NIRMA UNIVERSITY

INSTITUTE OF SCIENCE

NAAC ACCREDITED 'A' GRADE

STUDENT INFORMATION BOOKLET 2022

Volume II (About ISNU)

Content

Preamble

This Volume II of the handbook contains information about Institute of Science (IS), Nirma University (NU).

Information in this section is to make familiar about institute, its research and academic culture.

It includes important information on registration, grading system, academic standards, attendance norms, discipline and the like.

It also contains teaching scheme and syllabus for students reference.

It is the responsibility of all students to familiarize themselves with the rules and regulations of the Institute and the University.

The students shall abide by these rules and shall, at all times, conduct in a manner so as to bring credit to the University and enhance its prestige in the society.

The University reserves the right to amend the rules and regulations mentioned in the Handbook without any prior notice.

The decision of the University shall be final on all matters.

For any clarification, the Student Section may be contacted.

The Students shall return the Declaration Forms duly signed at the end of the Orientation Programme to the Student's Section.

Students should submit their personal details in the prescribed form to the Student's Section.

Prepared by
Dr. Sweta Patel

Prof. Sarat K. Dalai
Director

Institute of Science
Nirma University
Sarkhej Gandhinagar Highway
Ahmedabad

Message From Director, Institute of Science:

Dear Students,

Welcome to Nirma University.

Today Biology has reached its height and become multidisciplinary in nature. The success of human genome sequencing with the emergence of systems biology has revolutionized the field of Biology and led to the rapid progress in understanding the biological phenomena at molecular level. Personalized medicine is fast becoming a part of our life style in managing human health. The technologies including genomics and proteomics, microscopy and imaging developed during the last two decades not only help us give new dimension to the scientific innovations, but also reduce the cost of molecular diagnosis for many diseases.

Institute of Science at Nirma University will introduce the advancements in Modern Biology to you and motivate you to take up the challenges to make significant contributions to the knowledge generation and to develop novel technologies required for addressing the impending problems of health care, food quality & demand, and clean environment. Degree programmes of Master of Science in Biochemistry, Biotechnology and Microbiology are designed to provide students with a good understanding of the concepts and to identify, analyze and address scientific problems. Our multidisciplinary approach of teaching is innovative and emphasizes hands on learning of the basic principles and techniques that are critical to understand biological phenomena. The syllabi of M. Sc. programmes have been developed to make you ready for the academic research and industry.

You will be guided by structured lectures, relevant laboratory practical training, self-directed and computer-assisted learning, review of literature, group discussions, oral presentations and expert lectures. We expect that you will work diligently and effectively towards acquiring the required standard of knowledge, comprehension and technical skills that will make you productive and help you achieve your goals. At the post graduate level, research training plays a very important role. Therefore, greater emphasis has been given to dissertation project that lasts over a period of two

semesters. Active involvement of research scholars in the dissertation projects and continuous efforts of the faculty members, in improving the quality and scope of research, provide stimulating and vibrant environment for learning. Financial assistance from the funding agencies of Govt. of India and Govt. of Gujarat in addition to the support provided by Nirma University, in form of research and infrastructure grants to address the challenging biological problems, has catapulted our efforts to impart quality training to our students. As we have succeeded in imparting quality and effective training to our graduates, we are striving hard to give you exposure and training on the state of art technologies in the area of Biological research. Besides scientific training, you will also acquire soft skills to express yourselves best and to succeed in getting placement of your choice. These are some of the salient features of our educational programmes that aim at overall development of students to be good and worthy citizens of our country.

I congratulate you for choosing our academic programs. I am sure the two years of your association with the Institute of Science at Nirma University will bring in many memorable positive changes in your lives. Wish you all the success in all your endeavors and for your future career.

Sarat K. Dalai, PhD

Professor (Biotechnology) and Director

ABOUT THE INSTITUTE

Established in 2004, Institute of Science has grown exponentially in the last 18 years. Nirma University has established the Master of Science in Biochemistry and Biotechnology, and initiated Masters Program in Microbiology from 2009-2010, not only in anticipation of this need to provide an alternative to the students who desire a post graduate degree and whose career objectives goes beyond academic research. The Institute aims to provide students with a broad training and education in Biochemistry, Biotechnology and Microbiology encompassing science, business, legal, social and ethical aspects to enable them to explore wide career opportunities. The Institute also has an Alumni Association which meets on an Annual Basis. Student Association of institute of science organizes various events round-the-year. The graduates from the institute are well placed in top pharmaceutical companies and academic institutions or actively enrolled in numerous PhD programmes at reputed research institutions in India as well as abroad.

The Institute offers PhD programme in the various areas of Biology, e.g., Immunology, Genetic Engineering, Cytogenetics, Neurobiology, Agriculture and Industrial Biotechnology, and Physiology to name a few. The Institute also offers PhD programmes in the areas of Physical Sciences through recognised research centers. The Institute gives ample opportunities to its students and strives to equip them with skills, ability, and knowledge required for life-long learning and success.

The Institute has professionally qualified and experienced permanent faculties drawn from various areas of Life Sciences. A balanced mix of academicians and professionals, with rich academic and research experience contributes to the Institute's academic excellence. The quality and progress of the Institute is coordinated and ensured by Institute of Science Advisory Committee (ISAC) and Internal Quality Assurance Cell (IQAC) of the Institute.

Institute of Science promotes equity in letter and spirit hence stakeholders are informed that discrimination verbal or behavioral, based on the caste, religion, color, nationality, sex, gender, sexual orientation, and social status is strictly prohibited.

Research activities & instrumentation

The Institute is actively involved in research projects, with each faculty supervising 8-9 M.Sc. students for their In-House Dissertation and full time Ph.D. scholars working under them. The Faculties not only work on University Aided Research Projects, but have also got extramural research funding from various government funding agencies such as Department of Biotechnology, Department of Science and Technology, Ministry of AYUSH, Government of India, Gujarat State Biotechnology Mission and Gujarat Council of Science & Technology. This has led to recognition as SIRO by the DSIR. For these research activities, the Institute boasts ofa Sophisticated Instrumentation Facility which includes instruments like thermal cycler, gradient PCR, qPCR, HPLC, spectro-fluorimeter, Denaturing gradient gel electrophoresis, BiologTM, Hybridization Oven, ELISA Reader, advance Gel Documentation system, Ultra Sonicator, bath Sonicator, -80^{o} C and -20^{o}C freezers, CO2 incubator, Biosafety cabinet, liquid nitrogen storage facility; Compound, Inverted, and Dissection microscopes, etc. to name a few. We have received FIST grant to equip our lab with Flow Cytometer, inverted Fluorescence microscope and fermentor. Apart from these University has created Central Instrumentation facility which comprise of various sophisticated instruments from Institute of Science, Pharmacy and technology to make ease excess to students. These instruments are used by the IVth semester students for their dissertation work which is conducted In-House. The Human Ethical Committee, Animal Ethical Committee, Biosafety committee, and Research Advisory committee are in place for excellent monitoring of biological research. The students have communicated their research work in journals of repute like Journal of Biotechnology, Journal of Basic Microbiology, Journal of Environmental Management, International Journal of Toxicology, Molecular Neurobiology, Scientific reports, Inflammation, American Journal of Infectious Diseases, Frontier in Immunology, Cytotechnology , Journal of Molecular Structure to name a few. Institutional research environment motivates students in research area. Many of our alumni are enrolled in National and international research institution for Ph.d programme such as BITS pillani; IIT Gandhinagar, Indor; GBRC, Gandhinagar; ICMR, Delhi; JNCASR, Bangalore; TIFR, bangalore; CCMB, Hyderabad, Texas A&M University, USA; University of Lincon, New Zealand; University of New Castle, Australia; Conestoga College, Canada; University of

Nebraska Medical center, US; Heriot watt University, UK; University of Windsor, canada; to name a few. Our Alumni Ph.D scholars are doing Post-doctoral research and Assistant professors at various College of National and International research institute at US, UK, Canada, Germany etc.

Education Programs and their Programme Educational Objectives (PEO)

M.Sc. Biochemistry

The objective of the Master's Programme in Biochemistry is to prepare students for future careers in the various fields in which a core understanding of the chemistry of biological processes is important. Scientific disciplines such as human biochemistry, medical biochemistry and biotechnology will enhance the understanding of human health. The Biochemistry Programme will benefit the society on the whole by adding to the highly skilled scientific workforce, particularly for the biomedical research sectors, in the academic, industry as well as for research laboratories across the country and the globe.

M.Sc. Biotechnology

The objective of the Master's Programme in Biotechnology is to equip the students to apply knowledge of molecular mechanisms of cellular processes in living systems including microbes, plants, and higher order organisms to applied aspects. The laboratory training in addition to theory is included to prepare them for careers in the industry, agriculture, and applied research where biological system is increasingly employed. Basics and current updates in the areas of Industrial Microbiology, Fermentation Technology, Agriculture & Environmental Microbiology are included to train the students and also sensitize them to scope for research. The Masters in Biotechnology Programme will address the increasing need for skilled scientific manpower with an understanding of research ethics involving animals and humans to contribute to application, advancement, and impartment of knowledge in the field of biotechnology globally.

M.Sc. Microbiology

The objective of the Master's Programme in Microbiology is to equip the students to apply knowledge of prokaryotic and eukaryotic cellular processes, classification, interaction of microorganisms among themselves, with physical and chemical agents and higher order organisms . The laboratory training in addition to theory is included to prepare them for careers in the industry, agriculture, and applied research where biological system is increasingly employed. Basics and and current molecular updates in the areas of Industrial Microbiology, Fermentation Technology, Agriculture & Environmental Microbiology are included to train the students and also sensitize them to scope for research. The Masters in Microbiology Programme will address the increasing need for skilled scientific manpower with an understanding of research ethics involving microorganisms to contribute to application, advancement and impartment of knowledge in the field of microbiology and molecular biology globally.

Course & Assessment

A credit-based assignment system has been made available by Nirma University. It is designed to encourage students to study consistently and methodically. The importance of the ongoing evaluation of term assignments, lab work, and project work is high. In addition to the semester-end test, a continuous evaluation method is used for theory classes.

The institute has also initiated a number of measures to bring the curriculum and assessment system of these programmes into conformity with international norms. Provision is also made for remedial teaching wherever necessary. Students are also offered bridge courses and enrichment courses. During summer, supplementary learning activities and/ or practical training are planned. A summer internship is compulsory after Semester II. Final semester involves in-house and industrial projects.

INFRASTRUCTURE

Classrooms & Laboratories

The Institute of Science has spacious classrooms which are well-equipped with ICT tools and audio-visual equipment to facilitate effective learning. The classrooms are designed to promote maximum interaction between the faculty and the students. The Institute also houses 3 M.Sc. Laboratories, 3 Research laboratories, 2 instrumentation rooms, a central advance instrumentation facility (CAI), Animal cell culture facility, Insectarium and Animal house. There is also a user friendly institutional library with computers and internet facilities including high-end bioinformatics node by Gujarat State Biotechnology Mission (GSBTM).

Computing Facility

The central computer facilities consist of 27 servers and more than 1200 systems, which are interconnected by fibre optic cables and 12 MBPS dedicated optic fibre leased line and Wi-Fi Hotspots, which enable round-the-clock internet connectivity. Student can register their laptops to get wi-fi access in the campus. The Institute has 10 systems in the library with Internet and Intranet facilities for the students leased line internet connectivity. The Internet and Intranet facilities are available on the campus. E-mail facility is provided to the faculty and staff for faster and paper-less communication.

Library Resource Center

The Institute of Science is highly focused on academic, research, and development activities. In view of the focused objectives, the library plays a vital role in collecting, developing, and disseminating scientific and technical information to meet the present and future academic and research needs of varied users. The library at the Institute of Science houses more than 2605 volumes of books meticulously chosen for read ing and reference in addition to 104 CDs, 408 Bound Volumes, 443 M.Sc.Dissertations and 82 Ph.D. Theses. The Institute library has a subscription of 128 journals which comprises 4 print journals and 124 e journals including 8 e-Journals from Science-Direct and 116 e-journals from InfoTrac Engineering, Science and Technology Collection (IESTC) a DELNET Consortium.

The Library and Resource Cementum is fully automated with user-friendly library software KOHA that facilitates automated circulation of the books and location and availability information of the books stocked in the library. Online Public Access Catalog (OPAC) is also available on the internet for inquiring about the status of the resources. Bar-coding system is in set computerize the bibliographic details of the resources.

The Library Resource Cementum offers the following services:

- ✓ References
- ✓ Circulation
- ✓ Computerized Information Search
- ✓ Current Awareness Services
- ✓ New Arrival List of Books
- ✓ New Arrival List of Periodicals
- ✓ Newspaper Clippings
- ✓ Selective Dissemination of Information (SDI)
- ✓ Reprography
- ✓ Inter-Library Loan (ILL)
- ✓ User Education Program
- ✓ Library Orientation

For detailed information please visit; https://pharmscilibrary.nirmauni.ac.in/

Industry Institute Interaction Cell

Industry Institute Interaction Cell (III Cell) is established to provide close links with industries, contract research organization and other state and national level R & D organizations. The purpose of the cell is to find out the gap between need of the industry and end product of the institute. The cell is the bridge between the industry and the institute. One of the objectives is also to offer programs fulfilling the needs of continuing education of the industrial personnel. Industry institute interaction cell provides close links with industries. Placement of students for industry training/projects during summer has been benefiting

students to a great extent.

We believe in developing programs, which provide solution to real world problems with a strong desire of forging innovative alliance with industry to achieve synergy. III Cell imparts benefits to all components like students, faculty, institute and industry by interacting closely with the industries. Students are exposed to the real world and learn the needs of the future career.

The III Cell is governed by the advisory committee; headed by the director as a chairman, Head of department as member and placement-Training officer as a member secretary. III Cell facilitates student's visits to industries, industrial training, project placements & Campus interview.

Placement Cell

Campus interview are organized by inviting various companies for the placements of the student for jobs. It fulfill dual purposes, one for students securing their future career, another for the industry securing the best fresh talent available in the region to train and mold them for long time need of the employees. Various lecture series, training in CV writing, interpersonal skills development, mock interviews and workshops are organized by the placement cell for the students to prepare them for the campus interviews. Placement of students starts from the end of semester III. Various national and International companies absorb our students such as Torrent Pharmaceutical; Zydus-Cadila research centre; Intas bio-pharmaceutical; Lambda; Nivea; Cliantha Research, Amneal pharmaceutical; Macca healthcare, O2h pharmaceutical group; Veeda clinical research center; Sun pharma, baroda; to name a few.

Industrial Collaborative Programs

Intas Pharmaceuticals Ltd. has signed a MoU with the University for Development of excellent clinical research Center facilities for carrying out pre-clinical research work.

Collaboration with Research Institutes

The University recognizing research as the main drive of success in an academic setting established a distinct faculty of Doctoral Studies and Research to initiate research programs independently or in collaboration with national laboratories with relevant infrastructure

and expertise. Such collaboration exists with institutions like Physical Research Laboratory; Space Application centre; Forensic Science Laboratory, Gandhinagar; Dr. Reddy's Institute of Life Science, Hyderabad; JNU, Delhi; SGPGI, NIREH, Bhopal; Kailash Cancer and Research Hospital, baroda; Reagene Innovations Pvt. Ltd; etc.

Industry involvement in course curriculum design

In various academic bodies, there is adequate representation of industry expert which makes the curriculum rich and relevant to industries. Participation of experts from pharmaceutical industry is regularly helping us in designing and updating the curriculum

Summer Training for Postgraduate Students

Training is the integral part of the study to acknowledge them for real world problems. Students are placed at various industries or Research laboratory for 6 to 8 weeks and under supervision and guidance of respective industry/Lab personnel. The faculty carries out monitoring and evaluation regularly.

Co-curricular & extra-curricular activities

Co-curricular & extracurricular activities play an important role in the all-round development of professional students. They indeed serve as an adjunct to the rigorous course work. The objectives of these activities are:-

1. To promote disciplined corporate, intellectual, civil and cultural life amongst students andthe faculty of the institute.
2. To foster activities to bring out creativity, promote the study and discussion talents of thestudents.
3. To promote the study and discussion of subjects of national and international importance.
4. To create awareness amongst the students about their professional identity and their obligations to the profession and society at large.
5. To create a strong spirit of teamwork and cohesiveness by organizing various cultural, literary and professional activities along the academic routine.

Various students' activities like cultural festival, ras-garba, quizzes, elocution debates, annual

day, class picnics etc. are regularly organized by the institute with adequate involvement of faculty members.

The institute also gives importance to projects, industrial visits and training during vacationsto support their curricular work. The students are motivated to present seminars on latest developments in the field of science. Seminars enable students to develop many skills through internet, e-journals, books and journals on a specific topic. This helps to enhance their library reading, scientific writing and presentation skills. Students have participated at various national and state level competitions and have also won awards.

The institute organizes every year a cultural festival “Renaissance”, which is a compilation of various events like drama, skit, dances, songs & debate, where the budding artists show their talents. Sports events are also regularly organized every year. Celebration of Independence Dayand republic day are also organized at the University level.

Counseling

Counseling to students is an important feature of this institute. Each faculty member will be assigned a fixed number of students right at the time of their joining the program. The faculty in turn will have periodical meeting with those students in order to evaluate their academic performance and proper orientation towards the program, guide them to rectify any short comings and to solve any problem related to academics and adjustments with his/her colleagues and faculty.

Institute of Science Nirma University Alumni Association (ISNUAA)

Thirteen batches of PG students have graduated from the Institute. All activities necessary to fully integrate the Alumni Association with the development efforts of the Institute are being actively planned. Regular contact with the alumni is maintained and efforts for their full participation in the activities of the institute are being made.

FACULTY PROFILES

Dr. Sarat K. Dalai, Professor

Ph.D. in Immunology (Jawaharlal Nehru University, New Delhi)
M.Sc. in Biotechnology (Jawaharlal Nehru University, New Delhi)
Area of Expertise: Memory T Cell Generation and Maintenance
Experience: Research - 23 years, Teaching – 11.5 years
Email: sarat.dalai@nirmauni.ac.in

Dr. Sriram Seshadri, Associate Professor

Ph.D. in Science (University of Rajasthan, Jaipur)
M. Sc. in Comparative Endocrinology & Immunology (Sardar Patel University, Anand)
Area of Expertise: Animal Toxicological studies, Hepatocellular carcinoma and Liver dysfunction, Phytopharmaceutics, Probiotics & Metabolic Disorders ; Targeted Drug delivery ; Gut Microflora

Experience: Research – 18 years, Teaching – 18 years
Email: sriram.seshadri@nirmauni.ac.in

Dr. Sonal Rajiv Bakshi, Assistant Professor

Ph.D. in Life Science (Gujarat University)
M.Sc. in Microbiology (M.S. University of Baroda, Vadodara)
Area of Expertise: Genotoxicity, Cytogenetics, Leukemia Molecular Cytogenetics
Experience: Research - 15 years, Teaching - 12 years
Email: sonal.bakshi@nirmauni.ac.in

Dr. Vijay Kothari, Assistant Professor

Ph.D. in Science (Nirma University, Ahmedabad)
M. Sc. in Microbiology (Gujarat University, Ahmedabad),
Area of Expertise: Bio-active natural products, Bio-acoustics, Biological effects & applications of microwaves, Anti-microbial Resistance (AMR)

Experience: Research – 15 years, Teaching - 14 years
Email: vijay.kothari@nirmauni.ac.in

Dr. Nasreen Munshi, Assistant Professor

Ph.D. in Microbiology (Gujarat University, Ahmedabad)
M. Phil in Microbiology (Gujarat University, Ahmedabad)
M. Sc. in Microbiology (Gujarat University, Ahmedabad)
Area of Expertise: Bioremediation, Functional Microbial Diversity and Microbial Fuel Cell
Experience: Research - 14 years, Teaching - 13 years
Email: nasreen.munshi@nirmauni.ac.in

Dr. Amee K Nair, Assistant Professor

Ph.D. in Life Sciences (Neurobiology), (Cochin University of Science & Technology, Cochin)
M. Sc. in Botany (Environmental Biology)(M.G. University, Kerala)
Area of Expertise: Neurodegenerative Disease and Metabolic Disorders
Experience: Research - 12 years, Teaching - 12 years
E-mail: ameenair@nirmauni.ac.in

Dr. Ravi Kant, Assistant Professor

Ph.D. in Life Sciences (Immunology), National Institute of Immunology, New Delhi.
M. Biotechnology (Medical), All India Institute of Medical Science, New Delhi.
Area of Expertise: Autoimmune Diseases, Neuroimmunology, protein-peptide therapeutics.
Experience: Research - 7 years; Teaching - 0.5 years
E-mail: ravi.kant@nirmauni.ac.in

Dr. Aarthi Sundararajan, Assistant Professor

Ph.D. in Microbiology, University of Tennessee, Knoxville, Tennessee, USA
M.Sc. in Biochemistry, Osmania University, Hyderabad, Telangana
Area of Expertise: Reproductive Immunology, Reproductive Endocrinology, Viral Immunology, Maternal and Child Health
Experience: Research- 6 years, Teaching- 9 years
Email: aarthi.sundararajan@nirmauni.ac.in

Dr. Shruti Chatterjee, Assistant Professor

Ph.D. in Life Sciences (Microbiology), (Osaka Prefecture University, Japan)
M. Sc. in Marine Biology & Oceanography (Marine Microbiology) (CAS in Marine Biology, Annamalai University, TN)
Area of Expertise: Marine Biotechnology; Virulence regulation pathway and anti-virulent therapy in Enteropathogens; antibacterial formulations; animal model studies
Experience: Research - 11 years, Teaching - 8 years
E-mail: shruti.chatterjee@nirmauni.ac.in

Dr Heena V. Dave, Assistant Research Scientist

Ph.D. in Life Sciences (Cancer Research) (Gujarat University) M.Sc. in Life Sciences (Gujarat University)
Area of Expertise: Cancer Biomarkers, Cancer signalling
Experience: Research - 22 years, Teaching – 7 years
Email: heena.dave@nirmauni.ac.in

STAFF MEMBERS

Name of the staff	Designation
Mr. Hasit Trivedi	Junior Office Superintendent
Dr. Svetal Shukla	Assistant Librarian
Mr. Sachin Prajapati	Laboratory Supervisor
Mr. Rajendra Patel	Store Keeper
Dr. Sweta Patel	Laboratory Assistant
Mr. Parthiban S. Mudaliyar	PA cum Stenographer
Mr. Vicky Takhtani	Placement Officer

Contact places for students for different purposes

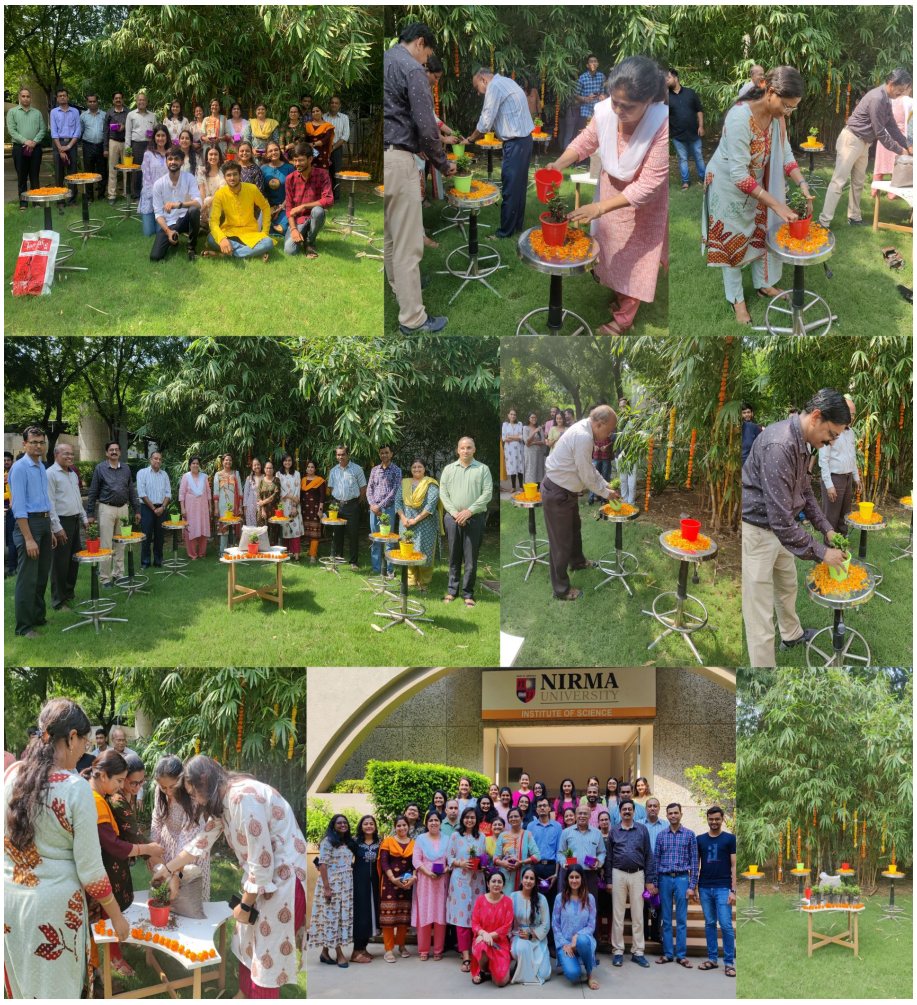
Name of Department	Name	Contact number
Student Section	Mr. Hasit Trivedi	079 71652756
Library	Dr. Svetal Shukla	079 71652754
Director office-PA	Mr. Parthiban S. Mudaliyar	079 71652753
Examination Section	Dr. Nilesh Patel	079 71652672
Account Section	Account officer	079 71652675
Academic Section	Dr. Ravindra Sen	079 71652680
Placement Cell	Mr. Vicky Takhtani	079 71652730

Institute of Science Student's Association (ISNUAA)

Institute of Science has one students' association called INSSA (Institute of Science Students' Association).

The Constitutional members of INSSA are:

President	Kedar Soni [Sem-III]
Vice President	Badal Patel [Sem-III] Priya Sharma (PhD student)
General Secretary	Zeel Bhatia (PhD student)
Treasurer	Nirali Thakkar [Sem-III]
Joint Secretary	Devangi Agrawal [Sem-III] Shruti Malani [Sem-III Milan Gajera [Sem-III]



The activities carried out by the association are in areas of academic, social, cultural and sports. Students take the responsibility to plan, organize, conduct, and review the events, thus developing their leadership and teamwork spirit. Some of the activities conducted by this association is Science Day celebration, Teachers' Day celebration, Guru-Purnima, social activity for old age homes, etc.

Student Representative of various committees

Committees	Faculty Co-ordinator	Student's Representative
Library Committee	Dr. Sonal Bakshi	Nikunj Tandel [17ftphds42] One representative from Sem-III
Website Committee	Dr. Amee Nair	Representatives from staff and Ph.D.
Social Media Committee	Dr. Amee Nair	Representatives from staff and Ph.D.
Anti-Ragging Committee	Dr. Vijay Kothari	Two representative from Sem-III Three representative from Sem-I
IQAC Committee	Dr. Nasreen Munshi	Representatives from Alumni
Student's Welfare Committee	Dr. Sonal Bakshi	Two representative from Sem-I Two representative from Sem-III
INSSA (Institute of Science Students Association)	Dr. Heena Dave	Kedar Soni [Sem-III] Badal Patel [Sem-III] Priya Sharma (PhD student)
Women Development Cell	Dr. Amee Nair	Two representative from Ph.D
Placement Committee	Mr. Vicky Takhtani Dr. Sonal Bakshi Dr. Nasreen Munshi	Two representative from Sem-III

Constitution of Anti-Ragging Committee at Institute Level

The Institute of Science has reconstituted anti-ragging committee (2022-23) as under.

Composition of the Committee

Chairman	**:**		Prof. Sarat Dalai Director, Institute of Science Nirma University Ahmedabad
Civil / Police Administration	**:**	(1)	Shri N R Waghela Police Inspector, Sola Police Station (M) 8264441441
Local Media	**:**	(1)	Shri Nilesh Dholakia The Indian Express Pvt. Ltd. Mob. 9426601929 nilesh.dholakia@expressindia.com
Representative of Faculty Members	**:**	(1)	Dr. Sriram Seshadri Assoc. Professor, Institute of Science
		(2)	Dr. Vijay Kothari Asst. Professor, Institute of Science
		(3)	Dr. Sonal Bakshi Asst. Professor, Inst. of Science
N.G.O.	**:**	(1)	Mrs. Pratima Pandya Kasturba Trust, Gujrat Branch, P.O. Kasturba Vidyalaya, Koba, Sector-9, Gandhi Nagar-382 009 pratima.pandya@rediffmail.com 09898722407
Representative of Parents	**:**		
		(1)	Shri Harshang Patel (Father of Ms. Khushali Patel of semester-III) Mob.: 98250 76940 patel_harshang@yahoo.com
Representative of Students	**:**	(1)	Yosha Thakar (sem-III)
		(2)	Yash Chabhiaya (sem-I)
		(3)	Tulsi Trivedi (sem-III)
		(4)	Ishita Agrawal (sem-I)
		(5)	Yesha Shah (sem-III)
		(6)	Stuti Shah (Sem-I)

2. Constitution of Anti-Ragging Squad :

Faculty Members	**:**		Vijay Kothari, Sriram Seshadri, Sonal Bakshi, Nasreen Munshi, Shruti Chatterjee, Ravi Kant
Non-teaching Members	**:**		Rajendra Patel, Sweta Patel, Parthiban Mudaliyar, Hasit Trivedi, Svetal Shukla

3. Constitution of Mentoring Cell :

Composition of the Cell

Senior Student representatives	**:**	Yosha Thakkar, Yesha Shah, Tulsi Trivedi (sem-III)
		Sweety Parmar (Ph.D. student)

List of Holidays

Sr. No.	Festivals	Date & Month	Day
1.	Makar Sankranti	14 January, 2022	Friday
2.	Republic Day	26 January, 2022	Wednesday
3.	Maha Shivratri	1 March, 2022	Tuesday
4.	Holi 2nd Day - Dhuleti	18 March, 2022	Friday
5.	Dr. Babasaheb Ambedkar's Birthday	14 April, 2022	Thursday
6.	Ramzan-Eid (Eid-ul-Fitra)	3 May, 2022	Tuesday
7.	Muharram (Ashoora)	9 August, 2022	Tuesday
8.	Raksha Bandhan	11 August, 2022	Thursday
9.	Independence Day	15 August, 2022	Monday
10.	Janmashtami	19 August, 2022	Friday
11.	Samvatsari/ Ganesh Chaturthi	31 August, 2022	Wednesday
12.	Dussehra	5 October, 2022	Wednesday
13.	Diwali	24 October, 2022	Monday
14.	New Year/ Bhaiduj	25 October, 2022	Tuesday
15.	Guru Nanak's Birthday	8 November, 2022	Tuesday

ACADEMIC RULES
&
REGULATIONS
WITH
EXAMINATION
&
TEACHING SCHEME

CHAPTER -11

* ACADEMIC REGULATIONS FOR POST GRADUATE DEGREE PROGRAMMES (M. Sc.) UNDER THE FACULTY OF SCIENCE

DEFINITIONS

PROGRAMME -- M.Sc. (Programmes as per Annexure 1)

COURSE -- One of the constituent subjects of the Programme

SEMESTER -- Duration for studying a course

TERM -- A portion of an academic year, normally coinciding with a semester. The words "Term" and "Semester" are generally used synonymously.

REGISTRATION -- Procedure for getting enrolment in a Course

LETTER GRADE -- A letter associated with a particular performance level of the student. A qualitative meaning and a numerical index are attached to each grade.
A+ to C+ are Passing grades, C -- Conditional pass, FF – Fail, IF – Interim fail

CREDIT -- A numerical figure associated with a course. On passing the course, the student earns this "credit"

GRANTING A TERM -- This expression is used to indicate that the student's in-semester performance is up to acceptable standards.
GT – Term granted, NT – Term not granted

REGULAR APPROVAL -- If a student is unable to attend the institute or appear in an examination on account of unavoidable reasons like illness, accident or unforeseen circumstances, prior/ prompt intimation and request to HOD is necessary for seeking approval for the absence. The approval of HOD so obtained will be referred as Regular Approval.

