control of plant pathogens using microbial antagonists
- Fungal diversity
- Molecular characterization of Polypores in Sri Lanka

Dr. Samawansha H. Tennakoon
Lecturer
BSc (India), MSc (UK), PhD (Austria)
Email: *samawansha@sci.sjp.ac.lk*

Areas of Specialty & Research Interests:

- Cell signaling
- Molecular basis of diseases
- Herbal medicine
- Molecular diagnostics

Dr. P. Dilakshini Dayananda
Senior Lecturer
BSc (Colombo), PhD (USJP)
Email: *dilakshini@sci.sjp.ac.lk*

Areas of Specialty & Research Interests:

- Dengue
- Dengue virus
- Virus research
- Molecular Entomology

Programme Educational Objectives (PEOs)

The Programme Educational Objectives of the study programmes are as follows:

- To provide a comprehensive understanding of the role of Genetics and Molecular Biology in biological sciences.
- To demonstrate that Biotechnology has a wide array of applications in multiple fields.
- To communicate the core concepts of the relevant subject areas.
- To enhance communication skills via presentations, scientific debates, poster sessions and seminars.
- To sharpen soft skills such as team working skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement.
- To provide opportunities to network with the wider scientific community.
- To provide opportunities to maximize employability upon graduation.
- To foster independence, confidence and social responsibility via mini-projects and individual research projects during the final year.
- To produce graduates capable of proposing experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
- To produce graduates who are independent, innovative thinkers with a positive attitude and can identify opportunities and take the initiative in academia, industry, and society.

Programme Learning Outcomes (PLOs)

Common PLOs have been developed for the BSc and BSc Honours degrees in the Faculty of Applied Sciences since the GMB subject is offered in combination with Biology and Chemistry subject combinations which are offered by sister departments in the faculty. Eligible students are selected for the BSc Honours in Genetics and Molecular Biology degree programme at the end of the second year and for the BSc Honours in Applied Sciences (Genetics and Molecular Biology) degree programme at the end of the third year. The PLOs for the respective degree programmes developed are as follows:

BSc Degree Programme

Upon successful completion of the BSc degree programme of the USJ, every graduate will be able to,

1. Demonstrate knowledge and understanding of underlying concepts of respective subject areas.
2. Demonstrate competency in practical/technical knowledge and skills for enquiry and application.
3. Enhance clear and coherent communication skills for the demonstration of knowledge and skills.
4. Enhance adaptability and emotional intelligence through teamwork which leads to improved leadership qualities, respect for diverse points of view and empathy.
5. Develop cognitive and creative skills to identify, collect, analyze, and interpret qualitative and quantitative data.
6. Acquire personal integrity through accountability and assuming responsibility.
7. Demonstrate positive and healthy attitudes and values and engage in lifelong learning for the betterment of society.

BSc Honours Degree Programmes

Upon successful completion of the BSc Honours degree programme of the USJ, a graduate will be able to,

1. Demonstrate advanced knowledge and understanding of underlying concepts of respective subject areas.
2. Acquire high levels of competence in practical/technical knowledge and skills for professional growth.

3. Enhance the ability to communicate acquired knowledge, information, ideas and solutions with clarity and coherence.

4. Enhance emotional intelligence through social engagement, networking and teamwork which leads to improved leadership qualities, respect for diverse points of view and empathy and develop strategies to adapt to changing circumstances.

5. Develop cognitive and creative skills in identifying, collecting, and critically analyzing data and in solving problems independently.

6. Exercise personal integrity through responsibility and accountability and acquire professional integrity through inculcated entrepreneurial, managerial, and time-management skills.

7. Demonstrate positive and healthy attitudes and values and engage in lifelong learning for the betterment of society.

Additional PLOs established the GMB Unit for the BSc Honours in Genetics and Molecular Biology degree programme:

Upon successful completion of the BSc Honours degree programme of the USJ, a graduate will be able to,

1. express the role of Genetics and Molecular Biology in biological sciences.

2. communicate the core concepts of relevant subject areas.

3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.

4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.

5. research scientific literature and disseminate knowledge to others.

6. function effectively within the scientific community.

7. employ soft skills such as teamworking skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement.

8. modulate as innovative thinkers who can take initiative in academia and industry.

Academic Programme

Degree Programmes offered

The unit, in concordance with other departments, contributes to the following degree programmes:

- BSc degree with Genetics and Molecular Biology as a subject
- BSc Honours degree in Genetics and Molecular Biology
- BSc Honours degree in Applied Sciences (Genetics and Molecular Biology)

The duration of the BSc degree programme is three years, while the BSc Honours degree programmes span the course of four years. All students follow Genetics and Molecular Biology, Biology and Chemistry subject combinations during the first two years. At the end of the second year, students have the opportunity to follow the Honours degree programmes in GMB, Biology or Chemistry on a merit basis. The students pursuing the BSc Honours degree in Genetics and Molecular Biology will follow sixty level 6 credits over the course of the final two years, of which eight credits will be allocated for the research project conducted during the final year. For successful completion of the degree, these students are required to submit and defend their thesis at a viva voce examination upon the culmination of the study programme.

Students following the BSc degree programme (three years) will continue to take five level 5 credits from each of the above three subject combinations during their third year. For successful completion of the degree, these students should complete ninety credits, thirty each from the above subject combinations.

At the end of the third year, students have the opportunity to follow a BSc Honours in Applied Sciences degree programme offered by each of the above subject combinations. The students pursuing this study programme offered by the Genetics and Molecular Biology Unit will follow thirty credits during their fourth year. Eight of these credits will be offered by the GMB Unit and twelve from the faculty. These students will complete a project worth ten credits in an industrial setting in the final semester of the study programme. For successful completion of the degree, these students are required to submit and defend their thesis at a viva voce examination upon the culmination of the study programme.

BSc with Genetics and Molecular Biology as a subject

	Credits* offered by			Total
	GMB	Biology	Chemistry	
Semester 1	5	5	5	15
Semester 2	5	5	5	15
Semester 3	5	5	5	15
Semester 4	5	5	5	15
Semester 5	5	5	5	15
Semester 6	5	5	5	15
Total credits required for the degree				**90**

BSc Honours in Genetics and Molecular Biology

	Credits* offered by				Total
	GMB		Biology	Chemistry	
Semester 1	5		5	5	15
Semester 2	5		5	5	15
Semester 3	5		5	5	15
Semester 4	5		5	5	15
Semester 5	15		-	-	15
Semester 6	15		-	-	15
Semesters 7 & 8	Courses	Research Project			
	22	8	-	-	30
Total credits required for the degree					**120**

BSc Honours in Applied Sciences (Genetics and Molecular Biology)

<table>
<tr><td rowspan="2"></td><td colspan="3">Credits* offered by</td><td rowspan="2">Total</td></tr>
<tr><td>GMB</td><td>Biology</td><td>Chemistry</td></tr>
<tr><td>Semester 1</td><td>5</td><td>5</td><td>5</td><td>15</td></tr>
<tr><td>Semester 2</td><td>5</td><td>5</td><td>5</td><td>15</td></tr>
<tr><td>Semester 3</td><td>5</td><td>5</td><td>5</td><td>15</td></tr>
<tr><td>Semester 4</td><td>5</td><td>5</td><td>5</td><td>15</td></tr>
<tr><td>Semester 5</td><td>5</td><td>5</td><td>5</td><td>15</td></tr>
<tr><td>Semester 6</td><td>5</td><td>5</td><td>5</td><td>15</td></tr>
<tr><td rowspan="2">Semesters 7 & 8</td><td colspan="2">Courses</td><td>Industrial Training</td><td rowspan="2"></td></tr>
<tr><td>GMB</td><td>Faculty-wide</td><td></td></tr>
<tr><td></td><td>8</td><td>12</td><td>10</td><td>30</td></tr>
<tr><td colspan="4">Total credits required for the degree</td><td>120</td></tr>
</table>

*1 credit is equivalent to 50 notional learning hours for taught, laboratory and field courses and 100 notional hours for research and industrial training. The notional learning hours include direct contact hours with teachers and trainers, time spent self-learning, preparation for assignments, carrying out assignments and assessments.

Main focus of the curriculum

The Main Focus Areas of the Curriculum

This subject mainly focuses on exploring the fields of Genetics and Molecular Biology in depth, demonstrating the applications of Genetics and Molecular Biology, providing scientific literacy, and ensuring career preparedness and enhancing the employability of the students.

Genetics

The following course units are offered under this theme:

Fundamentals of genetics, Fundamentals of molecular genetics, Quantitative and population genetics, Genomics and proteomics, Microbes and microbial genetics, Gene expression and regulation, Advanced population genetics, Human genetics and counseling, Developmental genetics, Epigenetics

Molecular Biology

The following course units are offered under this theme:

Molecular cell biology, Introduction to bioinformatics, Immunobiology, Biochemistry, Cell signaling and signal transduction, Fundamentals of nanobiology, Molecular modelling and computer biochemistry, RNA biology, Protein engineering, molecular entomology, molecular basis of diseases, Molecular ecology, Stem cells and regenerative biology, molecular microbial ecology, molecular and cellular toxicology,

Applications of Genetics and Molecular Biology

The following course units are offered under this theme:

Techniques in molecular biology and genetic engineering, Modern biotechnology, Laboratory work in RNA and protein techniques, marine biotechnology for sustainable development, pharmaceutical biotechnology, Molecular diagnostics and therapeutics, Tissue and cell culture, Advanced immunology, neurobiology, Molecular evolution, Systems biology

Scientific Literacy

The following course units are offered under this theme:

Scientific communication, Research methodology, Scientific writing, Journal club, Research projects, Case studies in Genetics and Molecular Biology, Special Topics in Genetics and Molecular Biology, Current Topics in Genetics and Molecular Biology

Career Preparedness and Employability

The following course units are offered under this theme:

Miniproject, Entrepreneurship, Introduction to computer programming and web designing, Bioelectronics, Career skills development, Occupational competence, Bioeconomics, Scientific communication.

Curriculum Outline

Curricula for BSc, BSc Honours in Genetics and Molecular Biology and BSc Honours in Applied Sciences (Genetics and Molecular biology) are shown below.

The notations used are as follows:

c: Core

a: Compulsory

o: Optional

*: level 6 courses open to students following the BSc and BSc Honors in Applied Sciences (Genetics and Molecular Biology) degree programs as optional subjects

**: courses open to students pursuing the BSc Honours in Applied Sciences (Genetics and Molecular Biology) degree programme as optional subjects under ASB course codes.

Course Code	Course Name	Category	Credits
First Year – Semester I			
Course Units for the BSc, BSc Honours in Genetics and Molecular Biology and BSc Honours in Applied Sciences (Genetics and Molecular Biology) Degree Programmes			
GMB 101 2.0	Molecular Cell Biology	c	2.0
GMB 102 2.0	Fundamentals of Genetics	c	2.0
GMB 131 1.0	Laboratory work in Genetics and Molecular Cell Biology	a	1.0
First Year – Semester II			
Course Units for the BSc, BSc Honours in Genetics and Molecular Biology and BSc Honours in Applied Sciences (Genetics and Molecular Biology) Degree Programmes			
GMB 103 2.0	Fundamentals of Molecular Genetics	c	2.0
GMB 105 2.0	Techniques in Molecular Biology and Genetic Engineering	c	2.0
GMB 132 1.0	Laboratory Work in Molecular Biology Techniques	a	1.0
Second Year – Semester I			
Course Units for the BSc, BSc Honours in Genetics and Molecular Biology and BSc Honours in Applied Sciences (Genetics and Molecular Biology) Degree Programmes			
GMB 207 1.0	Quantitative and Population Genetics	c	1.0
GMB 209 1.0	Introduction to Bioinformatics	c	1.0
GMB 210 2.0	Immunobiology	c	2.0
GMB 231 1.0	Laboratory Work in Recombinant DNA Technology and Immunology	a	1.0
Second Year – Semester II			
Course Units for the BSc, BSc Honours in Genetics and Molecular Biology and BSc Honours in Applied Sciences (Genetics and Molecular Biology) Degree Programmes			
GMB 203 1.0	Genomics and Proteomics	c	1.0
GMB 204 2.0	Microbes and Microbial Genetics	c	2.0
GMB 205 1.0	Gene Expression and Regulation	c	1.0
GMB 232 1.0	Laboratory Work in Microbial Genetics and Gene Expression	a	1.0

Third Year			
Course Units for the BSc and BSc Honours in Applied Sciences (Genetics and Molecular Biology) Degree Programme			
GMB 303 1.0	Fundamentals of Nanobiology	c	1.0
GMB 304 1.0	Developmental Genetics	o	1.0
GMB 305 1.0	Scientific Communication	c	1.0
GMB 317 2.0	Biochemistry	c	2.0
GMB 333 2.0	Mini-Project	a	2.0
GMB 336 1.0	Laboratory Work in Biochemistry, RNA and Protein Techniques	a	1.0
GMB 342 1.0	Epigenetics	c	1.0
Course Units for the BSc Honours in Genetics and Molecular Biology Degree programme open to students following BSc and BSc Honours in Applied Sciences (Genetics and Molecular Biology) Degree programmes as optional subjects			
GMB 301 1.0	Advanced Population Genetics	o*	1.0
GMB 311 2.0	Modern Biotechnology	c*	2.0
GMB 313 1.0	Cell Signalling and Signal Transduction	c*	1.0
GMB 314 1.0	Entrepreneurship	o*	1.0
GMB 315 2.0	Introduction to Computer Programming and Web Designing	o*	2.0
GMB 316 2.0	Bioelectronics	o*	2.0
GMB 317 2.0	Biochemistry	c	2.0
GMB 318 1.0	Human Genetics and Counselling	o*	1.0
GMB 319 1.0	Career Skills Development	o*	2.0
GMB 321 1.0	Molecular Modelling and Computational Biochemistry	o*	2.0
GMB 323 2.0	Protein Engineering	o*	1.0
GMB 326 2.0	Molecular Entomology	o*	1.0
GMB 327 1.0	Bioeconomics	o*	1.0
GMB 329 1.0	Occupational Competence	o*	1.0
GMB 336 1.0	Laboratory Work in Biochemistry, RNA and Protein Techniques	a	1.0

GMB 342 1.0	Epigenetics	c	1.0
GMB 343 2.0	Molecular Basis of Diseases	o*	1.0
GMB 344 1.0	RNA Biology	c	1.0
GMB 345 1.0	Virology	o*	1.0
Course Units offered solely for the BSc Honours in Genetics and Molecular Biology Degree Programme			
GMB 320 2.0	Research Methodology	c	2.0
GMB 328 1.0	Applications in Nanobiology	c	1.0
GMB 337 1.0	Laboratory work in Nanobiology and Advanced Laboratory Techniques	a	1.0
GMB 340 2.0	Special Topics in Genetics and Molecular Biology	c	2.0
GMB 341 3.0	Current Topics in Genetics and Molecular Biology	c	3.0

Fourth Year			
Course Units for the BSc Honours in Genetics and Molecular Biology Degree Programme open to students following the BSc Honours in Applied Sciences (Genetics and Molecular Biology) Degree programme as optional subjects under ASB course codes			
GMB 403 1.0/ ASB 464 1.0	Stem Cells and Regenerative Biology	o**	1.0
GMB 406 2.0/ ASB 467 2.0	Molecular Microbial Ecology	o**	2.0
GMB 411 2.0/ ASB 462 2.0	Molecular and Cellular Toxicology	c**	2.0
GMB 412 2.0/ ASB 469 2.0	Molecular Diagnostics and Therapeutics	o**	2.0
GMB 413 2.0/ ASB 463 2.0	Tissue and Cell culture	c**	2.0
GMB 415 1.0/ ASB 468 1.0	Journal Club	c**	1.0
GMB 418 2.0/ ASB 466 2.0	Marine Biotechnology for Sustainable Development	o**	2.0
Course Units offered solely for the BSc Honours in Genetics and Molecular Biology Degree Programme			
GMB 401 2.0	Case Studies in Genetics and Molecular Biology	c	2.0
GMB 402 1.0	Molecular Ecology	o	1.0
GMB 404 2.0	Advanced Immunology	c	2.0
GMB 407 1.0	Scientific Writing	c	1.0
GMB 408 2.0	Neurobiology	o	2.0
GMB 409 2.0	Pharmaceutical Biotechnology	o	2.0
GMB 410 8.0	Research Project	a	8.0
GMB 416 2.0	Molecular Evolution	o	2.0
GMB 419 1.0	Systems Biology	c	1.0

First Year

Course Units for the students following the:

BSc Degree Programme with Genetics and Molecular Biology as Subject

BSc Honours in Genetics and Molecular Biology Degree Programme

BSc Honours in Applied Sciences (Genetics and Molecular Biology) Degree Programme

Course Title	**Molecular Cell Biology**
Course Code	GMB 101 2.0
Credit Value	02
Status	Core
Year / Level	1st Year / Level 5
Theory: Practical: Independent learning	30: 00:70
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge about the eukaryotic and prokaryotic cell structure and function. This course also provides students with knowledge on cell surface receptors and their functions, basic regulatory mechanisms such as cell cycle and its control and physiologically important cellular events such as apoptosis and necrosis.