SHORT FORMS

Institute of Science	--	Institute
Director of Institute of Science	--	Director
Dean of the Faculty of Science	--	Dean
Head of concerned Department	--	HOD
Appeal Committee consisting of Director, Dean and Two Senior Faculty Members nominated by Director	--	Appeal Committee
Initial Registration	--	IR
Repeat Registration	--	RPR

* Published vide Notification no. NU-412 dated 27.8.2004, AC mtg. 8.7.2004, resol.-5(a), read with Notification no. NU-883 dated 10.3.2005, BoG mtg.-5.2.2005, reso.-5

[1]RL	--	Repeat Registration for LPW
[1] RS	--	Repeat Registration for Studying all components of a course
Term Not Granted	--	NT
[1]NTP & NTC ***Deleted***		
Re - examination Registration	--	RER
[1]REC	--	Re – examination registration for CE component of a course
[1]RES	--	Re – examination registration for SEE component of a course
[1]CE	--	Continuous Evaluation
Laboratory/Project work	--	LPW
Semester end examination	--	SEE
R. Science. (PG)	--	R.

[1] M.S.E & B.S. E ***Deleted***

[#]R. SCIENCE (PG) 1. PROGRAMMES - Annexure 1[#]

The Post Graduate Degree Programmes in Science, leading to the degree of Master of Biotechnology, Biochemistry and [2] Microbiology are offered by Nirma University. All Programmes are full time, of two years duration and are approved by Nirma University, under the faculty of science - Life Sciences. The Programmes offered are listed in Annexure 1[#].

Intake : To be decided by the Academic Council from time to time.

R.SCIENCE. (PG) 2A. ELIGIBILITY FOR ADMISSION

A student seeking admission to any Programme must fulfill the following criteria:

[3] He should have passed the qualifying examination of Bachelor of Science from a recognized university with minimum 50% marks (or equivalent cumulative grade point index),
OR

[3] The eligibility criteria should be Bachelors degree under 10+2+3/4/5, pattern of education in Chemistry, Biochemistry, Botany, Zoology, Microbiology, Life Sciences, Environmental Sciences, Bio-technology, Agricultural, Veterinary, Fishery & Dairy Sciences, Pharmacy, Medicine (MBBS), BDS, Bioinformatics, Genetics, Medical Laboratory Technology, BHMS, BAMS, B.Tech./ B.E. Biotechnology, Physiotherapy and Bio-medical Engineering *with at least 50% marks* as aggregate of all the semesters / years
OR

[3] He should have passed any other qualifying degree/diploma examination considered as equivalent by Nirma University (with minimum 50% marks or equivalent CPI).

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[2] Amended by addition vide noti No. NU-173 dated 9.4.2009, BoG mtg-27.3.09, resol-5(a)

[1] Amended by substitution & deletion vide noti No. NU-28 dated 20.04.2012, BoG mtg-30.03.12, resol-5(G)

[3] Amended by addition/substitution vide noti No. NU-35 dated 20.04.2013, BoG mtg-30.3.13, resol-5(C)(i)

[#] Amendments in the list of programmes are shown in Annexure - 1.

2B. DETERMINATION OF MERIT OF ADMISSION

1. Admission shall be given on merit by adopting one of the following methods as decided by the Academic Council.

(a) Marks obtained in Qualifying Examination.

OR

(b) The ENTRANCE TEST conducted by the NIRMA UNIVERSITY.

OR

(c) Marks obtained in Entrance Test and qualifying examination, weightage of which shall be decided by the Academic Council.

OR

(d) Any other method to be decided by the Academic Council.

R.SCIENCE (PG) 3. CATEGORIES OF COURSES

The following categories of courses are offered in the programmes.

3.1 CREDIT COURSES

These are compulsory courses. They are included in the schedules of various semesters. Credits earned for these courses will be considered for evaluating the academic performance levels of the student.

3.2 SUPPLEMENTARY COURSES

These courses will be offered as and when necessary. They are compulsory courses. They are not included in the schedules of the semesters but are shown as additional courses, wherever applicable.

No credits are assigned to these courses. However performance in these courses will be considered while deciding continuation of the student in the Programme or his registration in higher semester.

NOTE: Hereafter, the Credit Courses will be referred to simply as "courses". Supplementary courses will be specifically mentioned as such.

R.SCIENCE (PG) 4. COMPONENTS OF A COURSE

The academic schedule of the courses may consist of one or more of the following components with their respective scope as described.

- LECTURES (LECT) - Teaching learning processes conducted in real and virtual class rooms with various multi media aids.

- TERM ASSIGNMENTS (TA)- Supplementary to classroom teaching. It consists of one or more of the following teaching strategies.
  Each strategy will form a UNIT.

  Self study exercises/quizzes/tests/objective questions/viva term paper, case study analysis, seminars etc.

- LABORATORY WORK / PROJECT WORK (LPW) -This component consists of one or more of the following practical exercises / projects.

  Each set of practical exercises / project will form a UNIT.

Laboratory experiments and their reports.
Viva, Synopsis, Seminar, industrial / professional training, analysis, design, research problems, Thesis work etc.

[1]R.SCIENCE (PG) 5. EXAMINATIONS

For assessment of the course, Examination/s are prescribed for each component.
These examinations are as follows.
LECTURES -- [1] Semester End Examination (SEE)

[1]Continuous Evaluation -- CE examination CE may include written examination/s and Term Assignments (TA) Examination
LABORATORY/PROJECT WORK -- LPW examination

R. SCIENCE (PG) 6. COURSE COORDINATOR, ADVISOR

The Dean will appoint faculty members for the following designations. The main functions of each designation are also mentioned.

COURSE COORDINATOR (to be appointed for each course) – to coordinate all matters related to the conduct and assessment of a course.
FACULTY ADVISOR (to be appointed for each semester) – to look after all matters, at the department level, regarding Registrations and Re-registrations of courses and also to provide guidance and counseling to students regarding these issues.

R. SCIENCE (PG) 7. TEACHING SCHEME -- Annexure 2

The teaching scheme for the course as a whole will be referred simply as Teaching Scheme.
The teaching scheme of the Units of TA and LPW will be referred as Supplementary Teaching Scheme.

The courses offered in each programme (semester- wise) and their teaching schemes are given in the Semester schedules (Annexure 2). The schemes show the various courses, distribution of teaching hours, course component/s, examinations, component weights and credits allotted to each course.
In certain Programmes, the teaching scheme will include, if necessary, summer vacation training in industry / professional / research organizations.
The Supplementary Teaching Schemes of various Units of TA and LPW together with their *inter se* weights, (within the overall weights of TA and LPW), shall be formulated by the course coordinator in consultation with HOD. These schemes

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[1] Amended by substitution vide noti No. NU-28 dated 20.04.2012, BoG mtg-30.03.12, resol-5(G) will be approved by the Dean, Faculty of Science before being notified to the students in the beginning of each semester.

R.SCIENCE (PG) 8. SEMESTER AND TERM

Normally courses will be offered semester-wise as given in the teaching scheme.
However the institute may offer certain course/s of a semester in both terms of an academic year in order to help students to pursue their study more expeditiously.

[1]R. SCIENCE (PG) 9. REGISTRATION IN COURSES

9.1 There will be [1]five categories of Registrations. All [1]five categories will be collectively referred to simply as Registration. Individual categories will be referred to by their symbols.

9.2 All Registrations, wherever applicable, will be subject to availability of courses.

9.3 Registration will be done course-wise.

9.4 CATEGORIES OF REGISTRATION

9.4.1 The [1] Five categories of Registration are:

IR- Initial registration,

RPR – Repeat registration with two sub categories [1] RL (Repeat registration for studying LPW component of a course) and [1] RS (Repeat registration for studying all components of a course)

RER – Re-examination registration [1]with two sub categories REC (Re examination registration of [1]CE component of a course) and RES (Re examination registration of SEE component of a course.)

9.4.2 Initial Registration (IR) **-** In order to study a course for the first time, the student will register under the IR category. This will imply regular attendance for study of all components of that course and appearing at all examinations thereof.

IR registrations for courses of a semester are to be done for ALL courses of that semester as shown in the teaching scheme; IR registration will not be permitted for lesser number of courses. The student who so registers (IR) for all courses of a semester will be considered as having been registered in that semester.

9.4.3 Repeat Registration ([1]RS)

The student whose Term is not granted for any registered course(R.12) will have to repeat the study of that course. He will have to seek fresh registration for this purpose. The category of such registration will be as follows :

Term not granted Category	Registration Category
[1]NT	[1]RS

[1]RS - This category will imply regular attendance to study all components (i.e. LECT, CE, LPW/*PW as applicable) and appearing at all examinations thereof.

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[1] Amended by substitution vide noti No. NU-28 dated 20.04.2012, BoG mtg-30.03.12, resol-5(G)

9.4.4 RE-Registration (RER) – This registration is necessary for appearing again in a particular examination of a course. It will not involve regular attendance for studying that course.

9.4.5 RPR Registration **-** This term will be used wherever necessary to include registrations of both categories [1]RL and [1]RS.

9.5 APPROVAL OF REGISTRATION

Every student must apply in the prescribed form for registrations, as applicable.

The decision on the student's request will be based on the availability of courses and applicable Regulations. The Director will issue appropriate orders for processing the application, including scrutiny, verification and final orders.

9.6 SIMULTANEOUS REGISTRATION IN DIFFERENT CATEGORIES

9.6.1 Semesters will be registered in chronological order.

9.6.2 A student will not be permitted to register (IR) in the next higher semester if the total number of [1] courses with RER and or RPR as applicable in his case exceeds Three.

9.6.3 The student who becomes eligible for IR registration in a higher semester must first register for all RER and RPR registrations as applicable in his case.

9.6.4 The student who is not eligible to register in a higher semester in any term must register, in that term, for all RER and RPR registrations applicable in his case.

R. SCIENCE (PG) 10. GRADES

PERFORMANCE LEVELS

The Performance level of the student in any examination will be adjudged in terms of the letter grades given in Table 1.

Table 1

Grade	Qualitative Meaning	Equivalent Grade Point
(G)	(GQ)	(g)
A+	Excellent	10
A	Creditable	9
B+	Very Good	8
B	Good	7
C+	Satisfactory	6
C	Conditional Pass	5
FF	Fail	0
IF	Interim Fail	0

R. SCIENCE (PG) 11. SCOPE OF EXAMINATIONS AND ASSESSMENT

In order to pass a course, the students will have to pass all examinations of that course. The scope of the examinations and the method of assessment will be as follows.

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[1] Amended by substitution vide noti No. NU-28 dated 20.04.2012, BoG mtg-30.03.12, resol-5(G)

11.1 In all mark based assessment, the overall percentage marks, if fractional, will be rounded off to the next higher integer value.

[1]11.2 [1]CE EXAMINATION (IR and RPR registration)

All exercises in [1]CE will be continuously assessed during the semester and given marks. Oral examination will be included in the assessment at all possible stages. The total marks of all Units of [1]CE will be aggregated based on their *inter se* weights to give the overall percentage of marks in the [1]CE examination.

[1]If the student fails in CE examination, the student will not be permitted to appear in SEE of that course and the student will have to seek fresh registration as REC in subsequent semester, if the student is otherwise eligible.

[1]11.3 LPW EXAMINATION (IR and [1]RL/RS)

All assignments in Laboratory / Practical Work will be continuously / periodically assessed (as applicable) during the semester. In addition there will be an Examination for overall assessment at the end of the semester. Oral examination will be included in the assessment at all possible stages. Each assessment will be given marks. The total marks of all Units of LPW will be aggregated based on their *inter se* weights to give the overall percentage of marks in the LPW examination.

The course coordinator will notify the procedure for assessment, review, viva voce etc to the students in advance.

[1]If the student fails in LPW examination, the student will not be permitted to appear in SEE of that course and the student will have to seek fresh registration. as RL in subsequent semester, if the student fulfills the condition of granting the term (R-12)"

11.4 [1] (M.S.E/B.S.E) deleted

11.5 SEMESTER END EXAMINATION (SEE)
(IR and RPR)
The expression "Semester end examination" refers to the written examination of a course taken at the end of a semester. This will cover the full syllabus.

The assessment will be mark based as per normal practice in written examinations.

11.6 SCHEDULES OF SEE
SEEs of all courses of the programme, as per the teaching scheme, will be held at the end of both terms.

11.7 Absence in any examination with or without Regular Approval will be assigned Zero mark.

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[1] Amended by substitution & deletion vide noti No. NU-28 dated 20.04.2012, BoG mtg-30.03.12, resol-5(G)

[1]R. SCIENCE (PG) 12. GRANTING OF TERM

12.1 The Term will be granted course-wise.

12.2 [1]The granting of Term for all the students (IR, RPR) will depend on the compliance of maintaining minimum 85 % attendance in all components of the course (as applicable) Regular approval for remaining absent up to 15 % is necessary.

Note: In the case of long duration training or project work, where final examination is not possible before the Term ends, a certificate by the course coordinator that the student's progress is satisfactory will be acceptable.

12.3 The student who has been given category NT may appeal to the Appeal Committee giving full reasons for his default. The decision of the Committee in all such cases will be final.

12.4 The student who is given NT category will not be permitted to appear in SEE of the concerned course. He will also be given grade FF in that course.

R. SCIENCE (PG) 13. GRADES IN EXAMINATIONS

[1]13.1 [1] CE and LPW EXAMINATIONS

Grades for the [1]CE and LPW examinations will be given on the basis of the percentage marks obtained by the student in the respective examinations.

Table 2(a) shall be referred for converting percentage marks into corresponding Grades (G) for all examinations except [1]CE, and Table 2 (b) for [1]CE.

Table 2 (a)

All examinations except CE

% marks	Grade(G)
90 and above	A+
80-89	A
70-79	B+
60-69	B
50-59	C+
Less than 50	[1]IF

Table 2 (b)

for CE

% marks	Grade(G)
90 and above	A+
80-89	A
70-79	B+
60-69	B
50-59	C+
[X]45-49	C
[X] Less than 45	[1]IF

13.2 GRADE IN SEE

In the normal course, a student (IR, RPR) and category GT will appear for SEE after his [1]CE and LPW examination, in the same semester.

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[1] Amended by substitution vide noti No. NU-28 dated 20.04.2012, BoG mtg-30.03.12, resol-5(G)

[X] Amended by substitution vide noti No. NU-082 dated 20.05.2017, BoG mtg-18.4.17, resol-4(D)(V)(a)

[X] Grade for the performance in SEE will be given on the basis of the percentage marks obtained by the student. Table 2(a) shall be referred to for converting percentage marks into corresponding grades (G) except that for categories - (i) and (ii) given below, grade IF will be given:

Performance	Grade
(i) Fail	IF
(ii) Absence	IF

Notwithstanding anything contained in terms of giving 'IF' grade as shown in (ii) in the table above, the Director of Institute will scrutinize the genuineness about remaining absence in Semester End Examination through Appeal Committee and if the Director, after said scrutiny, decides to show 'Ab' instead 'IF' in (ii) of above table then in the grade sheet, instead of 'IF', 'Ab(S)' shall be mentioned in such cases only.

13.3 GRADE IF IN SEE

The student who obtains grade IF in SEE will be allowed to appear in Three consecutively available subsequent SEE of the concerned course. The criteria for giving grades in these three attempts will be the same as given in R. 13.2. However, grade IF in the final attempt will be converted into grade FF.

[1&6]13.4 COURSE GRADE

Course grade will be given only when the student passes all component examinations.
Marks of SEE, [1]CE and LPW (as applicable) examinations shall first be aggregated on the basis of the component / *inter se* weights given in the Teaching Scheme. After the aggregate marks of the entire group are so calculated, the performance of each student in the course as a whole will be assigned a grade based on his aggregate percentage viewed in relation to the overall performance of the group.

In giving relative grades, the number and designation of various grades (G) shall be kept the same as shown in Table 2(a). [6] The course coordinator will decide the cut off percentages of relative grading subject to the guidelines prescribed by the Academic Council.

The Transcript will show only the Course Grade and not the Component Grades.

13.5 The provisions of R. 13.4 are subject to the maximum permissible duration to pass courses of first two semesters and the entire Programme given in R.17.

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[4] Amended by deletion vide notification no. NU-77 dated 19.4.2006, BoG mtg-31.3.2004, reso.-12
[5] Amended by addition vide notification no. NU-1345 dated 3.11.2006, BoG mtg.-13.10.2006, reso.-5(b)
[6] Amended by substitution vide notification no. NU-1345 dated 3.11.2006, BoG mtg-13..10.2006, reso.-5(a)
[1] Amended by substitution vide noti No. NU-28 dated 20.04.2012, BoG mtg-30.03.12, resol-5(G)
[5-A] Added vide noti. No. NU-261 dated 11.05.2016, BoG mtg.-16.04.16, reso. No. 3(B)

R. SCIENCE (PG) 14. INTERPRETATION OF GRADES

(a) Grade A+ should be given with great care and discretion. Normally it should be reserved for a very distinguished performance, with respect to both marks and quality of output.

(b) [1]Grade C+ is the minimum for passing. A student getting grade C in CE can improve his performance (at his option) by repeating CE in subsequent semester. Better of the grades obtained in the two examinations will be considered.

(c) Grade FF -

(i) If this grade is given because of [1] NT (R-12), the student will have to seek [1] RS registration respectively for repeat study of the course.

(ii) If the grade FF is given due to failure in the final admissible attempt in SEE, the student will have to seek [1]RS registration for repeat study.

(d) Grade IF - This is an interim fail grade given in [1]CE,LPW and SEE/SPE as under:

Performance	Grade
Fail in CE	IF(C)
Fail in LPW	IF(L)
Fail in SEE/SPE	IF(S)
Fail in Overall Course	IF(O)

Note: If a student getting IF(O) in a course, then he/she can improve his/her performance by repeating CE (all components of CE) of the course in the subsequent semester depending upon his/her choice. In such case, he/she will also reappear in SEE.

R. SCIENCE (PG) 15. PASSING STANDARDS

15.1 PASSING A COMPONENT

The standards of passing a component / course / Programme are given below.
(Min C+ means grade C+ or a better grade)

COMPONENT	-- Min C+ in each component examinations i.e. CE, LPW and SEE/SPE
[1]CE	-- Min C+ (in case of grade C, refer regulation for Gracing)
[1] LPW	-- Min C+
SEE	-- Min C+
[1]COURSE	-- Min C+

15.2 GRACING -- A student not satisfying condition given in R 15.1 for passing a given course will be deemed to have been "Graced for passing" the course if [1]the student fulfills the following two conditions:

[1] Amended by substitution vide noti No. NU-28 dated 20.04.2012, BoG mtg-30.03.12, resol-5(G)

(i) Grade C in [1]CE
(ii) Min C + in LPW and SEE (as applicable) and Min C+ in a course

A student will be allowed a total of only two Gracing in the entire programme.

No special mention about gracing will be made in the transcript. No Gracing will be allowed

in Major Project (Thesis).

15.3 PROGRAMME --- Total credits of all credit courses of the Programme with CPI min 6.0

15.4 FAILURE - Student not satisfying these criteria of Passing / Gracing / will be considered as having Failed in the Examination / Component / Course / Programme.

15.5 The student who has once passed an examination will not be allowed to appear at it again.

15.6 Grades/marks obtained by the student in examinations passed by him will be carried forward as necessary.

R. SCIENCE (PG) 16. PERFORMANCE LEVELS

16.1 INDICES

The performance level of the student in credit courses at different stages of his study is given by the following indices. All index values will be rounded off to the second place of decimal.

PIC -- Performance index for the course
PPI -- Progressive Performance Index
SPI -- Semester Performance index
CPI -- Cumulative Performance index
PIC = Equivalent grade point (g) corresponding to the course grade (R. 10 and 13.4)
PPI -- (Up to any stage under consideration)
PPI = (i1 c1 + i2 c2 + i3 c3 .....) / (sum of credits of all courses registered up to that stage) where:
i1, i2, i3…. are PIC values of CREDIT COURSES passed and
c1, c2, c3….. are the credit values of the respective courses.

SPI -- This index is similar to PPI except that the stage to be considered is the end of a semester.
CPI -- This index refers to the entire programme. It is calculated when the student passes the programme. The method of calculation is the same as for PPI or SPI but the summation is for the courses of all semesters of the programme.

16.2 CLASS AND PERCENTAGE (%) MARKS

In case an equivalence between CPI values and Class / % marks is desired, the same can be obtained as given below:

% marks = (CPI – 0.5)* 10

CLASS

CPI Value	Equivalent Class
6.00 to 6.49	Second

6.50 to 7.49 First
7.50 and above First – with distinction

R. SCIENCE (PG) 17. CANCELLATION OF ADMISSION

17.1 The admission in the Programme of the following categories of students is liable to be cancelled.

(i) Failure to earn credits for all courses of semester I within two years of admission to the Programme.

(ii) Failure to earn credits for all courses of semester II within two and a half years of admission to the Programme.

(iii) Failure to earn requisite credits and CPI minimum 6.00 to pass the Programme within three years of admission to the Programme.

[7]The student, whose admission is so cancelled, can appeal to the Appeal Committee. The Committee may grant an extension only upto one additional semester for one of the categories falling under 17.1 (i), (ii) or (iii) for clearing the courses in deserving cases, provided the student gives a viable assurance to make up the shortfall within that period.

[8]Notwithstanding anything contained above, the President may consider the cases of such students falling under category (i), (ii) & (iii), if the student has cleared all the courses and have earned the requisite number of credits except one course, on an appeal filed. The President will consider such appeal on the recommendation of the appeal committee prescribed under the regulations for the purpose and after considering the genuineness of the case may give one additional attempt to the student concerned to clear the remaining course.

17.2 The student who satisfies R. 17.1 (i) and (ii) but who is unable to satisfy R.17.1 (iii) only because of delay in completing the Thesis work may apply, giving full reasons, to the HOD for an extension to submit his Thesis. The HOD may recommend to the Appeal Committee to grant an extension of up to two years in addition to the limit specified R. 17.1 (iii). The decision of the Appeal Committee in the case will be final.

17.3 If a student avails of the benefit of R. 17.2, and he passes the Programme, his Grade for passing the Programme will be pegged at C+ and CPI at 6.0.

R.SCIENCE. (PG) 18. EXAMINERS

All continuous assessments will be carried out by the faculty concerned. All other assessments / examinations will be carried out by a panel of at least two examiners. The extent of associating external experts with the examinations, selection and appointment of all examiners will be decided by the Dean in consultation with a committee appointed for this purpose.

R. SCIENCE (PG) 19. SUPPLEMENTARY COURSES

The courses of this category are basically bridge courses to bring students of different universities to a common level in certain areas of basic importance to the Programme and courses which will be felt necessary.

The Dean of the Faculty of science is empowered to decide these courses, their curriculum, teaching and examination schemes, passing standards and such other matters as may be necessary for efficient conduct of the courses.

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[7] Amended by addition vide notification no. NU-101 dated 13.4.2007, BoG mtg.-31.3.2007, reso.-3(d)

[8] Amended by addition & then substitution vide Notification No. NU-1864A dated 08.11.2007, BoG mtg.-30.10.07, reso. No.5(a) & then, Notification No. NU-125 dated 14.10.13, BoG mtg.-28.09.13, reso. No. 5(b)

Annexure-I
[Refer: R.SCIENCE(PG)-1]

List of Programmes:

1. M. Sc. in Biotechnology
2. M. Sc. in Biochemistry
3. M. Sc. in Microbiology

ANNEXURE-I

M.Sc. Biotechnology

APPENDIX-A

Institute of Science
Nirma University

Teaching & Examination Scheme of M.Sc. Biotechnology (2022-23)

Sr. No.	Course Code	Course Title	Teaching Scheme				Examination Scheme				
							Duration		Component Weightage		
			L	LPW/ PW	T	C	SEE	LPW/ PW	CE	LPW/ PW	SEE
Semester-I											
1	3SBC101	Metabolism	3	-	-	3	3.0	-	0.60	-	0.40
2	3SBT102	Cell Biology	3	-	-	3	3.0	-	0.60	-	0.40
3	3SBT103	Molecular Biology	3	-	-	3	3.0	-	0.60	-	0.40
4	3SBT109	General & Applied Microbiology	3	-	-	3	3.0	-	0.60	-	0.40
5	3SBT111	Basic Immunology	3	-	-	3	3.0	-	0.60	-	0.40
6	3SBT112	Laboratory I	-	12	-	6	-	10.0	1.00	-	-
7	3SBT113	Seminar I	-	1	-	1	-	-	1.00	-	-
		Total	**15**	**13**		**22**					
Supplementary Course											
8	3SBT1S3	Basics of Animal Physiology	-	-	2	-	-	-	1.00	-	-
		Total	**15**	**13**	**2**	**22**					
Semester-II											
1	3SMB201	Industrial Microbiology & Fermantation Technology	3	-	-	3	3.0	-	0.60	-	0.40
2	3SBT202	Bioanalytical Techniques	3	-	-	3	3.0	-	0.60	-	0.40
3	3SBT203	Genetic Engineering	3	-	-	3	3.0	-	0.60	-	0.40
4	3SBT204	Microbial Genetics	3	-	-	3	3.0	-	0.60	-	0.40
5	3SBT211	Laboratory II	-	14	-	7	-	10.0	1.00	-	-
6	3SBT212	Seminar II	-	2	-	2	-	-	1.00	-	-
		Total	**12**	**16**		**21**					
Supplementary Courses											
7	3SBT2E2	Professional English	1	-	-	-	-	-	1.00	-	-
Value Added Course											
8	3SBT2S1	Professional Development and Resume Writing	2	-	-	-	-	-	1.00		
		Total	**15**	**16**		**21**					
Institute Elective											
9		Elective I	3	-	-	3	3.0	-	0.60	-	0.40
		Total	**18**	**16**		**24**					
Semester-III											
1	3SBT301	Molecular Microbial Physiology	3	-		3	3.0	-	0.60	-	0.40
2	3SBC304	Cancer Biology	3	-	-	3	3.0	-	0.60	-	0.40
3	3SBT308	Animal Biotechnology	3	-	-	3	3.0	-	0.60	-	0.40
4	3SBT3E1	Genomic & Proteomics	3	-	-	3	3.0	-	0.60	-	0.40
5	3SBT311	Laboratory III	-	8	-	4	-	6.0	1.00	-	-
6	3SBT312	Research Methods	3	6	-	6	-	-	0.60	-	0.40
7	3SBT3S6	Summer Training*	-	-	-	2					
		Total	**15**	**14**		**24**					
Supplementary Courses											
8		Dissertation Tutorials	-	-	1	-	-	-	1.00	-	-
Institute Elective											
9		Elective II	3	-	-	3	3.0	-	0.60	-	0.40
		Total	**18**	**14**	**1**	**27**					
Semester-IV											
1		Training	-	-		25	-	-	0.60	0.40	-
2	3SBT404	Comprehensive Viva Voce	-	2	-	2	-	-	1.00	-	-
Value added Course											
3	3SBT406	Interpersonal and Networking Skills	2	-	-	-	-	-	1.00	-	-
		Total	2	**2**	**-**	**27**					

***Compulsory summer training following semester II for 21 working days**

L: Lectures, T: Tutorial, C: Credits
CE: Continuous Examination
LPW / PW: Laboratory / Project Work
SEE: Semester End Examination

Elective I (*Semester II*)
3SMB2E2 Microbial Ecology
3SBC2E1 Human Genetics
3SBC2E2 Reproductive Physiology
3SBC203 Advanced Immunology
3SBC211 Neurobiology

Elective II *(Semester III)*
3SMB304 Agriculture & Environmental Microbiology
3SMB307 Microbial Diversity and systematics
3SBT309 Vaccinology

Training (*Semester IV)*
3SBC402 Dissertation
3SBT407 Internship

Value added Course
Semester II 3SBT2S1 Professional Development and Resume Writing
Semester IV 3SBT406 Interpersonal and Networking Skills

Supplementary Courses
Semester I 3SBT1S3 Basics of Animal Physiology

Semester II 3SBT2E2 Professional English

Semester III **Dissertation Tutorials**
3SBC3A1 Neuroendrocrine Regulation of Behavior
3SBC3A2 Endocrinology & Immunology of Pregnancy
3SBC3S1 Understanding Gastrointestinal Hormones and Gut associated cancer
3SBC3S3 Pathogenesis of Diabetes
3SBC3S4 Genotoxicity Testing for Cancer Risk Assessment
3SBC3S5 Applied Human Cytogenetics
3SBT3S2 Immunological Memory
3SBT3S3 Tumor markers in cancer managemnet
3SBT3K1 Immunology of Vaccine Adjuvants
3SMB3N1 Microbial Community Dynamics and Ecological Succession
3SMB3V1 Antimicrobial Agents

Dr. Sriram Seshadri **Prof. Sarat Dalai**

Institute of Science
Nirma University

SEMESTER I

Core Courses

L	T	P	C
3	-	-	3

Course Code	**3SBC101**
Course Title	**Metabolism**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Have an **understanding** of the metabolic pathways - the energy-yielding and energy requiring reactions in life; understand the diversity of metabolic regulation, and how this is specifically achieved in different cells
2. **Evaluate** the different metabolic process occurring in the cells
3. **Relate** the link between the metabolic processes and their regulation as a response to external and internal factors
4. **Analyse** the differences and similarities between the various anabolic and catabolic processes occurring in the body

Syllabus: **Teaching hours**: **45 Hours**

Unit 1: Metabolism of Carbohydrates: 5 Hours

Glycolysis, citric acid cycle, pentose phosphate pathways, glycogenesis and glycogenolysis and their regulation, Gluconeogenesis and its regulation. Metabolism of Fructose and Galactose. Hormonal regulation of carbohydrate metabolism.

Unit 2: Metabolism of Lipids: 8 Hours

Synthesis of various lipids, bile acids and cholesterol. Elongation of fatty acids, Desaturation of fatty acids in microsomes. Regulation of fatty acid synthesis, Cholesterol metabolism. Composition and synthesis of basic groups of Lipoproteins and their changes during transport in the body.

Unit 3: Metabolism of Amino Acids: 8 Hours

General reactions of amino acid metabolism: transamination, oxidative deamination and decarboxylation. Catabolic fate of -amino acids and their regulation, glucogenic and ketogenic amino acids. Urea cycle and its regulation. Amino acid biosynthesis.

Unit 4: Metabolism of Nucleotides: 8 Hours

Biosynthesis of purines and pyrimidine- De novo and salvage pathways and their regulation. Catabolism of purines and pyrimidine. Biosynthesis of ribonucleotides and deoxyribonucleotides.

Unit 5: Enzymes: Basic Bio-thermodynamics 8 Hours

Enzyme classification and nomenclature, Enzyme kinetics: Michaelis-Menten equation: Formula, Derivation and Significance; Alternate plotting procedures. Types of Inhibitors and their mode of action.

Unit 6: Enzyme Mechanisms and Regulation: 8 Hours

Different mechanisms of enzyme activity; Strategies for enzyme regulation; Allosteric Enzymes and their Kinetics. Isoenzymes and Multienzyme Complexes.

Suggested Readings:

1. Voet, D., Fundamentals of Biochemistry, J. Wiley, 2008.

2. Voet, D. and Voet, J. G. Biochemistry, 3rd Edition. John Wiley and Sons, 2004. 3. Boyer, R., Concepts in Biochemistry, Brookes, 1999.

3. Metzler, D. E., Metzler, C. M., Biochemistry: the chemical reactions of living cells. Vols. I and II, Academic Press, 2001.