Intended Learning Outcomes (ILOs):

At the completion of this course student should be able to:

- identify the basic and ultra-structure of eukaryotic and prokaryotic cells
- describe functions and properties of cells
- describe the in-detailed fluid mosaic model
- explain the different mechanisms of transportation across the cell membranes
- describe the structure and function of cell surface receptors and cell signaling pathways
- describe the biomolecules in the cells and their functions in the body
- describe the cell cycle and its control
- identify the apoptosis and necrosis as physiologically important cellular events
- describe cellular events related to aging

Course Content:

Introduction to cell Biology, cell theory, structure of cells – pro sub-cellular eukaryotes, types of cells and their structure, sub-cellular organelles, cell membrane, fluid mosaic model, Extra cellular matrix and cell adhesion, macro molecules, DNA replication, protein synthesis, Transport across cell membranes: cell surface receptors and signal transduction, cell division, regulation of cell cycle, check points in the mammalian cell cycle, Apoptosis, necrosis and cell aging.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas

3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolutionand work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1		***		*	***		*	
ILO 2		***			***		*	
ILO 3		***			***		**	
ILO 4		***			***		**	
ILO 5		***			***			
ILO 6		***			***			*
ILO7		***		**	***		**	
ILO 8		***		**	***	*		**
ILO 9		***				*	*	

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% + FA2 (Oral presentation) 5% = 25% of Total Mark

Summative Assessment (SA): End Semester Examination: 02-hour paper covering 4 Essay type questions (75%) = 75% of Total Mark

References:

- Krieger, M., Scott, M. P., Matsudaira, P. T., Lodish, H. F., Darnell, J. E., Zipursky, L., & Berk, A. (2004). Molecular cell biology. *San Francisco*.
- Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (1994). *The cell* (pp. 1173-1175). New York: Garland publishing.
- Alberts, B., Bray, D., Hopkin, K., Johnson, A. D., Lewis, J., Raff, M., ... & Walter, P. (2015). *Essential cell biology*. Garland Science.

Course Title	**Fundamentals of Genetics**
Course Code	GMB 102 2.0
Credit Value	02
Status	Core
Year / Level	1st Year / Level 5
Theory: Practical: Independent learning	30: 00:70
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire basic knowledge about genetics and its concepts. This course covers a wide area starting from basic mendelian experiments, concepts up to analysis of genetic mutations and identification of inheritance patterns. Further this course provides knowledge on basic viral genetics and other genetic model organisms.

Intended Learning Outcomes (ILOs):

At the completion of this course student should be able to:

- define Genetics and terminology used
- explain the Mendelian experiment, laws derived from it and deviations of Mendelian genetics
- analyze karyotypes and pedigrees
- categorize mutations at the chromosomal and gene level
- explain linkage mapping, meiotic and mitotic segregation and recombination
- discuss extra nuclear inheritance
- identify basic concepts of viral genetics
- explain the concept of using model organisms
- discuss milestones in Genetics through discussions of key paper
- demonstrate the potential of Genetics using current examples from multiple fields
- develop soft skills through debates and discussions

Course Content:

Terminology of genetics, Mendelian experiment, laws derived from it and deviations of Mendelian genetics, karyotypes, pedigree analysis, mutations at the chromosomal and gene level, linkage mapping, meiotic and mitotic segregation and recombination, extra nuclear inheritance, viral genetics, model organisms

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:

Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratorysafety.
4. propose experiments and suitable solutions in different contexts, while being aware of research,societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolutionand work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***			***			
ILO 2	***	***	***	**	***		***	
ILO 3	***	***	**	**	***		***	*
ILO 4	***	***	**	**	***		*	
ILO 5	***	***	*	*	***		*	
ILO 6	***	***			***	*	**	
ILO 7	***	***			***			
ILO8	***	***			***			
ILO 9	***	***			***	**	***	
ILO 10	***	***			***		***	
ILO 11	***	*	*	**	***	***	***	***

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% + FA2 (Oral presentation) 5% = 25% of Total Mark

Summative Assessment (SA): End Semester Examination: 02-hour paper covering 4 type Essay-questions (75%) = 75% of Total Mark

References:

- Suzuki, D. T., & Griffiths, A. J. (1976). *An introduction to genetic analysis*. WH Freeman and Company.

Course Title	**Fundamentals of Molecular Genetics**
Course Code	GMB 103 2.0
Credit Value	02
Status	Core
Year / Level	1st Year / Level 5
Theory: Practical: Independent learning	30: 00: 70
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire basic knowledge about composition, structure, and function of genes. Further the student will get an in-depth knowledge on DNA replication, transcription, translation, modifications and repair mechanisms.

Intended Learning Outcomes (ILOs):

At the completion of this course student should be able to:

- explain the composition, structure and functions of genes.
- describe the topography of chromosomes.
- explain different aspects of genomes.
- describe DNA replication.
- explain mutations at the gene level.
- identify various repair mechanism in organisms.
- analyze recombinants and create maps
- explore transcription and post transcriptional mechanisms.
- explore translation and post translational mechanisms
- discuss milestones of Molecular Genetics through discussions of key paper
- demonstrate the potential of Genetics using current examples from multiple fields
- demonstrate soft skills through debates and discussions

Course Content:

Composition, structure and functions of genes, topography of chromosomes, aspects of genomes, DNA replication, mutations at the gene level, repair mechanism in organisms, analyze recombinants and create maps, transcription and post transcriptional mechanisms, translation and post translational mechanisms

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas

3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolutionand work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***			**		**	
ILO 2	***	***			**		*	
ILO 3	***	***			**		**	
ILO 4	***	***			**			
ILO 5	***	***			**			
ILO 6	***	***			**			
ILO 7	***	***			**		**	*
ILO 8	***	***			**			
ILO 9	***	***			**			
ILO 10	***	**			**		***	*
ILO 11	***	**			**	*		
ILO 12	***				***	**	***	***

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% + FA2 (Oral presentation) 5% = 25% of Total Mark

Summative Assessment (SA): End Semester Examination: 02-hour examination with 04 Essay type questions (75%) = 75% of Total Mark

References:

- Lewin, B., Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2014). *Lewin's Genes XI*. Jones and Bartlett learning.
- Brown, T. A. (2012). *Introduction to genetics: a molecular approach*. Garland Science.

Course Title	**Techniques in Molecular Biology and Genetic Engineering**
Course Code	GMB 105 2.0
Credit Value	02
Status	Core
Year / Level	1st Year / Level 5
Theory: Practical: Independent learning	30: 00: 70
Other: Pre-requisite Course/s	-

Aim of the Course:

This course provide knowledge on a wide range of laboratory techniques used in molecular biology and genetic engineering such as labelling techniques, blotting techniques, amplification methods and gene manipulation methods. Further, the course will give an in site to on different types of vectors and knowledge on ethics to be considered when conducting molecular biology and genetic engineering research.

Intended Learning Outcomes (ILOs):

At the completion of this course student should be able to:

- describe the theories behind the techniques
- describe the different techniques that can be used based on the situation
- discuss the ethical issues pertinent to molecular biology and genetic engineering

Course Content:

Introduction to genetic engineering, extraction of macromolecules, Analysis of nucleic acids, Restriction enzymes and RFLP, DNA blotting, RNA blotting, Probes – end labeling, random primer labeling, nick translation,
dot-blot, In-Situ, Fluorescent In-Situ hybridization, DNA arrays, Lab on a chip, IP pull-down assays, Analysis of proteins via Western blotting, Eastern blotting, ELISA, immunocytochemistry, immunohistochemistry, mining for genes with desirable properties, Various amplification methods (PCR from DNA and cDNA – RT-PCR, qPCR, qTR-PCR), ARMS, MLPA, Gel electrophoresis - vertical, horizontal, TAE vs TBE, EtBr and other visualizing agents such as SYBR dyes, Gene transfer, Cloning vectors vs expression vectors, different types of vectors (plasmids, TE, viruses, microinjection and direct DNA uptake), Cloning: digestion, Ligation, Visualization – colony hybridization, screening (blue-white), Transformation and DNA sequencing (sanger, Nextgen)
Whole genome sequencing, RNA sequencing, Expression platforms such as Yeast, Cell lines – insect, mammalian etc, uses as a research tool, Gene manipulation techniques Chromosome walking, Construction of DNA libraries, Current examples of genetic engineering in plants, animals, medicine, Ethics in molecular biology and genetic engineering.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
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	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***	**	**	***		***	***
ILO 2	***	***	***	***	***		***	***
ILO 3	**	***	*	*	***		***	***

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% + FA2 (Oral presentation) 5% = 25% of Total Mark

Summative Assessment (SA): End Semester Examination: 02-hour examination with 04 Essay type questions (75%) = 75% of Total Mark

References:

- Berg, J. M., & Tymeczko, G. J. (2015). Gatto, and L. Stryer. *Biochemistry, 8th Edition, Freeman Macmillan*.Brown, T. A. (2012). *Introduction to genetics: a molecular approach*. Garland Science.
- Thieman, W. J. (2009). *Introduction to biotechnology*. Pearson Education India.

Course Title	**Laboratory Work in Genetics and Molecular Cell Biology**
Course Code	GMB 131 1.0
Credit Value	01
Status	Compulsory
Year / Level	1st Year / Level 5
Theory: Practical: Independent learning	00: 33:17
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire basic knowledge on good laboratory practices and hands on experience on microscopy. Student will gain the ability to identify cellular structures and cell division stages. Further this course will provide knowledge on karyotyping and identification of deviations of Mendelian genetics.

Intended Learning Outcomes (ILOs):

At the completion of this course student should be able to:

- explain the theory related to each practical
- execute the protocols followed during the course

Course Content:

Good Laboratory Practices, Identification of cells, cellular structures, Observation of mitosis and meiosis stages, Viable cell counting, functions of cell membrane, Exploring inherited genetic characteristics, Deviations from Mendelian genetics, Karyotyping, Model organisms, Pedigree analysis, dosage compensation

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
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	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***	***	***	***		**	***
ILO 2	**	***	***	***	***	*	***	***

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Oral presentation) 5% + FA2 (Lab reports) 10% = 15% of Total Mark

Summative Assessment (SA): End Semester Examination: 01-hour Practical + Theory examination (85%) = 85% of Total Mark

References:

- Suzuki, D. T., & Griffiths, A. J. (1976). *An introduction to genetic analysis*. WH Freeman and Company.

Course Title	**Laboratory Work in Molecular Biology Techniques**
Course Code	GMB 132 1.0
Credit Value	01
Status	Compulsory
Year / Level	1st Year / Level 5
Theory: Practical: Independent learning	00: 33: 17
Other: Pre-requisite Course/s	-

Aim of the Course:

This course will provide hands on experience on a number of techniques used in molecular biology such as DNA extractions, quantification, amplification by PCR. Further, the course will cover steps involved in cloning: restriction digestion, ligation, transformation, colony screening and colony PCR and sequencing.

Intended Learning Outcomes (ILOs):

At the completion of this course student should be able to:

- conduct the protocols of the techniques taught in the course independently.
- explain the theory of each technique
- explain the importance of each step in the protocols and chemicals used

Course Content:

Genomic and plasmid DNA extraction, Gel electrophoresis, DNA quantification, Polymerase Chain Reaction (PCR), PCR purification, Restriction digestion, Ligation, Transformation, Primer designing, Southern blotting and probe hybridization, Cloning, Blue-white colony screening, Colony PCR, Sequence analysis, Detection of single nucleotide polymorphisms, Determination of the purity and the quantity of nucleic acids, DNA sequence analysis

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
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	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***	***	***	**	*	**	***
ILO 2	***	***	***	***	**			
ILO 3	***	***	***	***	**	**	***	***

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Lab report) 10% + FA2 (Oral presentation) 5% = 15% of Total Mark

Summative Assessment (SA): End Semester Examination: 01-hour examination with 02 Essay type questions (85%) = 85% of Total Mark

References:

- Relevant protocols and manuals

Second Year

Course Units for the students following the:

BSc Degree Programme with Genetics and Molecular Biology as Subject

BSc Honours in Genetics and Molecular Biology Degree Programme

BSc Honours in Applied Sciences (Genetics and Molecular Biology) Degree Programme

ourse Title	**Genomics and Proteomics**
Course Code	GMB 203 1.0
Credit Value	01
Status	Core
Year / Level	2nd Year / Level 5
Theory: Practical: Independent learning	15: 00:35
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge about the emerging areas of Genomics and Proteomics. This course also provides students with knowledge of the tools used in the fields of Genomics and Proteomics and their functions.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- Compare top-down approach with bottom-up approach.
- Comprehend scholarly work on omics.
- Describe advantages and disadvantages of omics techniques compared to classical genetic approaches.
- Identify errors in simple R codes and modify as required.
- Explain omics to academics.

Course Content:

Introduction to genomics, RNA bacteriophage MS2 genome sequencing project. Λ genome project, Different approaches of retrieving information from genomic sequences, Human genome project. Publicly funded genomics projects. EST databases in gene identification. Genome-wide experimental characterization of protein functions. Introduction to proteomics, 2D PAGE. Introduction to transcriptomics, microarray

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences.
2. communicate the core concepts of relevant subject areas.
3. design laboratory experiments, choosing suitable techniques while adhering to laboratorysafety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community

7. employ soft skills such as team working skills, time management, leadership, conflict resolutionand work ethics for personal and professional advancement.
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1		**			*			
ILO 2	*	***			***			
ILO 3	**	***	*	**	**	**	*	
ILO 4		**		**				**
ILO 5	***	***	**	***	**	***	**	**

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Oral presentations) 30% = 30% ofTotal Marks

Summative Assessment (SA): End Semester Examination: 1-hour paper covering 2 Essay-type question (70%) = 70% of Total Marks

References:

- Kooning, E.V. and M.Y. Galperin. 2nd Ed. 2004. Sequence-Evolution- Function Computational approaches in comparative genomics. Springer Science.

Course Title	**Microbes and Microbial Genetics**
Course Code	GMB 204 2.0
Credit Value	02
Status	Core
Year / Level	2nd Year / Level 5
Theory: Practical: Independent learning	30: 00:70
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge about the field of microbial genetics and basic applications of microbial genetics in scientific experiments. This course also provides students with knowledge of the genetic structures of microbes including bacteria, fungi, and viruses.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- Describe the general biology of microbes.
- Explain the concepts, areas, and techniques of microbial genetics.
- Compare the nature of genome organization of bacteria, fungi, and viruses.
- Experience in reading and evaluating scientific articles.
- Understand how microbial genetics has advanced science and society.

Course Content:

Microorganisms - an overview, The Phylogenetic Tree of Life, Bacterial Genetics, Properties of Bacteria that Facilitate Genetic Experiments, Plasmid Replication, Viral Genomes, Bacteriophage Genetics, The Lytic and lysogenic Cycles of Bacteriophages, Transformation, DNA Uptake in Gram-Negative Bacteria, Conjugation, Mechanism of DNA Transfer During Conjugation, Transduction, Role of Transduction In Bacterial Evolution, Transposable Elements and Transposition, Structure of Bacterial Transposons.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences.
2. communicate the core concepts of relevant subject areas.
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community

7. employ soft skills such as team working skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement.
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	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	**	***		*	***			
ILO 2	**	***				*		
ILO 3	***	***	*	**	***	**	**	
ILO 4	*	**			***	***	*	**
ILO 5				***			**	***

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% + FA2 (oral examination) 5% = 25% of Total Marks

Summative Assessment (SA): End Semester Examination: Final Report and presentation (75%) = 75% of Total Marks

References:

- Snyder L, Peters JE, Henkin TM, and Champness W (2013), Molecular Genetics of Bacteria, 4th Edition, ASM Press, Washington (DC).
- Griffiths AJF, Wessler SR, Carroll SB and Doebley J (2015), An Introduction to Genetic Analysis 11th Edition, W .H. Freeman & Co Ltd, USA.
- Hogg, S (2013), Essential microbiology, 2nd Edition, John Wiley & Sons, USA.
- Madigan MT, MarTinko JM, Bender KS, Buckley DH, and Stahl DA (2015), Brock Biology of Microorganisms, 14th Edition, Pearson Education, Inc. Glenview USA.
- Xu JR, and Bluhm BH (eds.) (2011), Fungal Genomics: Methods and Protocols, Methods in Molecular Biology, vol. 722, Humana Press, USA.

Course Title	**Gene expression and Regulation**
Course Code	GMB 205 1.0
Credit Value	01
Status	Core
Year / Level	2nd Year / Level 5
Theory: Practical: Independent learning	15: 00:35
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge about the regulatory processes that govern gene expression in prokaryotes and eukaryotes. The students will also get a basic understanding of the consequences of the misregulation of these processes.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- describe regulation of prokaryotic and eukaryotic gene expression
- describe various regulatory mechanisms such as histone modifications, epigenetic modifications.
- discuss transcriptional and post-transcriptional modifications.
- describe translational and post-translational modifications.
- discuss small-RNA mediated regulation.
- discuss repercussions of incorrect in-correct gene regulation

Course Content:

Regulation of prokaryotic gene expression: lac operon, trp operon, arabinose operon, regulation of eukaryotic gene expression, epigenetic modifications: histone modifications, chromatin remodelling, DNA methylation transcriptional and post-transcriptional modifications, translational and post-translational modifications, small-RNA mediated regulation, diseases arising from incorrect gene regulation: cancer.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.

5. research scientific literature and disseminate knowledge to others.
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	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1		***			**			
ILO 2		***			**			
ILO 3		***			*			
ILO 4		***			**			
ILO 5		***			*			
IOL 6		***		*	*		**	*

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% + FA2 (oral examination) 5%
= 25% of Total Marks

Summative Assessment (SA): End Semester Examination: 1-hour paper covering 2 Essay- type question (75%) = 75% of Total Marks

References:

- Molecular Biology of the Cell.