4. Nelson, D. C. and Lehninger, Principles of Biochemistry, Mac Millan, 2000.

5. Murray, R. K., Granner D. K., Mayes, P. A., Rodwell, V. W., Harper's Biochemistry, 27th Edition, McGraw Hill, 2006.

6. Stryer, L., Bery, J. M., Dymoczko, J. L., Biochemistry Only. 6th edition, WH Freeman and Co. New York, 2006.

L	T	P	C
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Course Code	**3SBT102**
Course Title	**Cell Biology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand and appraise the fundamentals of cell as a unit of living organisms and their organelles in terms of structure and functions
2. Evaluate the cellular mechanisms of cell-cell interactions, cell communications, cell signalling pathways and cell division
3. Evaluate the molecular mechanisms and their cross-talk responsible for various diseases

including cancer, diabetes and other diseases, articulate host-environment interactions
4. Demonstrate understanding of in vitro and in vivo isolation of cell, it's utility in various areas of research including stem cell

Syllabus: Teaching hours: 45 Hours

Unit 1: Plasma membranes: 5 Hours
Membrane Structure, Molecular Composition and function; Lipid bilayer and protein, diffusion, osmosis, ion channels, active and passive transport, membrane pumps and transporters

Unit 2: Cytoskeleton: 8 Hours
Microfilaments, Intermediate Filaments and Microtubules – Structure and Dynamics; Microtubules and Mitosis; Cell Movements. Intracellular Transport and the Role of Kinesin and Dynein

Unit 3: Intracellular Protein Traffic: 8 Hours
Protein Synthesis on Free and Bound Polysomes, Uptake into ER, Membrane Proteins, Golgi Sorting, Post- Translational Modifications

Unit 4: Cell Signalling: 8 Hours
Cell Surface Receptors; Signalling from Plasma Membrane To Nucleus, Map Kinase Pathways, G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signalling pathways, neurotransmission and regulation

Unit 5: Cell – Cell Adhesion and Communication: 8 Hours
Ca++ Dependent Cell-Cell Adhesion; Ca++ Independent Cell-Cell Adhesion. Cell Junctions and Adhesion Molecules, Movement of Leukocytes into Tissues, Extracellular matrix

Unit 6: Cell Cycle: 8 Hours
Mitosis, Meiosis, Cell Cycle, Role of Cyclins and Cyclin Dependent Kinases, Regulation of Cdk – Cyclin Activity, Regulation of Cell cycle, senescence and apoptosis

Suggested Readings:

1. Pollard, T. D., and Earnshaw, W. C., Cell Biology 2nd Edition, Saunders Elsevier, 2008.
2. Gerald K., Cell and Molecular Biology, Concept and Experiment, 5th Edition, Wiley, 2007.
3. Kleinsmith, L. J. J. Principles of Cell and Molecular Biology, 2nd Edition, Benjamin Cummings, 1997.
4. Lodish, H., Berk A., Kaiser C. A., Krieger M., Scott M.P., Bretscher A., Ploegh H., and Matsudaira P., Molecular Cell Biology, 6th Edition, Freeman, W. H. and Co., 2008.
5. Roberts, K., Lewis J., Alberts B., Walter P., Johnson A., and Raff. M., Molecular Biology

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Course Code	**3SBT103**
Course Title	**Molecular Biology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. understand a basic understanding of molecular events of discovery of science and it's biological implications
2. understand the role of each components of molecular events in prokaryotes as well as eukaryotes
3. Justify and correlate the importance of these molecular events in the gene expression as well as in the gene regulation
4. analyze and correlate the deregulation in any event leading to disorders and envisage probable strategies

Syllabus: Teaching hours: 45 Hours

Unit 1: Genome organization in prokaryotes and eukaryotes: 5 Hours
Structure of DNA and RNA, physical properties of DNA- cot plot, kinetic and chemical complexity, satellite DNA. Organization of the Chromosome, structure of chromatin-nucleosomes, Chromatin domains and isochores, structure and functional organization of centromeres and telomeres.

Unit 2: DNA Replication: 8 Hours
Prokaryotic DNA polymerase I, II and III, Eukaryotic DNA polymerases, Fidelity and Catalytic Efficiency of DNA polymerases, Okazaki Fragments, Replication Origin, Primosomes, Concurrent Replication mechanism involving leading and copying strands of DNA.

Unit 3: Transcription: 8 Hours
Prokaryotic and Eukaryotic polymerases, Promotors, Enhancers, silencers, transcriptional activators. Mechanism of Prokaryotic and eukaryotic biosynthesis of rRNA, tRNA and mRNA. Transcriptional inhibitors, Transcription factors and machinery, formation of

initiation complex, transcription activators and repressors, elongation and termination

Unit 4: RNA Processing: 8 Hours

Prokaryotic and eukaryotic rRNA, tRNA, mRNA editing, Capping, Polyadenylation, splicing. Processing of poly A- mRNA, Mi and Si RNAs, Group I and II introns, alternate splicing, RNA transport.

Unit 5: Translation: 8 Hours

Prokaryotic and Eukaryotic Protein synthesis and processing: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetases, translational proof-reading, translational inhibitors, post- translational modification of proteins.

Unit 6: Gene Expression Regulation: 8 Hours

Control of gene expression at transcription and translation level, Regulation of prokaryotic and eukaryotic gene expression, phages and viruses, Operon concept, positive and negative regulation, catabolite repression, role of chromatin remodelling in regulating gene expression and gene silencing.

Suggested Readings:

1. Meyers, R. A. (1995). Molecular biology and biotechnology: a comprehensive desk reference. John Wiley & Sons...
2. Lodish, H. (2008). Molecular cell biology. Macmillan.
3. Brown, T. A. (1991). Essential molecular biology: volume II a practical approach. Oxford University Press.
4. Krebs, J. E., Lewin, B., Goldstein, E. S., & Kilpatrick, S. T. (2014). Lewin's genes XI. Jones & Bartlett Publishers.
5. Watson, J. D., & Levinthal, C. (1965). Molecular biology of the gene. Molecular biology of the gene.

L	T	P	C
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Course Code	**3SBT109**
Course Title	**General and Applied Microbiology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Get aquainted with the basic concepts of various fields of Microbiology, and also learn about growth pattern of microbes in different ecosystems.
2. Acquire experimental know-how of essential microbiological techniques e.g. microscopy, cultivation of microbes, etc.
3. Develop an understanding of various facets of microbes and their applications e.g. medical microbiology, industrial microbiology, agricultural microbiology, etc.

Syllabus: **Teaching hours**: **45 Hours**

Unit 1. Foundation in Microbiology: 7 hours

A brief history of microbiology; Types and diversity of Microorganisms; Microbes in our lives

Unit 2. Microbial Growth: 8 hours

Theory and measurement of bacterial growth; Media used for bacterial growth; Overview on Biofilms **.**

Unit 3. Tools to study microbiology: 7hours

Methods for studying microbes; Methods of Culturing microorganisms; Culture preservation

Unit 4. Elements of Microbial Nutrition and Ecology: 7 hours

Environmental factors that influence microbes; Microbe-microbe interactions; Microbial interaction with plants and animals

Unit 5. Metabolic Diversity among microbes: 8 hours

Phototrophy, autotrophy, chemolithotrophy; Catabolism of organic compounds

Unit 6. Applied Microbiology: 8 hours

Overview of applications of microorganisms in Agriculture, Environment, Food, Industry and Medical Sciences e.g. Alternative energy sources and biofuels obtained through microbes; Role of microbes in food production and Food preservation

Suggested Readings:

1. Microbiology (2018). ASM Press: Openstax.
2. Tortora et al. (2019). Microbiology. Pearson Education.
3. Barton and Northup (2011). Microbial Ecology. Wiley-Blackwell.
4. KP Talaro (2008). Foundations in Microbiology. McGraw-Hill International Edition.
5. Brock Biology of Microorganisms (2009). Pearson International Edition.
6. Prescott, Harley, and Klein’s Microbiology (2008). McGraw-Hill Higher Education.

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L	T	P	C
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Course Code	**3SBT111**
Course Title	**Basic Immunology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Develop good understanding on how immune system discriminate self-from non-self.
2. Design irnmunoassays based on the monoclonal antibodies
3. Evaluate the immune response of the host encountering the pathogen or upon vaccination

Syllabus: Teaching Hours: 45

Unit 1: Nature of Antigen and Antibody: 6 Hours

Antigen Vs Immunogen, Haptens, Structure and functions of immunoglobulins, Isotypic, allotypic and Idiotypic variations.

Unit 2: Structure and function of primary and secondary lymphoid organs. 8 Hours

MALT system; Lymphocyte circulation, Mechanisms of Migration of immune cells into primary and secondary lymphoid organs.

Unit 3: Complement System - Activation, regulation and abnormalities 8 Hours

Unit 4: Production of Antibodies and its Applications: 8 Hours

Production of polyclonal and monoclonal antibodies and its clinical applications. Abzymes. Measurement of Antigen – Antibody Interaction: Principles, techniques and applications, Agglutination and precipitation techniques, Radio immunoassay, ELISA, Immunofluorescence assays, Fluorescence activated cell sorter (FACS) techniques. Immuno PCR.

Unit 5: Generation of Diversity of Immunoglobulins and T cell Receptors 7 Hours

Unit 6: MHC structure and polymorphism: Antigen processing and presentation, T cell activation 6 Hours

Suggested Readings:

1. Janeway, C (2012) Janeway's immunobiology. Garland Science 8th Edition.
2. Kindt, T. J (2009). Kuby immunology. Macmillan. 7th Edition
3. Paul, W. E (2008). Fundamental immunology. Lipincott& Wilkins, 6th Edition
4. Abbas, A. K., Lichtman, A. H., & Pillai, Shiva. (2012). Cellular and molecular immunology WB Saunders Co. Philadelphia, Pennsylvania, 186-204.7th Edition
5. Coico, R. (2015). Immunology: A Short course. John Wiley & Sons, 7th edition
6. Peter J. Delves, Seamus J. Martin, Dennis R. Burton and Ivan M. Roitt. (2017). Roitt's essential immunology John Wiley & Sons. 13th Edition

L	T	P	C
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Course Code	**3SBT112**
Course Title	**Laboratory I**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Perform fundamental microbiological, biochemical and cell culture techniques.
2. Analyze and interpret the results of biochemical estimations and microbiological experimental data.
3. Apply techniques to the advanced level practicals and dissertation carried out in further semesters.

Syllabus Teaching Hours: 192 hrs

1. Introduction to human chromosome complement using Giemsa stained metaphase cells.
2. Observation of mitotic cell division stages in onion root tip
3. Observation of meiosis stages using fixed slides
4. Demonstration of Short term blood culture for metaphase chromosome preparation
5. Measurement of microscopic structures using micrometre
6. To study the effect of various parameters viz. inoculum size, aeration, etc. on bacterial growth through the growth curve experiment
7. Estimation of bacterial load in various environmental/ food samples through viable counting
8. Gram-staining
9. Bacteriophage isolation from sewage sample
10. Enzyme assay for Amylase under various conditions
11. Sample Preparation and Separation of Amino Acids, Lipids and Sugars by TLC.
12. Estimation of bio-molecules (Sugar, Protein, Cholesterol, Urea) by spectrophotometer

Suggested Reading:

1. Patel, RJ. Experimental Microbiology. Vol-1, Aditya Publishers, India, pp: 60-61, 2009
2. Sherma, Joseph, and Bernard Fried, 2nd eds. Handbook of thin-layer chromatography. CRC press, 2007.
3. Stahl, Egon, 2nd eds. "Thin-layer chromatography: a laboratory handbook." Thin-layer chromatography: a laboratory handbook. 2007.
4. Cappuccino, James G., and Natalie Sherman, 7th eds. "Microbiology: A laboratory manual." Addision-six 1999 2007.
5. Mu, Plummer, and David T, 3rd eds. Plummer. Introduction to practical biochemistry. Tata McGraw-Hill Education, 2007.
6. Bates, Steven E. "Classical cytogenetics: karyotyping techniques." Human Pluripotent Stem Cells. Humana Press, 177-190, 2011..
7. Rao, Beedu Sashidhar and Deshpande, Vijay, Experimental Biochemistry, A student Companion, I. K. International Pvt. Ltd, 2005
8. Tom Maniatis, E. F. Fritsch, Joseph Sambrook, Molecular cloning-a laboratory manual, 3rd eds, Cold Spring Harbor Laboratory, 2001
9. Primrose, S. et.al., 7th eds. Principles of Gene Manipulation. Oxford: Blackwell Science, 2008 2001.
10. Prescott.L.M, 7th eds. Microbiology, McGraw Hill Publication, 2008
11. Mitosis, Meiosis and Genetics, J. L. Stein Carter & D. B. Fankhauser, Genetics, 2010.
12. Alberts, Bruce, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter. Molecular Biology of the Cell. 6th ed. New York: Garland Science, Taylor and Francis Group, LLC, 2015.

L	T	P	C
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Course Code	**3SBT113**
Course Title	**Seminar I**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand and present scientific concepts
2. Analyze the scientific idea and concept of the given topic

Syllabus:

The students have to give seminars on a scientific topic of their interest from any of the biological fields which will be open for discussion. The students will have to submit the hardcopy of the selected topic along with a summarised write up in their own words. This course has been designed to provide a platform for the students to develop their communication, presentation and confidence to face the audience.

Supplementary Course:

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Course Code	**3SBC1S2**
Course Title	**Basics of Animal Physiology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Refresh understanding of basic principles of biochemistry, and Physiology.
2. Be at par with other students who are already well versed with the subject.

Syllabus

Unit 1: Organisation of Vertebrate Body 3 Hours

Structural organization of body; Overview of structure and functions of an animal cell; Structure and functions of various tissues; Metabolism and Homeostatic State; Regulation of body temperature.

Unit 2: Cardiovascular System 4 Hours

Blood composition; Formed elements; physiology of blood coagulation, blood grouping & RH factor; basic structure of heart, conduction system and cardiac cycle; Organisational structure of blood vessels and lymphatic vessels.

Unit 3: Respiratory System and Digestive System 3 Hours

Structural Organisation of Respiratory System; Physiology of Respiration, Transportation of respiratory gases. Structural organisation of GI tract; role of major and accessory organs; Digestive Processes, Physiology of digestion, absorption and elimination.

Unit 4: Urinary System 3 Hours

Structure of nephron and kidney; Physiology of urine formation (glomerular filtration, tabular reabsorption, tabular secretion) and its homeostatic regulation.

Unit 5: Nervous System 3 Hours

Organisation of Nervous System-CNS & PNS; Neurons and glial cells; Nerve impulse propagation. Brain,

Spinal Cord and their Functions; Structure and functions of Autonomic Nervous System

Monitoring & Assessment:

The students will be monitored and assessed by regular quizzes, term assignments.

SEMESTER II

Core Courses

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Course Code	3SMB201
Course Title	Industrial Microbiology and Fermentation Technology

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Get aquainted with the industrial aspect of the field of Microbiology, and also learn about growth pattern of microbes in different industrial systems.
2. Acquire experimental knowhow of microbial production of various industrail products such as alcohol, exopolysaccharides, enzymes, etc.
3. Develop an understanding of process control, upstream and downstrem process.

Syllabus: **Teaching hours**: **45**

Unit 1: Introduction to Fermentation Processes 7 Hours

Range of fermentation processes. Media and materials required for industrial microbiological processes - sources, formulation, anti-foams and optimization.

Unit 2: Microbial Growth Kinetics 7 Hours

Batch culture, Continuous culture, Fed-batch culture, Applications and examples, Scale up of fermentation processes, Sterilization of media, fermenter and feeds.

Unit 3: Design of a Fermenter 8 Hours

Functions, construction, and maintenance of aseptic conditions. Types of fermenter, Aeration and agitation (Non-Newtonian fermentations).

Unit 4: Industrial products produced by microorganisms: 8 hours

e.g. Enzymes, organic acids, amino acids. Production of antibiotics, vitamins, alcohol fermentation, Glycerol-based fermentations.

Unit 5: Process Control: 7 Hours

Enzyme probes - Bio sensors, Control of various parameters, Computer applications in fermentation technology.

Unit 6: Downstream processing: 8 Hours

Unit operations, Recovery and purification of fermentation products.

Suggested Reading:

1. Biochemical Engineering, Aiba, S., Humphrey, A.E. and Millis, N.F. Univ. of Tokyo Press.
2. Process engineering in Biotechnology, Jackson, A. T. Prentice Hall, Engelwood Cliffs.
3. Biochemical Reactors, Atkinson, B., Pion Ltd, London.
4. Fermentation Microbiology & Biotechnology, E L - Mansi and Bryce, Taylor & Francis, 1999.
5. Industrial Microbiology, Prescott & Dunn, Fourth Edition.
6. Industrial Microbiology by Casida. LE, New age International (P) Limited, Publishers.
7. Industrial Microbiology by Prescott & Dunns, AVI Publishing Company Inc.
8. Industrial Microbiology by A.H. Patel.
9. Principles of Fermentation Technology by P.F. Stanbury, A. Whitaker and S.J. Hall, Butterworth Heineman, Aditya Books (P) Ltd.
10. A text book of Industrial Microbiology by Wulf Crueger and Anneliese Crueger, Panima Publishing Corporation.

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Course Code	**3SBT202**
Course Title	**Bioanalytical Techniques**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand the principles and applications of various techniques used in the isolation, purification and analysis of biomolecules
2. Apply the concepts of modern analytical and instrumental techniques relevant to quantitative measurements in biology
3. Justify and relate the selection of bio analytical methods to characterize a given sample
4. Critically evaluate the advantages, limitations and future prospects of various bioanalytical techniques

Syllabus: Teaching hours: 45 hours

Unit 1: Separation and characterization of macromolecules: 8 Hours

Principles and applications of ultracentrifugation, ultrafiltration, precipitation and equilibrium dialysis; Horizontal and vertical electrophoresis. Native and SDS Polyacrylamide gel electrophoresis, 2 D electrophoresis

Unit 2: Chromatography: 9 Hours

Basic principles and applications of Paper chromatography, TLC, Gas Chromatography, Size exclusion chromatography, Ion-exchange chromatography, Affinity chromatography, Reverse phase chromatography, HPLC, FPLC

Unit 3: Spectroscopy: 7 Hours

Basic Principles and Applications of UV/Visible absorption, CD, Raman, Infrared, Fluorescence and Atomic Absorption Spectroscopy

Unit 4: Radioisotope Techniques: 6 Hours

Radioactive decay, half-life, Types of radiations, properties of α, β and γ rays, radioisotope tracer techniques, Measurement of radio activity, autoradiography, radiation protection and measurements, Applications of radioisotopes for analysis of biological samples

Unit 5: Structural determination of Biomolecules: 8 Hours

Basic Principle, instrumentation and applications of Nuclear Magnetic Resonance & ESR, X-Ray Crystallography, Mass Spectrometry

Unit 6: Microscopy: 7 Hours

Principles and applications of bright field, dark field, phase contrast, DIC etc., fluorescence, confocal, deconvolution, super-resolution, multiphoton, SEM,TEM and various types.

Suggested Readings:

1. Pattabhi, V. and Gautham, N. Biophysics, Kluwer Academic Publishers, 2002.
2. Cooper, A, Biophysical Chemistry, Royal Society of Chemistry, 2004.
3. Christian, G. D., Analytical Chemistry, John Wiley & Sons (Asia) Pvt. Ltd., 2004.
4. Hammes, G. G., Spectroscopy for Biological Sciences, John Wiley & Sons, 2005.
5. Westmeier, Reiner, Electrophoresis in Practice;Wiley-VCH Verlag Gmbh. 2005
6. Michael Hoppert;Microscopic Techniques in Biotechnology, John Wiley & Sons, Inc. 2006
7. Skoog, D. A., Holler, F. J. and Crouch, S. R., Instrumental Analysis, Brooks/Cole Cengage Learning, 2007.
8. Roberts, K., Lewis J., Alberts B., Walter P., Johnson A., and Raff. M., Molecular Biology of

the Cell, 5th Edition, Garland Publishing Inc., 2008.
9. Wilson, K. and Walker, J. ; Principles and Techniques of Biochemistry and Molecular Biology, 7th edition, Cambridge University press., 2010
10. Robert L. Wixom and Charles W. Gehrke, Chromatography: A Science of Discovery.John Wiley & Sons, Inc. 2010
11. Bhasin, S. K., Pharmaceutical Organic Chemistry; Elsevier India Pvt. Ltd. 2012
12. Monk, Paul, Physical Chemistry: Understanding our Chemical World; John Wiley and Sons. 2013
13. Peter Jomo Walla.; Modern Biophysical Chemistry: Detection andanalysis of Biomolecules: WileyPyblishing. 2014

L	T	P	C
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Course Code	**3SBT203**
Course Title	**Genetic Engineering**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand the fundamental concept of genetic engineering.
2. Analyse the technique of genetic engineering.
3. Apply the concept and techniques in designing and conducting experiments and research.

Syllabus: **Teaching hours**: **45**

Unit 1: Fundamental Tool and Technique in Recombinant DNA Technology: 5 Hours

Restriction enzymes: types, mode of action and nomenclature, RE independent cloning strategies, DNA modifying enzymes rnethylases, DNA polymerases, Klenow-enzyme, reverse transcriptase, terminal transferase, alkaline phosphatase, polynucleotide kinase. Ligase, DNase, RNase and Sl nuclease. Blunt end ligation with linkers. Adapter and homo-polymer tailing, Nick translation, Random priming. Polymerase-Chain-Reaction. Real Time PCR (SYBR and Taqman-based chemistry), Principles and application of nucleic acid hybridizations, Preparation of nucleic acid probes. Radioactive and nonradioactive procedures, DNA sequencing (Maxam and Gilbert method and Sanger method) including automated DNA sequencing.

Unit 2: Cloning Vehicles and their Application: 8 Hours

Cloning vectors, Definition and properties of cloning vectors - plasmids, bacteriophage lambda and M13 - based vectors, cosmids, and shuttle vector, YAC and BACs, viral vector (SV40, retrovirus and Adenovirus), Ti and Ri Plasmids, cloning of PCR product, TA and TOPO cloning, sub cloning and GATWAY cloning.

Unit 3: Genomic and cDNA Library: 8 Hours

Strategies for Construction of Genomic library, Construction of cDNA library- mRNA enrichment, Reverse transcription, Selection and screening of recombinant clones- screening of genomic and cDNA libraries.

Unit 4: Cloning interacting genes and in vitro mutagenesis: 8 Hours

Gel retardation assay, DNA foot printing, Yeast Two System and Yeast Three Hybrid System. ChIP-chip split hybrid and reverse hybrid, Phage display and transposon tagging, Site-directed mutagenesis and Protein Engineering, Transcript analysis techniques, Protein- protein interactions by GST- pull down, Western-blot, Far western, co-immunoprecipitation etc.

Unit 5: Expression Strategies for Heterologous Genes: 8 Hours

DNA Transfection methods, Reporter gene assays, Expression in Bacteria, Yeast, Insect and mammalian systems

Unit 6: Application of DNA Recombinant Technology: 8 Hours

Generation of transgenic organism, Gene knockdown and knockout (TALEN, CRISPR/Cas9, RNAi, and antisense). Artificial chromosomes, gene therapy, Recombinant DNA technology in medicine, agriculture and industry.

Suggested Readings:

1. Watson JD. Caudy AA. Myers RM., Witkowski JA. (2007) Recombinant DNA: Genes and Genomes—A Short Course 3rd
2. Hardin, C., Pinczes, J., Riell, A., Presutti, D.,

Miller, W., & Robertson, D. (2001). Cloning, gene expression, and protein purification (pp. 196-384). Oxford: Oxford University Press.
3. Sambrook, J., Fritsch, E. F., & Maniatis, T. (1989). Molecular cloning: a laboratory manual, Vol I, II and III. Cold spring harbor laboratory press. 3rd revised edition.
4. Glover, D. M., & Hames, B. D. (1995). DNA cloning 3: a practical approach. IRL Press Ltd.
5. Walker, M. R., & Rapley, R. (1997). Route Maps in Gene Technology. Blackwell Science Ltd., Oxford.
6. Kingsman, S. M., & Kingsman, A. J. (1988). Genetic engineering: an introduction to gene analysis and exploitation in eukaryotes. Blackwell Scientific Publications.
7. Glick, B. R., & Pasternak, J. J. (1998). Principles and applications of recombinant DNA. ASM, Washington DC, 683.
8. Primrose, S. B., & Twyman, R. (2013). Principles of gene manipulation and genomics. John Wiley & Sons.
9. Nicholl, D. S. (2008). An introduction to genetic engineering. Cambridge University Press.
10. Singrer M., & Berg, P (1991). Genes & Genomes, a Changing perspective. University Science Books, Mill Valley, California
11. Horve, C. (2016), Gene Cloning and Manipulation. Cambridge: Cambridge University cross. doi: 10. 1017/CB0978051180.
12. Tererrce A. (T.A.) Brown (2017) Genomes 4, Fourth edition. Garland Science: New York, NY.
13. Terence A (T. A) Brown T.A. (2016) Gene cloning and DNA analysis: an introduction 6th ed. Wiley-Blackwell UK.

L	T	P	C
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Course Code	**3SBT204**
Course Title	**Microbial Genetics**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to -

1. Identify types of mutations including spontaneous and induced mutations and understand mechanisms of mutagenesis, DNA damage repair and DNA recombination pathways.
2. Understand molecular mechanisms of gene transfer in microbes and phages and relate the role of these mechanisms for fine structure mapping of genes.
3. Apply the knowledge on the results of genetic experiments to find out number of genes involved in a process, gene order, distance between genes and fine structure mapping of genes.
4. Integrate the role of extrachromosomal elements including plasmids and transposons in genetic analysis and their roles in evolution.

Syllabus: **Teaching hours: 45**

Unit I: Principles of Microbial Genetics: 7 Hours
Basic procedure and terminology, selection and classification of variations, Mutations – Types and screening; Mechanism of mutagenesis, Directed mutations, Use of mutations.

Unit 2: Genetic Analysis of Bacteria: 9 Hours
Genetic mapping, Linkage and Multifactor Crosses, Deletion mapping, Complementation, Gene transfer mechanisms—transformation, conjugation, transduction.

Unit 3: Phage Genetics: 8 Hours
Genetics of temperate and virulent phage, Lytic phage - Phage mutants, genetic recombination in phages; Fine structure mapping of T4 *rII* locus.

Unit 4: DNA Damage and Repair: 6 Hours
Types and mechanisms of DNA repair.

Unit 5: Recombination: 7 Hours
Models of recombination - homologous, site-specific and non-homologous or illegitimate recombination. Transposons in bacteria and yeast; Mechanism of transposition.

Unit 6: Extra-chromosomal Genetic Elements: 8 Hours
Plasmids – Classification, Incompatibility, copy number control; Genetics of restriction modification systems.

Suggested Readings:

1. Brown, T.A. Genetics - A Molecular Approach, 3rd edition, BIOS Scientific Publishers, 2004.
2. Brown, T.A. Genomes 3, G.S. Garland Science, 2007.
3. Dale, J.W. and Park, S.F. Molecular Genetics of Bacteria, 5th edition, Wiley-Blackwell, 2010.
4. Das, H.K. Textbook of Biotechnology, 2nd edition, Wiley Dreamtech, 2005.

5. Gardner, E.J. Simmons, M.J. and Snustad, D.P. Principles of Genetics, 8th edition, John Wiley and sons, 2004.
6. Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. (Eds.), Lewin's Genes X, 10th edition, 2011.
7. Maloy, S.R., Cronan Jr., J.E. and Freifelder, David. Microbial Genetics, 2nd edition, Narosa Publishing House, 2009.
8. Snustad, D.R. and Simmons, M.J. Principles of Genetics, 5th edition, John Wiley and sons, 2010.

L	T	P	C
-	-	14	7

Course Code	3SBT211
Course Title	Laboratory II

Course Learning Outcomes

At the end of the course, students will be able to-

1. Understand the basics of bioinformatics tools, immunological techniques and experiments related to molecular biology, microbial genetics, microbial fermentation and clinical biochemistry.
2. Analyze the data obtained from molecular analysis of RNA, DNA and protein, clinical biochemistry, genetics and fermentation experiments and interpret the results.
3. Apply the techniques based on requirement in analysis of biomolecules and in conducting research.

Syllabus: **Teaching hours: 210**

1. Pubmed searches, Scopus and Biological databases
2. Structure visualization and statistical methods, sequence similarity search, Introduction to Metagenomics, Pairwise and multiple sequence alignment
3. Docking of protein and ligand, protein-protein docking and its interpretation for clinical targets.
4. Prediction of protein structure, 2D-3D protein structure and prediction
5. Use of UCSC genome browser to find locations of a sequence in a particular genome
6. Phylogeny and its evolutionary analysis
7. Lead generation and optimization
8. Drug docking and its analysis, Use of Computer simulation, In-silico cloning
9. Isolation of Plasmid DNA, Genomic DNA and RNA, Agarose gel electrophoresis
10. Perform Restriction digestion
11. Perform PCR and qPCR
12. UV Survival curve
13. UV mutagenesis, Isolation of drug resistant mutants
14. Determination of MIC and MBC of streptomycin for bacteria
15. Induction of the lac operon in E. coli
16. Microbial production, recovery and estimation of Exopolyaccharide/ Alcohol/ Citric acid in shake flask/ lab-scale fermentor
17. Solid-state fermentation
15. Purification of Immunoglobulin from normal serum/ anti- sera using affinity and ion-exchange chromatography
16. SDS-PAGE and immunoblot for isolated IgG
17. Perform ELISA for serum antigen

Suggested Reading:

1. Mount, David W., and David W. Mount. Bioinformatics: sequence and genome analysis. Vol. 1. Cold Spring Harbor, NY: Cold spring harbor laboratory press, 2001.
2. Andreas D.Baxevanis, B.F. Francis Ouellette, "Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins", Third edition, 2005 2006, ISBN : 978-81-265-2192-0, published by John Wiley & Sons INC. , U.K.
3. Vittal R.Srinivas, "Bioinformatics - A Practical Guide to the analysis of Genes and Proteins" , 2005, ISBN : 978-81-203-2858-7, published by PHI Learning Private Limited, New Delhi.
4. Current Protocols in Immunology (1995) 1.0.3-1.0.6,Contributed by John Donovan and Patricia Brown.
5. Jain, S. Mohan and Saxena, Praveen K. Methods in Molecular Biology: Protocols for In Vitro Cultures and Secondary Metabolite Analysis of Aromatic and Medicinal Plants. Humana Press, 2009
6. Pollack, Robert A.; Mondschein, Walter; Modesto, R. Ronald and Findlay, Lorraine, Laboratory Exercises in Microbiology, 3rd eds. John Wiley & sons Inc. 2009

7.Casida, Lester Earl. "Industrial microbiology." Industrial microbiology. 2016.

L	T	P	C
-	-	2	2

Course Code	**3SBT212**
Course Title	**Seminar II**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand the concepts of scientific paper presentation.
2. Analyze the scientific writing and data presented in Research papers.
3. Apply the knowledge and skill for structured writing and presentation of technical research reports.

Syllabus: **Teaching Hours: 30**

The students have to give seminars on a research paper of their interest from any of the biological fields which will be open for discussion. The students will have to submit the hardcopy of the selected manuscript along with a summarised write up of the paper in their own words. This course has been designed to provide a platform for the students to develop their communication, presentation and confidence to face the audience.

Supplementary Courses

L	T	P	C
1	-	-	-

Course Code	**3SBT2E2**
Course Title	**Professional English**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand the basics of English grammar, phonetics and mechanics of language.
2. Use appropriate English vocabulary for fluent and confident communication in English.
3. Demonstrate communication capacities in speaking, writing, listening and narrating in English.

Syllabus: **Teaching Hours: 15**

Unit 1: Introduction to communication: Idioms & Phrases, Basic Nonverbal communication, Barriers to Communication,

Unit 2: Business Communication at work place: Letter components and layouts, planning a letter, Process of Letter writing, Email Communication, Employment Communication, Notice Agenda and Minutes of Meeting

Unit 3: Report Writing: Effective Writing, Types of Business Reports, Structure of Reports, Gathering Information, Organization of Material, Writing Abstract and Summaries, Writing Definitions, Meaning of Plagiarism and Precaution.

Unit 4: Required Skill: Reading Skill, Note-Making, Precise Writing, Audio visual Aids, Oral Communication.

Unit 5: Mechanics of Writing: Transition, Spelling Rules, Hyphenation, Transcribing Numbers, Abbreviating Technical and Non-Technical Terms, Proof Reading.

Suggested Readings:

1. Technical Communication: Principles and Practice, by Meenakshi Raman and Sangeeta Sharma, Oxford University Press, IInd Edition

Value Added Course:

L	T	P	C
2	-	-	-

Course Code	**3SBT2S1**
Course Title	**Professional Development and Resume Writing**

Course Learning Outcomes (CLO):

At the end of the course, the students will be able to:

Design their CV which will evoke interest and help them in their summer internship; will provide an attitude of professionalism and empower them with decision making abilities.

Syllabus:

Unit 1:Interview Etiquettes and CV writing: **8 hour**

Right approach to interview, Preparation for interview, Do's and Don'ts in Interview. Making Effective CV and understanding essential do's and don'ts.

Unit 2: Professional development: 8 hour
Understanding Professionalism. Aspects of professionalism. Traits of effective and successful professionals. Professional Ethics.

Unit 3:Decision Making: 8 hour
Process of decision making, Factors to consider while making a decision, Tools for making good decisions, Win-Win approach to decision making. 8 hours

Unit 4: Self Study and Group Discussion 6 hour

Elective Courses

L	T	P	C
3	-	-	3

Course Code	**3SBC2E1**
Course Title	**Human Genetics**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand and appraise the fundamental principles of inheritance, structural and functional aspects of cellular genetic material, will learn collecting and interpreting genetic related history, making pedigree chart, and linkage and association prediction studies
2. Evaluate various laboratory approaches of study of genetic material including conventional and updated methods of genomic studies for nuclear and mitochondrial genetic elements, coding and non-coding DNA and RNA
3. Demonstrate understanding regarding various models of study of genetic aetiology involved in various single gene, complex, and multifactorial disease conditions; Evaluate the molecular mechanisms and their cross-talk responsible for various diseases including cancer, diabetes and other dreadful diseases, articulate host-environment interactions
4. Demonstrate understanding of available knowledge and can employ them by making use of various updated databases related to human genetic, genomic, phenotypic, and genetic conditions related databases

Syllabus: **Teaching hours**: **45**

Unit 1: Mendelian principles of inheritance: 10 Hours

Dominance, segregation, independent assortment; alleles, multiple alleles, pseudo-allele, complementation tests; Extensions of Mendelian principles: Co-dominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters; extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance, mitochondrial mutations and myopathies.

Unit 2: Organization of human genome and genes: 9 Hours

General organization of human Genome-Nuclear and Mitochondrial, Mitochondrial Genome organization, distribution of tandems and interspersed repetitive DNA, Gene distribution and density in human nuclear genome, Organization of genes: rRNA encoding Genes, mRNA encoding Genes, small nuclear RNA genes, Overlapping genes, genes within genes, multigene families, pseudo genes, truncated genes and gene fragments.

Unit 3: Gene mapping: 10 Hours

Pedigree analysis, LOD score for linkage testing, linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids; strategies in identifying human disease genes in pre and post Human Genome project; low and high resolution mapping; Principles and strategies for identifying unknown disease or susceptibility genes

Unit 4: Animal Models for Human Diseases: 6 Hours

Potential of using animal models for human diseases, Types of animal models, transgenic animals, procedures of production and application in the study of different diseases; Gene editing and gene therapy**,** Induced pluripotent stem cells; transgenic animals to model complex diseases.

Unit 5: Cytogenetics and other methods of detection of genetic aberrations: 6 Hours

Human chromosomes structure, number and classification, methods of chromosome preparation, banding patterns. Structural and numerical alterations of autosomes and sex chromosomes; Molecular cytogenetic techniques, Fluorescence in situ hybridization using various types of probes, Multiplex FISH and spectral karyotyping, comparative genomic

hybridization, microarray, Whole Exome and Whole Genome sequencing.

Unit 6: Data Mining in Genetics Research & Clinical Management: 4 Hours

Introduction to Internet based cataloguing of Genetic Aberrations in various diseases including Cancer, OMIM, Mitelman database of chromosome aberrations in cancer, Borgaonkar database of chromosomal variations in man, London Dysmorphology Database, Human Variome project, Human Phenome project, Encode project, Phenomizer and other automation approaches in phenotyping.

Suggested Readings:

ISCN 2016, Jean McGowan-Jordan, A. Simons, M. Schmid; Karger, 2016

1. Rooney D. E., and Czepulkowski, B. H., Human Cytogenetics: A Practical Approach (Vol. I & II), 1992 Edition, Oxford University Press, 1992.
2. Griffith A. J.F., Wessler S.R., Carroll, S.B., and Doebley J., Introduction to Genetic Analysis, 10th Edition, W. H. Freeman, 2010.
3. Benjamin P., Genetics: A Conceptual Approach & Problem Solving, 2008, W. H. Freeman, 2008.
4. Hedrick, P. W. (2011) Genetics of Populations, 4th Edn., Jones & Bartlett Publ.
5. Vogel and Motulsky's Human Genetics: Problems and approaches, Michael R. Speicher, Stylianos E. Antonarakis, Arno G. Motulsky, Springer; 4th ed. 2010 edition.
6. The AGT Cytogenetics Laboratory Manual, M.J.Barch, T.Knutsen, and J.Spurbeck.,Third Edition,Lippincott-Raven Publishers, Philadelphia (1997)
7. Genomic Imprinting and Uniparental Disomy in Medicine by Eric Engel, Stylianos E. Antonarkis, Wiley-Liss, Inc. ISBNs: 0-471-35126-1 (Hardback); 0-471-22193-7
8. Ricki Lewis Human Genetics Concepts and Applications 10th Edition, 2011, McGraw-Hill Science.
9. The Science of Genetics, Atherly et al (1999), Saunders
10. Robbins & Cotran, Pathologic Basis of Disease, 8th Edition, Elsevier, 2010.
11. Strachan Tom and Read Andrew P. (2011) Human Molecular Genetics, 4th Edition, Garland Science (Taylor and Francis Group), London and New York

L	T	P	C

3	-	-	3

Course Code	3SBC2E2
Course Title	Reproductive Physiology

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Demonstrate an understanding of structure and function of reproductive systems.
2. Apply the basic knowledge to understand the molecular mechanisms of gametogenesis and its regulation.
3. Analyse the functional modulation and establish a relationship between various functional aspects of reproductive physiology
4. Evaluate and interpret the cause of pathogenicity or dysfunction and critically identify the mode of action.
5. Create and develop therapeutic or preventive strategies for reproductive irregularities.

Syllabus **Teaching hours**: **45 Hours**

Unit 1: Human Reproductive System 8 Hours

Structure, function of male and female reproductive function; Functional assessment of male and female functioning; Mechanism and molecular events of fertilization, Preembryonic Development, Pregnancy, Labour and Lactation.

Unit 2: Gametogenesis 10 Hours

Spermatogenic Cycle; Its Molecular changes, Hormonal Regulation, Spermiation and Spermiogenesis; Sperm capacitation; Molecular and Biochemical changes, decapacitation. Process of folliculogenesis and its hormonal control. Recruitment, selection, dominance of follicle and signalling for ovulation. Follicle wall: Theca, differentiation, steroid hormone synthesis, menstrual cycle and Menopause. Mechanism and hormonal control of ovulation; Histogenesis, function, maintenance and luteolysis during Corpus Luteum. Prostaglandins and their role in reproduction.

Unit 3: Gonadal Steroidogenesis 9 Hour

Autocrine, Paracrine and Endocrine Regulation of Gonadal Steroidogenesis, Regulation of Expression of Genes Encoding Steroidogenic Enzymes.

Unit 4: Molecular Aspect of Sex Differentiation

5 Hours

Location of Sry -Gene and its Critical Period of Expression, Specific Cell Type Engaged in SRY - Gene Expression, Downstream Genes Regulation by SRY -- Gene Like Amh Gene, Aromatase Gene, Ar-Gene, 5a-Reductase Gene, Sox -9 gene and Z-Gene.

Unit 5: Stress and Reproduction 5 Hour

Stress and Pituitary Gonadotropin, Stress and Cytokines, Oxidative Stress and Reproductive Activities

Unit 6: Reproductive Immunology 8 Hours

Role of immunological cells in the male and female reproductive system, understanding the normal and abnormal physiological events influenced by reproductive immune cells.

Suggested Readings:

1. Knobil, E. and Neil, J. D., The Physiology of Reproduction, Vol 1 and 2, Raven Press, 1988.
2. Wang, C., Male Reproductive Function, Kluwer Academic Publishers, 1999.
3. Zuckerman, B. S. Z., Weir, B. J. and Baker, T. G., The Ovary, Academic Press, 1977.
4. Leung, P. C. K. and Adashi, E. Y. (Ed), The Ovary, Elsevier (Academic Press), 2004.
5. Desjardins, C. and Ewing, L. L., Cell and Molecular Biology of Testis, Oxford University Press, USA, 1993
6. Yen, S. S. C., Jaffe, R. B., and Barbieri, R. L. (Ed), Reproductive Endocrinology: Physiology, Pathophysiology, and Clinical Management, Saunders Publisher. USA, 1999.
7. Chedrese, P. J., Reproductive Endocrinology: A Molecular Approach, Springer Publishers, 2009.
8. Carrell, D. T. and Peterson, C. M., Reproductive Endocrinology and Infertility, Springer Publishers 2010.

L	T	P	C
3	-	-	3

Course Code	**3SBC203**
Course Title	**Advanced Immunology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand how MHCs play critical role in shaping specific adaptive immune responses
2. Select target antigen or immunogen against which immune response is generated
3. Design adjuvant to induce B and T cell responses
4. Develop strategies to regulate immune response against the self

Syllabus: Teaching hours: 45

Unit 1: Major Histocompatibility Complex (MHC) Genes and Products: 9 Hours

Polymorphism of MHC genes, Role of MHC antigens in immune responses, MHC antigens in transplantation.

Unit 2: 10 Hours

Antigen processing and presentation, Cytokines and Chemokines; Microbial Associated Molecular Patterns – TLR, NLRs.

Unit 3: B-Lymphocyte Development and Differentiation: 6 Hours

B cell differentiation in Bone marrow, B cell signal transduction, Antigen dependent B cell differentiation - primary and secondary follicles.

Unit 4: T lymphocyte development and Differentiation: 10 Hours

Thymus – Negative and positive selection. T lymphocyte Activation and differentiation - subtypes of Th cells, CD8 T cell activation, γδ T lymphocytes, T and B cell memory.

Unit 5: Tolerance: 7 Hours

Peripheral tolerance, Immunosuppression, Transplantation

Unit 6: Clinical Immunology: 7 Hours

Hypersensitivity - Types I, II, III and IV; Autoimmunity; Cancer immunology.

Suggested Readings:

1. Murphy, K., & Weaver, C. (2016). Janeway's immunobiology. Garland Science.
2. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2007). Kuby immunology. Macmillan.
3. Greenberg, S., Silverstein, S. C., & Paul, W. E. (1993). Fundamental immunology. Fundamental Immunology, 509.
4. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2014). Cellular and molecular immunology. Elsevier Health Sciences.
5. Coico, R., & Sunshine, G. (2015). Immunology: a short course. John Wiley & Sons.
   Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2016). Roitt's essential immunology. John Wiley & Sons.

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L	T	P	C
3	-	-	3

Course Code	**3MB2E2**
Course Title	**Microbial Ecology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand principles of ecology and interactions among microorganisms and their environment
2. Analyze beneficial and pathogenic interactions of microorganisms with plants and animals
3. Comprehend role of microorganisms in biogeochemical cycling of elements

Syllabus

Unit 1: Fundamentals of ecology: 5 Hours

The ecosystem, energy in ecological systems, energy partitioning in food chains and food webs, history and scope of ecology

Unit 2: Interactions among microbial populations: 7 Hours

positive and negative interactions, interactions between diverse microbial populations

Unit 3: Interactions between microorganisms and plants: 8 Hours

Interaction with plant roots – rhizosphere and mycorrhizae, interactions with aerial plant structures, microbial diseases of plants

Unit 4: Microbial interactions with animals: 9 Hours

Microbial contribution to animal nutrition, fungal predation on animals, other symbiotic relationship eg. Symbiotic light production and novel prokaryotic endosymbionts, ecological aspects of animal diseases.

Unit 5: Biogeochemical cycling I: 8 Hours

Carbon cycle, Hydrogen cycle, Oxygen cycle

Unit 6: Biogeochemical cycling II: 8 Hours

Nitrogen cycle, Sulphur cycle, Phosphorus cycle, cycling of other elements

Suggested Readings:

1. Atlas, R.M. and Bartha, R. Microbial Ecology, 4th edition, Pearson Education, 2009.
2. Maier, R.M., Peppper, I.L. and Gerba, C.P. Environmental Microbiology, 2nd edition, Elsevier Academic Press, 2009.
3. Paul and Clerk, Soil Microbiology and Biochemistry, 2007.
4. Paul, E.A. (Ed.). Soil Microbiology, Ecology and Biochemistry, 3rd edition, Academic Press, 2007.
5. Pepper, I.L. and Gerba, C.P. Environmental Microbiology – A Laboratory Manual, 2nd edition, Elsevier Academic Press, 2005.
6. Manahan, S.E. Environmental Chemistry, 9th edition, CRC Press, 2010.
7. Odum, E.P. and Barrett, G.W, Fundamentals of Ecology, 5th edition, Cengage Learning, 2005

L	T	P	C
3	-	-	3

Course Code	**3SBC211**
Course Title	**Neurobiology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to

1. To understand basic concept of organisation of human nervous system, its components and their interrelationship along related theories and principles
2. To comprehend and analyse how brain exerts its functional regulation on physiologocial function via down stream molecular signalling.
3. To discuss and relate brain's dynamic changes over time during physiological functions.
4. To discuss and analyze biochemical events and pathophysiological changes leading to mental & behaviuoral disorders and critically evaluate new possible therapies being investigated to treat neurological disease.

Syllabus: **Teaching hours**:**45**

Unit 1: Physiology of Nervous System: 9 Hours

Components of the Nervous System, Neuron and Glial Cells - Different Types, Structure, Function. Synapse: Nerve Impulse, Neurotransmitters. Organization of Nervous System- CNS, PNS. PNS- Somatic Nervous System; Autonomic Nervous System-Sympathetic and Parasympathetic System; Enteric Nervous System

Unit 2: Brain and Spinal Cord 9 Hours

Embryological development, protection, blood brain barrier, CSF, structural and functional organization, Spinal cord anatomy, Spinal Nerves, Spinal Meninges, Grey and White Matter of Spinal Cord, Joint Reflexes.

Unit 3: Neurotransmitters 9 Hours
Chemistry, Synthesis, Storage and Release of Neurotransmitters, Transmitter Action, Neurotransmitter Receptor types-Ionotropic and Metabotropic, Classification for Glutamate, GABA, Acetylcholine, Serotonin, Epinephrine and Norepinephrine Receptors, Synaptic Modulation and Mechanism of Neuronal Integration.

Unit 4: Synaptic Transmission 6 Hours
Transmission across the Synapse, Pre and Post Synaptic Events, Membrane Potential in the Steady State Action, Action Potential and propagation of Nerve Impulse, Mechanism of Action of cAMP, cGMP, IP3, DAG, Calcium as second messengers, Neurotransmitter Sensitive second messengers and their role in Neuronal Function.

Unit 5: Psychopharmacology and Biochemical theories of Mental Disorders: 9 Hours
Chemistry of Neuroleptics and Anxiolytics, Antidepressants, Hallucinogenic Agents, Biochemical theories of Mental Disorders and Neurodegenerative Disorders like Parkinson's, Alzheimer's disease, Amyotrophic lateral sclerosis and Senile Dementia.

Unit 6: Sleep, Learning and Memory: 6 Hours
Mechanism of Sleep- Intrinsic rhythms, SCN & pineal gland, States of sleep, pathway and its physiology- REM & NREM sleep, Wakefulness, Functions of Sleep. Definition & Types of learning, Long term Potentiation & Long term Depression, Memory consolidation and priming, Agents affecting Learning and Memory.

Suggested Readings:

1. Purves, D, Augustine, G., Neuroscience, Sinauer, 2000.
2. Tortora, G. J. and Derrickson, B. H., Principles of Anatomy and Physiology, Weily and Sons, 2009
3. Breedlove, M. C., Watson, N. V., Rozenzweig M. R., Biological Psychology: An Introduction to Behavioural, Cognitive and Clinical Neuroscience. Sinauer Associates, 6th Edition, 2010.
4. Gross C. G. A Hole in Head- More tales in the history of neuroscience. Cambridge MIT Press, First edition, 2012.
5. Amthor Frank, Neuroscience for dummies. USA John Wiley & Sons Canada Ltd. 2012.
6. Kolb, Bryan; Whishaw, Ian Q. An Introduction to Brain and Behavior, New York Worth Publishers 2011
7. Longstaff, A. Developmental Biology. Sinauer Associates, 6th Edition, 2010.
8. Hell, J. W., Ehlers, M. D., (Editors), Structural and functional organization of the synapse, Springer, 2008
9. Turkingtons, C., The Brain and Brain Disorders, Viva Books, 2009
10. Kandel, E., Schwartz, J. and Jessell T., Essentials of Neural Science and Behaviour, McGraw-Hill, 2003.
11. Levitan, I. B., Kaczmarek L.K., The Neuron, Cell and Molecular Biology, Oxford University Press, 2001

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SEMESTER III

Core Courses

L	T	P	C
3	-	-	3

Course Code	**3SBT301**
Course Title	**Molecular Microbial Physiology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Describe the principles of the energy-yielding and consuming reactions, the various catabolic and anabolic pathways, the transport systems and the mechanisms of energy conservation in microbial metabolism
2. Recognize the extent of metabolic diversity present in this microbial world and identify various physiological groups of bacteria with their metabolic special features.
3. Analyse microbial physiology related topics by working on assignments and to compose a concise report
4. Critically think and integrate conceptual information into an understanding of signal transduction, adaptation to stress and differentiation of microbial systems

Syllabus: **Teaching hours**: **45**

Unit 1: Central Metabolism: 10 Hours

Glycolysis, ED pathway, phosphoketolase pathway oxidative pentose phosphate pathway TCA cycle, glyoxalate cycle, gluconeogenesis, regulatory aspects, Metabolism of sugars other than glucose

Unit 2: Electron transport chains and Phototrophy: 9 Hours

Mitochondrial and bacterial electron transport chains, Aerobic respiration and anaerobic respiration, Bacteriorhodopsin and energy generation, oxygenic and anoxygenic Photosynthesis. Mechanism of photosynthesis in bacteria, cyanobacteria and algae

Unit 3: Chemolithotrophy and CO_2 fixation: 10 Hours

Nitrate reduction: assimilatory vs. dissimilatory, nitrification, denitrification, electron transport in iron bacteria, sulphur bacteria, Calvin cycle, reductive TCA cycle

Unit 4: Signal Transduction in Prokaryotes: 6 Hours

Two component system, Phosphorelay, Chemotaxis-Genes and Proteins involved in chemotactic response to attractant and repellent.

Unit 5: Microbial Adaptation to stress: 6 Hours

Temperature, salt and osmotic stress and oxidative stress, Quorum sensing.

Unit 6: Differentiation in Microbial Systems 4 Hours

The model of Sporulation in Bacillus, the two component signalling system, stages of Sporulation, Proteins and genes involved in Sporulation.

Suggested Readings:

12. White, D., Physiology and Biochemistry of prokaryotes, 3rd Edn. Oxford Univ. Press, 2007.
13. 2. Moat, A. G. and Foster, J. W., Microbial Physiology, 3rd Edition, Wiley-Liss Publ, 1995.
14. E. L. Sharoud, Bacterial Physiology – A Molecular Approach, Springer, 2008.
15. Byung Hong Kim, Geoffrey Michael Gadd, Bacterial Physiology and Metabolism, Cambridge University Press, Cambridge, 2008.
16. Doelle HW, Bacterial Metabolism, Elsevier India Pvt. Ltd., New Delhi, 2005.
17. Gerhard Gottschalk, Bacterial Metabolism, 2nd edn., Springer-Verlag, New York, 2006.

L	T	P	C
3	-	-	3

Course Code	**3SBC304**
Course Title	**Cancer Biology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Describe and appraise the fundamentals of cellular processes involving molecular genetic basis of multistep process of carcinogenesis
2. Illustrate mechanisms of physical, biological, and chemical cancer causing agents as well as

spontaneous cancer onset in terms of role of oncogenes and tumour suppressor genes, deregulation of cell cycle and differentiation in cancer cells

3. Articulate host-environment interactions including susceptibility factors in cancer predisposition; cancer classification systems; principles of cancer diagnosis, prognosis, and response to therapy and management in the laboratory
4. Demonstrate understanding of cancer control for disease-free, relapse-free, and metastasis-free longer survival using knowledge of molecular players and factors governing cancer spread from primary sites, metastasis cascade, and invasion.

Syllabus: **Teaching hours**: **45 Hours**

Unit 1: Introduction to Cancer Biology: 8 Hours
History of cancer and various theories of carcinogenesis, Warning signs of cancer; Hallmarks of cancer; Types of cancer; cancer classification systems: TNM, FAB, WHO; Cancer staging and Grading; Global Trends in cancer incidence and death rate; Baseline and environmentally induced cancer rate

Unit 2: Molecular Cell Biology of Cancer: 8 Hours
Proto-oncogenes and Oncogenes, Mechanisms of inactivation of proto-oncogenes and affected cellular pathways; modulation of growth factors, receptors, signal transduction, and cell cycle; Retroviruses and Oncogenes; Tumour suppressor genes, two-hit theory, Identification and detection of oncogenes and tumor suppressor genes, mi-RNA and other regulators of cellular pathways and cancer

Unit 3: Cancer Genetics, Cytogenetics and Genomics: 8 Hours
Constitutional and Acquired Genetic Determinants of Cancer; Genetic Predisposition to Cancer; Familial Cancers; Molecular pathogenesis of acquired chromosomal aberrations, fusion genes, gene amplification, whole genome, various approaches for detection of genetic changes and targeted therapy with examples of clinical importance

Unit 4: Principles of Carcinogenesis: 8 Hours
Physical, Chemical and Biological Carcinogenesis, Genotoxic and non-genotoxic Metabolism and Targets of Carcinogenesis, Molecular mechanism of Carcinogenesis. Cancer risk factors and differential susceptibility, Cancer metabolism

Unit 5: Cancer Metastasis: 8 Hours
Metastatic cascade; Basement Membrane disruption; Three-step theory of Invasion; Heterogeneity of metastatic phenotype; Epidermal Mesenchymal Transition, Molecular signatures and organ preference in metastasis, Proteinases and invasion

Unit 6: Therapeutic Approaches: 5 Hours
Strategies for cancer treatment; Tumor markers and molecular markers for cancer diagnosis, prognosis, and therapy decisions; Cancer Immunology and therapeutic interventions, Targeted drug delivery and drug delivery systems, Cancer vaccine, Clinical trials, Gene Therapy, Targeted therapy, personalized medicine, survival and response monitoring

Suggested Readings:

1. Weinberg R., Biology of Cancer, Garland Science, June, 2010
2. D. Liebler, Proteomics in cancer research, 2004
3. David M. Terrian, Cancer cell signalling, Methods and protocols, Volum 218 (Methods in Molecular Biology), 2003.
4. Strachan Tom and Read Andrew P. (2010) Human Molecular Genetics, 4th Edition, Garland Science (Taylor and Francis Group), London and New York
5. K.L. Rudolph, Telomeres and Telomerase in ageing, disease, and cancer, 2008.
6. Maly B.W.J., Virology: A practical approach, IRL Press, Oxford, 1987.
7. Dunmock N.J and Primrose, S.B., Introduction to modern Virology, Blackwell Scientific Publications. Oxford, 1988.
8. Knowles, M.A., Selby P., An Introduction to the Cellular and Molecular Biology of Cancer, Oxford Medical publications, 2005.
9. Vincent, T. De Vita, Lawrence T. S., Rosenberg, S. A., Cancer: Principles & Practice of Oncology, 10th Edition, Lippincot, 2011
10. http://atlasgeneticsoncology.org
11. http://cgap.nci.nih.gov/Chromosomes/Mitelman
12. http://www.humanvariomeproject.org
13. https://www.genome.gov/hapmap

Final Syllabus of Biotechnology for the Academic year 2022-23

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L	T	P	C
3	-	-	3

Course Code	**3SBT308**
Course Title	**Animal Biotechnology**

Course Learning Outcomes (CLO)

At the end of the course, students will be able to -

1. Describe the basics of maintainence of mammalian cell and generation of cell line using proper sterile techniques and optimum conditions of growth to develop mamalian cells.
2. To identify and comprehend experimental knowhow of various techniques involved in cell separation and quantitation using latest technology.
3. To relate and evaluate the applications of animal biotechnology gene therapy, toxicity testing, cancer research, animal breeding, vaccine production and other biotechnological products of industrial and medical benefits.
4. To relate to the social, cultural, economical, legal issues associated and comprehend the need Bioethics and IPR in biotechnological research.

Syllabus: Teaching hours: 45

Unit 1: The Culture Media for Animal Cell culture: 9 Hours

Introduction, history and concept of biotechnology. Media and Supplements, Serum, Serum Free Media, Natural Media, Feeder Layer on Substrate, Gas Phase for Tissue Culture. Source of Tissue, Primary culture. Stages of Commitment and Differentiation, Proliferation, Malignancy.

Unit 2: Subculture and Cell lines: 9 Hours

Cross Contamination, Terminology, Naming and Choosing cell line and its maintenance. Criteria for subculture, growth cycle and split ratio, propagation in suspension and attached culture.

Unit 3: Cloning and hybridoma technology:6 Hours

Vectors and Cloning, Somatic Cell Fusion, Hybridomas, HAT Selection, Medium, Suspension Fusion, Selection of Hybrid Clones, Organ Culture, Tumourigenesis

Unit 4: Cell Separation and Quantitation: 9 Hours

Separation techniques based on density, size, sedimentation velocity, antibody based techniques - immune panning, magnetic sorting, and fluorescence activated cell sorting. Quantitation- Cell counting, cell weight, DNA content, protein, rate of synthesis, measurement of cell proliferation.

Unit 5: Characterization and differentiation: 6 Hours

Authentication, Record keeping, Provenance, parameters of characterization, Lineage and Tissue markers, cell morphology, Karyotyping, Chromosome banding. Differentiation- commitment, terminal differentiation. Lineage selection, proliferation and differentiation, commitment and lineage, markers of differentiation, induction of differentiation, cell interaction- homotypic and heterotypic. Cell – matrix interaction.

Unit 6: Applications of animal biotechnology and related problems: 6 Hours

Artificial animal breeding, cloning and transgenic animals, medicines, vaccines, diagnosis of diseases and disorders, gene therapy forensic application. Social, Cultural, Economical, Legal problems. Bioethics. IPR.

Suggested Readings:

1. Freshney, I., Cultures of Animal Cells, John Wiley and Sons Inc, 2010.
2. Cibelli, J., Robert P., Keith L.H.S., Campbell H., and West M. D., (Editors) Principles of Cloning, St. Diego Academic Press, 2002.
3. Mathur, S., Animal Cell and Tissue Culture, Agrobios (India), 2000.
4. Panno, J., The New Biology Series: Animal Cloning, Viva books Pvt. Ltd, New Delhi, 2010.
5. Mepham B. M., Bioethics- An introduction for Bioscience by, 2nd Edition, Oxford University Press, 2008.
6. Jacker, N. S., Johnson A. R., Pearlman R. A., Bioethics- An introduction to the history method and practice, 2nd Edition, Johnson Bartlett Publ. New York. 2010
7. Satheesh, M. K. Bioethics and Biosafety, I.K. International Publishing House Ltd, New Delhi. 2005

8. Glick, B. R., and Pasternak J. J., Molecular Biotechnology - Principles and applications of recombinant DNA, ASM Press , 3rd Edition., 2003.
9. Sullivan, S., Cowen C., and Eggan K., Human Embryonic Stem Cell: The Practical Handbook, 2007.
10. Freshney, R. I. (2010) Culture of Animal Cells, 6th Edn., Wiley-Blackwell.
11. Ramadass, P, Animal Biotechnology: Recent Concepts and Developments
12. Portner, Ralf. Animal Cell Biotechnology: Methods and Protocols.

L	T	P	C
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Course Code	**3SBT3E1**
Course Title	**Genomics and Proteomics**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1.Describe the understanding of origin and evolution of genomics and gene mapping.
2.Apply the knowledge to establish new molecular classification of the disease.
3.Evaluate the possibilities for application of pharmacogenomics and proteomics in drug discovery and development of personalized medicine.

Syllabus: Teaching Hours: 45hrs

Unit-1 Origin and Evolution of genomics and gene mapping 8 Hours

Origin of genomics, the first DNA genomes, genomes and human evolution, evolution of nuclear, mitochondrial and chloroplast genome, the concept of minimal genome and possibility of synthesizing it, genetic maps, physical maps, functional maps, comparative genomics and collinearity, synteny in maps.

Unit-2 Whole Genome sequencing technologies and genome assembly 8Hours

Principle of genome sequencing tools, automated Sanger sequencing, pyrosequencing, Illumina. oxford nanopore and PacBio Sequencing. Whole genome assembly pipeline. k- mer de bruijin graph. Human, Arabidopsis and Drosophila genome

Unit-3 Functional genomics 6 Hours

Concept of forward and reverse genetics, insertion mutagenesis (T-DNA and transport insertion), Targeting Induced Local Lesions in Genomes (TILLING), gene expression and transcript profiling, EST contigs, use of DNA chips and microarrays

Unit-4 Principle of basic protein preparation and separation 8 Hours

Preparation of protein isolates and fractionation /separation of proteins and peptides - basic methods of protein isolation from various sample types; electrophoretic separation techniques (IEF, SDS-PAGE, 2-D gel electrophoresis, DIGE, etc.); liquid chromatography (HPLC and FPLC); separation procedures for analysis of phospho-proteins and glycosylated proteins: multidimensional procedures for analysis of complex protein samples.

Unit-5 Strategies for protein identification 8 Hours

Mass-spectrometry of proteins - basic types of ionization techniques (ESI and MALDI) and hybrid instruments (TOF, ion trap and FTMS); protein identification methods; characterization of protein modifications. methods of protein quantification (relative and absolute quantification techniques)

Unit-6 Protein interactomes and protein modification in Proteomics and application 7 Hours

Methods of protein-protein interaction study (Y2H, tagging TAP, FLAG, His; ion mobility utilization); Phosphoproteomics, Glycoproteomics, protein microarray. Human proteome project. application of proteomics in diagnostic, drug development and agriculture.

Suggested Readings:

1.Pevsner, J., Bioinformatics and Functional Genomics, Second Edition, Wiley-Blackwell, 2009.
2.Mount, D. W., Bioinformatics: Sequence and Genome Analysis, CBS Publishers, 2004
3.Liebler, D., Introduction to Proteomics: Tools for New Biology, Human Press Totowa, 2002.

4.Campbell, A.M. & Heyer, L.J., Discovering Genomics, Proteomics and Bioinformatics. Benjamin/Cummings, 2002.
5. Twyman, R. Principles of Proteomics. London: Taylor & Francis, 2014.
6. Lovric J. Introducing Proteomics: From Concepts to Sample Separation. Mass Spectrometry and Data Analysis, published by Wiley, 2011

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Course Code	**3SBT311**
Course Title	**Laboratory III**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1.Perform experiments of primary cell and cell line culture, wastewater characterization and microbial physiology

2.Analyse the data obtained from cell culture, water analysis and microbial experiments to interpret the results.

3.Apply and correlate the knowledge obtained to analyse various agricultural and environmental conditions for designing probable treatment strategies.

Syllabus: Teaching Hours: 128 hrs

1. Isolation and preparation of hepatocyte, pancreatic cells or lymphocytes for primary cell culture
2. Estimation of live cells using Trypan blue test by hemocytometer and viability testing
3. Estimation of live cells using PI by flow cytometry
4. 4.Cell line passaging for establishing continuous cell culture
5. 5.To study early and terminal differentiation of mammalian cell using specific markers by
6. immunofluorescence technique
7. To study mammalian gene transfection in CHO/HEK 293 cells in vitro
8. Plotting diauxic growth of E. coli, establishing catabolite repression in E.coli through β-galactosidase activity.
9. Enumeration of free living nitrogen fixing population in soil by most probable number (MPN) method.
10. Estimation of the most probable number (MPN) of sulphate reducing bacteria in soil samples
11. Estimating soil microbial activity through soil respiration
12. Estimating soil microbial activity by dehydrogenase enzyme
13. Estimation of BOD
14. Testing for microbiological quality (Coli-form test) for potable water
15. Physico-chemical characterization of wastewater
16. Perform Protein purification by size exclusion chromatography and HPLC

Suggested Reading:

1. Doyle, Alan. Cell and tissue culture: laboratory procedures in biotechnology. John Wiley & Sons Ltd, 1998.
2. Freshney, R. Ian. "Basic principles of cell culture." Culture of cells for tissue engineering 3-22, 2006.
3. Freshney, R. Ian. Culture of animal cells: a manual of basic technique and specialized applications. 7th eds. John Wiley & Sons, 2016.
4. Prescott M. Lansing, Harley P. John, Klein A. Donald, Microbiology, 7th eds. McGraw-Hill Higher Education, 2008.
5. Cappuccino G .James, Sherman Natalie, Microbiology A laboratory manual, 7th eds. India Pearson Education Asia Pte. Ltd, 2007
6. Ian Pepper Charles Gerba Jeffrey Brendecke, Environmental Microbiology -A Laboratory Manual. 2nd eds. , Academic Press, 2005.
7. SOIL MICROBIOLOGY Second Edition by Robert L. Tate III
8. Principles and Practice of Soil Science: The Soil as a Natural Resource, 4th Edition, Robert E. White, 2005
9. Bailey & Scott's Diagnostic Microbiology, 14th Edition by Patricia Tille, 2021
10. Clescerl, L., A. Greenberg, and A. Eaton. "Standard Methods for Examining Water and Wastewater." American Public Health Association (APHA)/the American Water Works Association (AWWA)/the Water Environment Federation (WEF), Washington, DC 1999.

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Course Code	3SBT312
Course Title	Research Methods

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand the various kind of research designs and their importance in conducting the research work.
2. Propose original research proposal and demonstrate skills for effective communication through its defence.
3. Application of bio statistical tools for evaluation of statistical relevance of results obtained.

Syllabus: **Teaching Hour: 45**

Unit 1: Research: **8 Hours**

Definition of Research, Applications of Research and Types, Validity, Literature Review, Develop a Theoretical and Conceptual Framework, Writing up the Review, Formulating and Research Problem: Sources, Considerations, Definition of Variables, Types, Research Modeling: Types of Models, Model Building and Stages, Data Consideration.