Course Title	**Quantitative and Population Genetics**
Course Code	GMB 207 1.0
Credit Value	01
Status	Core
Year / Level	2nd Year / Level 5
Theory: Practical: Independent learning	15: 00:35
Other: Pre-requisite Course/s	-

Aim of the Course:

Provide a solid understanding of the fundamental concepts of Quantitative and Population Genetics. This course also delivers ample opportunities for sharpening soft skills via individual and group activities such as presentations, discussions, and debates. Further this course also provides knowledge to analysis methods and tools in quantitative and population genetic applications.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- Understand the terms population genetics and quantitative genetics.
- Define the terms population, species, allelic frequencies, genotypic frequencies, gene pool, genetic drift, gene flow, bottle-neck effect, founder effect.
- Explain the major forces evolution (natural selection, genetic drift, mutation and migration)
- Explain the patterns of genetic variation within populations, population structure and speciation process.
- Understand the use of different analysis methods and tools in quantitative and population genetic applications.
- Explain the principals and theories of quantitative and population genetics.
- Interpret the related events in terms of quantitative and population genetics

Course Content:

Introduction to Quantitative Genetics, Extending Mendelian genetics to quantitative traits, Study of phenotypic variance , Statistical determination of the variance due to environmental and phenotypic differences in genotype, Additive gene action, Dominance and Epistasis, Heritability of quantitative traits, Identifying QTLs and mapping techniques, Applications of quantitative genetics, Introduction to Population Genetics, Hardy-Weinberg principle, Genotypic and gene frequencies in populations in equilibrium, Linkage disequilibrium, Factors determining population variation, Systematic factors – mutation, selection, migration, Dispersive factors – Fixation, loss of alleles, inbreeding (inbreeding depression and breeding systems), Genetic drift and Coalescent, Population structure and Gene flow, Natural selection, Modes of selection, Genetic polymorphism, Measurement of diversity within and between populations, Applications of population genetics, Introduction of analysis methods.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences.
2. communicate the core concepts of relevant subject areas.
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement.
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	**	***			***			
ILO 2		***			***			
ILO 3	***	***		**	**			
ILO 4	**	***	**	*	**	**		
ILO 5		**	**				**	**
ILO 6		***				**		
ILO 7		*	*	**		*		**

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 30% = 30% of Total Marks

Summative Assessment (SA): End Semester Examination: 2-hour paper covering 4 Essay- type question (70%) = 70% of Total Marks

References:

- Gillespie, J. H. (2004). Population Genetics, a concise guide. 2nd Edition. The John Hopkins University Press
- Nei, M. and S. Kumar. (2000). Molecular evolution and phylogenetics. Oxford University Press
- Maynard, S. J. (1989). Evolutionary genetics. Oxford University Press
- Hedrick, P. W. (2000). Genetics of populations. 2nd Edition. Jones and Bartlett.
- Hartl, D. L. and A. G. Clark. (1997). Principles of population genetics. 3rd Edition. Sinauer
- Hamilton, M.B., *Population Genetics*, John Wiley & Sons, West Sussex, UK, 2009.

Course Title	**Introduction to Bioinformatics**
Course Code	GMB 209 1.0
Credit Value	01
Status	Core
Year / Level	2nd Year / Level 5
Theory: Practical: Independent learning	08:08:34
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge about the principles of Bioinformatics and standard analysis methods for different types of biological data. This course also provides students with the knowledge to predict the structure and function of a newly discovered gene and evaluate biological data using bioinformatic tools coupled with different analyses.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- access public databases of molecular data
- predict structure and function of a newly discovered gene.
- do a multiple sequence alignment by sum of pairs method.
- use unfamiliar bioinformatic tools by self-studying.
- critically evaluate bioinformatic tools and select best tool for analysis.

Course Content:

Introduction to Bioinformatics, central dogma of Molecular Biology, Data acquisition with emphasis on introduction of errors, C value, PCR, construction of cDNA and genomics libraries, determination of protein structure, Global expression analysis. Low throughput and high throughput methods, Generation of protein interaction data and databases. File formats. Annotated sequence databases, subsidiary sequence databases, submission of sequences to databases, genome and organism specific databases, Miscellaneous databases, Database searches, Homologs, orthologs and paralogs. ORF prediction, Sequence similarity searches, sequence alignment, alignment scores and gap penalties, BLAST, p and E value, sensitivity and specificity, substitution matrices, Multiple sequence alignment, sum of pairs method, PCR primer design, Introduction to phylogenetic analysis.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences.
2. communicate the core concepts of relevant subject areas.
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
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	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	*	***	*		**		**	**
ILO 2	*	**			**	**	**	***
ILO 3		***	*	**	***	**	**	**
ILO 4		**		*	**		**	***
ILO 5	**				*		**	***

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 10% = 10% of Total Marks

Summative Assessment (SA): End Semester Examination: 2-hour paper covering 4 Essay-type questions (90%) = 90% of Total Marks

References:

- Baxevanis, A. D. and Francis, B. F. (2004). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. John Wiley & Sons.
- Gibas, C., Fenton, J. F., Jambeck, P. and Lejenne, L. (2001). Developing Bioinformatics Computer Skills. O'Reilly & Associates.
- Mount, D. W. and Mount, D. (2004). Bioinformatics: Sequence and Genome Analysis. 2nd Edition. Cold Spring Harbor Laboratory.
- Westhead, D.R. and H. Parish. Bioinformatics. 2nd Ed., 2003, Viva Books (pvt) Ltd,India.

Course Title	**Immunobiology**
Course Code	GMB 210 2.0
Credit Value	02
Status	Core
Year / Level	2nd Year/ Level 5
Theory: Practical: Independent learning	30: 00:70
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge about the complexity of the immune system of the body, inflammatory processes and regulatory mechanisms. Further this course also provides knowledge to interpret adaptive immunity and regulations in relation to infections. They will be able to improve the skills in industry including vaccine development and research related to disease prevalence.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- Discuss the complexity of the immune system of the body
- Describe how the inflammatory process is initiated, regulated and controlled in the immune system against various infections.
- Explain how the body's adaptive immunity is regulated and activated in various infections.
- Explain how immunological principles are used in industry and research.

Course Content:

Overview of the immune system, development and history, Innate and Adaptive arms of immune system; recognition and receptors, Cells involved in immunity, haemopoietic system, Innate immunity, Receptors, complement system, acute inflammation, Inflammatory mediators (complement system, reactive oxygen metabolites, lysosomal enzymes, cytokines, chemotactic factors), inflammatory cells (phagocytosed cells, interaction with inflammatory mediators); inflammation process, including immune system development and construction (antibodies structure and function, antibody formation, the interaction between antigen-presenting cells, B - cells and T cells) cells, Adaptive Immunity, Immunoglobulin super family, MHC classes, T cell receptors, antibody diversification and synthesis, Antibody structure and function, Cells – Lymphocytes, Primary lymphoid organs and lymphogenesis, secondary lymphoid organs and lymphocyte traffic, Cellular and immunochemical techniques, Vaccines, diseases and problems caused by the immune system (allergic reactions, autoimmune diseases, problems with different types of implants), immunological methods and principles (antigen-antibody reaction, agglutination, precipitation, including flow cytometry and ELISA).

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1		***			***			
ILO 2		***			***		**	***
ILO 3		***			***		**	***
ILO 4		***		*	**		**	***

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% + FA2 (Presentation) = 40% of TotalMarks

Summative Assessment (SA): End Semester Examination: 2-hour paper covering 4 Essay- type question (60%) = 60% of Total Marks

References:

- Kenneth, M., and Casey, W., 2017. *Janeway's Immunobiology.* 9th Garland
- Male, D., Brostoff, J., Roth, D. and Roitt, I. 2012 *Immunology*, 8th Edition, Saunders.
- Journals – Journal of Immunology, Immunity, TRENDS in Immunology

Course Title	**Laboratory work in Recombinant DNA Technology and Immunobiology**
Course Code	GMB 231 1.0
Credit Value	01
Status	Compulsory
Year / Level	2nd Year / Level 5
Theory: Practical: Independent learning	00: 33:17
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge about the bioinformatic tools to be used in various applications. This course also provides students with the knowledge on areas of PCR primer designing, molecular data handling and submission.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- Write simple commands in R.
- Design PCR primers
- Evaluate bioinformatic tools.
- Predict putative function of a novel gene.
- Develop a consensus sequence.
- Submit sequences to a public database.

Course Content:

Database acquisition, Protein secondary structure prediction, BLAST, Multiple sequence alignment, View of three dimensional structures of proteins, PCR primer designing, Analysis of microarray data, R programming language.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences.
2. communicate the core concepts of relevant subject areas.
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community

7. employ soft skills such as team working skills, time management, leadership, conflict resolutionand work ethics for personal and professional advancement.
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1		*	*		**	*	**	**
ILO 2	*	***			***		*	***
ILO 3		**		*	**		**	
ILO 4	***	*	*	**	*			
ILO 5		*		*	***	*	**	***
ILO 6	*	**	**	*		***	**	

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Oral presentations) 10% = 10% of Total Marks

Summative Assessment (SA): End Semester Examination: 3-hour practical examination (90%) = 90% of Total Marks

References:

- Relevant protocols and manual

Course Title	**Laboratory work in microbial techniques and gene expression**
Course Code	GMB 232 1.0
Credit Value	01
Status	Compulsory
Year / Level	2nd Year / Level 5
Theory: Practical: Independent learning	00: 33:17
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge about the practical aspects of microbial techniques and gene expression. This course also provides students with the knowledge on areas of gene expression at the DNA, RNA and protein levels, microbial enumeration, Bacterial transformation, isolation of bacteriophages from environmental sources.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- conduct the protocols of the techniques taught in the course independently.
- explain the theory of each technique.
- explain the importance of each step in the protocols and chemicals used.
- analyze results and derive conclusions from them.

Course Content:

lac operon, assessment and comparison of gene expression at the DNA, RNA and protein levels, deducing pathways, deducing functions of genes using mutants, Enumeration of microorganisms, Bacterial transformation, Isolation of Bacteriophages from Environmental Sources and Demonstration of Their Lytic Event, Bacterial Conjugation.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences.
2. communicate the core concepts of relevant subject areas.
3. design laboratory experiments, choosing suitable techniques while adhering to laboratorysafety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.

6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolutionand work ethics for personal and professional advancement.
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	**	*	***	***	**		**	
ILO 2		***			***		*	
ILO 3	***	*	**	**		**		**
ILO 4			**	**			***	***

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Lab reports) 10% + FA2 (Presentation) 5% =
15% of Total Marks

Summative Assessment (SA): End Semester Examination: 3-hour Practical examination (85%) = 85% of Total Marks

References:

- Relevant protocols

Third Year

Course Units for the students following the:

BSc Degree Programme with Genetics and Molecular Biology as Subject

BSc Honours in Applied Sciences (Genetics and Molecular Biology) Degree Programme

Course Title	**Fundamentals of Nanobiology**
Course Code	GMB 303.1.0
Credit Value	01
Status	Core
Year / Level	3rd Year / Level 5
Theory: Practical: Independent learning	15: 00:35
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge about the nanobiological techniques and tools to be used in various applications. The knowledge on emerging areas of nano-medicine*, bio-mimicry and nano biotechnology* will be acquired. This course also provides students with knowledge of ethical concerns and law that associatewith nano-science, policy making and current technologies.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- Describe the different tools and techniques use in the field of nanobiology
- Describe the applications of nanobiology in terms of emerging areas such as Nano-medicine, Bio-mimicry to create Nano-materials, and Nano-biotechnology.
- Summarize the ethical concerns that are associated with the study of nanoscience, its place in lawand policy making.
- Discuss where the current technology and field of biology is moving in the future
- Discuss how the novel inventions can be used in nanobiological applications for the wellbeing oflives.

Course Content:

Introduction to Nano technology and Nanobiology, Biology inspired concepts; Biological networks, biological neurons, function of neuronal cells, biological neuronal cells on silicon modeling of neuronal cells by NLSI circuits, Food engineering, bioelectronics, molecular processor, DNA analyzer as a biochip, Bio mimicry; Material engineering, Nano biometrics; introduction, lipid as Nano bricks and mortar. Self-assembled nanolayers. Three dimensional structures using DNA to build acid, biological computing, Tissue engineering, Nano medicine; Drug delivery, cancer treatment.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:

Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas

3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***	*		***		*	**
ILO 2	**	***			***		*	***
ILO 3				**	**			*
ILO 4	***		*	**	*		**	***
ILO 5	**		*	***	***		**	***

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 40% = 40% of Total Marks

Summative Assessment (SA): End Semester Examination: 1-hour paper covering 2 Essay- type question (60%) = 60% of Total Marks

References:

- Binns, C. eBook. *Introduction to Nanosciences and Nanotechnology*- http://pugetsound.worldcat.org/oclc/649906274

Course Title	**Developmental Genetics**
Course Code	GMB 304 1.0
Credit Value	01
Status	Optional
Year / Level	3rd Year / Level 5
Theory: Practical: Independent learning	15: 00:35
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge about the embryonic development, cellular mechanisms associated with development and morphogens. This course also provides knowledge in the genetic toolkit for development epigenetics, genetic dissection of developmental pathways, allele classification, complementation, epistasis, cell-cell communication, regulatory DNA, gene expression patterns in development, maternal genes, anterior/ posterior axis generation in a developing embryo, segmentation and homeotic genes, asymmetric cell division, regeneration, aging, and cancer. Furthermore, this course imparts skills in scientific writing and presentations.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- Explain the key terms, concepts and principles in developmental genetics
- Explain how genes influence the developmental processes of an organism
- Explain how regulatory DNA defines gene expression patterns in development
- Discuss on how cellular determinants are segregated during embryonic development

Course Content:

The genetic toolkit for development, Embryonic development, Cellular mechanisms associated with development, morphogens: long range effect and nuclear gradients, lateral inhibition, induction and pattern formation, Genomic equivalence, Epigenetics, Genetic dissection of developmental pathways, Allele classification, Complementation, Epistasis, Cell-Cell communication, Regulatory DNA, Gene expression patterns in development, Maternal genes, Anterior/ Posterior axis generation in a developing embryo, Segmentation genes, Homeotic genes, Asymmetric cell division, Regeneration, Aging, and Cancer

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:

Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas

3. design laboratory experiments, choosing suitable techniques while adhering to laboratorysafety.
4. propose experiments and suitable solutions in different contexts, while being aware of research,societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolutionand work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***			***		**	
ILO 2	***	***			***		**	
ILO 3	***	***			***		**	
ILO 4	***	***			***		**	

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% + FA2 (Presentation) 20% = 40% of Total Marks

Summative Assessment (SA): End Semester Examination: 1-hour paper covering 2 Essay-type question (60%) = 60% of Total Marks

References:

Developmental Biology 11th Edition, Scott Gilbert

Course Title	**Scientific Communication**
Course Code	GMB 305 1.0
Credit Value	01
Status	Core
Year / Level	3rd Year / Level 5
Theory: Practical: Independent learning	00: 30:25
Other: Pre-requisite Course/s	-

Aim of the Course:

Impart the skills required for analyze scientific literature and translate the scientific data for the usage of non-scientists. Acquire knowledge about the components and procedures of writing research proposals and manuscripts. This course also includes the development of soft skills via journal article discussion, individual and group presentations.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- Critically analyze scientific literature
- Critically analyze data
- Translate scientific literature and data into layman terms
- Summarize scientific literature and data in layman terms
- Present scientific literature and data to various audiences in and out of the field of expertise

Course Content:

Analyze scientific literature, Critically analyze publications on scientific topics from various non-scientific printed and online media, Critically analyze scientific data, Translate the scientific data for theusage of non-scientists, Communicate scientific topics on various non-scientific printed and/or online media

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:

Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community

7. employ soft skills such as team working skills, time management, leadership, conflict resolutionand work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	**	***			***	*	**	
ILO 2	**	***		**	***	*	**	
ILO 3	**	***			***	*	***	**
ILO 4	**	***			***	*	***	**
ILO 5	**	***			***	***	**	***

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Presentation) 40% = 40% of Total Marks

Summative Assessment (SA): End Semester Examination: Final project (40%) and practical (20%) = 60% of Total Marks

References:

Course Title	**Mini-project**
Course Code	GMB 333 2.0
Credit Value	02
Status	Compulsory
Year / Level	3rd Year / Level 5
Theory: Practical: Independent learning	00: 00:100
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge about different research methodologies and techniques can be used in various fields. This course also provides an opportunity to carry out independent studies on scientific issues/ problems and conduct an individual short-term project on a novel topic.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- Explain the Scientific method of research
- Describe different research methodologies and techniques can be used in various fields
- Explain the data analysis and presenting methods

Course Content:

Scientific method, Research methodology, Techniques in sampling, Experimental designs, Data acquisition, analysis and interpretation, Writing project proposals, Conducting projects, Data analysis, Use of analysis tools (Spss, Minitab etc..) , Interpretation and presenting

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolutionand work ethics for personal and professional advancement

8. work ethics for personal and professional advancement
9. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1		***		**	***			
ILO 2		***			***			
ILO 3		***		**	**		**	**

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Presentation) 20% = 20% of Total Marks

Summative Assessment (SA): End Semester Examination: An individual short-term project (80%) = 80% of Total Marks

References:

- Kumar, R. (2018) Research methodology, a step by step guide, SAGE publications

Third Year

Course Units for the students following the

BSc Honours in Genetics and Molecular Biology Degree Programme,

which are also open to students following the

BSc Degree Programme with Genetics and Molecular Biology as Subject

and

BSc Honours in Applied Sciences (Genetics and Molecular Biology)

Degree Programme

as optional subjects

Course Title	**Advanced Population Genetics**
Course Code	GMB 301.1.0
Credit Value	01
Status	Optional
Year / Level	3rd Year / Level 6
Theory: Practical: Independent learning	10: 12:28
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge about the principals of the genetics of populations and standard analysis methods for different types of data. This course also provides students with knowledge to interpret population genetic variations, natural selection and evolution. They will be able to suggest solutions for biology related problems using the knowledge of population genetics.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- Interpret the genetic principles in the population genetics field
- Describe the standard statistical analyses for investigating population genetic variation
- Discuss the natural phenomena in the environment related to the population genetics and to solve the biological problems using the knowledge of population genetics
- Orally present scientific papers in the field of population genetics

Course Content:

Genetic drift, Wright – Fisher model, Mutation drift balance, Coalescent theory; Basic coalescent processes, Tajima's D, Migration, Population structure/sub structure; F statistics, Hierarchical F, AMOVA, Likelihood, Bayesian clustering, Selection; Fitness, Balancing selection, Genetic load, Shifting balance theory, Gene flow, Inbreeding depression and breeding systems, Practical use of computer-based programs in population genetics analysis.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.

4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolutionand work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***			**			
ILO 2		***		***	**		**	
ILO 3		***		***	***		**	***
ILO 4	**	***		*	***		**	**

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 40% = 40% of Total Marks

Summative Assessment (SA): End Semester Examination: 1-hour paper covering 2 Essay- type questions (60%) = 60% of Total Marks

References:

- Gillespie, J. H. 2004. *Population Genetics, a concise guide*. 2nd Edition. The John Hopkins University Press.
- Maynard, S.J. 1989. *Evolutionary genetics*. Oxford University Press.
- Hedrick, P.W. 2000. *Genetics of populations*. 2nd Ed. Jones and Bartlett.
- Hartl, D.L. and Clark, A.G. 2006. *Principles of population genetics*. 4th Ed. Sinauer

Course Title	**Modern Biotechnology**
Course Code	GMB 311.2.0
Credit Value	02
Status	Core
Year / Level	3rd Year / Level 6
Theory: Practical: Independent learning	30: 00:70
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge about the field of Biotechnology and basic applications of biotechnology. This course also provides students with knowledge of the properties of microbes that use in biotechnology, applications in modern medicine and ethical challenges, genetic techniques and approaches for the improvement of crops and livestock.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- Define biotechnology
- List some basic applications of biotechnology
- Explain the process of biotechnology product development discussing particular techniques
- Relate the properties of microbes to their uses for biotechnology
- Outline the contribution of biotechnology to modern medicine, including practical and ethical challenges
- Discuss different genetic techniques and approaches for the improvement of crops and livestock

Course Content:

Introduction to Biotechnology, historical development, land mark discoveries and pioneering scientists, Applications of Biotechnology in medicine, food production and environmental protection. Bioterrorism and bio piracy, and secure biotechnology, Future of biotechnology, Transgenic organisms, plant as bioreactors, molecular farming and pharming, metabolic engineering and hairy root culture for secondary plant products, bioremediations, tools andmethods of marine biotechnology, Ethical issues in biotechnology, Future aspects.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas

3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolutionand work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***						
ILO 2	**	***	*	**	***			*
ILO 3	**	***	**	***	**		*	**
ILO 4		***	**	**	**			*
ILO 5	***		*	***	***			**
ILO 6	***	**	**	***	***		**	***

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% + FA2 (Presentation) 20% = 40% ofTotal Marks

Summative Assessment (SA): End Semester Examination: 2-hour paper covering 4 Essay-type question (60%) = 60% of Total Marks

References:

- Smith J. E. 2006. *Biotechnology*, 3rd Edition, Cambridge University Press
- Thieman, W.J., and Palladino, M.A. 2012. *Introduction to Biotechnology*, (Third Edition). Benjamin Cummings.
- Walker, S. 2006. *Biotechnology* Demystified, (Fifth Edition). The McGraw-Hill Companies

Course Title	**Cell Signaling and Signal Transduction**
Course Code	GMB 313.1.0
Credit Value	01
Status	Core
Year / Level	3rd Year /Level 6
Theory: Practical: Independent learning	15: 00:35
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge about the signal transduction pathways including receptors, adaptor proteins and second messengers, classes of cell receptors, structure of receptor tyrosine kinases, links between cellular signals, signaling pathways in cells and interaction between signaling pathways. This course also provides students with knowledge of G protein coupled receptors, their functions and relevance ofcell signaling in various physiological and pathological responses.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- Describe the components of signal transduction pathways including receptors, adapter proteins, second messengers
- Describe different classes of cell surface receptors
- Explain the structures of different Receptor tyrosine kinases (RTKs)
- Explain the link between extracellular signals, intracellular events and cellular/physiological responses with examples
- Describe the major intracellular signaling pathways in cells
- Describe the complexity and the interactions between signaling pathways
- Explain the role of G protein coupled receptors and G proteins in signaling pathways
- Discuss with examples the relevance of cell signaling in a variety of physiological and pathological responses

Course Content:

Principles of cell signaling, Types of intercellular signaling, Signaling molecules, Components of signal transduction pathways, Cell surface receptors, G-protein coupled receptors and G proteins, Receptor tyrosine kinases, Signal transducing adaptor proteins, Second messengers, Effectors, Adenylyl cyclases and cyclic AMP (cAMP), Phospholipases, Signal transduction cascade involving cAMP, Inositol triphosphate (IP3) and control of intracellular cellular Ca^{2+} levels, -Cross-talk betweensignaling pathways, Role of G-proteins in diseases, Student presentations

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolutionand work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1		***			**			
ILO 2		***			**			
ILO 3		***			*			
ILO 4		***			**			
ILO 5		***			*			
IOL 6		***			*			
ILO 7		***			*			
ILO 8		***			**		**	*

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 40% = 40% of Total Marks

Summative Assessment (SA): End Semester Examination: 1-hour paper covering 2 Essay-type question (60%) = 60% of Total Marks

References:

- Gomperts, B.D. et al. 2002. *Signal Transduction*, Elsevier Academic Press.
- Hancock, J.T. 2005. *Cell Signaling* (2nd edition), Oxford University Press.

Course Title	**Entrepreneurship**
Course Code	GMB 314.1.0
Credit Value	01
Status	Optional
Year / Level	3rd Year / Level 6
Theory: Practical: Independent learning	12: 09:29
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge about and the areas of entrepreneurship. Students will understand the role and importance of entrepreneurship for economic development, personal creativity and key steps in business. This course also provides students with knowledge of the stages of the process and resources required for successful development of entrepreneurial ventures.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- Describe basic concepts in the area of entrepreneurship
- Explain the role and importance of entrepreneurship for economic development
- Apply personal creativity and explain how to take entrepreneurial initiative
- Identify key steps in the elaboration of business ideas
- Describe the stages of the entrepreneurial process and the resources needed for the successful development of entrepreneurial ventures.

Course Content:

Conceptual definition of entrepreneurs and entrepreneurship, Entrepreneurship in economic theory, Historical development, Entrepreneurial practice, The importance of small business, Entrepreneurial economy, Entrepreneurship and Economic Development, Type of Entrepreneurship, Entrepreneur and small business, Features and types of businesses and entrepreneurs, Sources of business ideas, Innovation and entrepreneurship, Forms of entrepreneurial organization, Entrepreneurial strategies, Starting a new company, Entrepreneurial project, Writing a business plan.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:

Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.

4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1		***			**			
ILO 2		***		**	*		*	***
ILO 3		*		***			**	***
ILO 4		**		*			*	**
ILO 5		***		**				**

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% + FA2 (Presentation) 20% =
40% of Total Marks

Summative Assessment (SA): End Semester Examination: 1-hour paper covering 2 Essay-
type question + Final Project (60%) = 60% of Total Marks

References:

- Read, S., Sarasvathy, S., Dew, N. and Wiltbank, R. 2016. *Effectual Entrepreneurship* 2nd Edition. ISBN: 1138923788

Course Title	**Introduction to Computer Programming**
Course Code	GMB 315.2.0
Credit Value	02
Status	Optional
Year / Level	3rd Year / Level 6
Theory: Practical: Independent learning	15: 30:55
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge about basic concepts in computer programing. This course also provides students with knowledge of the real-world problems and how it translate into programming languages, correlating problems in genetics and molecular biology into programs and emerging trends and technologies in computer programing.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- Describe basic concepts in computer programming.
- Translate programming algorithms into a physical programming language that meets user requirements, and validate input.
- Translate simple real-world problems into programming algorithms applying a design methodology.
- Propose solutions to various problems in genetics and molecular biology using computer programming.
- Develop and use a test plan for determining the correctness of a program.
- Discuss emerging technologies and trends in computer programming.

Course Content:

Introduction, Identifiers, Data types, Variables, Expressions, Evaluating Variables, Operators, Operator Precedence, If Statements, Nested if – else, For Loops, While Loops, Nesting loops, Break, Continue, Comments, Working with Data Structures, Built-in Functions and Modules, Libraries and applications.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas

3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolutionand work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1		***						
ILO 2			***					
ILO 3			***	***				
ILO 4	***			***	***		***	***
ILO 5				***			***	***
ILO 6				*	***	***	***	***

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% + FA2 (Reports) 20% = 40% of Total Marks

Summative Assessment (SA): End Semester Examination: 2-hour paper covering 4 Essay-type question (60%) = 60% of Total Marks

References:

- Althoff, C. The Self-Taught Programmer: The Definitive Guide to Programming Professionally.
- Matthes, E. Python Crash Course: A Hands-On, Project-Based Introduction to Programming.
- Barry, P. Head First Python: A Brain-Friendly Guide Paperback.
- Lambert, K.A. The Fundamentals of Python: First Program

Course Title	**Bioelectronics**
Course Code	GMB 316.2.0
Credit Value	02
Status	Optional
Year / Level	3rd Year / Level 6
Theory: Practical: Independent learning	21: 27:52
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge about the basic electronic components, digital and analog electronic circuits and basics of measurement equipment. This course also provides students with knowledge of how design circuits with operational amplifier for biomedical applications, conversion methods of analog signals intoa digital signal and designing and programing of microcontroller-based instrumentation

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- Identify the basic electronic components, digital & analog electronic circuits and Basics measurement equipment's
- Learn how to design circuits with operational amplifier for biomedical applications.
- Learn how an analog signal can be converted into a digital signal.
- Design and program the microcontroller-based instrumentation

Course Content:

Elementary concepts of DC electric circuits: Basic Terminology including voltage, current, power, resistance, emf; Resistances in series and parallel; Current and Voltage Division Rules; Capacitors & Inductors: V-I relations and energy stored. Ohms Law and Kirchhoff's laws-Problems Basic electroniccircuits: Rectifiers and power supplies: Block diagram description of a dc power supply, working of a full wave bridge rectifier, capacitor filter, working of simple zener voltage regulator, regulator IC, Operation Amplifier and instrumentation: Introduction to operational amplifier, Op-amps with negativefeedback, Inverting and Non inverting Amplifier, comparator. Frequency response of Op-amp, IC- Op-amp, Application of op-amp (Summing, Differentiator and Integrator), small signal amplifier, Digital Electronics: number system, Boolean Algebra, Basic logic circuits, Logic gates, Introduction to digitallogic family such as TTL and CMOS, combinational logic circuits applications, Flip flop and Timing circuit: set-reset laches, D-flipflop, R-S flip-flop, J-K Flip-flop, edge triggered flip-flop, T flip-flop, sequential circuits, counters, Sensors and Transducers, biosensors (photometric, biometric, glucose), Basic sensor instrumentation and electrochemical sensor interfaces. Introduction to Microprocessors and Microcontrollers

architecture, Introduction to Arduino, Introduction to Embedded C and its Programming (using Arduino), Introduction to I/O ports in microcontroller, Introduction to Analog to Digital Converters and Digital to Analog Converters, Serial Communication, serial port and data communication, biomedical applications.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1		***			*			
ILO 2		**	***					
ILO 3		**	**					
ILO 4			***	***	*		**	***

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% + FA2 (Mini-project) 20% = 40% of TotalMarks

Summative Assessment (SA): End Semester Examination: 2-hour paper covering 4 Essay-type question (60%) = 60% of Total Marks

References:

- Gibilisco, S. 2016. *Teach Yourself electricity and electronics.* McGraw-Hill.
- Pethig, R.R. and Smit, S. 2012. *Introductory Bioelectronics: For Engineers and Physical Scientists*. Wiley.
- Monk, S. 2016. *Programming Arduino Getting Started with Sketches*. McGraw-Hill Education.

Course Title	**Biochemistry**
Course Code	GMB 317.2.0
Credit Value	02
Status	Core
Year / Level	3rd Year / Level 6
Theory: Practical: Independent learning	27: 09: 64
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge about the first and second laws of thermodynamics to biochemical processes, general principles of biochemistry and chemical reactions which deviate from general principles of biochemistry. This course also provides students with knowledge to compare and contrast primary metabolic pathways of animals and plants and perform biochemical tests to identify primary metabolites.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- Apply first and second laws of thermodynamics to biochemical processes.
- Explain the general principles of Biochemistry.
- Identify biochemical reactions which deviate from general principles of Biochemistry.
- Compare and contrast primary metabolic pathways of animals and plants.
- Perform biochemical tests to identify primary metabolites.

Course Content:

First and second laws of thermodynamics, high energy biomolecules, glycolysis, citric acid cycle, reduction potential, oxidative phosphorylation, chemiosmotic hypothesis, glyceraol 3-phosphate shuttle, malate - aspartate shuttle, pentose phosphate pathway, gluconeogenesis, substrate cycles, cori cycle, cooperation between glycolysis and gluconeogenesis, glycogen metabolism, synthesis of phospholipids and triacylglycerols, sphingolipid synthesis, cholesterol synthesis, lipid degradation, nitrogen metabolism. Tests for reducing sugars, carbohydrates, proteins, lipids and cholesterol.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:

Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research,

societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolutionand work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1		***						
ILO 2		***						
ILO 3		**						
ILO 4	**	***						
ILO 5	**	**	***	***	**		***	***

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% + FA2 (Reports) 20% = 40% of TotalMarks

Summative Assessment (SA): End Semester Examination: 2-hour paper covering 2 Essay-type question (40%) + Practical (20%) = 60% of Total Marks

References:

- Berg, J.M., Tymoczko, J.L. and Stryer. L. 2019. *Biochemistry*, 9th Ed., W.H. Freeman, New York.
- Nelson, D.L.and Cox, M.M. 2017, *Lehninger Principles of Biochemistry*, 7th Ed., W.H Freeman, New York.
- Alberts, B., Johnson, A., Lewis, J., et al. 2015. *Molecular Biology of the Cell*, 6th Ed., Garland Science, New York.
- Lodish H., Berk, A., Zipursky, S.L., et al. 2016. *Molecular Cell Biology*, 8th Ed., W.H. Freeman, New York.

Course Title	**Human Genetics and Counseling**
Course Code	GMB 318.1.0
Credit Value	01
Status	Optional
Year / Level	3rd Year / Level 6
Theory: Practical: Independent learning	12: 09:29
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge about the importance of genetic counseling as a profession. This course also provides students with knowledge of the importance of the family as a unit of genetic investigation and illustrate practical case histories on various topics.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- Explain the importance of genetic counseling as a profession
- Discuss the importance of the family as the unit of genetic investigation
- Illustrate practical case histories with examples covering the topics discussed in the course

Course Content:

Branches of genetics (prenatal genetic screening and diagnosis, familial cancer, cancer syndrome, cancer genetics and risk assessment), screening and diagnosis (invasive and non-invasive testing, presymptomatic and predictive testing, genetic registers, population screening, carrier screening), pedigree construction and analysis and the central role of pedigrees in the genetic counseling profession, management and remedial measures for genetic disorders (conventional approach, recombinant methods, multi-specialty approach, gene therapy, hormonal replacement therapy), preventive capabilities of genetics, the professional roles and responsibilities of genetic counselors within the context of the clinical genetics team, the health care community and society, ethical, social and legal issues, role play

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas

3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***			*		**	
ILO 2	**	***			**	*		
ILO 3		**		*	**	*	**	*

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 40% = 40% of Total Marks

Summative Assessment (SA): End Semester Examination: 1-hour paper covering 2 Essay-type question (60%) = 60% of Total Marks

References:

- MacFarlane, I.M., Veach, P.M. and LeRoy, B.S. 2014. *Genetic counseling research: apractical guide.*
- Schneider, K.A. *Counseling about cancer: strategies for genetic counseling*.

Course Title	**Carrier Skills Development**
Course Code	GMB 319.1.0
Credit Value	01
Status	Optional
Year / Level	3rd Year / Level 6
Theory: Practical: IndependentLearning	12: 09:29
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge about the components of various carrier development theories, decision making models and approaches for conceptualization of inter relationships among and between various factors.This course also provides students with knowledge of the technique relevant to carrier planning, decisionmaking, placement, follow up and evaluation of clients 'experiences and life work planning and management.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- Describe components of various career development theories and decision-making models
- Identify the approaches for conceptualizing the inter-relationships among and between work, mental well-being, relationships, and other life roles and factors.
- Explain their usefulness and techniques relevant to career planning, decision making, placement, follow-up, and evaluation and for assessing work environments as related to clients' life experiences.
- Identify strategies for facilitating client skill development for career, educational, and life-work planning and management.