Unit 2: Research Design: **14 Hours**

Design of Experiments, Objectives, Strategies, Replication, Randomization, Blocking, Guidelines for Design of Experiments, Simple Comparative Experiments- Two Sample T-Test, P-Value, Confidence Intervals, Paired Comparisons, Single Factor Experiment: Analysis of Variance (ANOVA), Randomized Complete Block Design .

Unit 3: Research Proposal: **12 Hours**

Contents-Preamble, The Problem, Objectives, Hypothesis, Study Design, Setup, Measurement Procedures, Analysis of Data, Organization of Report; Displaying Data tables, Graphs and Charts, Writing a Research Report- Developing an Outline, Key Elements- Objective, Introduction, Design or Rationale of Work, Experimental Methods, Procedures, Measurements, Results, Discussion, Conclusion, Referencing and Various Formats for Reference.

Unit 4 Scientific Communication skills: **11 hours**

Importance of communication in science, Types of communications, Communicating with scientific and non-scientific audiences,

Writing skills: Writing of Books and Research Papers, Report & Thesis Writing, Formats of Publications in Research Journals.

Verbal and presentation skills: Oral and Poster Presentations, Graphical abstract

Unit 5: Ethics and Scientific Conduct:

Good Laboratory practice (GLP) – Data Documentation, SOP Plagiarism, Scientific conduct and misconduct, Ethical Guidelines, Biosafety; Principles of Human and Animal Research ethics.

Suggested Readings:

1. Central Drugs Standard Control Organization Http://CDSCO.NIC.IN/
2. Http://WWW.Patentoffice.NIC.IN/
3. WWW.OECD.ORG/DATAOECD/9/11/33663321.PDF
4. Http://WWW.FDA.GOV/FDAC/Special/Testtubetopatient/Studies. Html
5. Ranjit Kumar, Research Methodology- A Step-By-Step Guide for Beginners, Pearson Education, Delhi. 2006.
6. Trochim, William M.K., 2/E, Research Methods, Biztantra, Dreamtech Press, New Delhi, 2003.
7. Montgomery, Douglas C. 5/E, Design and Analysis of Experiments, Wiley India, 2007.
8. C.R. Kothari and Gag, Gaurav, Research methodology- Method and Techniques, New Age International, New Delhi, 2019.
9. Besterfield, Dale H. 3/E, Total Quality Management, Pearson Education, New Delhi, 2005.
10. C. George Thomas, Research Methodology and Scientific Writing, New Delhi, 2015.
11. G Nageswara Rao, Bio-statics and Research Methodology, Hyderabad, 2018.
12. Kartikeyan, S. Chaturvedi, R.M and Bhosale, Comprehensive Textbook of Bio-statics and Research Methodology, Mumbai, 2016.

Practical

The students have to perform wet lab experimentation on the topic of project assigned to them such as standardization of the protocols.

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Course Code	3SBT3S6
Course Title	Summer Training

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

To provide an opportunity for the students to understand the laboratory need of industry and academics as well as research institutes and to prepare them for their goal.

Outline:
All the students undergo summer training during the summer break following their Semester II. This training has to be for minimum period of 21 days. The report and certificate should be submitted to library.

Elective Courses II

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Course Code	**3SBT309**
Course Title	**Vaccinology**

Course Learning Outcomes (CLO):
At the end of the course, students will be able to-

1. Have an idea about the history of various vaccines (subunit vaccines, peptide, DNA and RNA vaccines, live & killed vaccines and edible vaccines), composition of vaccines
2. Learn and develop understanding on the effective delivery of developed vaccine formulation to achieving robust immune responses
3. Understand the various methods to develop vaccines against viral diseases including, HIV, hepatitis, flu etc.
4. Learn and understand the basics of bacterial, protozoan vaccines with reference to malaria parasite
5. To design an efficacious vaccine based on our understanding of the immune response generated due to natural infection as well as the same induced by successful vaccines tried in human beings since 18th century.

Syllabus: **Teaching hours**: **45 Hours**

Unit 1: Introduction to Vaccinology and Classification: 7 Hours
History of vaccines, Immunological principles, Composition of vaccines: vaccine, adjuvant, conservative Concepts of vaccine development, types of vaccine (Conventional vaccines; Live and killed vaccines; New generaration vaccines; Sub unit vaccines; Synthetic peptide vaccines; Anti-idiotype vaccines; Recombinant DNA vaccines; Deleted mutant vaccines; Reassortment vaccines; DNA vaccines; Edible vaccines) vaccine, heat killed, X-irradiated, or live attenuated whole pathogen., challenges and possibilities with new vaccines and vaccine strategies

Unit 2: Development of novel vaccines and Vaccine Delivery: 6 Hours
Novel adjuvants, vaccine formats (DNA, viral vectors, dendritic cells), vaccines in development (HIV, malaria, pandemic influenza), Adjuvants; Carriers; Haptens; Vaccine delivery using nano particles; Standardization of vaccines; Safety, sterility and potency testing.

Unit 3: Vaccines for viruses: 8 Hours
HIV, CMV, flu, Hepatitis, herpes viruses, Conventional vaccines killed and attenuated, modern vaccines—recombinant proteins, subunits, DNA vaccines, peptides, immunomodulators (cytokines), Antisense RNA, siRNA, ribozymes, in silico approaches for drug designing.

Unit 4: Vaccine for bacteria: 8 Hours
Shigella, vibrio cholera, diphtheria, tetanus, pertusis, pneumococcus meningitis, toxoplasma, mycobacterium (BCG)

Unit 5: Vaccine for protozoa and parasite: 8 Hours
Malaria, Leishmaniasis, Enamoeba histolitica, schistosomiasis and other helminthic infections.

Unit 6: Reverse vaccinology and immunoinformatics: 8 Hours
Databases in Immunology , B-cell epitope prediction methods, T-cell epitope prediction methods, Resources to study antibodies, antigen-antibody interactions, Structure Activity Relationship – QSARs and QSPRs, QSAR Methodology, Various Descriptors used in QSARs: Electronics; Topology; Quantum Chemical based Descriptors. Use of Genetic Algorithms, Neural Networks and Principle Components Analysis in the QSAR equations

Suggested Readings:

1. Plotkin, S. A., Orenstein, W. A., and Offit, P. A., Vaccines. 5th Editon, Elsevier, 2008.
2. Immunopotentiators in Modern Vaccines by Schijns and O'Hagen
3. Robinson, A., Hudson, M.J., Cranage, M.P. Vaccine Protocols, C Second Edition, Humana Press, NY, 2003.

4. Chimeric Virus like Particles as Vaccines. Wolfram H. Gerlich (Editor), Detlev H. Krueger (Editor), Rainer Ulrich (Editor), November 1996 Publisher: Karger, S. Inc
5. Kindt, Kuby-Immunology (complements)
6. Current protocols in Immunology
7. Complement regulators and inhibitory proteins. Nat immunology Review volume 9, Oct 2009, 729-40

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Course Code	**3SMB307**
Course Title	**Microbial Diversity and Systematics**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to -

1. Recognize the extent of microbial diversity present in this world including prokaryotic and eukaryotic microbes and the importance of microbial diversity in different habitats including extreme environments.
2. Understand conventional and molecular methods used for studying microbial diversity and problems and limitations in microbial diversity studies.
3. Describe the microbial classification schemes and methods used for taxonomy, distinguish and differentiate the use of various taxonomic tools apt for classification and identification of microorganisms.
4. Apply the knowledge of biochemistry and physiology of extremophiles for their application potentials in Biotechnology.

Syllabus: **Teaching hours: 45 Hours**

Unit 1: Principles of Microbial Diversity: 9 Hours
Evolution of life, Principles and concepts of microbial diversity, Ecological diversity, Structural and Functional Diversity. Methods of studying microbial diversity – microscopy, nucleic acid analysis, physiological studies, CLPP, FAME.

Unit 2: Issues of Microbial Diversity: 7 Hours
Problems and limitations in microbial diversity studies, Diversity Indices, Loss of diversity, Sustainability and Resilience, Indicator species, Exploitation of microbial diversity, Conservation and economics.

Unit 3: Microbial Classification and Taxonomy: 9 Hours
Phenetic, Phylogenetic and Genotypic classification, Numerical Taxonomy, Taxonomic Ranks, Techniques for determining Microbial Taxonomy and Phylogeny – classical and molecular characteristics, phylogenetic trees; major divisions of life, Bergey's Manual of Systematic Bacteriology, Prokaryotic Phylogeny and major groups of bacteria.

Unit 4: The Archaea: 7 Hours
Ecology, Archaeal cell walls and membranes, genetics and molecular biology, metabolism, archaeal Taxonomy, Phylum Crenarchaeota, and Phylum Euryarchaeota.

Unit 5: Eukaryotic Diversity: 7 Hours
Physiological variation, identification, cultivation and classification of important groups of fungi, algae and protozoa.

Unit 6: Microbial Diversity in Extreme Environments: 6 Hours
Habitat, diversity, physiology, survival and adaptation, and biotechnological potentials of: Cold and thermal environment, Saline and deep sea environment, Anaerobic environment, Osmophilic and xerophilic environment, Alkaline and acidic environment.

Suggested Readings:

1. Cavicchioli, R. Archaea – Molecular and Cellular Biology, ASM Press, Washington, 2007.
2. Dworkin, M., Falkow, S., Rosenberg, E., Schleifer, K.H., Stackebrandt, E. (Eds.). The Prokaryotes. Vol. I – VII, Springer, 2006.
3. Garrity, G.M. and Boone, D.R. (Eds.), Bergey's Manual of Systematic Bacteriology, 2nd edition, Vol. I, Springer, 2001.
4. Garrity, G.M., Brenner, D.J., Kreig, M.R. and Staley, J.T. (Eds.), Bergey's Manual of Systematic Bacteriology, 2nd edition, Vol. II, Springer, 2005.
5. Gerday, C. and Glansdorff, N. Physiology and Biodiversity of Extremophiles, ASM Press, Washington, 2007.
6. Hurst, C.J, Crawford, R.L., Garland, J.L., Lipson, D.A., Mills, A.L. and Stetzenbach, L.D. Manual of Environmental Microbiology, 3rd Edition, ASM Press, Washington, 2007.
7. Madigan, M.T. and Martinko, J.M. Brock Biology of Microorganisms, 11th edition, Pearson Prentice Hall, 2006.

8. Mueller, G.M., Bills, G.F. and Foster, M.S. Biodiversity of Fungi – Inventory and Monitoring Methods, Elsevier Academic Press, 2004.
9. Willey, J.M., Sherwood, L.M. and Woolverton, C.J. Prescott, Harley and Klein's Microbiology, 7th edition, McGraw Hill, 2008.

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Course Code	**3SMB304**
Course Title	**Agriculture & Environmental Microbiology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Describe role of microorganism in recycling soil nutrients, biodegradation of complex plant polymers, sustaining and improving plant growth through improving nutrient availability, production of plant growth promoting substances and inhibiting pathogens.
2. Critically discuss the need for environmental microbiology and agricultural microbiology and explain their limitations.
3. Clarify application of microorganisms in varied fields of agricultural and environmental microbiology like bioremediation, bio fertilizers and waste water treatment.
4. Analyse various aspects of N_2 fixation, P solubilization, PGPR, biodegradation and bioremediation mechanisms provided by microbes

Syllabus: Teaching hours: 45

Unit 1: Biological Nitrogen fixation: 10 Hours

Physiology and Biochemistry of Nitrogen fixing organisms, Genetics and regulation of nif gene expression, Signalling factors and molecular interaction in establishing Rhizobia legume symbiosis

Unit 2: Phosphate Biofertilizers: 6 Hours

PSMs, Inorganic phosphate solubilization and its mechanisms, Phosphate mineralizers – phytate and organic phosphate hydrolyzing bacteria, and Ecto- and Endo- Mycorrhizae

Unit 3: Plant Growth Promoting Rhizobacteria: 6 Hours

PGPR in improving plant growth, Mechanism in plant growth promotion, Factors affecting rhizosphere colonization.

Unit 4: Environmental Problems and Monitoring: 8 Hours

Pollution and its classification, Effluent standards: examination of waste water characteristics, municipal and industrial waste water, Global environmental problems: global warming, acid rain, ozone depletion, Sampling and analysis, Environmental monitoring and audit, Environmental laws and policies in India.

Unit 5: Bio-Treatment Kinetics and Reactor Design: 8 Hours

Principals of biological treatments, Biological treatments: Composting, Suspended growth systems, Attached growth systems, Bioreactor design: Activated Sludge Process, Tickling Filters, Fluidised bed and Packed bed reactor, Rotating Biological Contractors, Oxidation Ponds and Ditches, Lagoons, Anaerobic Reactors.

Unit 6: Bioremediation and Biodegradation: 7 Hours

Bioremediation principles and Processes: Bio sorption, Bioaccumulation, Bioconversion, Biotransformation, Bioleaching, Biodegradation, Detoxification, Activation, Acclimatisation and Co-metabolism, strategies and techniques of bioremediation: in situ and ex situ, of Hydrocarbons, Pesticides and Dyes, GMO's in bioremediation and biodegradation.

Suggested Readings:

1. Alexander, M. Biodegradation and Bioremediation, Academic Press, 1994.
2. Arceivala, S.J. and Asolekar, S.R., Wastewater treatment for Pollution Control and Reuse, 3rd edition, Tata McGraw Hill, 2007.
3. Atlas, R.M. and Bartha, R. Microbial Ecology, 4th edition, Pearson Education, 2009.
4. Bhatia, S.C. Handbook of Environmental Microbiology, Vol. III, Atlantic Publishers, 2008.
5. Das, H.K. Textbook of Biotechnology, 2nd edition, Wiley Dreamtech, 2005.
6. Dworkin, M., Falkow, S., Rosenberg, E., Schleifer, K.H., Stackebrandt, E. (Eds.). The Prokaryotes. Vol. I – VII, Springer, 2006.

7. Evans, G.M. and Furlong, J.C. Environmental Biotechnology – Theory and Application, John Wiley and Sons, 2004.
8. Hurst Christon J., Manual of Environmental Microbiology, ASM Press, Washington DC, 2007.
9. Khan M. S., Zaidi A. and Musarrat J, Microbes for legume improvement, Springer Wien, New York, 2010.
10. Maier, R.M., Peppper, I.L. and Gerba, C.P. Environmental Microbiology, 2nd edition, Elsevier Academic Press, 2009.
11. Paul and Clerk, Soil Microbiology and Biochemistry, 2007.
12. Paul, E.A. (Ed.). Soil Microbiology, Ecology and Biochemistry, 3rd edition, Academic Press, 2007.
13. Pepper, I.L. and Gerba, C.P. Environmental Microbiology – A Laboratory Manual, 2nd edition, Elsevier Academic Press, 2005.
14. Rao, N. S. Subba, Soil Microbiology, 4th edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 2008.
15. Thakur, I.S. Environmental Biotechnology – Basic concepts and Applications, I.K. International, 2006.
16. Varma A., Oelmuller R. Advanced Techniques in Soil Microbiology, Springer (India) Pvt. Ltd, 2007.

Dissertation Tutorials

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Course Code	3SBC3A1
Course Title	Neuroendocrine Regulation of Behaviour

Course Learning Outcomes (CLO)

At the end of the course, students will be able to -

1. To describe the role of various neuro- hormones involed in auditory and optical senses, feeding and emotional behavior
2. To discuss the pathophysiological changes associated with mental and behavioural disorders and debate the role and effect of available psychotic drugs..
3. To identify and relate various behavioural models to study cognitive and motor behaviour.

Syllabus: **Teaching hours**: **15**

Emotion and behaviour - Neuro-anatomy of limbic system; Behavioural control of hormonal secretion, feeding behaviour; drinking behaviour; emotional behaviour, Physiological changes associated with emotion and Integration of emotional behaviour; Physiology in brief of vision and auditory sense; Motivation, addiction and its neurobiology. Behavioural model of fear, anxiety and depression and related psychotic drugs.

Suggested Readings:

1. Purves, D, Augustine, G., Neuroscience, Sinauer, 2000.
2. Tortora, G. J. and Derrickson, B. H., Principles of Anatomy and Physiology, Weily and Sons, 2009
3. Breedlove, M. C., Watson, N. V., Rozenzweig M. R., Biological Psychology: An Introduction to Behavioural, Cognitive and Clinical Neuroscience. Sinauer Associates, 6th Edition, 2010.
4. Amthor Frank, Neuroscience for dummies. USA John Wiley & Sons Canada Ltd. 2012.
5. Kolb, Bryan; Whishaw, Ian Q. An Introduction to Brain and Behavior, New York Worth Publishers 2011
6. Turkingtons, C., The Brain and Brain Disorders, Viva Books, 2009
7. Kandel, E., Schwartz, J. and Jessell T., Essentials of Neural Science and Behaviour, McGraw-Hill, 2003.

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Course Code	3SBC3A2
Course Title	Endocrinology & Immunology of Pregnancy

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Comprehend the endocrine regulation of pregnancy.
2. Understand roles of specific immune system components during pregnancy.
3. Analyze the effects of imbalanced immune response and prenatal hormones in pregnancy complications.

Syllabus:

Overview of endocrinology (introduction to endocrinology, endocrine glands, hormone biosynthesis), their role in pregnancy (implantation,

decidualization, placentation, placental hormones, parturition), hormonal interactions between mother, placenta and fetus. Overview of immunological aspects of pregnancy, roles of uterine immune cells during pregnancy (macrophages, natural killer cells, neutrophils, B cells, regulatory T cells), immunological aspects of decidua, placental regulation of immune cells. Immunological and endocrine imbalance effects during pregnancy leading to poor birth outcome. Flow cytometry (basics and application for diagnosis of pregnancy complications).

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Course Code	3SBC3S1
Course Title	Understanding Gastrointestinal Hormones and Gut Associated Cancer

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand the diversity of G.I. Tract hormones and gastrointestinal associated cancers
2. Determine the probable targets and causes of hormonal modulation and cancer induction.
3. Analyse and evaluate the molecular mechanism and probable targets as therapeutic approaches.

Syllabus:

Introduction to Gut associated cancers and their pathogenesis, Molecular markers identification, Genetic & Epigenetic markers, Mechanism of Induction, Existing therapies, New Trends in cancer therapy, Gut Hormones involved in metabolism and gastric cancer, Role of hormone in cancer, Identification of newer therapeutic targets.

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Course Code	3SBC3S3
Course Title	Pathogenesis of Diabetes

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand the mechanisms of onset of diabetes and differentiating it from obesity.
2. Determine the role of triad i.e., interaction of gut, liver and pancreas in diabetes.
3. Analyse and evaluate the molecular mechanism and probable targets as therapeutic approaches.

Syllabus:

Type I and II Diabetes, Mechanism of induction, Metabolic Disturbances, Drug and Diet Induced Diabetes, Endocrine Disorders, Role of Gut microflora, Role of Liver and Pancreas in diabetes, Identification of Therapeutic strategies.

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Course Code	3SBC3S4
Course Title	Genotoxicity Testing for Cancer Risk Assessment

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand methods and mechanisms of laboratory tools for biological safety assessment
2. Apply cell culture techniques based cytogenetic and genetic damage assays
3. Appreciate regulatory guidelines and best practices in study of biological effect of environmental factors on genome

Syllabus:

Cell culture techniques for in vitro cytogenetic assays: Chromosome breakage, Cytokinesis blocked micronucleus assay, Comet assay, Sister Chromatid Exchange assay, in vitro metabolic activation systems, Regulatory guidelines and best practices of Genotoxicity studies; National and International regulations for establishing genotoxicity of a substance, application in safety studies of novel drugs, nanoparticles, and other environmental agents and exposed population; OECD, EPA guidelines for scoring and analysis

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Course Code	3SBC3S5
Course Title	Applied Human Cytogenetics

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Grasp methods and mechanisms of cell culture methods for karyotyping using various tissues
2. Apply ISCN guidelines for interpretation of genetics analysis
3. Understand normal and abnormal genetic constitution of human at chromosomal level and scope of molecular genetic analysis
4. Appraise genotype-phenotype correlation in various human genetic conditions

Syllabus

In vitro short term culture techniques for metaphase chromosome preparations from blood, bone marrow, and other tissue samples; chromosome banding, karyotyping, ISCN guidelines, Clinical applications in Prenatal Genetic Diagnosis, Pregnancy, Post-Natal, and Cancer; Introduction to molecular cytogenetics; FISH & m-FISH.

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Course Code	3SBT3S2
Course Title	Immunological Memory

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand how memory T and B cells are generated following natural infection
2. Evaluate and analyse the immune response to provide long-term protection
3. Manipulate the antigenic exposure to immune system to generate memory T cells
4. Design immunomodulator(s) to induce long-term protection

Syllabus: **Teaching Hours: 15**

Generation of T cell and B cell memory, Requirement for maintenance of memory T cells, Interaction of memory B cells with memory T cells, Role of Innate Immunity in maintenance of memory T cells

L	T	P	C
1	-	-	1

Course Code	3SBT3S3
Course Title	Tumor markers in cancer management

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. To identify and analyse the factors influencing process of carcinogenesis for solid and haematological malignancies
2. To understand the role of various tumor markers for diagnosis, prognosis, selection of treatment modalities and disease monitoring
3. To discuss the treatment strategies that pave the way to personalized medicine.

Syllabus: **Teaching hours: 15**

Molecular pathogenesis of cancer, Historical overview of Tumor markers, Types of tumor markers, Alterations in solid tumors and haematological malignancies, Management of Cancer, Existing treatment modalities, Current and newer therapeutic approaches in cancer and their limitations, Personalized and Precision Medicine

Suggested Reading:

1. Vincent, T. De Vita, Lawrence T. S., Rosenberg, S. A., Cancer: Principle & Practice of Oncology, 10th Edition, Lippincot, 2011.
2. Weinberg R., Biology of Cancer, Gerland Science, June, 2010.

L	T	P	C
1	-	-	1

Course Code	3SBT3K1
Course Title	Immunology of Vaccine Adjuvants

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. To have a clear understanding of antigenicity and immunogenicity.
2. Currently available adjuvants and their mode of action.
3. Adjuvant-free vaccination strategies.

Syllabus

Antigen, Immunogen, methods to enhance immunogenicity of candidate antigens, currently available adjuvants for experimental and clinical use and their mechanism of action, cellular and molecular targets of available adjuvants, adjuvants that induce CD8+ T-cells, tissue-resident memory cells, adjuvants targeting pattern recognition receptors other than toll-like receptors, need for adjuvant free vaccination strategies and systems vaccinology.

Institute of Science
Nirma University

SEMESTER IV

Core Courses

L	T	P	C
1	-	-	1

Course Code	3SMB3N1
Course Title	Microbial Community Dynamics And Ecological Succession

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Identify role of microorganisms and microbial Community shifts in ecological succession. They will understand aspects of sustainability, resilience and importance of indicator species.
2. Understand various methods for microbial diversity estimations and multivariate statistical tools and to use them.

Syllabus: **Teaching hours: 15**

Principles and concepts of microbial diversity, Ecological diversity, Loss of diversity, Sustainability and Resilience, Indicator Species, Ecological Succession, Methods used for 'Microbial Diversity Analysis', Multivariate statistical tools for Microbial Diversity Analysis using SPSS.

L	T	P	C
1	-	-	1

Course Code	3SMB3V1
Course Title	Antimicrobial Agents

Course learning outcomes:

At the end of the course, students will be able to-

1. Be familiar with currently available antimicrobial agents, their scope and limitations.
2. Learn evolution of drug-resistance, its molecular basis, and also be familiar with strategies for discovery and development of novel antimicrobials.
3. Understand the need for finding novel drug targets

Syllabus: **Teaching hours: 15**

A concise overview of currently available antimicrobial agents; Drug-resistance among pathogens, and its molecular basis; Strategies for development of novel antimicrobials; challenges involved; Antimicrobial susceptibility tests: Utility, limitations and challenges.

L	T	P	C
-	-	-	25

Course Code	3SBT402
Course Title	Dissertation

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Develop understanding in the field of scientific research at the academic as well as industrial sector. This will students to identify scientific problems and design proposals to address and implement ideas. This enables them to communicate the same to a greater audience.
2. This will benefit the students to perform well in their job interviews and to design their CV which can evoke interest in the employers to know more about the candidate.

Outline:

The students have to carry out their dissertation work. They have to perform wet lab experimentation on the topic of project assigned to them. The Viva will be conducted as interim presentation as well as final presentations, where the students have to defend their dissertation work

L	T	P	C
-	-	2	2

Course Code	3SBT407
Course Title	Internship

Outline:

The students will be deputed to industry/academic institutes/laboratories have undertake training to enhance their skills in order to improve their employability in the field of interest. The students will have a guide allocated at the host institute and have to present their progress of training in the form of interim presentation. They will be submitting a comprehensive report as well as well as an final presentation, comprising of the training undertaken by them.

Institute of Science
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L	T	P	C
-	-	2	2

Course Code	**3SBT404**
Course Title	**Comprehensive Viva Voce**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Develop understanding in the field of scientific research at the academic as well as industrial sector. This will students to identify scientific problems and design proposals to address and implement ideas. This enables them to communicate the same to a greater audience.
2. Shape up their career in the field of research at the academic as well as industrial sector. This will be helpful to students in identifying scientific problems and design proposals to address and implement ideas, enables them to communicate the same to a greater audience.

Outline:

Viva voce will be conducted towards the end of the semester which will be covering the complete syllabus. This will test the student's learning and understanding during the course of their post graduate programme. In doing so, the main objective of this course is to prepare the students to face interview both at the academic and the industrial sector.

Supplementary Course:

L	T	P	C
-	-	1	-

Course Code	**3SBT406**
Course Title	**Interpersonal and Networking Skills**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

Develop effective network and would be able to positively influence people; will be able to manage stress and failures and will show enhanced interpersonal skills

Syllabus:

Unit 1: Effective Networking and Influencing people: 8 Hour

Networking and its importance. Building and growing a network. Importance of collaboration and cross functional networking. Use of LinkedIn and other Social media tools to grow networks. Importance of influence, How to positively influence people.

Unit 2: Stress Management and Facing Failures: 8 Hour

Introduction to Stress, Causes of stress and impact of stress. Managing Stress. Factors affecting Failure, Learning from Failures, Overcoming failures

Unit 3: Interpersonal Skills: 8 Hour

Defining Interpersonal relationship, human perceptions, understanding people and types of interpersonal relationships, conflict resolution, Negotiation skills.

Unit 4: Self Study and Group Discussion 6 Hour

ANNEXURE-I

M.Sc. Biochemistry

APPENDIX-A

Institute of Science
Nirma University
Teaching & Examination Scheme of M.Sc. Biochemistry (2022-23)

Sr. No.	Course Code	Course Title	Teaching Scheme				Examination Scheme				
							Duration		Component Weightage		
			L	LPW/ PW	T	C	SEE	LPW/ PW	CE	LPW/ PW	SEE
Semester-I											
1	3SBC101	Metabolism	3	-	-	3	3.0	-	0.60	-	0.40
2	3SBC102	Human Physiology	3	-	-	3	3.0	-	0.60	-	0.40
3	3SBT102	Cell Biology	3	-	-	3	3.0	-	0.60	-	0.40
4	3SBT103	Molecular Biology	3	-	-	3	3.0	-	0.60	-	0.40
5	3SBT111	Basic Immunology	3	-	-	3	3.0	-	0.60	-	0.40
6	3SBT112	Laboratory I	-	12	-	6	-	10.0	1.00	-	-
7	3SBT113	Seminar I	-	1	-	1	-	-	1.00	-	-
		Total	**15**	**13**		**22**					
Supplementary Courses											
8	3SBC1S2	Basics of Microbiology	-	-	2	-	-	-	1.00	-	-
		Total	**15**	**13**	**2**	**22**					
Semester-II											
1	3SBC211	Neurobiology	3	-		3	3.0	-	0.60	-	0.40
2	3SBT202	Bioanalytical Techniques	3	-	-	3	3.0	-	0.60	-	0.40
3	3SBT203	Genetic Engineering	3	-	-	3	3.0	-	0.60	-	0.40
4	3SBC2E2	Reproductive Physiology	3	-	-	3	3.0	-	0.60	-	0.40
5	3SBC204	Laboratory II	-	14	-	7	-	10.0	1.00	-	-
6	3SBT212	Seminar II	-	2	-	2	-	-	1.00	-	
		Total	**12**	**16**		**21**					
Supplementary Courses											
7	3SBT2E2	Professional English	1	-	-	-	-	-	1.00	-	-
Value Added Course											
8	3SBT2S1	Professional Development and Resume Writing	2								
		Total	**15**	**16**	**-**	**21**					
Institute Elective											
9		Elective I	3	-	-	3	3.0	-	0.60	-	0.40
		Total	**18**	**16**		**24**					
Semester-III											
1	3SBC302	Biochemical Toxicology	3	-		3	3.0	-	0.60	-	0.40
2	3SBC304	Cancer Biology	3	-	-	3	3.0	-	0.60	-	0.40
3	3SBC307	Endocrinology	3	-	-	3	3.0	-	0.60	-	0.40
4	3SBT308	Animal Biotechnology	3	-	-	3	3.0	-	0.60	-	0.40
5	3SBC309	Laboratory III	-	8	-	4	-	6.0	1.00	-	-
6	3SBT312	Research Methods	3	6	-	6	-	-	0.60	-	0.40
7	3SBT3S6	Summer Training*	-	-	-	2					
		Total	**15**	**14**		**24**					
Supplementary Courses											
8		Dissertation Tutorials	-	-	1	-	-	-	1.00	-	
Institute Elective											
9		Elective II	3	-	-	3	3.0	-	0.60	-	0.40
		Total	**18**	**14**	**1**	**27**					
Semester-IV											
1		Training	-	-	-	25	-	-	0.60	0.40	-
2	3SBC404	Comprehensive viva	-	2	-	2	-	-	1.00	-	-
		Total	**-**	**2**	**-**	**27**					
Value Added Course											
3	3SBT406	Interpersonal and Networking Skills	2	-	-	-	-	-	1.00	-	-
		Total	**2**	**2**	**-**	**27**					

***Compulsory summer training following semester II for 21 working days**

L: Lectures, T: Tutorial, C: Credits
CE: Continuous Examination
LPW/ PW: Laboratory / Project Work
SEE: Semester End Examination

Elective I (*Semester II*)
3SMB2E2 Microbial Ecology
3SBC2E1 Human Genetics
3SBC203 Advance Immunology
3SBT204 Microbial Genetics

Elective II *(Semester III)*
3SBT3E1 Genomics & Proteomics
3SMB307 Microbial Diversity and Systematics
3SBT309 Vaccinology

Training (*Semester IV)*
3SBC402 Dissertation
3SBT407 Internship

Value added Course
Semester II 3SBT2S1 Professional Development and Resume Writing
Semester IV 3SBT406 Interpersonal and Networking Skills

Supplementary Courses
Semester I 3SBT1S4 Basics of Microbiology

Semester II 3SBT2E2 Professional English

Semester III **Dissertation Tutorials**
3SBC3A1 Neuroendrocrine Regulation of Behavior
3SBC3S1 Understanding Gastrointestinal Hormones and Gut associated cancer
3SBC3S3 Pathogenesis of Diabetes
3SBC3S4 Genotoxicity Testing for Cancer Risk Assessment
3SBC3S5 Applied Human Cytogenetics
3SBT3S2 Immunological Memory
3SMB3N1 Microbial Community Dynamics and Ecological Succession
3SMB3V1 Antimicrobial Agents
3SBT3S3 Tumor markers in cancer managemnet
3SBC3A2 Endocrinology & Immunology of Pregnancy
3SBT3K1 Immunology of Vaccine Adjuvants

Dr. Sriram Seshadri **Prof. Sarat Dalai**

Final Syllabus of Biochemistry for the Academic year 2022-23

Institute of Science

Nirma University

SEMESTER I

Core Courses

L	T	P	C
3	-	-	3

Course Code	3SBC101
Course Title	Metabolism

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Have an **understanding** of the metabolic pathways - the energy-yielding and energy requiring reactions in life; understand the diversity of metabolic regulation, and how this is specifically achieved in different cells
2. **Evaluate** the different metabolic process occurring in the cells
3. **Relate** the link between the metabolic processes and their regulation as a response to external and internal factors
4. **Analyse** the differences and similarities between the various anabolic and catabolic processes occurring in the body

Syllabus: **Teaching hours**: **45 Hours**

Unit 1: Metabolism of Carbohydrates: 5 Hours

Glycolysis, citric acid cycle, pentose phosphate pathways, glycogenesis and glycogenolysis and their regulation, Gluconeogenesis and its regulation. Metabolism of Fructose and Galactose. Hormonal regulation of carbohydrate metabolism.