Course Content:

Introduction to carriers, Carrier development theories, Different decision making models Skills identification models - Bolles and his parachute model, Mental well-being of workers, working environment, Labor market information, Organizations, Carrier management, Applying and facing interviews

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research,

societal and environmental ethics.

5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1		***			**			
ILO 2		**		**	**	*	***	*
ILO 3				**			***	**
ILO 4		**			*		**	***
ILO 5								

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 40% = 40% of Total Marks

Summative Assessment (SA): End Semester Examination: 1-hour paper covering 2 Essay- type question (40%) + Presentation (20%) = 60% of TotalMarks

References:

Course Title	**Molecular Modelling and Computational Biochemistry**
Course Code	GMB 321 1.0
Credit Value	01
Status	Optional
Year / Level	3rd Year / Level 6
Theory: Practical: IndependentLearning	05: 24:21
Other: Pre-requisite Course/s	-

Aim of the Course:

Provide an overview and applications of Molecular Modelling and Computational Biochemistry. This course also describes the key concepts and principles of protein sequence analysis, protein structure homology modelling, molecular graphics/ visualization and the uses of basic computer programs/softwares in modeling while developing the soft skills such as presentation and communication competences.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- Describe what is molecular modeling and computational usage for modeling
- Execute basic standard computer-based tools for molecular modeling
- Predict the structure of a protein using structure-based homology modeling
- Extract information of metabolic pathways by using databases
- Analyze protein sequence information using computer programs and software
- Analyze biochemical data with statistical significance
- Analyze (computationally) biochemical compounds and predict interactive partners

Course Content:

Introduction to Molecular modelling, Protein sequence analysis, Protein structure homology modelling, Molecular graphics and visualization, Introduction to PyMol, Sequence homology based protein structure prediction and molecular docking, Applications in molecular modelling, Basic computer simulation techniques, Use of basic computer programs/softwares in modelling, Statistical analysis of biochemical data, Structure prediction and analysis of biochemical compounds, Characterization of biomolecular structures, Biomacromolecule-ligand interactions, Introduction to enzyme databases, enzyme kinetics, Metabolic pathways and databases

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences

2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***			**			
ILO 2	**	***		**				
ILO 3	**	***		**				
ILO 4	**	***	**		**			
ILO 5		**	**	**	**			
ILO 6		**	**	**	**			
ILO 7		**	**	**	**			*

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% + FA2 (Presentation) 10% = 20% of Total Marks

Summative Assessment (SA): End Semester Examination: 1-hour paper covering 2 Essay-type question: Theory and practical (60%) = 60% of TotalMarks

References:

- Principles of Biochemistry by Nelson and Cox, Lehninger. W H Freeman & Co. 2009
- Fundamentals of Computer Algorithms by Horowitz, S. Sahini, and Rajasekharan. Galgotia Publications.1984
- An introduction to bioinformatics algorithms by Neil C. Jones, Pavel Pevzner. MIT Press. 2004

Course Title	**Protein Engineering**
Course Code	GMB 323 2.0
Credit Value	02
Status	Optional
Year / Level	3rd Year / Level 6
Theory: Practical: Independent learning	20: 27:53
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge about protein engineering strategies and its applications. This course also describes the potentials of Protein Engineering for national and global development.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- describe the concepts of protein engineering
- apply bioinformatics tools in protein analysis and prediction
- recognize random & *invitro* mutagenesis strategies
- explain the principles of methods of expression, extraction, isolation, and purification of proteins
- discuss the factors affecting protein structure
- describe the use of recombinant proteins in medical practice/therapeutics
- design an experiment to obtain a protein with improved stability/reactivity.

Course Content:

Introduction to Protein engineering, Protein synthesis, Hierarchical nature of protein structure and theirstructural characteristics, Methods of protein extraction, isolation and purification of proteins, Strategies of protein engineering, random and *in-vitro* mutagenesis in protein engineering, Bioinformatics in protein structure and function prediction, Identification of putative enzymes in bioinformatics databases, protein library construction and screening, Binding interactions and mechanisms, Therapeutic protein engineering, Antibody engineering, amino acid incorporations, Antibody-drug conjugates, Alternative scaffolds for protein engineering, Engineering florescent proteins/molecular probes, Applications of protein engineering in Sri Lanka.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***			**			
ILO 2	***	***	**	***	*			**
ILO 3	***	***			**			
ILO 4	***	***			**			
ILO 5	***	***			**			
ILO 6	***	***		***	**		**	**
ILO 7	***	***	***	***	**		**	***
ILO 8								
ILO 9								

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% + FA2 (Presentation) 05% = 25% of Total Marks

Summative Assessment (SA): End Semester Examination: 2-hour paper covering 4 Essay-type question (75%) = 75% of Total Marks

References:

- Lutz, S. (2009) Protein engineering handbook. Uwe Bornscheuer. Weinheim: Wiley-VCH
- Alan, F. (1998). Structure and mechanism in protein science: A guide to enzyme catalysis and protein folding. New York: W.H. Freeman

Course Title	**Molecular Entomology**
Course Code	GMB 326 2.0
Credit Value	02
Status	Optional
Year / Level	3rd Year / Level 6
Theory: Practical: Independent learning	15: 36:49
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge about the insect genomes. This course also provides knowledge in the Sex determination of insects, Insecticide resistance, Molecular phylogenetics, Mosquito genome, Other disease vector species and their genomes, Insect transformation, Insect applications; Genetic modifications, Sterile male techniques. Furthermore, this course imparts skills in scientific writing andpresentations.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- summarize basic concepts and methods of molecular biology and genetics of insects
- describe some of the major discoveries using these methods with *Drosophila melanogaster*
- propose solutions to various problems in entomology
- discuss novel methods to control disease transmission by insect vectors

Course Content:

Insect genome, size, genomic regions, mitochondrial genome, Drosophila mutants, Drosophila genome, Transposable elements, P elements, Use of P elements, Alcohol dehydrogenase, Developmental genes, Homeotics, Sex determination of insects, Circadian rhythms, Insecticide resistance, Baculoviruses, Wolbachia, Molecular phylogenetics, Mosquito genome, Other disease vector species and their genomes, RNA interference, Insect transformation, Insect applications; Genetic modifications, Sterile male techniques.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research,

societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***			***			
ILO 2	***	***			***		**	
ILO 3	***	***	**	***	***		***	**
ILO 4	***	***	**	***	***	*	***	**

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% = 20% of Total Marks

Summative Assessment (SA): End Semester Examination: 2-hour paper covering 4 Essay-type question (60%) + Practical (20%) = 80% of Total Marks

References:

- Hagedon HH, Hilderbrand JG, Kidwell MG & Law JH. 1990. Molecular Insect Science. Plenum Press, New York.
- Oakeshott J & Whitten MA.. 1994. Molecular Approaches to Fundamental and Applied Entomology, Springer Verlag.
- Rechcigl JE & Rechcigl NA. 1998. Biological and Biotechnological Control of Insect Pests. Lewis Publ., North Carolina.

Course Title	**Bioeconomics**
Course Code	GMB 327 1.0
Credit Value	01
Status	Optional
Year / Level	3rd Year / Level 6
Theory: Practical: Independent learning	12: 09:29
Other: Pre-requisite Course/s	-

Aim of the Course:

Provide an overview and applications of Bioeconomy. This course also describes the key concepts and principles of Permanent tanable development, Economic development based on biological raw materials and Biotechnology.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- explain the key definitions, theories and history of the bioeconomy in a global context
- describe the different innovation sectors that make up the bioeconomy.
- identify the conceptual underpinnings of the bioeconomy with respect to other areas of theory and knowledge including innovation ecosystems and ecology.
- identify emerging socio-economic trends in the bioeconomy
- analyse the size and contribution of the bioeconomy to the European Economic Area, and an awareness of competitor regions and countries.

Course Content:

Basic characterization of tanable and untanable development of national economy, basic global problems, Permanent tanable development – characterization, principles, economic indicators, components, tanable model of economy, central documents, new strategy for tanable development. Tenability of production, consumption and competitivity of industrial concern. Biology and national economy. Economic development based on biological raw materials – production of bioproducts, biotechnologies, waste economic. Bioeconomy – characterization, targets and components, strategies (climatic change, energy security, food security, tanable management of biological sources, utilization of industrial waste material). Biotechnology – characterization, typies, basic sources, raw materials and modern biotechnologies, utilization of biotechnologies and their apport in construction of industry.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:

Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***			**			
ILO 2	***	***			**			***
ILO 3	***	***			**			***
ILO 4	***	***			**			***
ILO 5	***	***			**			***

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% = 20% of Total Marks

Summative Assessment (SA): End Semester Examination: 1-hour paper covering 2 Essay-type question (60%) + Practical (20%) = 80% of Total Marks

References:

- Polívka Ľ, Urgeová E. (2007). Bioeconomy and white biotechnology as a basic pillar of the Lisbon strategy. Nova Biotechnologica VII-I, 69- 76

Course Title	**Occupational Competence (Similar to industrial training)**
Course Code	GMB 329 1.0
Credit Value	01
Status	Optional
Year / Level	3rd Year / Level 6
Theory: Practical: Independent learning	00: 50:50
Other: Pre-requisite Course/s	-

Aim of the Course:

This course provides hands-on experience in the field of training related to Genetics and Molecular Biology. Impart the skills of project management and develop the soft skills such as presentation and communication competences.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- describe how the boundaries of knowledge can be expanded through research and development
- explain how to integrate classroom theory with workplace practice
- explain the ethical basis of professional practice in the relevant industry
- critically analyze and learn independently
- write formatted report explaining the work in industrial training the experience
- analyze options in career plans and goals
- describe how to make a gradual transition from academia to career

Course Content:

A training will be offered depending on the institute students enroll for the industrial training. All the institutes will be in the field of Genetics and Molecular Biology related.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.

6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1		***		**	***	***	***	**
ILO 2		***		***		**	***	**
ILO 3				**		***	***	***
ILO 4				**		***	***	***
ILO 5						***	***	***
ILO 6			**	***			***	***
ILO 7				***		***	***	***

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Monthly reports) 20% = 20% of Total Marks

Summative Assessment (SA): End Semester Examination: Oral Presentation (40%) + Written report (40%) = 80% of Total Marks

References:

Relevant literature

Course Title	**Laboratory work in Biochemistry, RNA and Protein Techniques**
Course Code	GMB 336.1.0
Credit Value	01
Status	Compulsory
Year / Level	3rd Year / Level 6
Theory: Practical: Independent learning	00: 32:18
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge about different extraction methods of protein from various sources, quantify, and prepare apparatus for gel electrophoresis, transferring techniques, RNA extraction methods and cDNA synthesis. This course also provides students with knowledge of conducting RT PCR.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- obtain protein extracts from various sources
- quantify protein concentration in a sample
- cast a vertical polyacrylamide gel, load protein samples and run the gel
- transfer the protein bands from the gel to a membrane
- detect a protein of interest using protein specific antibodies
- extract RNA
- synthesize cDNA by carrying out reverse transcription
- conduct RT-PCR

Course Content:

Functions of Proteins, Sources of Proteins, Preparation of Cell lysis buffer, Protein extraction: Simple boiling, Sonication, Homogenization, Enzymatic lysis, Freezing and grinding, Protein Quantification: Absorbance measurement, Bradford assay, SDS-PAGE, Western Blotting, RNAextraction, cDNA synthesis by reverse transcription, RT-PCR

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research,
5. societal and environmental ethics.
6. research scientific literature and disseminate knowledge to others.
7. function effectively within the scientific community
8. employ soft skills such as team working skills, time management, leadership, conflict resolutionand work ethics for personal and professional advancement
9. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***	***		***		***	
ILO 2	***	***	***		***		***	
ILO 3	***	***	***		***		***	
ILO 4	***	***	***		***		***	
ILO 5	***	***	***		***		***	
ILO 6	***	***	***		***		***	
ILO 7	***	***	***		***		***	
ILO 8	***	***	***		***		***	

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% + FA2 (Reports) 20% = 40% of TotalMarks

Summative Assessment (SA): End Semester Examination: 1-hour Practical + Theory examination (60%) = 60% of Total Marks

References:

- Robyt, J.F. and White, B.J. *Biochemical Techniques; theory & Practice*.
- Mu, P. and Plummer, D.T. 2001. *Introduction to Practical Biochemistry* Tata McGraw-Hill Education

Course Title	**Epigenetics**
Course Code	GMB 342.1.0
Credit Value	01
Status	Core
Year / Level	3rd Year / Level 6
Theory: Practical: Independent learning	10:28
Other: Pre-requisite Course/s	

Aim of the Course:

Acquire knowledge about the principles of epigenetics by examining selected epigenetic phenomena in eukaryotes, mechanisms controlling these effects and their phenotypic consequences when normal regulation is lost. This course also provides students with the knowledge to interpret different epigenetic mechanisms and how they are propagated.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- Describe the need for epigenetics to fully explain heritability.
- Discuss the organization of chromatin in the nucleus and different epigenetic marks
- Describe how multiple varieties of chemical modifications determine the epigenome and its activity.
- Analyze what we can learn from the epigenetic phenomena in different model organisms.
- Discuss how epigenetics can influence the life of an organism.
- Describe the role of environmental changes in influencing heritability.
- Discuss the role of epigenetics in diseases.
- Describe the role of epigenetics in drug discovery.
- Describe various technologies used in epigenetic research.

Course Content:

Fundamentals of epigenetics: basic overview and a brief history of the field, the Paradigm shift from genetics to epigenetics. Dynamic organization of the genome and its impact on gene regulation and epigenetic processes. Molecular mechanisms regulating epigenetic processes: DNA methylation, Histone modifications, chromatin remodeling, Non-coding RNAs, Epigenetic modifications and gene expression, Epigenetic phenomena in model animals: Transgenerational epigenetic inheritance in animals, plants and fungi. Influence of epigenetics at the beginning of life: epigenetic reprogramming and genomic imprinting, X-inactivation, the role of epigenetic mechanisms during cell differentiation, epigenetic variations in human populations. Epigenetics and the environment: Nature vs. Nurture, the effects of nutrition, drugs, and environmental stressors on epigenetics, Epigenetics in ageing and diseases I: Imprinting disorders, Rett syndrome, ICF syndrome, cancer, Epigenetics in drug discovery, Experimental techniques in epigenetic

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research,societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolutionand work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***			**			**
ILO 2		***		***	**		**	
ILO 3	***	***		***	***		**	***
ILO 4	**	***		*	***		**	**
ILO 5		***						
ILO 6		***						
ILO 7		***						
ILO 8		***						**

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 40% = 40% of Total Marks

Summative Assessment (SA): End Semester Examination: 1-hour paper covering 2 Essay-type questions (60%) = 60% of Total Marks

References:

- Epigenetics, CSHL press, 2nd edition
- Epigenetics Protocols (Methods in Molecular Biology) 2nd edition

Course Title	**Molecular Basis of Diseases**
Course Code	GMB 343 2.0
Credit Value	2
Status	Optional
Year / Level	3rd Year/ Level 6
Theory: Practical: Independent learning	30:00:70
Other: Pre-requisite Course/s	-

Aim of the Course:

To introduce molecular mechanisms involved in basic diseases and to introduce molecular diagnostics.

Intended Learning Outcomes (ILOs):

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

- describe common diseases with a significant molecular basis
- describe molecular mechanisms responsible for common diseases
- describe how inheritance of mutated genes leads to pathology either in childhood or in later life
- discuss how the lifestyle of an individual or his/her environment can give rise to genetic or physiological change within the adult cell that results in diseases
- describe how normal cellular processes change, fail or get destroyed in common complex diseases such as cancer, diabetes, and cardiovascular and brain-related disorders
- discuss how rational design of novel therapies can arise from knowledge of the molecular basisof disease
- discuss and orally present scientific papers within the field of molecular diseases

Course Content:

Molecular Basis of and mechanisms of selected common diseases including cardiovascular disease, diabetes, cancer, Ion channels disease, muscle diseases, neurodegeneration, thrombosis and metabolic diseases, Use of Molecular Knowledge for Diagnosis.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.

5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***			**			
ILO 2	***	***			**			
ILO 3	***	***			**			
ILO 4	***	***			**			
ILO 5	***	***			***			
ILO 6	***	***		**	**		**	***
ILO 7	***	***			**	**	**	***

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (news and views) 20% + FA2 (Presentations) 10% + FA3 (Discussion of a research article) 10% = 50% of Total Marks

Summative Assessment (SA): End Semester Examination: 2-hour paper covering 4 Essay- type question (60%) = 60% of Total Marks

References:

- John Macloed (1988). Davidson's principles and Practice of Medicine., 24th Ed. Churchill Livingstone, Snustad, D.P. & Femmans,
- Gillham, B., Despo, K.P., Thomas, J.H. (1997). Will's Biochemical Basis of Medicine., ReedEducational and Profesional Publishing Ltd.
- **Web resources:** Different research articles

Course Title	**RNA Biology**
Course Code	GMB 344 1.0
Credit Value	01
Status	Core
Year / Level	3rd Year / Level 6
Theory: Practical: IndependentLearning	15: 35
Other: Pre-requisite Course/s	-

Aim of the Course:

Provide knowledge in different RNAs and their roles in cells and impart skills to conduct review of literature, summarization, preparation of visual aids and presentation based on a chosen topic related to RNA Biology.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- Explain the biology, chemistry, structure, and function of the RNA molecule
- Explain the role of RNA molecule in the control of living cells and how it is regulated by protein
- Evaluate practical applications of the RNA molecule within medicine and biotechnology
- Solve biological problems by applying methods that are based on the properties of the RNA molecule
- Critically evaluate scientific literature in the area summarize published literature in the area

Course Content:

Introduction to RNA world, Ribozymes, Riboswitches and RNA Sensors, RNA viruses, Transcriptome,Complexity of transcriptome, alternative splicing, RNA editing, CRISPR, Different RNAs and their roles in cells. RNAs involved in protein synthesis; mRNA, tRNA, rRNA, RNAs involved in post- transcriptional modification, Regulatory RNAs, Experimental RNA Profiling Strategies, Anti-sense RNA technology,RNAi technology, Ribozymes, Catalytic RNA Molecules Telomerase, Long non-coding RNAs, Research paper discussions.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:

Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***			***			
ILO 2	***	***			***			
ILO 3	***	***		***	***			
ILO 4	***	***	**	***	***		*	***
ILO 5	***	***			***			**

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA):
FA1 (Mid-term) 20% + FA2 (Presentation) 5% + FA3 (Review article) 10 % = 35% of Total Marks

Summative Assessment (SA): End Semester Examination: = 65% of Total Marks

References:

- Meister, G. (2011) RNA Biology, 1st Edition, Willy Publication
- Elliot, D., Ladomery, M. (2016) Molecular Biology of RNA, 2nd Edition, Oxford University Press.

Course Title	**Virology**
Course Code	GMB 345.1.0
Credit Value	01
Status	Optional
Year / Level	3rd Year / Level 6
Theory: IndependentLearning	15:35
Other: Pre-requisite Course/s	

Aim of the Course:

The Course aims to equip students with a solid foundation in virology, enabling them to pursue further studies, research, or careers in virology, immunology, epidemiology, public health, and related fields.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- Describe the fundamental principles of virology.
- Describe the genetic makeup of viruses and their evolution over time.
- Describe the life cycle and the viral replication inside the host cells.
- Explain the host-pathogen interactions that leads to viral diseases and pathogenesis.
- Describe the viral epidemiology, transmission and the impact on public health.
- Explain the antiviral strategies and vaccines, and the challenges associated with developing effective treatments.
- Differentiate the available antiviral and vaccine strategies for a given virus.
- Describe the basic laboratory techniques used in virology.
- Discuss the recent research in virology, current issues and emerging viral diseases.
- Describe the ethical considerations and biosecurity in virology research.
- Explain the virology concepts to both scientific and non-scientific audiences.

Course Content:

Introduction to viruses, Viral Genetics and Evolution,. Viral replication and life cycle, Host-pathogen interaction, Epidemiology and emerging virus diseases, Vaccine and antiviral therapy, Virology research.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:

Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement
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	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***						
ILO 2	***	***						
ILO 3	***	***						
ILO 4	***	***	*					
ILO 5	***	**		**			***	
ILO 6	***	***	*	**	***	*	***	**
ILO 7	***	***			***	**	***	***
ILO 8	***	***	**	**	*		**	
ILO 9					***		***	**
ILO 10			**	**	*	***	***	
ILO 11					***	***	***	***

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA: Mid-term, Assignements= 40% of Total Marks

Summative Assessment (SA): End Semester Examination: = 60% of Total Marks

References:

- Flint, S.J., Racaniello, V.R., Rall, G.F., Hatziioannou, T. and Skalka, A.M., 2020. Principles of virology, Volume 2: pathogenesis and control. John Wiley & Sons.
- Dimmock, N.J., Easton, A.J. and Leppard, K.N., 2015. Introduction to modern virology. John Wiley & Sons.

Third Year

Course Units offered solely to the students following the

BSc Honours in Genetics and Molecular Biology Degree Programme

Course Title	**Research methodology**
Course Code	GMB 320 2.0
Credit Value	02
Status	Core
Year / Level	3rd Year / Level 6
Theory: Practical: Independent Learning	15: 36:49
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge in research and scientific method and provides a training to write reports and publish manuscripts. This course also imparts the skills of research methodologies and develops the soft skills such as presentation and communication competences.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- Describe the basic framework of research process
- Identify the scientific method
- Describe various research designs and techniques
- Identify various sources of information for literature review and data collection
- Explain ethical aspects research
- Identify the components of scholarly writing and evaluate its quality

Course Content:

Introduction to research and scientific method, Research theory building, Understanding concepts of research, Problems and Hypotheses, Research design – experimental and non-experimental research, field research and survey research, Methods of data collection – secondary data, qualitative and quantitative data, Measuring and scaling, Sampling techniques – nature of sampling, sampling design, determination of sample size, Analysis of data, Research ethics and ethical considerations in research, Report writing and referencing

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:

Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory

safety.

4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1		***			***			
ILO 2		***			***			
ILO 3		***		*	***			
ILO 4		***			***			
ILO 5		***		**	***		**	
ILO 6		***			***		**	

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Project proposal) 25% + FA2 (Presentation) 25% = 50% of Total Marks

Summative Assessment (SA): End Semester Examination: Final Project (50%) = 50% of Total Marks

References:

- Chawla, Deepak & Sondhi, Neena (2011). Research methodology: Concepts and cases, VikasPublishing House Pvt. Ltd. Delhi.
- Neuman, W.L. (2008). Social research methods: Qualitative and quantitative approaches,Pearson Education.
- Kerlinger, F.N., & Lee, H.B. (2000). Foundations of Behavioural Research (Fourth Edition), Harcourt Inc.

Course Title	**Applications in Nanobiology**
Course Code	GMB 328 1.0
Credit Value	01
Status	Core
Year / Level	3rd Year / Level 6
Theory: Practical: Independent learning	15: 00:35
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge acquire knowledge in current topics in nanobiology. This course also provides knowledge in the Tools and techniques in nanoscience, Applications of Nanostructures in Drug and Food.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- discuss the applications of nanobiology in terms of emerging areas such as Nano-medicine, Bio-mimicry to create Nano-materials, and Nano-biotechnology.
- explain the production and applications of various types of nanostructured materials.
- gain an understanding of some of the ethical issues that are associated with the study of nanoscience,its place in law and policy making.
- analyze a risk assessment of a nanobiotechnological project.

Course Content:

Tools and techniques in Nanoscience, Development of nanobiotechnology, Biological nanoparticles production, Biosensors, Cellulose nanofibers, Nanotoxicology, Application of Nanotechnology in Food Science, Nano-Biomimicry, Nanocarriers, Nano thin films, Nanoclays and nanocomposites, The blood–brain barrier, Nanomedicine, Protein-based Nanostructures, Nano Printing of DNA, RNA, and Proteins, Applications of Nanostructures in Drug: Discovery, Delivery, and Controlled Release, Aerogels, Nanotechnology for Tissue Engineering, Nanobiotechnological applications in Environment, Nanoethics

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences

2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	**	***	*	*	***		*	***
ILO 2	**	***	*		***			
ILO 3	**	***			***			
ILO 4	**	***	*	***	***		**	***

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% = 20% of Total Marks

Summative Assessment (SA): End Semester Examination: 1-hour paper covering 2 Essay- type question (80%) = 80% of Total Marks

References:

- Mirkin CA & Niemeyer CM. Nanobiotechnology: Concepts, Applications and Perspectives (2004), Wiley-VCH Verlag GmbH & Co.
- Mirkin CA & Niemeyer CM. Nanobiotechnology - II more concepts and applications. (2007), Wiley VCH
- Murty, B.S., Shankar, P., Raj, B., Rath, B.B., Murday, J. (2013). Textbook of Nanoscience and Nanotechnology. Springer-Verlag Berlin Heidelberg
- Husain, Mushahid, Khan, Zishan Husain (2016) Advances in Nanomaterials (Eds.). Springer India

Course Title	**Laboratory work in Nanobiology and Advanced Laboratory Techniques**
Course Code	GMB 337 1.0
Credit Value	01
Status	Compulsory
Year / Level	3rd Year / Level 6
Theory: Practical: Independent learning	00: 30:20
Other: Pre-requisite Course/s	-

Aim of the Course:

Explain and demonstrate the experimental procedures in Nanobiology. This course also imparts skills to plan, conduct and report the experiments.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- acquire an understanding of biological systems on the nanoscale by investigating the structures and functions of its components.
- describe the most common bottom-up and top-down processes for the synthesis of nanomaterials.
- describe the main tools for practical processing, characterization, and application of nanobiotechnology.
- impart skills to write comprehensive scientific reports and understand the applications and work environment of nanobiology in the laboratories.

Course Content:

Characterisation of interaction of nanomaterials/nanomedicines with biological systems (proteins, enzymes, cell membranes), Synthesis of nanomaterials, analysis of nanoporous materials, electron microscopy and atomic force microscope (AFM), analysis of nanoporous materials, Characterization of cell and blood toxicity of nanomaterials. In vitro assays for genotoxicity, immunotoxicity and cytotoxicity, polymer chemistry and materials science in the development of biocompatible materials, Case studies of industrial nanoprojects

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences

2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	**	***			**			
ILO 2	**	***			**			
ILO 3	**	***			**			
ILO 4	**	***		**	**		**	**
ILO 5								

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Lab reports) 20% + FA2 (Presentation) 10% = 30% of Total Marks

Summative Assessment (SA): End Semester Examination: Practical exam (70%) = 70% of Total Marks

References:

- Winkelmann, K. (2009). Practical aspects of creating an interdisciplinary nanotechnology laboratory course for freshmen. Journal of Nano Education, 1(1), pp.34-41.
- Jai Poinern GE,(2014) A Laboratory Course in Nanoscience and Nanotechnology (1st Edition).CRC Press

ourse Title	**Special Topics in Genetics and Molecular Biology**
Course Code	GMB 340 2.0
Credit Value	03
Status	Core
Year / Level	3rd Year / Level 6
Theory: Practical: Independent learning	00: 100:50
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge about relevant literature for a particular field and how to search for the current knowledge for a selected topic/field. This curse also provides soft skills of presenting scientific reports, briefing, public speaking and responding to the audience.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- compile relevant literature and current knowledge for a given topic
- present comprehensive scientific reports
- make a speech (or simply speak) to the public on a current issue in Genetics and Molecular Biology
- discuss current topics in genetic and molecular biology field

Course Content:

Topics will be given to students.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement

8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***			**	***		***	
ILO 2	**	***			***		***	*
ILO 3	***	***		*	***	**	***	***
ILO 4	***	*			***	***	***	***

*** - Strongly Linked;

Mode of Assessment:

** - Medium linked; * Weakly linked

Formative Assessment (FA): FA1 (Mid-term) 20% + FA2 (oral examination) 20% = 40% of Total Marks

Summative Assessment (SA): End Semester Examination: Final Report and presentation (60%) = 60% of Total Marks

References:

- Key and current literature

Course Title	**Current topics in genetics and molecular biology**
Course Code	GMB 341 3.0
Credit Value	02
Status	Core
Year / Level	3rd Year / Level 6
Theory: Practical: Independent learning	00: 60:40
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge about the advanced concepts and details of the genetics and molecular biology. This course also provides an opportunity to conduct an independent study on a novel topic and develops the soft skills of students via journal article discussion, individual and group presentations.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- discuss and compile relevant literature and current knowledge for a given topic
- present comprehensive scientific reports
- develop presentation and public speaking skills
- discuss current topics in genetic and molecular biology field

Course Content:

Topics will be given to students.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	**		**	***			
ILO 2					**	**	***	**
ILO 3					**	**	***	**
ILO 4	***	***		***	**		***	**
ILO 5								

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Written reports) 50% + FA2 (Presentation) 50% = 50% of TotalMarks

Summative Assessment (SA): End Semester Examination: Final Project (50%) = 50% of Total Marks

References:

- Key and current literature

Fourth year

Course Units for the students following the:

BSc Honours in Genetics and Molecular Biology Degree Programme

and

BSc Honours in Applied Sciences (Genetics and Molecular Biology) Degree Programme under ASB Course Codes

Course Title	**Stem Cells and Regenerative Biology**
Course Code	GMB 403 1.0/ ASB 464 1.0
Credit Value	01
Status	Optional**
Year / Level	4th Year/ Level 6
Theory: Practical: Independent learning	15: 00:35
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge on stem cells with an emphasis on their properties and regulatory mechanisms. Thiscourse also imparts the applicability of stem cells in scientific, especially in regenerative research withthe consideration of their related ethical and political issues.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- describe the properties that defines stem cells
- explain how stem cells are derived for scientific research
- compare and contrast tissue specific stem cell types such as blood, skin and the basicmechanism that regulate them.
- describe common and extrapolate potential clinical use(s) of stem cells
- compare and contrast invertebrate and vertebrate animal models of regeneration research
- discuss the ethical and political issues related to stem cell research

Course Content:

Basic mechanisms of how cells differentiate into specific tissues in response to a variety of biologic signaling molecules, Use of such factors for *in vitro* tissue production; bone morphogenetic proteins can be used *in vitro* to drive the differentiation of adult stem cells towards bone and heart, Cellular mechanisms involved in the cloning of animals and how Scottish researchers produced the sheep Dolly using the nucleus of a mammary gland cell from an adult sheep, Organ production, such as the *in vitro* formation of beating heart cells, Molecular bases of cellular and functional changes of different organs that occur in disease and treatments that cause tissue remodeling to correct these changes, How studies of the developmental, cellular and molecular biology of regeneration have led to the discovery of new drugs.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1		***			***			
ILO 2	***	***			***			
ILO 3		***			***			
ILO 4		***		**	***			
ILO 5		***			***			
ILO 6		***			***			

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (News and views) 20% + FA2 (Presentations) 10% + Journal club 10% + FA3 (Quizzes) 10% = 50% of Total Marks

Summative Assessment (SA): End Semester Examination: 1-hour paper covering 2 Essay-type question (50%) = 50% of Total Marks

References:

- Burce M. Carlson (2007). Principle of regenerative biology. Elsevier publisher
- David L. Stocum (2006). Regenerative Biology and Medicine. (1st edition) Academic publication, UK
- Christine Mummery, Ian Sir Wilmut, Anja Van De Stolpe, and Bernard Roelen. **Stem Cells: Scientific**
- **Facts and Fiction.** Academic Press, 2011. Available at the SDSU Bookstore.
- **Web resources:** Selected research articles https://www.sciencedirect.com/science/article/pii/S1672022915000029

Course Title	**Molecular Microbial Ecology**
Course Code	GMB 406 2.0/ ASB 467 2.0
Credit Value	02
Status	Optional**
Year / Level	4th Year/ Level 6
Theory: Practical: IndependentLearning	25: 15: 60
Other: Pre-requisite Course/s	-

Acquire knowledge on basic concepts within the field of microbial ecology which would help to interpret various ecological principles that impact microbes. This course also develops the skill to analyze and design

Aim of the Course:

Acquire knowledge on the molecular aspects of microbial ecology including interactions, molecular applications and experimental approaches used in the field of microbial ecology.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- describe the relation between microbial diversity and function in simple and complex natural ecosystems
- describe different types of interactions between microorganisms and their biological and physicochemical environment
- discuss the role of microorganisms in the cycling of elements
- explain how microorganisms can transform environmental pollutants
- explain experimental observations as indicators of specific microbial processes;
- discuss modern molecular techniques for the analysis of complex microbial ecosystems
- describe ecological functions of genomic and metagenomic data
- design experimental strategies for the detection of microbes and their activities in the environment

Course Content:

Introduction to molecular microbial ecology, Concepts of microbial ecology, Ecology of macro- and microorganisms: definitions, terminology, concepts, Individuals and populations: productivity,growth, distribution, Communities: colonization, succession, diversity, structure, Microbial functions in ecosystems and global cycles, Methods in microbial ecology, Habitat characterization, Characterization of microbial communities in molecular level, cell stains, Characterization of microbial communities: PCR, real-time PCR, molecular fingerprints, Characterization of microbial communities: FISH, sequencing, pyrosequencing, Microbial interactions, Microbial guilds and biogeochemical cycles, Antibiotics, Interactions of microorganisms with animals and humans, Ecology of natural and engineered microbial habitats, Marine ecosystems, Wastewater treatment reactors, bioremediation, Culture collections, food ecosystems, agricultural systems, aquaculture,

Synthetic communities and applied microbial ecology.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:

Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	**	***			***			
ILO 2	**	***			***			
ILO 3	**	***			***			
ILO 4	**	***		***	***			
ILO 5	**	***		***	***			***
ILO 6	**	***		***	***			***
ILO 7	**	***			***			
ILO 8	**	***	**	***	***		***	***

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% + FA2 (Oral presentations) 5% = 25% of TotalMarks

Summative Assessment (SA): End Semester Examination: 2-hour paper covering 4 Essay-type question (65%) + Practical 10% = 75% of Total Marks

References:

- Michael T. Madigan; Kelly S. Bender; [et.al]. (2018). Brock Biology of Microorganisms. 15 ed.

Course Title	**Molecular and cellular toxicology**
Course Code	GMB 411 2.0/ ASB 462 2.0
Credit Value	2
Status	Core**
Year / Level	4th Year/ Level 6
Theory: Practical: IndependentLearning	30:00:70
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge on various molecular mechanisms involved in molecular and cellular toxicology and various methods of predicting and measuring toxicity.