Unit 2: Metabolism of Lipids: 8 Hours

Synthesis of various lipids, bile acids and cholesterol. Elongation of fatty acids, Desaturation of fatty acids in microsomes. Regulation of fatty acid synthesis, Cholesterol metabolism. Composition and synthesis of basic groups of Lipoproteins and their changes during transport in the body.

Unit 3: Metabolism of Amino Acids: 8 Hours

General reactions of amino acid metabolism: transamination, oxidative deamination and decarboxylation. Catabolic fate of -amino acids and their regulation, glucogenic and ketogenic amino acids. Urea cycle and its regulation. Amino acid biosynthesis.

Unit 4: Metabolism of Nucleotides: 8 Hours

Biosynthesis of purines and pyrimidine- De novo and salvage pathways and their regulation. Catabolism of purines and pyrimidine. Biosynthesis of ribonucleotides and deoxyribonucleotides.

Unit 5: Enzymes: Basic Bio-thermodynamics 8 Hours

Enzyme classification and nomenclature, Enzyme kinetics: Michaelis-Menten equation: Formula, Derivation and Significance; Alternate plotting procedures. Types of Inhibitors and their mode of action.

Unit 6: Enzyme Mechanisms and Regulation: 8 Hours

Different mechanisms of enzyme activity; Strategies for enzyme regulation; Allosteric Enzymes and their Kinetics. Isoenzymes and Multienzyme Complexes.

Suggested Readings:

1. Voet, D., Fundamentals of Biochemistry, J. Wiley, 2008.

2. Voet, D. and Voet, J. G. Biochemistry, 3rd Edition. John Wiley and Sons, 2004. 3. Boyer, R., Concepts in Biochemistry, Brookes, 1999.

3. Metzler, D. E., Metzler, C. M., Biochemistry: the chemical reactions of living cells. Vols. I and II, Academic Press, 2001.

4. Nelson, D. C. and Lehninger, Principles of Biochemistry, Mac Millan, 2000.

5. Murray, R. K., Granner D. K., Mayes, P. A., Rodwell, V. W., Harper's Biochemistry, 27th Edition, McGraw Hill, 2006.

6. Stryer, L., Bery, J. M., Dymoczko, J. L., Biochemistry Only. 6th edition, WH Freeman and Co. New York, 2006.

L	T	P	C
3	-	-	3

Course Code	3SBC102
Course Title	Human Physiology

Course Learning Outcomes (CLO):

At the end of the course, students will be able to -

1. To identify basic organisation of biological system of the human body and define their role.
2. To describe and relate the structure to functional role of each organ and organ system.
3. To comprehend interactions amongst various

organs within/between system/s, their negative and positive feedback to maintain steady state and equilibrium in the body.

4. To discuss, interpret and analyze biochemical alterations and evaluate the pathophysiological changes during diseased condition.

Syllabus: **Teaching hours**: **45**

Unit 1: Digestive System 9 Hours

Digestive Processes; Structural organisation and functions of Alimentary Canal (GI tract); Structure and functions of salivary gland, teeth, pancreas, liver; Physiology of digestion and absorption. Diseases/Disorders of digestive system.

Unit 2: Cardiovascular System 9 Hours

Structure and functions of blood — formed elements (blood cells) and plasma, physiology of blood coagulation. Grouping of blood; Basic structure of heart, conduction system and cardiac cycle; Organisational structure of blood vessels and lymphatic vessels. Diseases/Disorders of CVS.

Unit 3: Respiratory System 6 Hours

Structural Organisation of Respiratory System: Structure and functions of nose, larynx, trachea, bronchi, and lungs; Physiology of Respiration (inspiration, expiration, pulmonary air volumes and capacities), Transportation of respiratory gases. Diseases/Diseases of Respiratory System.

Unit 4: Urinary System 9 Hours

Anatomical Structure of functional unit of kidney (Nephron); Blood and nerve supply of kidney; Physiology of urine formation (glomerular filtration, tabular re-absorption, tabular secretion); characteristics of urine and its utility in measuring health states; Homeostasis. Diseases/Diseases of Urinary System.

Unit 5: Skeletal System 6 Hours

Structural Organisation of Skeletal System — Axial and appendicular system; structure and types of bones; Articulations - fibrous, cartilaginous, and synovial joints; Types of Synovial joints (gliding, hinge, pivot, ellipsoidal, saddle and ball and socket joints). Diseases/Disorders of Skeletal System.

Unit 6: Muscular System 6 Hours

Types, characteristic and functions of muscles (skeletal, smooth and cardiac muscles); neuro muscular junctions; homeostasis and muscles (oxygen debt, muscle fatigue and heat production). Diseases/Disorders of Muscular System.

Suggested Readings:

1. Guyton, H., Textbook of Medical Physiology, Elsevier, 2000.
2. Tortora, G. J. and Derrickson, B. H., Principles of Anatomy and Physiology, Wiley and Sons, 2009
3. Gilbert, S. E., Developmental Biology, Sinauer Associates, 6th Edition, 2010.
4. Holes Human Anatomy and Physiology by David Shier, Jackie Butler, Ricki Lewis. McGraw hill Education 2015, 8th ed.
5. Essential of Human Physiology for Pharmacy by McCorry, Laurie Kelly, Boca Raton CRC Press 2008
6. Basic Anatomy: General Anatomy and Upper limg by Oommen Anitha, New Delhi Ane Books Pvt. Ltd. 2010
7. Anatomy & Physiology by Gerard Tortora J,Derrickson, Bryan., Delhi Wiley India (P) Ltd. 2014.
8. Anatomy & Physiology; workbook by Gerard Tortora J,Derrickson, Bryan., Delhi Wiley India (P) Ltd. 2014.

L	T	P	C
3	-	-	3

Course Code	**3SBT102**
Course Title	**Cell Biology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand and appraise the fundamentals of cell as a unit of living organisms and their organelles in terms of structure and functions
2. Evaluate the cellular mechanisms of cell-cell interactions, cell communications, cell signalling pathways and cell division
3. Evaluate the molecular mechanisms and their cross-talk responsible for various diseases including cancer, diabetes and other diseases, articulate host-environment interactions

4. Demonstrate understanding of in vitro and in vivo isolation of cell, it's utility in various areas of research including stem cell

Syllabus: **Teaching hours: 45**

Unit 1: Plasma membranes: **5 Hours**
Membrane Structure, Molecular Composition and function; Lipid bilayer and protein, diffusion, osmosis, ion channels, active and passive transport, membrane pumps and transporters

Unit 2: Cytoskeleton: **8 Hours**
Microfilaments, Intermediate Filaments and Microtubules – Structure and Dynamics; Microtubules and Mitosis; Cell Movements. Intracellular Transport and the Role of Kinesin and Dynein

Unit 3: Intracellular Protein Traffic: **8 Hours**
Protein Synthesis on Free and Bound Polysomes, Uptake into ER, Membrane Proteins, Golgi Sorting, Post- Translational Modifications

Unit 4: Cell Signalling: **8 Hours**
Cell Surface Receptors; Signalling from Plasma Membrane To Nucleus, Map Kinase Pathways, G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signalling pathways, neurotransmission and regulation

Unit 5: Cell – Cell Adhesion and Communication: **8 Hours**
Ca++ Dependent Cell-Cell Adhesion; Ca++ Independent Cell-Cell Adhesion. Cell Junctions and Adhesion Molecules, Movement of Leukocytes into Tissues, Extracellular matrix

Unit 6: Cell Cycle: **8 Hours**
Mitosis, Meiosis, Cell Cycle, Role of Cyclins and Cyclin Dependent Kinases, Regulation of Cdk – Cyclin Activity, Regulation of Cell cycle, senescence and apoptosis

Suggested Readings:

1. Pollard, T. D., and Earnshaw, W. C., Cell Biology 2nd Edition, Saunders Elsevier, 2008.
2. Gerald K., Cell and Molecular Biology, Concept and Experiment, 5th Edition, Wiley, 2007.
3. Kleinsmith, L. J. J. Principles of Cell and Molecular Biology, 2nd Edition, Benjamin Cummings, 1997.
4. Lodish, H., Berk A., Kaiser C. A., Krieger M., Scott M.P., Bretscher A., Ploegh H., and Matsudaira P., Molecular Cell Biology, 6th Edition, Freeman, W. H. and Co., 2008.
5. Roberts, K., Lewis J., Alberts B., Walter P., Johnson A., and Raff. M., Molecular Biology

L	T	P	C
3	-	-	3

Course Code	**3SBT103**
Course Title	**Molecular Biology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. understand a basic understanding of molecular events of discovery of science and it's biological implications
2. understand the role of each components of molecular events in prokaryotes as well as eukaryotes
3. Justify and correlate the importance of these molecular events in the gene expression as well as in the gene regulation
4. analyze and correlate the deregulation in any event leading to disorders and envisage probable strategies

Syllabus: **Teaching Hours: 45**

Unit 1: Genome organization in prokaryotes and eukaryotes: **5 Hours**
Structure of DNA and RNA, physical properties of DNA- cot plot, kinetic and chemical complexity, satellite DNA. Organization of the Chromosome, structure of chromatin-nucleosomes, Chromatin domains and isochores, structure and functional organization of centromeres and telomeres.

Unit 2: DNA Replication: **8 Hours**
Prokaryotic DNA polymerase I, II and III, Eukaryotic DNA polymerases, Fidelity and Catalytic Efficiency of DNA polymerases, Okazaki Fragments, Replication Origin, Primosomes, Concurrent Replication mechanism involving leading and copying strands of DNA.

Unit 3: Transcription: **8 Hours**
Prokaryotic and Eukaryotic polymerases, Promotors, Enhancers, silencers, transcriptional activators. Mechanism of Prokaryotic and eukaryotic biosynthesis of rRNA, tRNA and mRNA. Transcriptional inhibitors, Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, elongation and termination

Unit 4: RNA Processing: 8 Hours
Prokaryotic and eukaryotic rRNA, tRNA, mRNA editing, Capping, Polyadenylation, splicing. Processing of poly A- mRNA, Mi and Si RNAs, Group I and II introns, alternate splicing, RNA transport.

Unit 5: Translation: 8 Hours
Prokaryotic and Eukaryotic Protein synthesis and processing: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetases, translational proof-reading, translational inhibitors, post- translational modification of proteins.

Unit 6: Gene Expression Regulation: 8 Hours
Control of gene expression at transcription and translation level, Regulation of prokaryotic and eukaryotic gene expression, phages and viruses, Operon concept, positive and negative regulation, Catabolite repression, role of chromatin remodelling in regulating gene expression and gene silencing.

Suggested Readings:

1. Meyers, R. A. (1995). Molecular biology and biotechnology: a comprehensive desk reference. John Wiley & Sons...
2. Lodish, H. (2008). Molecular cell biology. Macmillan.
3. Brown, T. A. (1991). Essential molecular biology: volume II a practical approach. Oxford University Press.
4. Krebs, J. E., Lewin, B., Goldstein, E. S., & Kilpatrick, S. T. (2014). Lewin's genes XI. Jones & Bartlett Publishers.
5. Watson, J. D., & Levinthal, C. (1965). Molecular biology of the gene. Molecular biology of the gene.

L	T	P	C
3	-	-	3

Course Code	**3SBT111**
Course Title	**Basic Immunology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Develop good understanding on how immune system discriminate self-from non-self.
2. Design immunoassays based on the monoclonal antibodies
3. Evaluate the immune response of the host encountering the pathogen or upon vaccination

Syllabus: Teaching Hours: 45

Unit 1: Nature of Antigen and Antibody: 6 Hours
Antigen Vs. Immunogen, Haptens, Structure and functions of immunoglobulins, Isotypic, allotypic and Idiotypic variations.

Unit 2: Structure and function of primary and secondary lymphoid organs. 8 Hours
MALT system; Lymphocyte circulation, Mechanisms of Migration of immune cells into primary and secondary lymphoid organs.

Unit 3: Complement System - Activation, regulation and abnormalities 8 Hours

Unit 4: Production of Antibodies and its Applications: 8 Hours
Production of polyclonal and monoclonal antibodies and its clinical applications. Abzymes. Measurement of Antigen – Antibody Interaction: Principles, techniques and applications, Agglutination and precipitation techniques, Radio immunoassay, ELISA, Immunofluorescence assays, Fluorescence activated cell sorter (FACS) techniques. Immuno PCR.

Unit 5: Generation of Diversity of Immunoglobulins and T cell Receptors 7 Hours

Unit 6: MHC structure and polymorphism: Antigen processing and presentation, T cell activation 6 Hours

Suggested Readings:

1. Janeway, C (2012) Janeway's immunobiology. Garland Science 8th Edition.
2. Kindt, T. J (2009). Kuby immunology. Macmillan. 7th Edition
3. Paul, W. E. (2008). Fundamental immunology. Lipincott& Wilkins, 6th Edition
4..Abbas, A. K., Lichtman, A. H., & Pillai, Shiva. (2012). Cellular and molecular immunology WB Saunders Co. Philadelphia, Pennsylvania, 186-204.7th Edition
5. Coico, R. (2015). Immunology: A Short course. John Wiley & Sons, 7th edition
6. Peter J. Delves, Seamus J. Martin, Dennis R. Burton and Ivan M. Roitt.(2017). Roitt's essential immunology John Wiley & Sons. 13th Edition

L	T	P	C
-	-	12	6

Course Code	**3SBT112**
Course Title	**Laboratory I**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Perform fundamental microbiological, biochemical and cell culture techniques.
2. Analyze and interpret the results of biochemical estimations and microbiological experimental data.
3. Apply techniques to the advanced level practicals and dissertation carried out in further semesters.

Syllabus **Teaching Hours: 192hrs**

1. Introduction to human chromosome complement using Giemsa stained metaphase cells.
2. Observation of mitotic cell division stages in onion root tip
3. Observation of meiosis stages using fixed slides
4. Demonstration of Short term blood culture for metaphase chromosome preparation
5. Measurement of microscopic structures using micrometre
6. To study the effect of various parameters viz. inoculum size, aeration, etc. on bacterial growth through the growth curve experiment
7. Estimation of bacterial load in various environmental/ food samples through viable counting
8. Gram-staining
9. Bacteriophage isolation from sewage sample
10. Enzyme assay for Amylase under various conditions
11. Sample Preparation and Separation of Amino Acids, Lipids and Sugars by TLC.
12. Estimation of bio-molecules (Sugar, Protein, Cholesterol, Urea) by spectrophotometer

Suggested Reading:

1. Patel, RJ. Experimental Microbiology. Vol-1, Aditya Publishers, India, pp: 60-61, 2009
2. Sherma, Joseph, and Bernard Fried, 2nd eds. Handbook of thin-layer chromatography. CRC press, 2007.
3. Stahl, Egon, 2nd eds. "Thin-layer chromatography: a laboratory handbook." Thin-layer chromatography: a laboratory handbook. 2007.
4. Cappuccino, James G., and Natalie Sherman, 7th eds. "Microbiology: A laboratory manual." Addision-six 1999 2007.
5. Mu, Plummer, and David T, 3rd eds. Plummer. Introduction to practical biochemistry. Tata McGraw-Hill Education, 2007.
6. Bates, Steven E. "Classical cytogenetics: karyotyping techniques." Human Pluripotent Stem Cells. Humana Press, 177-190, 2011..
7. Rao, Beedu Sashidhar and Deshpande, Vijay, Experimental Biochemistry, A student Companion, I. K. International Pvt. Ltd, 2005
8. Tom Maniatis, E. F. Fritsch, Joseph Sambrook, Molecular cloning-a laboratory manual, 3rd eds, Cold Spring Harbor Laboratory, 2001
9. Primrose, S. et.al., 7th eds. Principles of Gene Manipulation. Oxford: Blackwell Science, 2008 2001.
10. Prescott.L.M, 7th eds. Microbiology, McGraw Hill Publication, 2008
11. Mitosis, Meiosis and Genetics, J. L. Stein Carter & D. B. Fankhauser, Genetics, 2010.
12. Alberts, Bruce, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter. Molecular Biology of the Cell. 6th ed. New York: Garland Science, Taylor and Francis Group, LLC, 2015.

L	T	P	C
-	-	1	1

Course Code	**3SBT113**
Course Title	**Seminar I**

Course Learning Outcomes:

At the end of the course, students will be able to-

1. Understand and present scientific concepts
2. Analyze the scientific idea and concept of the given topic
3. Develop basic presentation skills

Syllabus: **Teaching Hours: 30**

The students have to give seminars on a scientific topic of their interest from any of the biological fields which will be open for discussion. The students will have to submit the hardcopy of the selected topic along with a summarised write up in their own words. This course has been designed to provide a platform for the students to develop their communication, presentation and confidence to face the audience.

Institute of Science

Nirma University

Supplementary Courses

L	T	P	C
-	2	-	-

Course Code	**3SBT1S2**
Course Title	**Basics of Microbiology**

Course Learning Outcomes:

At the end of the course, students will be able to-

1. Refresh understanding of basic principles of biochemistry, Molecular Biology and Microbiology.
2. Be at par with other students who are already well versed with the subject.
3. Develop a foundation for other advanced courses

Syllabus

Unit 1: Fundamentals of Microbiology 3 Hours

Microbes in our lives, Types of microorganisms, Functional anatomy of prokaryotic cell: Structures external to the cell wall - glycocalyx, flagella, archaella, fimbriae and pili, The cell
wall, Structures internal to the cell wall - plasma membrane, cytoplasm, the nucleoid, ribosomes, inclusions and endospores

Unit 2: Cultivation, isolation and preservation of microbes 4 Hours

Bacterial cell cycle, growth curve, environmental factors affecting growth, growth requirement and microbiological media - types of media and preparation; methods of obtaining pure cultures - streaking, spreading, serial dilution; measurement of microbial growth, preservation methods; Short-term (subculturing; oil overlay method); and long-term (lyophilization, cryopreservation) preservation methods.

Unit 3: Nutritional types of microbes and modes of energy generation 3 Hours

Nutritional types on basis of carbon source, energy source and electron source; introduction to
modes of energy generation - aerobic respiration, anaerobic respiration, fermentation, chemolithotrophy and phototrophy

Unit 4: Microscopy and bacterial staining 3 Hours

Basics of microscopy, preparation of specimens for light microscopy staining - fixation, dyes and simple staining, Differential staining, staining specific structures

Unit 5: Sterilization, disinfection and antisepsis 3 Hours

Control of microbial growth, physical methods of microbial control – sterilisation by heat, filtration, high pressure; chemical methods of microbial control – principles of effective disinfection, types of disinfectants.

Monitoring & Assessment:

The students will be monitored and assessed by regular quizzes, term assignments.

SEMESTER II

Core Courses

L	T	P	C
3	-	-	3

Course Code	**3SBC211**
Course Title	**Neurobiology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to

1. To understand basic concept of organisation of human nervous system, its components and their interrelationship along related theories and principles
2. To comprehend and analyse how brain exerts its functional regulation on physiologocial function via down stream molecular signalling.
3. To discuss and relate brain's dynamic changes over time during physiological functions.
4. To discuss and analyze biochemical events and pathophysiological changes leading to mental & behaviuoral disorders and critically evaluate new possible therapies being investigated to treat neurological disease.

Syllabus: **Teaching hours**:**45**

Unit 1: Physiology of Nervous System: 9 Hours

Components of the Nervous System, Neuron and Glial Cells - Different Types, Structure, Function. Synapse: Nerve Impulse, Neurotransmitters. Organization of Nervous System- CNS, PNS. PNS- Somatic Nervous System; Autonomic Nervous System-Sympathetic and Parasympathetic System; Enteric Nervous System

Unit 2: Brain and Spinal Cord 9 Hours

Embryological development, protection, blood brain barrier, CSF, structural and functional organization, Spinal cord anatomy, Spinal Nerves, Spinal Meninges, Grey and White Matter of Spinal Cord, Joint Reflexes.

Unit 3: Neurotransmitters 9 Hours

Chemistry, Synthesis, Storage and Release of Neurotransmitters, Transmitter Action, Neurotransmitter Receptor types-Ionotropic and Metabotropic, Classification for Glutamate, GABA, Acetylcholine, Serotonin, Epinephrine and Norepinephrine Receptors, Synaptic Modulation and Mechanism of Neuronal Integration.

Unit 4: Synaptic Transmission 6 Hours

Transmission across the Synapse, Pre and Post Synaptic Events, Membrane Potential in the Steady State Action, Action Potential and propagation of Nerve Impulse, Mechanism of Action of cAMP, cGMP, IP3, DAG, Calcium as second messengers, Neurotransmitter Sensitive second messengers and their role in Neuronal Function.

Unit 5: Psychopharmacology and Biochemical theories of Mental Disorders: 9 Hours

Chemistry of Neuroleptics and Anxiolytics, Antidepressants, Hallucinogenic Agents, Biochemical theories of Mental Disorders and Neurodegenerative Disorders like Parkinson's, Alzheimer's disease, Amyotrophic lateral sclerosis and Senile Dementia.

Unit 6: Sleep, Learning and Memory: 6 Hours

Mechanism of Sleep- Intrinsic rhythms, SCN & pineal gland, States of sleep, pathway and its physiology- REM & NREM sleep, Wakefulness, Functions of Sleep. Definition & Types of learning, Long term Potentiation & Long term Depression, Memory consolidation and priming, Agents affecting Learning and Memory.

Suggested Readings:

1. Purves, D, Augustine, G., Neuroscience, Sinauer, 2000.
2. Tortora, G. J. and Derrickson, B. H., Principles of Anatomy and Physiology, Weily and Sons, 2009
3. Breedlove, M. C., Watson, N. V., Rozenzweig M. R., Biological Psychology: An Introduction to Behavioural, Cognitive and Clinical Neuroscience. Sinauer Associates, 6th Edition, 2010.
4. Gross C. G. A Hole in Head- More tales in the history of neuroscience. Cambridge MIT Press, First edition, 2012.
5. Amthor Frank, Neuroscience for dummies. USA John Wiley & Sons Canada Ltd. 2012.
6. Kolb, Bryan; Whishaw, Ian Q. An Introduction to Brain and Behavior, New York Worth Publishers 2011
7. Longstaff, A. Developmental Biology. Sinauer Associates, 6th Edition, 2010.

8. Hell, J. W., Ehlers, M. D., (Editors), Structural and functional organization of the synapse, Springer, 2008
9. Turkingtons, C., The Brain and Brain Disorders, Viva Books, 2009
10. Kandel, E., Schwartz, J. and Jessell T., Essentials of Neural Science and Behaviour, McGraw-Hill, 2003.
11. Levitan, I. B., Kaczmarek L.K., The Neuron, Cell and Molecular Biology, Oxford University Press, 2001

L	T	P	C
3	-	-	3

Course Code	**3SBT202**
Course Title	**Bioanalytical Techniques**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand the principles and applications of various techniques used in the isolation, purification and analysis of biomolecules
2. Apply the concepts of modern analytical and instrumental techniques relevant to quantitative measurements in biology
3. Justify and relate the selection of bio analytical methods to characterize a given sample
4. Critically evaluate the advantages, limitations and future prospects of various bio analytical techniques

Syllabus: **Teaching hours: 45**

Unit 1: Separation and characterization of macromolecules: 8 Hours

Principles and applications of ultracentrifugation, ultrafiltration, precipitation and equilibrium dialysis; Horizontal and vertical electrophoresis. Native and SDS Polyacrylamide gel electrophoresis, 2 D electrophoresis

Unit 2: Chromatography: 9 Hours

Basic principles and applications of Paper chromatography, TLC, Gas Chromatography, Size exclusion chromatography, Ion-exchange chromatography, Affinity chromatography, Reverse phase chromatography, HPLC, FPLC

Unit 3: Spectroscopy: 7 Hours

Basic Principles and Applications of UV/Visible absorption, CD, Raman, Infrared, Fluorescence and Atomic Absorption Spectroscopy

Unit 4: Radioisotope Techniques: 6 Hours

Radioactive decay, half-life, Types of radiations, properties of α, β and γ rays, radioisotope tracer techniques, Measurement of radio activity, autoradiography, radiation protection and measurements, Applications of radioisotopes for analysis of biological samples

Unit 5: Structural determination of Biomolecules: 8 Hours

Basic Principle, instrumentation and applications of Nuclear Magnetic Resonance & ESR, X-Ray Crystallography, Mass Spectrometry

Unit 6: Microscopy: 7 Hours

Principles and applications of bright field, dark field, phase contrast, DIC etc., fluorescence, confocal, deconvolution, super-resolution, multiphoton, SEM,TEM and various types.

Suggested Readings:

1. Pattabhi, V. and Gautham, N. Biophysics, Kluwer Academic Publishers, 2002.
2. Cooper, A, Biophysical Chemistry, Royal Society of Chemistry, 2004.
3. Christian, G. D., Analytical Chemistry, John Wiley & Sons (Asia) Pvt. Ltd., 2004.
4. Hammes, G. G., Spectroscopy for Biological Sciences, John Wiley & Sons, 2005.
5. Westmeier, Reiner, Electrophoresis in Practice;Wiley-VCH Verlag Gmbh. 2005
6. Michael Hoppert;Microscopic Techniques in Biotechnology, John Wiley & Sons, Inc. 2006
7. Skoog, D. A., Holler, F. J. and Crouch, S. R., Instrumental Analysis, Brooks/Cole Cengage Learning, 2007.
8. Roberts, K., Lewis J., Alberts B., Walter P., Johnson A., and Raff. M., Molecular Biology of the Cell, 5th Edition, Garland Publishing Inc., 2008.
9. Wilson, K. and Walker, J. ; Principles and Techniques of Biochemistry and Molecular Biology, 7th edition, Cambridge University press., 2010
10. Robert L. Wixom and Charles W. Gehrke, Chromatography: A Science of Discovery.John Wiley & Sons, Inc. 2010
11. Bhasin, S. K.;, Pharmaceutical Organic Chemistry; Elsevier India Pvt. Ltd.. 2012

12. Monk, Paul, Physical Chemistry: Understanding our Chemical World; John Wiley and Sons. 2013
13. Peter Jomo Walla.; Modern Biophysical Chemistry: Detection andanalysis of Biomolecules: WileyPyblishing. 2014

L	T	P	C
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Course Code	**3SBT203**
Course Title	**Genetic Engineering**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand the fundamental concept of genetic engineering.
2. Analyse the technique of genetic engineering.
3. Apply the concept and techniques in designing and conducting experiments and research.

Syllabus: **Teaching hours**: **45**

Unit 1: Fundamental Tool and Technique in Recombinant DNA Technology: 5 Hours

Restriction enzymes: types, mode of action and nomenclature, RE independent cloning strategies, DNA modifying enzymes methylases, DNA polymerases, Klenow-enzyme, reverse transcriptase, terminal transferase, alkaline phosphatase, polynucleotide kinase. Ligase, DNase, RNase and Sl nuclease. Blunt end ligation with linkers. Adapter and homo-polymer tailing, Nick translation, Random priming. Polymerase-Chain-Reaction. Real Time PCR (SYBR and Taqman-based chemistry), Principles and application of nucleic acid hybridizations, Preparation of nucleic acid probes. Radioactive and nonradioactive procedures, DNA sequencing (Maxam and Gilbert method and Sanger method) including automated DNA sequencing.

Unit 2: Cloning Vehicles and their Application: 8 Hours

Cloning vectors, Definition and properties of cloning vectors - plasmids, bacteriophage lambda and M13 - based vectors, cosmids, and shuttle vector, YAC and BACs, viral vector (SV40, retrovirus and Adinovirus), Ti and Ri Plasmids, cloning of PCR product, TA and TOPO cloning, subcloning and GATWAY cloning.

Unit 3: Genomic and cDNA Library: 8 Hours

Strategies for Construction of Genomic library, Construction of cDNA library- mRNA enrichment, Reverse transcription, Selection and screening of recombinant clones- screening of genomic and cDNA libraries.

Unit 4: Cloning interacting genes and in vitro mutagenesis: 8 Hours

Gel retardation assay, DNA foot printing, Yeast Two System and Yeast Three Hybrid System. ChIP-chip split hybrid and reverse hybrid, Phage display and transposon tagging, Site-directed mutagenesis and Protein Engineering, Transcript analysis techniques, Protein- protein interactions by GST- pull down, Western-blot, Far western, co-immunoprecipitation etc.

Unit 5: Expression Strategies for Heterologous Genes: 8 Hours

DNA Transfection methods, Reporter gene assays, Expression in Bacteria, Yeast, Insect and mammalian systems

Unit 6: Application of DNA Recombinant Technology: 8 Hours

Generation of transgenic organism, Gene knockdown and knockout (TALEN, CRISPR/Cas9, RNAi, and antisense). Artificial chromosomes, gene therapy, Recombinant DNA technology in medicine, agriculture and industry.

Suggested Readings:

1. Watson JD., Caudy AA. Myers RM., Witkowski JA. (2007) Recombinant DNA: Genes and Genomes—A Short Course 3rd
2. Hardin, C., Pinczes, J., Riell, A., Presutti, D., Miller, W., & Robertson, D. (2001). Cloning, gene expression, and protein purification (pp. 196-384). Oxford: Oxford University Press.
3. Sambrook, J., Fritsch, E. F., & Maniatis, T. (1989). Molecular cloning: a laboratory manual, Vol I, II and III. Cold spring harbor laboratory press. 3rd revised edition.
4. Glover, D. M., & Hames, B. D. (1995). DNA cloning 3: a practical approach. IRL Press Ltd.
5. Walker, M. R., & Rapley, R. (1997). Route Maps in Gene Technology. Blackwell Science Ltd.,

Oxford.
6. Kingsman, S. M., & Kingsman, A. J. (1988). Genetic engineering: an introduction to gene analysis and exploitation in eukaryotes. Blackwell Scientific Publications.
7. Glick, B. R., & Pasternak, J. J. (1998). Principles and applications of recombinant DNA. ASM, Washington DC, 683.
8. Primrose, S. B., & Twyman, R. (2013). Principles of gene manipulation and genomics. John Wiley & Sons.
9. Nicholl, D. S. (2008). An introduction to genetic engineering. Cambridge University Press.
10. Singrer M., & Berg, P (1991). Genes & Genomes, a Changing perspective. University Scicnce Books, Mill Valley, California
11. Horve, C. (2016), Gene Cloning and Manipulation. Cambridge: Cambridge University cross. doi: 10. 1017/CB0978051180.
12. Tererrce A. (T.A.) Brown (2017) Genomes 4, Fourth edition. Garland Science: New York, NY.
13. Terence A (T. A) Brown T.A. (2016) Gene cloning and DNA analysis: an introduction 6th ed. Wiley-Blackwell UK.

L	T	P	C
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Course Code	**3SBC2E2**
Course Title	**Reproductive Physiology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Demonstrate an understanding of structure and function of reproductive systems.
2. Apply the basic knowledge to understand the molecular mechanisms of gametogenesis and its regulation.
3. Analyze the functional modulation and establish a relationship between various functional aspects of reproductive physiology
4. Evaluate and interpret the cause of pathogenicity or dysfunction and critically identify the mode of action.
5. Create and develop therapeutic or preventive strategies for reproductive irregularities.

Syllabus **Teaching hours**: **45**

Unit 1: Human Reproductive System 8 Hours

Structure, function of male and female reproductive function; Functional assessment of male and female functioning; Mechanism and molecular events of fertilization, Preembryonic Development, Pregnancy, Labour and Lactation.

Unit 2: Gametogenesis 10 Hours

Spermatogenic Cycle; Its Molecular changes, Hormonal Regulation, Spermiation and Spermiogenesis; Sperm capacitation; Molecular and Biochemical changes, decapacitation. Process of folliculogenesis and its hormonal control. Recruitment, selection, dominance of follicle and signaling for ovulation. Follicle wall: Theca, differentiation, steroid hormone synthesis, menstrual cycle and Menopause. Mechanism and hormonal control of ovulation; Histogenesis, function, maintenance and luteolysis during Corpus Luteum. Prostaglandins and their role in reproduction.

Unit 3: Gonadal Steroidogenesis 9 Hours

Autocrine, Paracrine and Endocrine Regulation of Gonadal Steroidogenesis, Regulation of Expression of Genes Encoding Steroidogenic Enzymes.

Unit 4: Molecular Aspect of Sex Differentiation 5 Hours

Location of Sry -Gene and its Critical Period of Expression, Specific Cell Type Engaged in SRY -Gene Expression, Downstream Genes Regulation by SRY -- Gene Like Amh Gene, Arometase Gene, Ar-Gene, 5a-Reductase Gene, Sox -9 gene and Z-Gene.

Unit 5: Stress and Reproduction 5 Hour

Stress and Pituitary Gonadotropin, Stress and Cytokines, Oxidative Stress and Reproductive Activities

Unit 6: Reproductive Immunology 8 Hours

Role of immunological cells in the male and female reproductive system, understanding the normal and abnormal physiological events influenced by reproductive immune cells.