Intended Learning Outcomes (ILOs):

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

- discuss mechanistic concepts and techniques of toxicology at the cellular and molecular levels
- describe the molecular mechanisms behind the deleterious effects of selected chemicals on membranes, proteins and DNA
- discuss impact and timing of toxic manifestations in a cell
- describe the molecular mechanisms behind the deleterious effects of selected chemicals on energy production and metabolism
- discuss toxic effects on the organ level as a consequence of molecular events
- describe the cellular defence systems against oxidative stress, metals and lipophilic compounds
- identify various molecular events and cellular modifications that result from and/or areassociated with chemically/environmentally induced toxicity and disease

Course Content:

Background to molecular and cellular toxicology, individual susceptibility to toxic chemicals, '-omics profile as biomarkers for toxicity, *in vitro* systems for predicting *in vivo* toxicity, genotoxicity and its measurements, emerging techniques and current literature.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research,

societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
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7. employ soft skills such as team working skills, time management, leadership, conflict resolutionand work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***			***			
ILO 2	***	***			***			
ILO 3	***	***			***			
ILO 4	***	***			***			
ILO 5	***	***			***			
ILO 6	***	***			***			
ILO 7	***	***			***			

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (news and views) 20% + FA2 (Presentations) 10% + FA3 (Discussion of a research article) 10% + FA4 (Quizzes) 10%
= 50% of Total Marks

Summative Assessment (SA): End Semester Examination: 2-hour paper covering 4 Essay- type question (50%) = 50% of Total Marks

References:

- Molecular and Biochemical Toxicology 4th edition.Smart, Hodgson.Wiley

Course Title	**Molecular diagnostics and therapeutics**
Course Code	GMB 412 2.0/ ASB 469 2.0
Credit Value	2
Status	Optional**
Year / Level	4th Year/ Level 6
Theory: Practical: Independent learning	30:00:70
Other: Pre-requisite Course/s	-

Aim of the Course:

To introduce common diseases with significant molecular basis, various molecular mechanisms responsible for common diseases, the idea of developing personalized medicine

Intended Learning Outcomes (ILOs):

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

- identify common diseases with a significant molecular basis
- describe molecular mechanisms responsible for common diseases
- discuss how predisposition for diseases can be detected in an early stage
- discuss how rational design of novel therapies can arise from knowledge of the molecular basisof a disease
- discuss on development of effective and less toxic integrated personalized medicine drug and test products
- discuss and orally present scientific papers within the field of molecular diseases

Course Content:

Various types of molecular diagnostic methods at the nucleic acid level and protein level will be discussed, typesof therapeutics (gene therapy, cellular therapy, recombinant therapy, immunotherapy and gene silencingtechnology), the concept of personalized medicine and pharmacogenomics, ethical issues.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
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	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***			**			
ILO 2	**	***			***			
ILO 3		***		**	***			**
ILO 4		***		***	***		**	**
ILO 5	***	***		***	***		*	***
ILO 6	*	**			***		**	*

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (news and views) 20% + FA2 (Presentations) 10% + FA3 (Discussion of a research article) 10% + FA4 (Quizzes) 10%
= 50% of Total Marks

Summative Assessment (SA): End Semester Examination: 2-hour paper covering 4 Essay- type question (50%) = 50% of Total Marks

References:

- John Macloed (1988). Davidson's principles and Practice of Medicine., 24th Ed. Churchill Livingstone, Snustad, D.P. & Femmans,
- Gillham, B., Despo, K.P., Thomas, J.H. (1997). Will's Biochemical Basis of Medicine., Reed Educational and Profesional Publishing Ltd.
- **Web resources:** Different research articles

Course Title	**Tissue and Cell Culture**
Course Code	GMB 413 2.0/ASB 463 2.0
Credit Value	2
Status	Core**
Year / Level	4th Year/ Level 6
Theory: Practical: Independent learning	15:30:55
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge on basic techniques of tissue and cell culture, the importance of these techniques and their applications.

Intended Learning Outcomes (ILOs):

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

- discuss the physiological responses of animal cells to environmental conditions in culture vessels
- carry out primary literature searches
- critically analyze scientific articles relating to tissue culturing
- explain applications of tissue culture techniques in different fields of biology
- describe the methods and technologies for the large-scale production of cell culture products
- perform basic techniques pertinent to the growth and maintenance of cell culturesuse sterile techniques in tissue culturing

Course Content:

The history of tissue culture, General techniques, animal cell culture; tissue culture media and preparation, Plantcell culture, Biology of cultured cells; culture environmental, cell adhesion, cell proliferation, Zygotic embryo culture; callus and free cell culture, Evidence for totipotency, Somatic embryogenesis, Organogenesis, Anther and pollen culture, Isolation culture and fusion of protoplasts, Genetic stability and soma clonal variation, Quantification and determination of cell viability, Kinesis and cell growth, Microbial contamination and prevention, Establishment and characterization of cell lines, Cloning selection and molecular techniques, Cryopreservation of cells, Chromosome Spreading and Karyotype Analysis, Mycoplasma: Detection and Control, Monoclonal Antibody Production, Insect Cell Culture**.** Practical experience in aseptic techniques in celland tissue culture, culturing different cell lines, gene expression in cell cultures, tissue culture

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
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	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***			**			
ILO 2	**	***			***			
ILO 3	**	**			***			
ILO 4	***	***			**			
ILO 5	***	***	**	***	**		*	***
ILO 6		***						

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 10% + FA2 (Reports) 10% = 20% of TotalMarks

Summative Assessment (SA): End Semester Examination: 2-hour paper covering 4 Essay- type question = 80% of Total Marks

References:

- Culture of animal Cells: A Manual of Basic Techniques, 5th Edition, Wiley-Liss (R. Ian Freshley,2005).
- Dodds, J.H. and Roberts, L.W. (1995). Experiment in Plant Tissue Culture, 3rd Ed, CambridgeUniversity Press.

Course Title	**Journal Club**
Course Code	GMB 415 1.0 /ASB 468 1.0
Credit Value	1
Status	Core**
Year / Level	4th Year/ Level 6
Theory: Practical: Independent learning	00:30:20
Other: Pre-requisite Course/s	-

Aim of the Course:

Explore, analyze and critique various scientific literature and identify how to improve the study or analysis of the data presented in the journal article.

Intended Learning Outcomes (ILOs):

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

- List different sources of scientific data bases and archives
- Describe publication requirements and indexing criteria of publications
- Explain and interpret a scientific publication in critical manner

Course Content:

Students will be assigned to search online scholarly web sites including Science direct, Web of Science, Google Scholar and Pubmed for selected topics / subject areas. Individuals will be presenting critical analysis of selected research papers in open discussion forums.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
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	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1		***						
ILO 2		***			**			
ILO 3		***			***	**	**	
ILO 4								
ILO 5								

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% + FA2 (written-reports)
20% = 40% ofTotal Marks

Summative Assessment (SA): End Semester Examination: Mini-project and presentation
(60%) = 60% of Total Marks

References:

Online scholarly web sites and Journal sites

Course Title	**Marine Biotechnology for sustainable development**
Course Code	GMB 418 2.0/ ASB 466 2.0
Credit Value	02
Status	Optional**
Year / Level	4th Year/ Level 6
Theory: Practical: Independent learning	30: 00:70
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge on the application of molecular and cellular biology to marine and fresh water organisms for identifying, developing, and enhancing products derived from these organisms. This course also explains new developments in the field of marine biotechnology covering a variety of aspects such as marine biology, cell biology and genetics, genetic engineering and applications of immunology.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- explain the theory behind cloning
- describe the theory behind the production of marine pharmaceuticals
- discuss the rationale behind the production of genetically modified fish, including issues and environmental impacts
- discuss the importance of disease diagnosis in aquaculture
- systematically work on a process design for microalgae-based bioprocesses
- discuss ethical responsibility for sustainable resource utilization, industrial practice and innovation
- evaluate new developments in the field of marine biotechnology

Course Content:

Different types of marine products for healthcare including fatty acids, marine derived proteins, marine enzymes, chitin and chitosan, carotenoids, seaweeds and seaweed derived hydrocolloids, genetically modified fish; Growth regulation by overexpression of growth hormone, improved cold/freeze tolerance, Antifreeze genes, Improved disease resistance. Marine genomics and proteomics, marine microbiology diversity, biotechnological interventions in aquatic animal health. Marine algal biotechnology, applications of biotechnology in fish, aquaculture and seaweed industry. Genetically modified aquatic organisms. Special emphasis will be given to drugs and pharmaceuticals from marine sources, use of marine micro and macro algae as biomass from which to derive energy.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:

Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
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	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***			***			
ILO 2	***	***			***			
ILO 3	***	***			***			
ILO 4	***	***			***			
ILO 5	***	***	**	**	***		***	***
ILO 6	**	*			*	*		*
ILO 7	**	*			**	***	*	**

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Presentations) 20% + FA2 (Journal club) 20% = 40% of TotalMarks

Summative Assessment (SA): End Semester Examination: 2-hour paper covering 4 Essay-type question (60%) = 60% of Total Marks

References:

- Venugopal, V. (2009). Marine products for health care: Functional and bioactive nutraceuticalcompounds from the ocean. CRC Press/Taylor & Francis.
- Purohit, S.S. (2010). Biotechnology Fundamental and Applications, 4th Edition, Agrobios, India.
- Web resources: Selected research articles

Fourth Year

Course Units for the students following the

BSc Honours in Genetics and Molecular Biology Degree Programme

Course Title	**Case studies in Genetics and Molecular Biology**
Course Code	GMB 401 2.0
Credit Value	02
Status	Core
Year / Level	4th Year/ Level 6
Theory: Practical: Independent learning	00: 66:34
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge on relevant case studies in different areas of genetics and molecular biology and understand the ethical, social or legal issues associated with those cases. This course also develops presentation and public speaking skills on comprehensive scientific reports.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- discuss and compile relevant cases, literature and current knowledge in different areas of geneticsand molecular biology
- present a comprehensive scientific report
- develop presentation and public speaking skills
- discuss merit and ethical, social or legal issues pertinent to the cases

Course Content:

Topics will be given to students.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
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	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***		***	***		***	**
ILO 2	***	***			***	**	***	***
ILO 3	***	***			***	**	***	***
ILO 4	***	***			***	**	***	***

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Presentations) 25% + FA2 (Written reports) 25% = 50%of Total Marks

Summative Assessment (SA): End Semester Examination: Final project (25%) and 1-hour paper covering 1 Essay-type question (25%) = 50% of TotalMarks

References:

- Relevant and current literature assigned by the lecturer

Course Title	**Molecular Ecology**
Course Code	GMB 402 1.0
Credit Value	01
Status	Optional
Year / Level	4th Year/ Level 6
Theory: Practical: Independent learning	12: 09:29
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge on the molecular basis of ecological principals and molecular genetic techniques used in molecular ecology. This course also develops the data interpretation ability employed in literature on molecular ecological studies.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- describe the molecular basis of ecological principals
- describe common molecular markers and molecular genetic techniques used in molecular ecology
- interpret data from common analyses employed in molecular ecological studies
- Interpret and synthesize the primary literature to develop a written proposal for addressing an original ecological or evolutionary research question using molecular tools

Course Content:

Introduction to molecular ecology, History of molecular ecology, DNA Structure and Inheritance, Molecular Markers, Genomics and Next-Generation Sequencing, Simulating evolutionary processes, effective population size, Expansions and bottlenecks, inbreeding, population subdivision, gene flow, factors affecting genetic structure, Parentage, Molecular fingerprints, relatedness and reproductive strategies - mating systems, dispersal, predator-prey interactions, Adaptive genetic variations, Phylogeography: generating genealogical data, Conservation genetics: conservation strategies, Speciesconcepts, Cluster Analysis, Mutation Models, Molecular Clocks & Divergence Time Estimation, Landscape genetics, Ancient DNA and Genetic Epidemiology, Environmental Genomics, Recombination and Linkage Disequilibrium, Future of Molecular Evolution and Molecular Ecology.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas

3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
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ILO 1	***	***			***			
ILO 2	***	***			***			
ILO 3	***	***			***			
ILO 4	***	***		***	***	*	***	**

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% + FA2 (Presentations) 5% + Researchproposal 5% = 30% of Total Marks

Summative Assessment (SA): End Semester Examination: 1-hour paper covering 1 Essay-type question (60%) and Practical (10%) = 70% of TotalMarks

References:

- Freeland, J.R., Kirk, H., Petersen, S.D. (2011) Molecular Ecology (2nd ed), John Willy and Son
- Hartl, D. L. A Primer of Population Genetics, 3rd Ed'n. Sinauer & Associates.
- Frankham, R., J. D. Ballou, & D. A. Briscoe. Introduction to Conservation Genetics. CambridgeUniversity Press.

Course Title	**Advanced Immunology**
Course Code	GMB 404 2.0
Credit Value	02
Status	Core
Year / Level	4th Year/ Level 6
Theory: Practical: Independent learning	27: 09:64
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge on immunity with the emphasis on the structure of immune system molecules and their related functions. This course also enlightens potential immunotherapies and techniques associated with organ transplantation immunology.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- describe innate and acquired immunity
- describe how the structures of immune system molecules facilitate their functions
- explain at a molecular level how pathogens evade immune responses and cause infections
- describe how the immune system will respond to disease, cancer or pathogens
- discuss what vaccines are and how they work at a molecular level
- discuss developmental aspects of immunity and potential immunotherapies
- describe the HLA system and techniques of organ transplantation immunology

Course Content:

Structure and binding of peptides to MHC molecules, Genomic organization of the MHC, Activationof T lymphocytes - Signal transduction by the T lymphocyte receptor complex , Activation of transcription factors in T cells, Activation of B cells, Signal transduction by the B cell antigen receptor complex, CD40 and its role in T-B cooperation, Bidirectional molecular interactions between T-B cells, Immunologic tolerance, T Lymphocyte tolerance and B Lymphocyte tolerance,Homeostasis in the immune system, Effector mechanisms of immune responses, Cytokines – regulating innate and adaptive immunity and stimulate hematopoiesis, Cell mediated immunity, Humoral immunity, Immunity in defense and disease, Immunity to microbes and tumors, Disease course by immune responses – hypersensitivity and autoimmunity, Therapeutic approaches for immunologic diseases, Immunosuppression, Bone marrow transplantation immunology.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
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ILO 1		***			***			
ILO 2	***	***			***			
ILO 3	***	***			***			
ILO 4	***	***			***			
ILO 5	***	***			***			
ILO 6	***	***		*	***			
ILO 7	***	***			***			

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% + FA2 (Presentations) 10% = 30% of Total Marks

Summative Assessment (SA): End Semester Examination: 2-hour paper covering 4 Essay- type question (70%) = 70% of Total Marks

References:

- Male, D., Brostoff, J., Roth, D., Roitt, I. (2012) Immunology, 8th Edition, Saunders.
- Journals – Journal of Immunology, Immunity, TRENDS in Immunology

Course Title	**Scientific Writing**
Course Code	GMB 407 1.0
Credit Value	01
Status	Core
Year / Level	4th Year/ Level 6
Theory: Practical: Independent learning	05: 20:25
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge and practice on the conventions for writing and presenting scientific material/information for a variety of audiences, including scholarly and general, in print and online. This course expands information literacy for finding, evaluating and integrating necessary informationand visuals (i.e., charts, graphs, etc.). This course also develops presentation as well as public speakingskills on comprehensive scientific reports.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- present scientific information for scholarly audiences in print and online.
- apply critical thinking to writing and writing process, including revision.
- present complex scientific ideas clearly.
- effectively and ethically incorporate appropriate scientific exhibits (charts, graphs, visuals illustrations etc.) for designing presentations and posters, and for supplementing text.
- prepare scientific and technical papers and presentations.
- accept constructive criticism and use reviewers' comments to improve quality and clarity of written reports and presentations.

Course Content:

Concepts in scientific writing, Organizing your writing, Preparing outlines, Investigation of scholarly and popular science writing genres, Effective drafting techniques, scholarly and popular media, Articleanalysis (structure, style, voice, narrative), Press releases, Planning and running a workshop, Rip resources, Creating a literature review, Including and summarizing research data, Lists of references, Plagiarism, Writing Research proposals, Organization and formats for posters, Creating tables, charts, graphs, Writing Reports and Reviews.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:

Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolutionand work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1					**	***	***	**
ILO 2					**	***	***	**
ILO 3					***	***	***	**
ILO 4					***	***	***	**
ILO 5					**	***	***	**
ILO 6					***	***	***	**

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% + FA2 (Oral presentations) 20% = 40%of Total Marks

Summative Assessment (SA): End Semester Examination: 1-hour paper covering 4 Essay-type question (60%) = 60% of Total Marks

References:

Gastel B and Day RA, (2017) How to Write and Publish a Scientific Paper (8th Edition). Greenwood.

- Schimel J (2012) Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded.Oxford University Press Inc.
- Heard, SB (2016) The Scientist's Guide to Writing: How to Write More Easily and Effectivelythroughout your Scientific Career. Princeton University Press.
- Alley M (2013). The Craft of Scientific Presentations: Critical Steps to Succeed and Critical Errors toAvoid (2nd Edition). Springer.

Course Title	**Neurobiology**
Course Code	GMB 408 2.0
Credit Value	02
Status	Optional
Year / Level	4th Year/ Level 6
Theory: Practical: Independent learning	30: 00:70
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge on molecular and cellular neurobiology with the emphasis on mammalian neurobiology. This course focuses on neuroanatomy and basic neurocellular mechanisms, including chemical and electrical signaling, neurotransmission and more advanced functions of the nervous system from the molecular to the integrated level, such as the different senses (sight, smell, etc.), motor and movement control, reward system, emotions and pain. The course also describes current methods in neuroscience research.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- explain the components and functions of the nervous system
- explain the process of signal propagation in the nervous system
- explain the mechanisms in neurotransmission between synapses
- discuss on major concepts and recent advances in experimental neuroscience
- discuss the neurodevelopmental diseases with respect to cognitive function

Course Content:

Introduction to the Nervous system, Membrane channels, Receptors and signaling, Basis of the resting potential and action potential, Propagation of the action potential, Synaptic transmission, Mechanisms of neurotransmitter release at synapses, Axon guidance, Synapse formation/elimination and Neural plasticity, Biochemistry of neurotransmitters, Receptors, and second-messenger systems, Trophic factors, Neurotrophin signaling and cell survival, Cognitive functions and Neurodevelopmental diseases, Recent advances in experimental Neuroscience.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:

Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory

safety.

4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1		***			**			
ILO 2	***	***			**			
ILO 3	***	***			**			
ILO 4	***	***			**		***	
ILO 5	***	***			**			

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% = 20% of Total Marks

Summative Assessment (SA): End Semester Examination: 2-hour paper covering 4 Essay-type question (80%) = 80% of Total Marks

References:

- Levitan, Irwin B., and Leonard K. Kaczmarek. *The Neuron: Cell & Molecular Biology*. 3rd ed. New York, NY: Oxford University Press, 2001
- Hammond, C. Cellular and Molecular Neurobiology 2nd edition. San Diego, CA: Academic Press, 2001
- Byrne, JH, Roberts, JL (eds). From Molecules to Networks An Introduction to Cellular and Molecular Neuroscience. Amsterdam, the Netherlands: Elsevier Academic Press, 2001
- Squire, L. R., D. Berg, et al. *Fundamental Neuroscience*. 3rd ed. Academic Press, 2008

Course Title	**Pharmaceutical Biotechnology**
Course Code	GMB 409 2.0
Credit Value	02
Status	Optional
Year / Level	4th Year/ Level 6
Theory: Practical: Independent learning	30: 00:70
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge on biotechnological aspects of the field of Pharmacy and Pharmaceutical industry, including methods for industrial production of molecular pharmaceutical substances by means of biotechnology, such as antibiotics, vaccines and proteins. This course also deliberates the various techniques in biotechnology and their applications in the manufacturing of biopharmaceuticals and biomedical research.

Intended Learning Outcomes (ILOs):

On the successful completion of this course, the student should be able to:

- compare and contrast different gene therapy strategies and recognize the limitations of gene therapy.
- define regenerative medicine and provide examples of how cell and tissue transplantation and tissue engineering can be used.
- compare and contrast therapeutic cloning and reproductive cloning.
- discuss what stem cells are, describe how they can be isolated.
- provide examples of possible therapies that may be developed from stem cells.
- list the applications of nanotechnology and nanomedicine.
- outline the contribution of biotechnology to modern medicine, including safety and ethical challenges.

Course Content:

Historical Perspectives of Medical Biotechnology, Chromosomal Disorders and Gene Mapping, Production of Therapeutic Agents, Diagnosing and Treating Human Disease, Identifying sets of disease genes by microarray analysis, Protein Therapeutics, Nucleic Acid Therapeutic Agents and Human Gene Therapy, Medical Products and Applications of Biotechnology, Pharmacogenomics for personalized medicine, Vaccines and Therapeutic Antibodies, Nanotechnology and nanomedicine, Cell and Tissue Transplantation, The Potential of Regenerative Medicine , Stem Cells, Career Options in Medical Biotechnology, Safety and Ethical Issues.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolution and work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***			***			
ILO 2	***	***		**	***			**
ILO 3	***	***			**			
ILO 4	***	***			**			
ILO 5	***	***			**			
ILO 6		***			***			
ILO 7	***	***		*	***		***	**

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% = 20% of Total Marks

Summative Assessment (SA): End Semester Examination: 2-hour paper covering 4 Essay- type question (60%) + Presentation 20%= 80% of Total Marks

References:

- Khan, F.A. (2014) Biotechnology in Medical Sciences (1st Edition), CRC Press
- Glick, B.R., Delovitch T.L., Patten C.L. (2014) Medical biotechnology (1st Edition) ASM Press,Washington, DC.
- Thieman, W.J., and Palladino, M.A. (2012) Introduction to Biotechnology, (Third Edition). BenjaminCummings.
- Sasson A. (2005) Medical Biotechnology: Achievements, Prospects and Perceptions. United NationsUniversity Press

Corse Title	**Research Project**
Course Code	GMB 410 8.0
Credit Value	8
Status	Compulsory
Year / Level	4th Year/ Level 6
Theory: Practical: Independent learning	00:00:800
Other: Pre-requisite Course/s	Special topics genetics and molecular biology, scientific writing, research methodology

Aim of the Course:

The aim of this course is to guide the students through the research-conducting process from proposal writing to defending the thesis. The students will apply the knowledge gained from related courses such as special topics genetics and molecular biology, scientific writing, research methodology and statistics to identify a hypothesis, formulate a proposal, identify the necessary methodologies to be followed to achieve the objectives outlined, trouble-shoot and solve issues faced during the research project, analyze the data and derive conclusions from them and communicate their findings to the scientific community. The students will provide future directions from their research findings for the advancement of the science and society.

Intended Learning Outcomes (ILOs):

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

1. identify and apply the scientific method accurately
2. clearly identify research questions and formulate hypotheses
3. identify accurate and appropriate research methodologies
4. use library and other tools to search for existing research references relevant to their topic
5. carry out a substantial research-based project
6. demonstrate capacity to lead and manage change through collaboration with others
7. discuss the ethical issues associated with practitioner research
8. communicate confidently and constructively with graduate students and mentors
9. analyze data and describe research findings
10. report research findings in written and verbal forms
11. present the methodologies, results and findings to broader audiences
12. use research findings to advance education theory and practice
13. write research papers and to address reviewers' comments

Course Content:

Selected topics will be provided to students

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:

Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratorysafety.
4. propose experiments and suitable solutions in different contexts, while being aware of research,societal and environmental ethics.
5. research scientific literature and disseminate knowledge to others.
6. function effectively within the scientific community
7. employ soft skills such as team working skills, time management, leadership, conflict resolutionand work ethics for personal and professional advancement
8. modulate as innovative thinkers who can take initiative in academia and industry.

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***			***	*	*	*
ILO 2	***	***			***	*	*	*
ILO 3	***	***			***	*	*	*
ILO 4	***	***			***			
ILO 5	***	***	***	***	***	**	***	*
ILO 6						**	***	*
ILO 7		***			***	*	*	
ILO 8						***	***	
ILO 9	**	**			***	***	***	*
ILO 10	***	***			***	***	***	**
ILO 11	***	***			***	***	***	**
ILO 12					***		***	***
ILO 13					***	***	***	**

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Oral examination) 20% + FA2 (Written report) 20% =40% of Total Marks

Summative Assessment (SA): End Semester Examination: Final Project and presentation (60%) = 60% of Total Marks

References:

- Key and current literature
- Articles on relevant experimental procedures

Course Title	**Molecular Evolution**
Course Code	GMB 416 2.0
Credit Value	2
Status	Optional
Year / Level	4th Year/ Level 6
Theory: Practical: Independent learning	18:30:52
Other: Pre-requisite Course/s	-

Aim of the Course:

Acquire knowledge on evolutionary processes, the contribution of genetics to the study of evolution and to

Intended Learning Outcomes (ILOs):

gain practical experience in data analysis using various softwares.

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

- describe the molecular processes that contribute to evolutionary change
- describe techniques used to study molecular evolution
- discuss, present and critique primary research in the field of molecular evolution
- propose an original research project in the area of molecular evolution

Course Content:

Evolution in molecular scale – evolution of DNA and gene products, Theories of evolution, Forces and mechanisms by which genes, proteins and genomes change over time, Evolutionary processes in the eukaryoticgenome and genome compounds, Use of genetic data in evolutionary studies in organisms, Speciation processes,Mutational processes, evolution of mutation rates, evolution of DNA sequences, the molecular clock, selectionand genetic drift on the molecular level, nucleotide composition, polymorphism and SNPs, Natural selection, Recent research using modern genetic, computational and molecular approaches to explain molecular evolution.**Practical experience in** software packages as Paup, RaXML and MrBayes to analyze datasets to describe evolution in natural populations.

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.

4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.
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	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***			**		**	
ILO 2	***	***		**				
ILO 3					***	**	**	*
ILO 4	**	***		***	***	**	**	***

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (Mid-term) 20% + FA2 (Oral presentations) 10% + FA3 (Research proposal) 10% = 40% of Total Marks

Summative Assessment (SA): End Semester Examination: 2-hour paper covering 4 Essay-type question (60%) theory and practical = 60% of TotalMarks

References:

- Nei, M. and S. Kumar. 2000. Molecular evolution and phylogenetics. Oxford University Press.
- Gillespie, J. H. 2004 Population Genetics, a concise guide. 2nd Edition. The John Hopkins University Press.
- Maynard Smith, J. 1989. Evolutionary genetics. Oxford University Press.
- Hedrick, P. W. 2000. Genetics of populations. 2nd Ed. Jones and Bartlett.

Course Title	**Systems Biology**
Course Code	GMB 419 1.0
Credit Value	2
Status	Core
Year / Level	4th Year/ Level 6
Theory: Practical: Independent learning	30:00:70
Other: Pre-requisite Course/s	-

To combine various aspects of biology and genetics learnt thus far to see how they come together in an organism.

Aim of the Course:

Intended Learning Outcomes (ILOs):

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

- explain the regulation of gene transcription and the network motifs associated with it.
- explain the principles of cell signaling
- explain network motifs in signaling networks
- explain the biological function of genetic and biochemical networks
- discuss the strategies of drug development in relation to biological networks

Course Content:

Molecules of life: Genes and proteins, Overview of gene control/regulation, Transcription networks, Regulationof gene transcription, Network motifs in transcription regulation, Principles of cell signaling, Network motifs insignaling networks, Genetic switches, Genetic oscillators, Autoregulation, feedback control, feedforward control, Genomics and Epigenomics, Metagenomics, Proteomics and protein-protein Interactions, Metabolomics, Biological networks and drug development

Linking Program Learning Outcomes with ILOs:

Program Learning Outcomes:
Graduates of the program should be able to;

1. express the role of Genetics and Molecular Biology in biological sciences
2. communicate the core concepts of relevant subject areas
3. design laboratory experiments, choosing suitable techniques while adhering to laboratory safety.
4. propose experiments and suitable solutions in different contexts, while being aware of research, societal and environmental ethics.

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	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
ILO 1	***	***			**		**	
ILO 2	***	***			**		**	
ILO 3	***	***			**		**	
ILO 4	***	***			**		**	
ILO 5	***	***		***	**	**	**	***

*** - Strongly Linked; ** - Medium linked; * Weakly linked

Mode of Assessment:

Formative Assessment (FA): FA1 (midterm) 20% + FA2 (Presentation) 20% = 40% of Total Marks

Summative Assessment (SA): End Semester Examination: 2-hour paper covering 4 Essay-type question (60%) = 60% of Total Marks

References:

- Alberts, Bruce, et. al. *Molecular Biology of the Cell*. 4th ed. New York: Garland Science, 2002
- Lodish, Harvey, et al. *Molecular Cell Biology*. 5th ed. New York: W. H. Freeman and Company,2003
- Alon, Uri. *An Introduction to Systems Biology: Design Principles of Biological Circuits*. Chapman& Hall / CRC, 2006
- Alberts, Bruce. *Essential Cell Biology*. Garland Science, 2009

Equipment and Facilities

The Genetics and Molecular Biology (GMB) Unit at the Faculty of Applied Sciences offers its students a spacious lecture hall, adequate space to conduct practical sessions and a well-equipped research laboratory to conduct research, especially for fourth-year students. Students are always guided by the lecturer-in-charge, or they are under the guidance of laboratory demonstrators. We encourage our students to conduct research in the high-quality research laboratory that is equipped with a wide range of instruments including a Stereo microscope, Microcentrifuge, Conventional PCR machine, Analytical balances, Water bath, Temperature regulated orbital shaker, Rocker, General incubator and Thermoblock.

Academic Awards

<u>BSc degree with Genetics and Molecular Biology as a Subject</u>

A Gold Medal is awarded annually to the graduand who obtains the highest-Grade Point Average (GPA) for the Genetics and Molecular Biology subject with a First or Second Class (Upper).

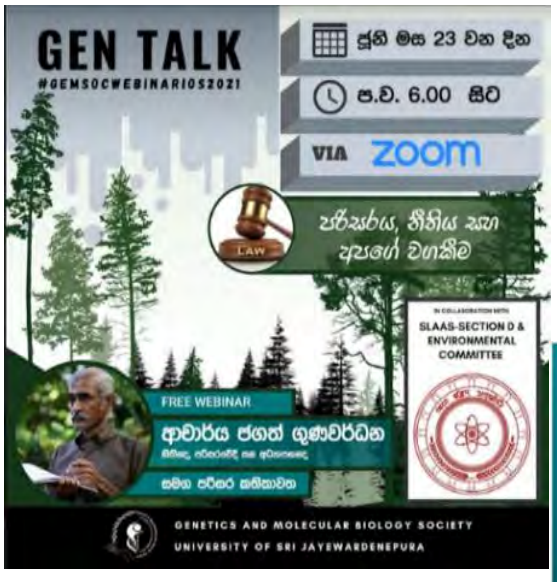
<u>BSc Honours degree in Genetics and Molecular Biology</u>

A Gold Medal is awarded annually to the graduand who obtains the highest-Grade Point Average (GPA) for the Genetics and Molecular Biology subject with a First Class.

Co and Extra-curricular Activities

Genetics and Molecular Biology Society (GEMSOC)

The Genetics and Molecular Biology Society (GeMSoc) of the Unit was formed in November 2020 with the intention of disseminating knowledge, developing soft skills, and providing entertainment for the students, especially during the hard times of COVID-19 closures. The society has conducted many activities during the two years since its inception; the students conducted an online trivia competition for interschool and interuniversity participants, webinars and discussions with experts in academia and the industry in Sri Lanka and from abroad, online workshops for O/L and A/L students and game nights to relive stress and strengthen the bonds between the students and academics of the unit to name a few.



GenePlay: a luminous interactome of the Sciences

The GeMSoc successfully organized “GenePlay”, the GMB unit’s first-of-its-kind faculty-wide event of games and music on the 06th of July 2023. Going with the theme of “FAS as One”, it was a fun-filled memorable evening for all participants as students, lecturers and non-academic staff interacted with each other.

Achievements

A group of 3rd year students submitted an entry to the InnoCentive Challenge on Problems to be Solved to Improve Global Health Wellness in October 2021 and won an award.

Three groups of students submitted entries to the ASTMH Innovation Pitch Competition organized by the American Society of Tropical Medicine and Hygiene Annual Meeting, November 2021 and two groups were selected to final round consisting of five entries.

Contribution to Science

- **Best School Innovator Competition 2022 –** this competition was organized by the academic staff of the Unit in collaboration with the Sri Lanka National Chapter of the Organization for Women in Science for the Developing World (OWSD) to promote innovations through STEM. Schoolchildren from all around the country participated in this competition. Workshops on educating the applicants on how to protect their innovations and how to further them to potentially lead to marketable products were also conducted. The final round of the competition was held on the 14th of October 2022 at the University of Sri Jayewardenepura, where an exhibition of all entries was held alongside providing everyone an opportunity to display their entries and increase visibility.

- We conduct O/L and A/L workshops for school students. We encourage our experienced students to conduct the O/L workshop by explaining the concepts of genetics covered in O/L syllabus whereas the academic staff of our unit conduct lectures at the A/L workshop on the newly introduced A/L unit on molecular biology.

- Our unit extends its service to undergraduate students from other institutes by providing the facilities and guidance to conduct their research projects under our supervision.
- Academics of the Unit engage in discussions on topics of interest to students studying science and the public.

Contribution to Society

The humanitarian project "Akura" is a commendable community service project initiated by the students where the students and staff provided all the school supplies to students entering Grade 1 at a school in Neluwa, Galle.

Academic Standards and Administrative Procedures

At the beginning of each semester, the students must:

- Enroll in appropriate subjects through LMS or Google classroom for each semester, according to the credit requirement stipulated in the curriculum. The students have to check,
  - Pre-requisites.
  - Departmental GPA credit requirement of the subject stream.
  - Non-Departmental GPA credit requirement.
  - Non-GPA credit requirement.
- Verify the accuracy of initial student registration details published on the departmental notice board.
- Add/drop subjects within 2 weeks from the commencement of each semester and finalize the subject selection for a particular semester.
- Collect previous semester result sheets from the examinations division website – pes.sci.sjp.ac.lk.

During the stay at the Unit, students are advised to contact Academic Advisers, Level Coordinators and Student Counsellors for advice regarding streams/subject selections and in any other matters that requires assistance. Students may contact Industrial Training coordinator in the Unit in connection with suitable training opportunities. Industrial Training Division will assist the students on monthly training report submission, updating training diary, regular inspections, final training report submission and oral examinations.

For further information please contact

Genetics and Molecular Biology Unit
Faculty of Applied Sciences
University of Sri Jayewardenepura
Gangodawila
Nugegoda
Sri Lanka
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