Books Recommended

1. Knobil, E. and Neil, J. D., The Physiology of Reproduction, Vol 1 and 2, Raven Press, 1988.
2. Wang, C., Male Reproductive Function, Kluwer Academic Publishers, 1999.

3. Zuckerman, B. S. Z., Weir, B. J. and Baker, T. G., The Ovary, Academic Press, 1977.
4. Leung, P. C. K. and Adashi, E. Y. (Ed), The Ovary, Elsevier (Academic Press), 2004.
5. Desjardins, C. and Ewing, L. L., Cell and Molecular Biology of Testis, Oxford University Press, USA, 1993
6. Yen, S. S. C., Jaffe, R. B., and Barbieri, R. L. (Ed), Reproductive Endocrinology: Physiology, Pathophysiology, and Clinical Management, Saunders Publisher. USA, 1999.
7. Chedrese, P. J., Reproductive Endocrinology: A Molecular Approach, Springer Publishers, 2009.
8. Carrell, D. T. and Peterson, C. M., Reproductive Endocrinology and Infertility, Springer Publishers 2010.

L	T	P	C
-	-	14	7

Course Code	**3SBC204**
Course Title	**Laboratory II**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand the basics of bioinformatics tools, immunological techniques, neurobiology of diseases, reproductive physiology and experiments related to molecular biology and clinical biochemistry.
2. Analyze the data obtained from molecular analysis of RNA, DNA and protein, clinical biochemistry experiments and interpret the results.
3. Apply the techniques based on requirement in analysis of biomolecules and diseases and for conducting research.

Syllabus: Teaching hours: 224hrs

1. Pubmed searches, Scopus and Biological databases
2. Structure visualization and statistical methods, sequence similarity search, Introduction to Metagenomics, Pairwise and multiple sequence alignment
3. Docking of protein and ligand, protein-protein docking and its interpretation for clinical targets.
4. Prediction of protein structure, 2D-3D protein structure and prediction
5. Use of UCSC genome browser to find locations of a sequence in a particular genome
6. Phylogeny and its evolutionary analysis
7. Lead generation and optimization
8. Drug docking and its analysis, Use of Computer simulation, In-silico cloning
9. Isolation of Plasmid DNA, Genomic DNA and RNA, Agarose gel electrophoresis
10. Perform Restriction digestion
11. Perform PCR and qPCR
12. UV Survival curve
13. UV mutagenesis, Isolation of drug resistant mutants
14. Determination of MIC and MBC of streptomycin for bacteria
15. Induction of the lac operon in E. coli
16. Microbial production, recovery and estimation of Exopolyaccharide/ Alcohol/ Citric acid in shake flask/ lab-scale fermentor
17. Solid-state fermentation
15. Purification of Immunoglobulin from normal serum/ anti- sera using affinity and ion-exchange chromatography
16. SDS-PAGE and immunoblot for isolated IgG
17. Perform ELISA for serum antigen

Suggested Reading:

1. Ausubel, Frederick M; Seidman, J. G.; Moore, David D.; Kingston, Robert E.; Brent, Roger; Struhl, Kevin and Smith, John M. Short protocols in molecular biology, Vol. I, II & III, 5th eds. John and Wiley Sons, Inc. 2002
2. Hohenegger M, Rudas B (1971). Kedney Function in Experimental diabetic
3. Tyndale-Biscoe, C. E., Hugh Tyndale-Biscoe, and Marilyn Renfree. Reproductive physiology of marsupials. Cambridge University Press, 1987.
4. Mount, David W. 2nd eds. Bioinformatics: sequence and genome analysis. Vol. 1. , New Delhi, C. B. S. Publishers & Distributors, 2005.
5. Andreas D.Baxevanis, B.F. Francis Ouellette, "Bioinformatics: A Practical Guide to the Analysis og Genes and Proteins, 3rd eds. Wiley India (P) Ltd. 2006

6. Vittal R.Srinivas, Bioinformatics: A Modern Approach, New Delhi: PHI Learning Private Limited, 2005
7. Current Protocols in Immunology (1995) 1.0.3-1.0.6,Contributed by John Donovan and Patricia Brown.
John R.Crowther ,Methods In Molecular Biology, The Elisa Guide Book, Humana Press, Volume 42

L	T	P	C
-	-	2	2

Course Code	**3SBT212**
Course Title	**Seminar II**

Course Learning Outcomes (CLO):
At the end of the course, students will be able to-

1. Understand the concepts of scientific paper presentation.
2. Analyze the scientific writing and data presented in Research papers.
3. Apply the knowledge and skill for structured writing and presentation of technical research reports.

Syllabus: **Teaching Hours: 30**

The students have to give seminars on a research paper of their interest from any of the biological fields which will be open for discussion. The students will have to submit the hardcopy of the selected manuscript along with a summarised write up of the paper in their own words. This course has been designed to provide a platform for the students to develop their communication, presentation and confidence to face the audience.

Supplementary Course:

L	T	P	C
1	-	-	-

Course Code	**3SBT2E2**
Course Title	**Professional English**

Course Learning Outcomes (CLO):
At the end of the course, students will be able to-

1. Understand the basics of English grammar, phonetics and mechanics of language.
2. Use appropriate English vocabulary for fluent and confident communication in English.
3. Demonstrate communication capacities in speaking, writing, listening and narrating in English.

Syllabus: **Teaching Hours: 15**

Unit 1: Introduction to communication: Idioms & Phrases, Basic Nonverbal communication, Barriers to Communication,

Unit 2: Business Communication at work place: Letter components and layouts, planning a letter, Process of Letter writing, Email Communication, Employment Communication, Notice Agenda and Minutes of Meeting

Unit 3: Report Writing: Effective Writing, Types of Business Reports, Structure of Reports, Gathering Information, Organization of Material, Writing Abstract and Summaries, Writing Definitions, Meaning of Plagiarism and Precaution.

Unit 4: Required Skill: Reading Skill, Note-Making, Precise Writing, Audio visual Aids, Oral Communication.

Unit 5: Mechanics of Writing: Transition, Spelling Rules, Hyphenation, Transcribing Numbers, Abbreviating Technical and Non-Technical Terms, Proof Reading.

Books Recommended

1. Technical Communication: Principles and Practice, by Meenakshi Raman and Sangeeta Sharma, Oxford University Press, IInd Edition

Value Added Course:

L	T	P	C
2	-	-	-

Course Code	**3SBT2S1**
Course Title	**Professional Development and Resume Writing**

Course Learning Outcomes (CLO):
At the end of the course, the students will be able to:
Design their CV which will evoke interest and help them in their summer internship; will provide an attitude of professionalism and empower them with decision making abilities.

Final Syllabus of Biochemistry for the Academic year 2022-23

Institute of Science

Nirma University

Syllabus:

Unit 1:Interview Etiquettes and CV writing: 8 hour

Right approach to interview, Preparation for interview, Do's and Don'ts in Interview. Making Effective CV and understanding essential do's and don'ts.

Unit 2: Professional development: 8 hour

Understanding Professionalism. Aspects of professionalism. Traits of effective and successful professionals. Professional Ethics.

Unit 3:Decision Making: 8 hour

Process of decision making, Factors to consider while making a decision, Tools for making good decisions, Win-Win approach to decision making. 8 hours

Unit 4: Self Study and Group Discussion 6 hour

Elective Courses I

L	T	P	C
3	-	-	3

Course Code	**3SBC2E1**
Course Title	**Human Genetics**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand and appraise the fundamental principles of inheritance, structural and functional aspects of cellular genetic material, will learn collecting and interpreting genetic related history, making pedigree chart, and linkage and association prediction studies
2. Evaluate various laboratory approaches of study of genetic material including conventional and updated methods of genomic studies for nuclear and mitochondrial genetic elements, coding and non-coding DNA and RNA
3. Demonstrate understanding regarding various models of study of genetic aetiology involved in various single gene, complex, and multifactorial disease conditions; Evaluate the molecular mechanisms and their cross-talk responsible for various diseases including cancer, diabetes and other dreadful diseases, articulate host-environment interactions
4. Demonstrate understanding of available knowledge and can employ them by making use of various updated databases related to human genetic, genomic, phenotypic, and genetic conditions related databases

Syllabus: **Teaching hours**: **45**

Unit 1: Mendelian principles of inheritance: 10 Hours

Dominance, segregation, independent assortment; alleles, multiple alleles, pseudo-allele, complementation tests; Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters; extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance, mitochondrial mutations and myopathies.

Unit 2: Organization of human genome and genes: 9 Hours

General organization of human Genome-Nuclear and Mitochondrial, Mitochondrial Genome organization, distribution of tandems and interspersed repetitive DNA, Gene distribution and density in human nuclear genome, Organization of genes: rRNA encoding Genes, mRNA encoding Genes, small nuclear RNA genes, Overlapping genes, genes within genes, multigene families, pseudo genes, truncated genes and gene fragments.

Unit 3: Gene mapping: 10 Hours

Pedigree analysis, LOD score for linkage testing, linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids; strategies in identifying human disease genes in pre and post Human Genome project; low and high resolution mapping; Principles and strategies for identifying unknown disease or susceptibility genes

Unit 4: Animal Models For Human Diseases: 6 Hours

Potential of using animal models for human diseases, Types of animal models, transgenic animals, procedures of production and application in the study of different diseases; Gene editing and gene therapy**,** Induced pluripotent stem cells; transgenic animals to model complex diseases.

Unit 5: Cytogenetics and other methods of detection of genetic aberrations: 6 Hours

Human chromosomes structure, number and classification, methods of chromosome preparation,

banding patterns. Structural and numerical alterations of autosomes and sex chromosomes; Molecular cytogenetic techniques, Fluorescence in situ hybridization using various types of probes, Multiplex FISH and spectral karyotyping, comparative genomic hybridization, microarray, Whole Exome and Whole Genome sequencing.]

Unit 6: Data Mining in Genetics Research & Clinical Management: 4 Hours

Introduction to Internet based cataloguing of Genetic Aberrations in various diseases including Cancer, OMIM, Mitelman database of chromosome aberrations in cancer, Borgaonkar database of chromosomal variations in man, London Dysmorphology Database, Human Variome project, Human Phenome project, Encode project, Phenomizer and other automation approaches in phenotyping.

Suggested Readings:

1. ISCN 2016, Jean McGowan-Jordan, A. Simons, M. Schmid; Karger, 2016
2. Rooney D. E., and Czepulkowski, B. H., Human Cytogenetics: A Practical Approach (Vol. I & II), 1992 Edition, Oxford University Press, 1992.
3. Griffith A. J.F., Wessler S.R., Carroll, S.B., and Doebley J., Introduction to Genetic Analysis, 10th Edition, W. H. Freeman, 2010.
4. Benjamin P., Genetics: A Conceptual Approach & Problem Solving, 2008, W. H. Freeman, 2008.
5. Hedrick, P. W. (2011) Genetics of Populations, 4th Edn., Jones & Bartlett Publ.
6. Vogel and Motulsky's Human Genetics: Problems and approaches, Michael R. Speicher, Stylianos E. Antonarakis, Arno G. Motulsky, Springer; 4th ed. 2010 edition.
7. The AGT Cytogenetics Laboratory Manual, M.J.Barch, T.Knutsen, and J.Spurbeck.,Third Edition,Lippincott-Raven Publishers, Philadelphia (1997)
8. Genomic Imprinting and Uniparental Disomy in Medicine by Eric Engel, Stylianos E. Antonarkis, Wiley-Liss, Inc. ISBNs: 0-471-35126-1 (Hardback); 0-471-22193-7
9. Ricki Lewis Human Genetics Concepts and Applications 10th Edition, 2011, McGraw-Hill Science.
10. The Science of Genetics, Atherly et al (1999), Saunders
11. Robbins & Cotran, Pathologic Basis of Disease, 8th Edition, Elsevier, 2010.
12. Strachan Tom and Read Andrew P. (2011) Human Molecular Genetics, 4th Edition, Garland Science (Taylor and Francis Group), London and New York

L	T	P	C
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Course Code	**3SBC203**
Course Title	**Advanced Immunology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand how MHCs play critical role in shaping specific adaptive immune responses
2. Select target antigen or immunogen against which immune response is generated
3. Design adjuvant to induce B and T cell responses
4. Develop strategies to regulate immune response against the self

Syllabus: Teaching hours: 45

Unit 1: Major Histocompatibility Complex (MHC) Genes and Products: 9 Hours

Polymorphism of MHC genes, Role of MHC antigens in immune responses, MHC antigens in transplantation.

Unit 2: 10 Hours

Antigen processing and presentation, Cytokines and Chemokines; Microbial Associated Molecular Patterns – TLR, NLRs.

Unit 3: B lymphocyte Development and Differentiation: 6 Hours

B cell differentiation in Bone marrow, B cell signal transduction, Antigen dependent B cell differentiation - primary and secondary follicles.

Unit 4: T lymphocyte development and Differentiation: 10 Hours

Thymus – Negative and positive selection. T lymphocyte Activation and differentiation - subtypes of Th cells, CD8 T cell activation, γδ T lymphocytes, T and B cell memory.

Unit 5: Tolerance: 7 Hours

Peripheral tolerance, Immunosuppression, Transplantation

Unit 6: Clinical Immunology: 7 Hours

Hypersensitivity - Types I, II, III and IV; Autoimmunity; Cancer immunology.

Suggested Readings:

1. Murphy, K., & Weaver, C. (2016). Janeway's immunobiology. Garland Science.
2. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2007). Kuby immunology. Macmillan.
3. Greenberg, S., Silverstein, S. C., & Paul, W. E. (1993). Fundamental immunology. Fundamental Immunology, 509.
4. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2014). Cellular and molecular immunology. Elsevier Health Sciences.
5. Coico, R., & Sunshine, G. (2015). Immunology: a short course. John Wiley & Sons.
6. Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2016). Roitt's essential immunology. John Wiley & Sons.

L	T	P	C
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Course Code	3MB2E2
Course Title	Microbial Ecology

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand principles of ecology and interactions among microorganisms and their environment
2. Analyze beneficial and pathogenic interactions of microorganisms with plants and animals
3. Comprehend role of microorganisms in biogeochemical cycling of elements

Syllabus:

Unit 1: Fundamentals of ecology: 5 Hours

The ecosystem, energy in ecological systems, energy partitioning in food chains and food webs, history and scope of ecology

Unit 2: Interactions among microbial populations: 7 Hours

positive and negative interactions, interactions between diverse microbial populations

Unit 3: Interactions between microorganisms and plants: 8 Hours

Interaction with plant roots – rhizosphere and mycorrhizae, interactions with aerial plant structures, microbial diseases of plants

Unit 4: Microbial interactions with animals: 9 Hours

Microbial contribution to animal nutrition, fungal predation on animals, other symbiotic relationship eg. Symbiotic light production and novel prokaryotic endosymbionts, ecological aspects of animal diseases.

Unit 5: Biogeochemical cycling I: 8 Hours

Carbon cycle, Hydrogen cycle, Oxygen cycle

Unit 6: Biogeochemical cycling II: 8 Hours

Nitrogen cycle, Sulphur cycle, Phosphorus cycle, cycling of other elements

Suggested Readings:

1. Atlas, R.M. and Bartha, R. Microbial Ecology, 4th edition, Pearson Education, 2009.
2. Maier, R.M., Peppper, I.L. and Gerba, C.P. Environmental Microbiology, 2nd edition, Elsevier Academic Press, 2009.
3. Paul and Clerk, Soil Microbiology and Biochemistry, 2007.
4. Paul, E.A. (Ed.). Soil Microbiology, Ecology and Biochemistry, 3rd edition, Academic Press, 2007.
5. Pepper, I.L. and Gerba, C.P. Environmental Microbiology – A Laboratory Manual, 2nd edition, Elsevier Academic Press, 2005.
6. Manahan, S.E. Environmental Chemistry, 9th edition, CRC Press, 2010.
7. Odum, E.P. and Barrett, G.W, Fundamentals of Ecology, 5th edition, Cengage Learning, 2005

L	T	P	C
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Course Code	3SBT204
Course Title	Microbial Genetics

Course Learning Outcomes (CLO):

At the end of the course, students will be able to -

1. Identify types of mutations including spontaneous and induced mutations and understand mechanisms of mutagenesis, DNA damage repair and DNA recombination pathways.
2. Understand molecular mechanisms of gene transfer in microbes and phages and relate the role of these mechanisms for fine structure mapping of genes.
3. Apply the knowledge on the results of genetic experiments to find out number of genes involved in a process, gene order, distance between genes and fine structure mapping of genes.

4. Integrate the role of extrachromosomal elements including plasmids and transposons in genetic analysis and their roles in evolution.

Syllabus: **Teaching hours: 45 Hours**

Unit I: Principles of Microbial Genetics: 7 Hours
Basic procedure and terminology, selection and classification of variations, Mutations – Types and screening; Mechanism of mutagenesis, Directed mutations, Use of mutations.

Unit 2: Genetic Analysis of Bacteria: 9 Hours
Genetic mapping, Linkage and Multifactor Crosses, Deletion mapping, Complementation, Gene transfer mechanisms—transformation, conjugation, transduction.

Unit 3: Phage Genetics: 8 Hours
Genetics of temperate and virulent phage, Lytic phage - Phage mutants, genetic recombination in phages; Fine structure mapping of T4 *rII* locus.

Unit 4: DNA Damage and Repair: 6 Hours
Types and mechanisms of DNA repair.

Unit 5: Recombination: 7 Hours
Models of recombination - homologous, site-specific and non-homologous or illegitimate recombination. Transposons in bacteria and yeast; Mechanism of transposition.

Unit 6: Extra-chromosomal Genetic Elements: 8 Hours
Plasmids – Classification, Incompatibility, copy number control; Genetics of restriction modification systems.

Suggested Readings:

1. Brown, T.A. Genetics - A Molecular Approach, 3rd edition, BIOS Scientific Publishers, 2004.
2. Brown, T.A. Genomes 3, G.S. Garland Science, 2007.
3. Dale, J.W. and Park, S.F. Molecular Genetics of Bacteria, 5th edition, Wiley-Blackwell, 2010.
4. Das, H.K. Textbook of Biotechnology, 2nd edition, Wiley Dreamtech, 2005.
5. Gardner, E.J. Simmons, M.J. and Snustad, D.P. Principles of Genetics, 8th edition, John Wiley and sons, 2004.
6. Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. (Eds.), Lewin's Genes X, 10th edition, 2011.
7. Maloy, S.R., Cronan Jr., J.E. and Freifelder, David. Microbial Genetics, 2nd edition, Narosa Publishing House, 2009.
8. Snustad, D.R. and Simmons, M.J. Principles of Genetics, 5th edition, John Wiley and sons, 2010.

SEMESTER III

Core Courses

L	T	P	C
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Course Code	**3SBC302**
Course Title	**Biochemical Toxicology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Demonstrate an understanding of basic toxicity and dose response relationship.
2. Apply the basic knowledge to understand the molecular mechanisms of toxicity induction.
3. Analyse the reversal mechanisms depending upon the type and extent of toxicity
4. Evaluate and interpret the need for the regulatory guidelines for various aspects and types of toxicity
5. Create and develop therapeutic or preventive strategies for toxicity induction

Syllabus **Teaching hours**: **45**

Unit 1: Introduction to Toxicology & Factors influencing Toxicity 9 Hours
Introduction, Dose Response Relationship, Determination of ED5O and- 'LD50, Acute and Chronic`c Exposures, Chemical and Biological Factors, Regulatory Guidelines and Toxicity Testing Protocols .

Unit 2: Toxicants and Toxicity 6 Hours
Insecticides, Organochlorides, Anti-Cholinesterases, Organophosphates and Carbamates, Consequences of Pesticide Toxicity, Toxicology of Food Additives and Heavy Metal Toxicity.

Unit 3: Structure, Mechanism and Regulation of Cytochromes P450 8 Hours.
Deposition (Absorption, Distribution and Excretion) and Metabolism (Types of metabolic changes), Introduction, Complexity of Cyio P450 gene superfamify, Structure, Mechanism of Catalysis, Regulation and Post-translation Modification of P450s.

Unit 4: Metabolism and Conjugation of Toxicants and Metabolic Interactions 10 Hours
Microsomal monooxygenations, Nonmicrosomal Oxidations; Phase I-Toxicogenetics; Polymorphism of CYP isoforms, Conjugation Reactions, Roles of

Phase II Genes and Polymorphisms, Antioxidant Responsive Elements .

Unit 5: Cellular Transport and Elimination 6Hour

Transport as determinant of Xenobiotic Action, Factors affecting Permeability, Transporters, Cell Death, Mitochondrial dysfunction

Unit 6: Cellular Protection Mechanisms and Toxicity 6 Hours

Oxidative Stress, Inflammation, Cellular Defence systems, Signalling systems and Antioxidant Defence, Enzymes involved in Bio activation.

Suggested Readings:

1. Briggs M. H., The Chemistry and Metabolism of Drugs and Toxins: An Introduction to Xenobiochemistry, Heinemann Medical Publication,
2. Freeman K. I., Evans J. P., Cerniglia, F. E., Xenobiochemistry, Elsevier (Amsterdam), 1985.
3. Hodgson, E., and Smart R. C., Introduction to Biochemical Toxicology, 3rd Edition, Wiley, 2001.
4. Timbrell J., Principles of Biochemical Toxicology, 4th Edition, Taylor & Francis, USA, 2004.
5. Paul R. Ortiz de Montellano (2004). Cytochrome P450: Structure, Mechanism, and Biochemistry, Kluwer Academic and 'Plenum Publishers, USA.

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Course Code	**3SBC304**
Course Title	**Cancer Biology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Describe and appraise the fundamentals of cellular processes involving molecular genetic basis of multistep process of carcinogenesis
2. Illustrate mechanisms of physical, biological, and chemical cancer causing agents as well as spontaneous cancer onset in terms of role of oncogenes and tumour suppressor genes, deregulation of cell cycle and differentiation in cancer cells
3. Articulate host-environment interactions including susceptibility factors in cancer predisposition; cancer classification systems; principles of cancer diagnosis, prognosis, and response to therapy and management in the laboratory
4. Demonstrate understanding of cancer control for disease-free, relapse-free, and metastasis-free longer survival using knowledge of molecular players and factors governing cancer spread from primary sites, metastasis cascade, and invasion.

Syllabus: Teaching hours: 45 Hours

Unit 1: Introduction to Cancer Biology: 8 Hours

History of cancer and various theories of carcinogenesis, Warning signs of cancer; Hallmarks of cancer; Types of cancer; cancer classification systems: TNM, FAB, WHO; Cancer staging and Grading; Global Trends in cancer incidence and death rate; Baseline and environmentally induced cancer rate

Unit 2: Molecular Cell Biology of Cancer: 8 Hours

Proto-oncogenes and Oncogenes, Mechanisms of inactivation of proto-oncogenes and affected cellular pathways; modulation of growth factors, receptors, signal transduction, and cell cycle; Retroviruses and Oncogenes; Tumour suppressor genes, two-hit theory, Identification and detection of oncogenes and Tumor suppressor genes, mi-RNA and other regulators of cellular pathways and cancer

Unit 3: Cancer Genetics, Cytogenetics and Genomics: 8 Hours

Constitutional and Acquired Genetic Determinants of Cancer; Genetic Predisposition to Cancer; Familial Cancers; Molecular pathogenesis of acquired chromosomal aberrations, fusion genes, gene amplification, whole genome, various approaches for detection of genetic changes and targeted therapy with examples of clinical importance

Unit 4: Principles of Carcinogenesis: 8 Hours

Physical, Chemical and Biological Carcinogenesis, Genotoxic and non-genotoxic Metabolism and Targets of Carcinogenesis, Molecular mechanism of Carcinogenesis. Cancer risk factors and differential susceptibility, Cancer metabolism

Unit 5: Cancer Metastasis: 8 Hours

Metastatic cascade; Basement Membrane disruption; Three-step theory of Invasion; Heterogeneity of metastatic phenotype; Epidermal Mesenchymal Transition, Molecular signatures and organ preference in metastasis, Proteinases and invasion

Unit 6: Therapeutic Approaches: 5 Hours
Strategies for cancer treatment; Tumor markers and molecular markers for cancer diagnosis, prognosis, and therapy decisions; Cancer Immunology and therapeutic interventions, Targeted drug delivery and drug delivery systems, Cancer vaccine, Clinical trials, Gene Therapy, Targeted therapy, personalized medicine, survival and response monitoring

Suggested Readings:

1. Weinberg R., Biology of Cancer, Garland Science, June, 2010
2. D. Liebler, Proteomics in cancer research, 2004
3. David M. Terrian, Cancer cell signalling, Methods and protocols, Volum 218 (Methods in Molecular Biology), 2003.
4. Strachan Tom and Read Andrew P. (2010) Human Molecular Genetics, 4th Edition, Garland Science (Taylor and Francis Group), London and New York
5. K.L. Rudolph, Telomeres and Telomerase in ageing, disease, and cancer, 2008.
6. Maly B.W.J., Virology: A practical approach, IRL Press, Oxford, 1987.
7. Dunmock N.J and Primrose, S.B., Introduction to modern Virology, Blackwell Scientific Publications. Oxford, 1988.
8. Knowles, M.A., Selby P., An Introduction to the Cellular and Molecular Biology of Cancer, Oxford Medical publications, 2005.
9. Vincent, T. De Vita, Lawrence T. S., Rosenberg, S. A., Cancer: Principles & Practice of Oncology, 10th Edition, Lippincot, 2011
10. http://atlasgeneticsoncology.org
11. http://cgap.nci.nih.gov/Chromosomes/Mitelman
12. http://www.humanvariomeproject.org
13. https://www.genome.gov/hapmap

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Course Code	**3SBC307**
Course Title	**Endocrinology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Demonstrate an understanding of the biosynthesis and function of the various endocrine hormones
2. Apply the basic knowledge to understand the molecular interaction of various hormones under different physiological conditions
3. Analyse the hormonal profile and correlate with its need during the metabolic state and growth
4. Evaluate and interpret the need for regulating the hormones
5. Create and develop therapeutic or preventive strategies for various hormonal disregularities

Syllabus Teaching hours: 45 Hours

Unit 1: Introduction to Endocrinology and hormone biosynthesis 7 Hours
Endocrine Glands, Types of Release, Receptors, Signal Transduction & Gene Regulation, Homeostasis and Feedback, The Hypothalamic-Pituitary System: Anatomy of Endocrine glands and associated diseases.

Unit 2: Tropic Hormones and their Regulation 9 Hours
Thyroid, adrenal and Reproductive Hormones, their Functioning and Physiological Implications. Peptide Hormones, Steroids, Catecholamines and Prostaglandins.

Unit 3: Gastrointestinal Hormones & Neurotransmitters 8 Hours
Cellular Communication, Neural Regulation of the Gastrointestinal Tract, Chemical Messengers, Regulation of Gastrointestinal Growth, Gastrointestinal Peptides.

Unit 4: Hormones in Metabolism and Growth 8 Hours
Calcium-Regulating Hormones, Insulin Action and Endocrinology of Fat Metabolism, circadian 'rhythm and metabolism

Unit 5: Hormones in Development and Behavior 7 Hours
Role of hormones during fetal development, sustenance of pregnancy, role of hormones in behavior, Mechanism of Molting and Metamorphosis

Unit 6: Microbial role in Endocrine functioning 6 Hours
Introduction, Evolutionary basis of Neurotransmitters in microbial and animal cells, Dietary Catechol and their correlation with microbial endocrinology, Modulation of interaction of Enteric bacteria with intestinal Mucosa, Stress, Immunity and indigenous Microflora .

Suggested Readings:

1. Barrington, E. J. W. - General and Comparative Endocrinology, Clarendon Press, 1975.
2. Bentley, P. J., Comparative Vertebrate Endocrinology, Cambridge University Press, 1998.
3. Williams, R. H. and Larsen P. R., Text Book of Endocrinology, W.B. Saunders, 2003.
4. Martin, C. R., Endocrine Physiology, Oxford University Press, 1985.
5. Gorbman, A. et al., Comparative Endocrinology, John Willey and Sons, 1983
6. Norris, D. O. Vertebrate Endocrinology-4th Edition, Elsevier Academic Press, 2007.
7. Greenspan, F. G. and Garden, D. G., Basic and Clinical Endocrinology, Mcgraw-Hill, 2004
8. Mark lyle and primrose p.e. Freestone. (2010). Microbial endocrinology- inter-kingdom signaling in infectious disease and health. Springer new york.
9. Mark lyle and john f. Cryan (2014). Microbial endocrinology; the microbiota-gut-brain axis in health and disease (advances in experimental medicine and biology). Springer new york.
10. Jameson, J. L. (2006). Harrison's Endocrinology, McGraw-Hill, 2006
11. Williams, R. H. and Larsen, P. R. (2003). Williams Textbook of Endocrinology, Saunders Publications

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Course Code	**3SBT308**
Course Title	**Animal Biotechnology**

Course Learning Outcomes (CLO)

At the end of the course, students will be able to -

1. Describe the basics of maintainence of mammalian cell and generation of cell line using proper sterile techniques and optimum conditions of growth to develop mamalian cells.
2. To identify and comprehend experimental knowhow of various techniques involved in cell separation and quantitation using latest technology.
3. To relate and evaluate the applications of animal biotechnology gene therapy, toxicity testing, cancer research, animal breeding, vaccine production and other biotechnological products of industrial and medical benefits.
4. To relate to the social, cultural, economical, legal issues associated and comprehend the need Bioethics and IPR in biotechnological research.

Syllabus: **Teaching hours**: **45**

Unit 1: The Culture Media for Animal Cell culture: 9 Hours

Introduction, history and concept of biotechnology. Media and Supplements, Serum, Serum Free Media, Natural Media, Feeder Layer on Substrate, Gas Phase for Tissue Culture. Source of Tissue, Primary culture. Stages of Commitment and Differentiation, Proliferation, Malignancy.

Unit 2: Subculture and Cell lines: 9 Hours

Cross Contamination, Terminology, Naming and Choosing cell line and its maintenance. Criteria for subculture, growth cycle and split ratio, propagation in suspension and attached culture.

Unit 3: Cloning and hybridoma technology:6 Hours

Vectors and Cloning, Somatic Cell Fusion, Hybridomas, HAT Selection, Medium, Suspension Fusion, Selection of Hybrid Clones, Organ Culture, Tumourigenesis

Unit 4: Cell Separation and Quantitation: 9 Hours

Separation techniques based on density, size, sedimentation velocity, antibody based techniques - immune panning, magnetic sorting, and fluorescence activated cell sorting. Quantitation- Cell counting, cell weight, DNA content, protein, rate of synthesis, measurement of cell proliferation.

Unit 5: Characterization and differentiation: 6 Hours

Authentication, Record keeping, Provenance, parameters of characterization, Lineage and Tissue markers, cell morphology, Karyotyping, Chromosome banding. Differentiation- commitment, terminal differentiation. Lineage selection, proliferation and differentiation, commitment and lineage, markers of differentiation, induction of differentiation, cell

interaction- homotypic and heterotypic. Cell – matrix interaction.

Unit 6: Applications of animal biotechnology and related problems: 6 Hours

Artificial animal breeding, cloning and transgenic animals, medicines, vaccines, diagnosis of diseases and disorders, gene therapy forensic application. Social, Cultural, Economical, Legal problems. Bioethics. IPR.

Suggested Readings:

1. Freshney, I., Cultures of Animal Cells, John Wiley and Sons Inc, 2010.
2. Cibelli, J., Robert P., Keith L.H.S., Campbell H., and West M. D., (Editors) Principles of Cloning, St. Diego Academic Press, 2002.
3. Mathur, S., Animal Cell and Tissue Culture, Agrobios (India), 2000.
4. Panno, J., The New Biology Series: Animal Cloning, Viva books Pvt. Ltd, New Delhi, 2010.
5. Mepham B. M., Bioethics- An introduction for Bioscience by, 2nd Edition, Oxford University Press, 2008.
6. Jacker, N. S., Johnson A. R., Pearlman R. A., Bioethics- An introduction to the history method and practice, 2nd Edition, Johnson Bartlett Publ. New York. 2010
7. Satheesh, M. K. Bioethics and Biosafety, I.K. International Publishing House Ltd, New Delhi. 2005
8. Glick, B. R., and Pasternak J. J., Molecular Biotechnology - Principles and applications of recombinant DNA, ASM Press , 3rd Edition., 2003.
9. Sullivan, S., Cowen C., and Eggan K., Human Embryonic Stem Cell: The Practical Handbook, 2007.
10. Freshney, R. I. (2010) Culture of Animal Cells, 6th Edn., Wiley-Blackwell.
11. Ramadass, P, Animal Biotechnology: Recent Concepts and Developments
12. Portner, Ralf. Animal Cell Biotechnology: Methods and Protocols.

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Course Code	**3SBC309**
Course Title	**Laboratory III**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand the basics of primary cell and cell line culture, endocrine system and concept of probiotics
2. Analyse the data obtained from cell culture, clinical biochemistry and probiotics experiments and interpret the results.
3. Apply and correlate the knowledge obtained to analyse various disease conditions and designing probable treatment strategies.

Syllabus: Teaching Hour 128 hrs

1. Isolation of Probiotic strain from the faecal samples and its Probiotic characterization using culture and spectrophotometric analysis
2. Estimation of Short Chain Fatty Acids from Serum and faecal samples using HPLC
3. Isolation and preparation of hepatocyte, pancreatic cells or lymphocytes for primary cell culture
4. Estimation of live cells using Trypan blue test by hemocytometer and viability testing
5. Estimation of live cells using PI by flow cytometry
6. Cell line passaging for establishing continuous cell culture
7. To study early and terminal differentiation of mammalian cell using specific markers by immunofluorescence technique
8. To study mammalian gene transfection in CHO/HEK 293 cells in vitro

Suggested Reading:

1. Doyle, Alan. Cell and tissue culture: laboratory procedures in biotechnology. John Wiley & Sons Ltd, 1998.
2. Freshney, R. Ian. "Basic principles of cell culture." Culture of cells for tissue engineering (2006): 3-22.
3. Freshney, R. Ian. Culture of animal cells: a manual of basic technique and specialized applications. 7th ed., John Wiley & Sons, 2016.

4. Tortora, Gerard J., and Bryan H. Derrickson. Principles of anatomy and physiology. 13th ed. John Wiley & Sons, 2011.
5. McMaster, Marvin C., and A. HPLC. A Practical User's Guide. 2nd ed. Wiley-Vch, 2007.
Prajapati, Bhumika, et al. "Divergent outcomes of gut microbiota alteration upon use of spectrum antibiotics in high sugar diet-induced diabetes in rats." RSC advances 8.46 (2018): 26201-26211.

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Course Code	**3SBT312**
Course Title	**Research Methods**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand the various kind of research designs and their importance in conducting the research work.
2. Propose original research proposal and demonstrate skills for effective communication through its defence.
3. Application of bio statistical tools for evaluation of statistical relevance of results obtained.

Syllabus: **Teaching Hour: 45**

Unit 1: Research: **8 Hours**

Definition of Research, Applications of Research and Types, Validity, Literature Review, Develop a Theoretical and Conceptual Framework, Writing up the Review, Formulating and Research Problem: Sources, Considerations, Definition of Variables, Types, Research Modeling: Types of Models, Model Building and Stages, Data Consideration.

Unit 2: Research Design: **14 Hours**

Design of Experiments, Objectives, Strategies, Replication, Randomization, Blocking, Guidelines for Design of Experiments, Simple Comparative Experiments- Two Sample T-Test, P-Value, Confidence Intervals, Paired Comparisons, Single Factor Experiment: Analysis of Variance (ANOVA), Randomized Complete Block Design .

Unit 3: Research Proposal: **12 Hours**

Contents-Preamble, The Problem, Objectives, Hypothesis, Study Design, Setup, Measurement Procedures, Analysis of Data, Organization of Report; Displaying Data tables, Graphs and Charts, Writing a Research Report- Developing an Outline, Key Elements- Objective, Introduction, Design or Rationale of Work, Experimental Methods, Procedures, Measurements, Results, Discussion, Conclusion, Referencing and Various Formats for Reference.

Unit 4 Scientific Communication skills: **11 hours**

Importance of communication in science, Types of communications, Communicating with scientific and non-scientific audiences,

Writing skills: Writing of Books and Research Papers, Report & Thesis Writing, Formats of Publications in Research Journals.

Verbal and presentation skills: Oral and Poster Presentations, Graphical abstract

Unit 5: Ethics and Scientific Conduct:

Good Laboratory practice (GLP) – Data Documentation, SOP Plagiarism, Scientific conduct and misconduct, Ethical Guidelines, Biosafety; Principles of Human and Animal Research ethics.

Suggested Readings:

1. Central Drugs Standard Control Organization Http://CDSCO.NIC.IN/
2. Http://WWW.Patentoffice.NIC.IN/
3. WWW.OECD.ORG/DATAOECD/9/11/33663321.PDF
4. Http://WWW.FDA.GOV/FDAC/Special/Testtubetopatient/Studies. Html
5. Ranjit Kumar, Research Methodology- A Step-By-Step Guide for Beginners, Pearson Education, Delhi. 2006.
6. Trochim, William M.K., 2/E, Research Methods, Biztantra, Dreamtech Press, New Delhi, 2003.
7. Montgomery, Douglas C. 5/E, Design and Analysis of Experiments, Wiley India, 2007.
8. C.R. Kothari and Gag, Gaurav, Research methodology- Method and Techniques, New Age International, New Delhi, 2019.
9. Besterfield, Dale H. 3/E, Total Quality Management, Pearson Education, New Delhi, 2005.
10. C. George Thomas, Research Methodology and Scientific Writing, New Delhi, 2015.
11. G Nageswara Rao, Biostatics and Research Methodology, Hyderabad, 2018.
12. Kartikeyan, S. Chaturvedi, R.M and Bhosale, Comprehensive Textbook of Bio-statics and Research Methodology, Mumbai, 2016.

Practicals

The students have to perform wet lab experimentation on the topic of project assigned to them such as standardization of the protocols.

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Course Code	**3SBT3S6**
Course Title	**Summer Training**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

To provide an opportunity for the students to understand the laboratory need of industry and academics as well as research institutes and to prepare them for their goal.

Outline:

All the students undergo summer training during the summer break following their Semester II. This training has to be for minimum period of 21 days. The report and certificate should be submitted to library.

Elective Courses II

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Course Code	**3SBT309**
Course Title	**Vaccinology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Have an idea about the history of various vaccines (subunit vaccines, peptide, DNA and RNA vaccines, live & killed vaccines and edible vaccines), composition of vaccines
2. Learn and develop understanding on the effective delivery of developed vaccine formulation to achieving robust immune responses
3. Understand the various methods to develop vaccines against viral diseases including, HIV, hepatitis, flu etc.
4. Learn and understand the basics of bacterial, protozoan vaccines with reference to malaria parasite
5. To design an efficacious vaccine based on our understanding of the immune response generated due to natural infection as well as the same induced by successful vaccines tried in human beings since 18th century.

Syllabus: **Teaching hours**: **45 Hours**

Unit 1: Introduction to Vaccinology and Classification: 7 Hours

History of vaccines, Immunological principles, Composition of vaccines: vaccine, adjuvant, conservative Concepts of vaccine development, types of vaccine (Conventional vaccines; Live and killed vaccines; New generation vaccines; Sub unit vaccines; Synthetic peptide vaccines; Anti-idiotype vaccines; Recombinant DNA vaccines; Deleted mutant vaccines; Reassortment vaccines; DNA vaccines; Edible vaccines) vaccine, heat killed, X-irradiated, or live attenuated whole pathogen., challenges and possibilities with new vaccines and vaccine strategies

Unit 2: Development of novel vaccines and Vaccine Delivery: 6 Hours

Novel adjuvants, vaccine formats (DNA, viral vectors, dendritic cells), vaccines in development (HIV, malaria, pandemic influenza), Adjuvants; Carriers; Haptens; Vaccine delivery using nano particles; Standardization of vaccines; Safety, sterility and potency testing.

Unit 3: Vaccines for viruses: 8 Hours

HIV, CMV, flu, Hepatitis, herpes viruses, Conventional vaccines killed and attenuated, modern vaccines—recombinant proteins, subunits, DNA vaccines, peptides, immunomodulators (cytokines), Antisense RNA, siRNA, ribozymes, in silico approaches for drug designing.

Unit 4: Vaccine for bacteria: 8 Hours

Shigella, vibrio cholera, diphtheria, tetanus, pertusis, pneumococcus meningitis, toxoplasma, mycobacterium (BCG)

Unit 5: Vaccine for protozoa and parasite: 8 Hours

Malaria, Leishmaniasis, Enamoeba histolitica, schistosomiasis and other helminthic infections.

Unit 6: Reverse vaccinology and immunoinformatics: 8 Hours

Databases in Immunology , B-cell epitope prediction methods, T-cell epitope prediction methods, Resources to study antibodies, antigen-antibody interactions, Structure Activity Relationship – QSARs and QSPRs, QSAR Methodology, Various Descriptors used in

QSARs: Electronics; Topology; Quantum Chemical based Descriptors. Use of Genetic Algorithms, Neural Networks and Principle Components Analysis in the QSAR equations

Suggested Readings:

1. Plotkin, S. A., Orenstein, W. A., and Offit, P. A., Vaccines. 5th Editon, Elsevier, 2008.
2. Immunopotentiators in Modern Vaccines by Schijns and O'Hagen
3. Robinson, A., Hudson, M.J., Cranage, M.P. Vaccine Protocols, C Second Edition, Humana Press, NY, 2003.
4. Chimeric Virus like Particles as Vaccines. Wolfram H. Gerlich (Editor), Detlev H. Krueger (Editor), Rainer Ulrich (Editor), November 1996 Publisher: Karger, S. Inc
5. Kindt, Kuby-Immunology (complements)
6. Current protocols in Immunology
7. Complement regulators and inhibitory proteins. Nat immunology Review volume 9, Oct 2009, 729-40

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Course Code	**3SBT3E1**
Course Title	**Genomics and Proteomics**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1.Describe the understanding of origin and evolution of genomics and gene mapping.
2.Apply the knowledge to establish new, molecular classification of the disease.
3.Evaluate the possibilities for application of pharmacogenomics and proteomics in drug discovery and development of personalized medicine.

Syllabus: Teaching Hours: 45hrs

Unit-1 Origin and Evolution of genomics and gene mapping 8 Hours

Origin of genomics, the first DNA genomes, genomes and human evolution, evolution of nuclear, mitochondrial and chloroplast genome, the concept of minimal genome and possibility of synthesizing it, genetic maps, physical maps, functional maps, comparative genomics and collinearity, synteny in maps.

Unit-2 Whole Genome sequencing technologies and genome assembly 8 Hours

Principle of genome sequencing tools, automated Sanger sequencing, pyrosequencing, Illumina. oxford nanopore and PacBio Sequencing. Whole genome assembly pipeline. k- mer de bruijin graph. Human, Arabidopsis and Drosophila genome

Unit-3 Functional genomics 6 Hours

Concept of forward and reverse genetics, insertion mutagenesis (T-DNA and transport insertion), Targeting Induced Local Lesions in Genomes (TILLING), gene expression and transcript profiling, EST contigs, use of DNA chips and microarrays

Unit-4 Principle of basic protein preparation and separation 8 Hours

Preparation of protein isolates and fractionation /separation of proteins and peptides - basic methods of protein isolation from various sample types; electrophoretic separation techniques (IEF, SDS-PAGE, 2-D gel electrophoresis, DIGE, etc.); liquid chromatography (HPLC and FPLC); separation procedures for analysis of phospho-proteins and glycosylated proteins: multidimensional procedures for analysis of complex protein samples.

Unit-5 Strategies for protein identification 8 Hours

Mass-spectrometry of proteins - basic types of ionization techniques (ESI and MALDI) and hybrid instruments (TOF, ion trap and FTMS); protein identification methods; characterization of protein modifications. methods of protein quantification (relative and absolute quantification techniques)

Unit-6 Protein interactomes and protein modification in Proteomics and application 7 Hours

Methods of protein-protein interaction study (Y2H, tagging TAP, FLAG, His; ion mobility utilization); Phosphoproteomics, Glycoproteomics, protein microarray. Human proteome project. application of proteomics in diagnostic, drug development and agriculture.

Suggested Readings:

1.Pevsner, J., Bioinformatics and Functional Genomics, Second Edition, Wiley-Blackwell, 2009.
2.Mount, D. W., Bioinformatics: Sequence and Genome Analysis, CBS Publishers, 2004
3.Liebler, D., Introduction to Proteomics: Tools for New Biology, Human Press Totowa, 2002.
4.Campbell, A.M. & Heyer, L.J., Discovering Genomics, Proteomics and Bioinformatics. Benjamin/Cummings, 2002.
5. Twyman, R. Principles of Proteomics. London: Taylor & Francis, 2014.
6. Lovric J. Introducing Proteomics: From Concepts to Sample Separation. Mass Spectrometry and Data Analysis, published by Wiley, 2011

L	T	P	C
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Course Code	**3SMB307**
Course Title	**Microbial Diversity and Systematics**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to -

1. Recognize the extent of microbial diversity present in this world including prokaryotic and eukaryotic microbes and the importance of microbial diversity in different habitats including extreme environments.
2. Understand conventional and molecular methods used for studying microbial diversity and problems and limitations in microbial diversity studies.
3. Describe the microbial classification schemes and methods used for taxonomy, distinguish and differentiate the use of various taxonomic tools apt for classification and identification of microorganisms.
4. Apply the knowledge of biochemistry and physiology of extremophiles for their application potentials in Biotechnology.

Syllabus: **Teaching hours: 45 Hours**

Unit 1: Principles of Microbial Diversity: 9 Hours
Evolution of life, Principles and concepts of microbial diversity, Ecological diversity, Structural and Functional Diversity. Methods of studying microbial diversity – microscopy, nucleic acid analysis, physiological studies, CLPP, FAME.

Unit 2: Issues of Microbial Diversity: 7 Hours
Problems and limitations in microbial diversity studies, Diversity Indices, Loss of diversity, Sustainability and Resilience, Indicator species, Exploitation of microbial diversity, Conservation and economics.

Unit 3: Microbial Classification and Taxonomy: 9 Hours
Phenetic, Phylogenetic and Genotypic classification, Numerical Taxonomy, Taxonomic Ranks, Techniques for determining Microbial Taxonomy and Phylogeny – classical and molecular characteristics, phylogenetic trees; major divisions of life, Bergey's Manual of Systematic Bacteriology, Prokaryotic Phylogeny and major groups of bacteria.

Unit 4: The Archaea: 7 Hours
Ecology, Archaeal cell walls and membranes, genetics and molecular biology, metabolism, archaeal Taxonomy, Phylum Crenarchaeota, Phylum Euryarchaeota.

Unit 5: Eukaryotic Diversity: 7 Hours
Physiological variation, identification, cultivation and classification of important groups of fungi, algae and protozoa.

Unit 6: Microbial Diversity in Extreme Environments: 6 Hours
Habitat, diversity, physiology, survival and adaptation, and biotechnological potentials of: Cold and thermal environment, Saline and deep sea environment, Anaerobic environment, Osmophilic and xerophilic environment, Alkaline and acidic environment.

Suggested Readings:

1. Cavicchioli, R. Archaea – Molecular and Cellular Biology, ASM Press, Washington, 2007.
2. Dworkin, M., Falkow, S., Rosenberg, E., Schleifer, K.H., Stackebrandt, E. (Eds.). The Prokaryotes. Vol. I – VII, Springer, 2006.
3. Garrity, G.M. and Boone, D.R. (Eds.), Bergey's Manual of Systematic Bacteriology, 2nd edition, Vol. I, Springer, 2001.
4. Garrity, G.M., Brenner, D.J., Kreig, M.R. and Staley, J.T. (Eds.), Bergey's Manual of Systematic Bacteriology, 2nd edition, Vol. II, Springer, 2005.

5. Gerday, C. and Glansdorff, N. Physiology and Biodiversity of Extremophiles, ASM Press, Washington, 2007.
6. Hurst, C.J, Crawford, R.L., Garland, J.L., Lipson, D.A., Mills, A.L. and Stetzenbach, L.D. Manual of Environmental Microbiology, 3rd Edition, ASM Press, Washington, 2007.
7. Madigan, M.T. and Martinko, J.M. Brock Biology of Microorganisms, 11th edition, Pearson Prentice Hall, 2006.
8. Mueller, G.M., Bills, G.F. and Foster, M.S. Biodiversity of Fungi – Inventory and Monitoring Methods, Elsevier Academic Press, 2004.
9. Willey, J.M., Sherwood, L.M. and Woolverton, C.J. Prescott, Harley and Klein's Microbiology, 7th edition, McGraw Hill, 2008.

Supplementary Course: Dissertation Tutorials

L	T	P	C
1	-	-	1

Course Code	3SBC3A1
Course Title	Neuroendrocrine Regulation of Behavior

Course Learning Outcomes (CLO)

At the end of the course, students will be able to -

1. To describe the role of various neuro- hormones involed in auditory and optical senses, feeding and emotional behavior
2. To discuss the pathophysiological changes associated with mental and behavioural disorders and debate the role and effect of available psychotic drugs..
3. To identify and relate various behavioural models to study cognitive and motor behaviour.

Syllabus: **Teaching hours**: **15**

Emotion and behaviour - Neuro-anatomy of limbic system; Behavioural control of hormonal secretion, feeding behaviour; drinking behaviour; emotional behaviour, Physiological changes associated with emotion and Integration of emotional behaviour; Physiology in brief of vision and auditory sense; Motivation, addiction and its neurobiology. Behavioural model of fear, anxiety and depression and related psychotic drugs.

Suggested Readings:

1. Purves, D, Augustine, G., Neuroscience, Sinauer, 2000.
2. Tortora, G. J. and Derrickson, B. H., Principles of Anatomy and Physiology, Weily and Sons, 2009
3. Breedlove, M. C., Watson, N. V., Rozenzweig M. R., Biological Psychology: An Introduction to Behavioural, Cognitive and Clinical Neuroscience. Sinauer Associates, 6th Edition, 2010.
4. Amthor Frank, Neuroscience for dummies. USA John Wiley & Sons Canada Ltd. 2012.
5. Kolb, Bryan; Whishaw, Ian Q. An Introduction to Brain and Behavior, New York Worth Publishers 2011
6. Turkingtons, C., The Brain and Brain Disorders, Viva Books, 2009
7. Kandel, E., Schwartz, J. and Jessell T., Essentials of Neural Science and Behaviour, McGraw-Hill, 2003.

L	T	P	C
1	-	-	1

Course Code	3SBC3A2
Course Title	Endocrinology & Immunology of Pregnancy

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Comprehend the endocrine regulation of pregnancy.
2. Understand roles of specific immune system components during pregnancy.
3. Analyze the effects of imbalanced immune response and prenatal hormones in pregnancy complications.

Syllabus:

Overview of endocrinology (introduction to endocrinology, endocrine glands, hormone biosynthesis), their role in pregnancy (implantation, decidualization, placentation, placental hormones, parturition), hormonal interactions between mother, placenta and fetus. Overview of immunological aspects of pregnancy, roles of uterine immune cells during pregnancy (macrophages, natural killer cells, neutrophils, B cells, regulatory T cells),

immunological aspects of decidua, placental regulation of immune cells. Immunological and endocrine imbalance effects during pregnancy leading to poor birth outcome. Flow cytometry (basics and application for diagnosis of pregnancy complications).

L	T	P	C
1	-	-	1

Course Code	3SBC3S1
Course Title	Understanding Gastrointestinal Hormones and Gut Associated Cancer

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand the diversity of G.I. Tract hormones and gastrointestinal associated cancers
2. Determine the probable targets and causes of hormonal modulation and cancer induction.
3. Analyse and evaluate the molecular mechanism and probable targets as therapeutic approaches

Syllabus:

Introduction to Gut associated cancers and their pathogenesis, Molecular markers identification, Genetic & Epigenetic markers, Mechanism of Induction, Existing therapies, New Trends in cancer therapy, Gut Hormones involved in metabolism and gastric cancer, Role of hormone in cancer, Identification of newer therapeutic targets.

L	T	P	C
1	-	-	1

Course Code	3SBC3S3
Course Title	Pathogenesis of Diabetes

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand the mechanisms of onset of diabetes and differentiating it from obesity.
2. Determine the role of triad i.e., interaction of gut, liver and pancreas in diabetes.
3. Analyse and evaluate the molecular mechanism and probable targets as therapeutic approaches.

Syllabus:

Type I and II Diabetes, Mechanism of induction, Metabolic Disturbances, Drug and Diet Induced Diabetes, Endocrine Disorders, Role of Gut microflora, Role of Liver and Pancreas in diabetes, Identification of Therapeutic strategies.

L	T	P	C
1	-	-	1

Course Code	3SBC3S4
Course Title	Genotoxicity Testing for Cancer Risk Assessment

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand methods and mechanisms of laboratory tools for biological safety assessment
2. Apply cell culture techniques based cytogenetic and genetic damage assays
3. Appreciate regulatory guidelines and best practices in study of biological effect of environmental factors on genome

Syllabus:

Cell culture techniques for in vitro cytogenetics assays: Chromosome breakage, Cytokinesis blocked micronucleus assay, Comet assay, Sister Chromatid Exchange assay, in vitro metabolic activation systems, Regulatory guidelines and best practices of Genotoxicity studies; National and International regulations for establishing genotoxicity of a substance, application in safety studies of novel drugs, nanoparticles, and other environmental agents and exposed population; OECD, EPA guidelines for scoring and analysis

L	T	P	C
1	-	-	1

Course Code	3SBC3S5
Course Title	Applied Human Cytogenetics

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Grasp methods and mechanisms of cell culture methods for karyotyping using various tissues
2. Apply ISCN guidelines for interpretation of genetics analysis

3. Understand normal and abnormal genetic constitution of human at chromosomal level and scope of molecular genetic analysis
4. Appraise genotype-phenotype correlation in various human genetic conditions

Syllabus

In vitro short term culture techniques for metaphase chromosome preparations from blood, bone marrow, and other tissue samples; chromosome banding, karyotyping, ISCN guidelines, Clinical applications in Prenatal Genetic Diagnosis, Pregnancy, Post-Natal, and Cancer; Introduction to molecular cytogenetics; FISH & m-FISH.

L	T	P	C
1	-	-	1

Course Code	**3SBT3S2**
Course Title	**Immunological Memory**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand how memory T and B cells are generated following natural infection
2. Evaluate and analyse the immune response to provide long-term protection
3. Manipulate the antigenic exposure to immune system to generate memory T cells
4. Design immunomodulator(s) to induce long-term protection

Syllabus: **Teaching Hours: 15**

Generation of T cell and B cell memory, Requirement for maintenance of memory T cells, Interaction of memory B cells with memory T cells, Role of Innate Immunity in maintenance of memory T cells

L	T	P	C
1	-	-	1

Course Code	**3SBT3S3**
Course Title	**Tumor markers in cancer management**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. To identify and analyse the factors influencing process of carcinogenesis for solid and haematological malignancies
2. To understand the role of various tumor markers for diagnosis, prognosis, selection of treatment modalities and disease monitoring
3. To discuss the treatment strategies that pave the way to personalized medicine.

Syllabus: **Teaching hours: 15**

Molecular pathogenesis of cancer, Historical overview of Tumor markers, Types of tumor markers, Alterations in solid tumors and haematological malignancies, Management of Cancer, Existing treatment modalities, Current and newer therapeutic approaches in cancer and their limitations, Personalized and Precision Medicine

Suggested Reading:

1. Vincent, T. De Vita, Lawrence T. S., Rosenberg, S. A., Cancer: Principle & Practice of Oncology, 10th Edition, Lippincot, 2011.
2. Weinberg R., Biology of Cancer, Gerland Science, June, 2010.

L	T	P	C
1	-	-	1

Course Code	**3SBT3K1**
Course Title	**Immunology of Vaccine Adjuvants**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. To have a clear understanding of antigenicity and immunogenicity.
2. Currently available adjuvants and their mode of action.
3. Adjuvant-free vaccination strategies.

Syllabus

Antigen, Immunogen, methods to enhance immunogenicity of candidate antigens, currently available adjuvants for experimental and clinical use and their mechanism of action, cellular and molecular targets of available adjuvants, adjuvants that induce CD8+ T-cells, tissue-resident memory cells, adjuvants targeting pattern recognition receptors other than toll-like receptors, need for adjuvant free vaccination strategies and systems vaccinology.

L	T	P	C
1	-	-	1

Course Code	3SMB3N1
Course Title	Microbial Community Dynamics And Ecological Succession

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Identify role of microorganisms and microbial community shifts in ecological succession. They will understand aspects of sustainability, resilience and importance of indicator species.
2. Understand various methods for microbial diversity estimations and multivariate statistical tools and to use them.

Syllabus: **Teaching hours: 15**

Principles and concepts of microbial diversity, Ecological diversity, Loss of diversity, Sustainability and Resilience, Indicator Species, Ecological Succession, Methods used for 'Microbial Diversity Analysis', Multivariate statistical tools for Microbial Diversity Analysis using SPSS.

L	T	P	C
1	-	-	1

Course Code	3SMB3V1
Course Title	Antimicrobial Agents

Course learning outcomes:

At the end of the course, students will be able to-

1. Be familiar with currently available antimicrobial agents, their scope and limitations.
2. Learn evolution of drug-resistance, its molecular basis, and also be familiar with strategies for discovery and development of novel antimicrobials.
3. Understand the need for finding novel drug targets

Syllabus: **Teaching hours: 15**

A concise overview of currently available antimicrobial agents; Drug-resistance among pathogens, and its molecular basis; Strategies for development of novel antimicrobials; challenges involved; Antimicrobial susceptibility tests: Utility, limitations and challenges.

SEMESTER IV

Core Courses- Training

L	T	P	C
-	-	-	25

Course Code	3SBT402
Course Title	Dissertation

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Develop understanding in the field of scientific research at the academic as well as industrial sector. This will students to identify scientific problems and design proposals to address and implement ideas. This enables them to communicate the same to a greater audience.
2. This will benefit the students to perform well in their job interviews and to design their CV which can evoke interest in the employers to know more about the candidate.

Outline:

The students have to carry out their dissertation work. They have to perform wet lab experimentation on the topic of project assigned to them. The Viva will be conducted as interim presentation as well as final presentations, where the students have to defend their dissertation work

L	T	P	C
-	-	2	2

Course Code	3SBT407
Course Title	Internship

Outline:

The students will be deputed to industry/academic institutes/laboratories have undertake training to enhance their skills in order to improve their employability in the field of interest. The students will have a guide allocated at the host institute and have to present their progress of training in the form of interim presentation. They will be submitting a comprehensive report as well as well as an final presentation, comprising of the training undertaken by them.

L	T	P	C
-	-	2	2

Course Code	**3SBT404**
Course Title	**Comprehensive Viva Voce**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Develop understanding in the field of scientific research at the academic as well as industrial sector. This will students to identify scientific problems and design proposals to address and implement ideas. This enables them to communicate the same to a greater audience.
2. Shape up their career in the field of research at the academic as well as industrial sector. This will be helpful to students in identifying scientific problems and design proposals to address and implement ideas, enables them to communicate the same to a greater audience.

Outline:

Viva voce will be conducted towards the end of the semester which will be covering the complete syllabus. This will test the student's learning and understanding during the course of their post graduate programme. In doing so, the main objective of this course is to prepare the students to face interview both at the academic and the industrial sector.

Supplementary Courses

L	T	P	C
-	-	1	-

Course Code	**3SBT406**
Course Title	**Interpersonal and Networking Skills**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

Develop effective network and would be able to positively influence people; will be able to manage stress and failures and will show enhanced interpersonal skills

Syllabus:

Unit 1: Effective Networking and Influencing people: 8 Hour

Networking and its importance. Building and growing a network. Importance of collaboration and cross functional networking. Use of LinkedIn and other Social media tools to grow networks. Importance of influence, How to positively influence people.

Unit 2: Stress Management and Facing Failures: 8 Hour

Introduction to Stress, Causes of stress and impact of stress. Managing Stress. Factors affecting Failure, Learning from Failures, Overcoming failures

Unit 3: Interpersonal Skills: 8 Hour

Defining Interpersonal relationship, human perceptions, understanding people and types of interpersonal relationships, conflict resolution, Negotiation skills.

Unit 4: Self Study and Group Discussion 6 Hour

ANNEXURE-I

M.Sc. Microbiology

APPENDIX-A

Institute of Science
Nirma University

Teaching & Examination Scheme of M.Sc. Microbiology (2022-23)

Sr. No.	Course Code	Course Title	Teaching Scheme				Examination Scheme				
							Duration		Component Weightage		
			L	LPW/ PW	T	C	SEE	LPW/ PW	CE	LPW/PW	SEE
Semester-I											
1	3SBC101	Metabolism	3	-	-	3	3.0	-	0.60	-	0.40
2	3SBT102	Cell Biology	3	-	-	3	3.0	-	0.60	-	0.40
3	3SBT103	Molecular Biology	3	-	-	3	3.0	-	0.60	-	0.40
4	3SBT109	General & Applied Microbiology	3	-	-	3	3.0	-	0.60	-	0.40
5	3SBT111	Basic Immunology	3	-	-	3	3.0	-	0.60	-	0.40
6	3SBT112	Laboratory I	-	12	-	6	-	10.0	1.00	-	-
7	3SBT113	Seminar I	-	1	-	1	-	-	1.00	-	-
		Total	**15**	**13**		**22**					
Supplementary Courses											
8	3SBT1S3	Basics of Animal Physiology	-	-	2	-	-	-	1.00	-	-
		Total	**15**	**13**	**2**	**22**					
Semester-II											
1	3SMB201	Industrial Microbiology & Fermantation Technology	3	-		3	3.0	-	0.60	-	0.40
2	3SBT202	Bioanalytical Techniques	3	-	-	3	3.0	-	0.60	-	0.40
3	3SBT203	Genetic Engineering	3	-	-	3	3.0	-	0.60	-	0.40
4	3SBT204	Microbial Genetics	3	-	-	3	3.0	-	0.60	-	0.40
5	3SBT211	Laboratory II	-	14	-	7	-	10.0	1.00	-	-
6	3SBT212	Seminar II	-	2	-	2	-	-	1.00	-	-
		Total	**12**	**16**		**21**					
Supplementary Courses											
7	3SBT2E2	Professional English	1	-	-	-	-	-	1.00	-	-
Value Added Course											
8	3SBT2S1	Professional Development and Resume Writing	2	-	-	-	-	-	1.00		
		Total	**15**	**16**	-	**21**					
Institute Elective											
9		Elective I	3	-	-	3	3.0	-	0.60	-	0.40
		Total	**18**	**16**	-	**24**					
Semester-III											
1	3SBT301	Molecular Microbial Physiology	3	-	-	3	3.0	-	0.60	-	0.40
2	3SMB303	Medical Microbiology & Virology	3	-	-	3	3.0	-	0.60	-	0.40
3	3SMB304	Agriculture & Environmental Microbiology	3	-	-	3	3.0	-	0.60	-	0.40
4	3SMB307	Microbial Diversity & Systematics	3	-	-	3	3.0	-	0.60	-	0.40
5	3SMB306	Laboratory III	-	8	-	4	-	6.0	1.00	-	-
6	3SBT312	Research Methods	3	6	-	6	-	-	0.60	-	0.40
7	3SBT3S6	Summer Training*	-	-	-	2					
		Total	**15**	**14**	-	**24**					
Supplementary Courses											
8		Dissertation Tutorials	-	-	1	-	-	-	1.00	-	-
Institute Elective											
9		Elective II	3	-	-	3	3.0	-	0.60	-	0.40
		Total	**18**	**14**	**1**	**27**					
Semester-IV											
1		Training	-	-		25	-	-	0.60	0.40	-
2	3SMB404	Comprehensive Viva Voce	-	2		2	-	-	1.00	-	-
		Total		**2**		**27**					
Value added Course											
3	3SBT406	Interpersonal and Networking Skills	2	-	-	-	-	-	1.00	-	-
		Total	2	**2**	-	**27**					

***Compulsory summer training following semester II for 21 working days**

L: Lectures, T: Tutorial, C: Credits
CE: Continuous Examination
LPW / PW : Laboratory / Project Work
SEE: Semester End Examination

Elective I (*Semester II*)
3SBC211 Neurobiology
3SMB2E2 Microbial Ecology
3SBC2E1 Human Genetics
3SBC203 Advance Immunology
3SBC2E2 Reproductive Physiology

Elective II *(Semester III)*
3SBT3E1 Genomics & Proteomics
3SBC304 Cancer Biology
3SBT309 Vaccinology

Training (*Semester IV)*
3SBC402 Dissertation
3SBT407 Internship

Value added Course
Semester II 3SBT2S1 Professional Development and Resume Writing
Semester IV 3SBT406 Interpersonal and Networking Skills

Supplementary Courses
Semester I 3SBT1S3 Basics of Animal Physiology

Semester II 3SBT2E2 Professional English

Semester III **Dissertation Tutorials**
3SBC3A1 Neuroendrocrine Regulation of Behavior
3SBC3S1 Understanding Gastrointestinal Hormones and Gut associated cancer
3SBC3S3 Pathogenesis of Diabetes
3SBC3S4 Genotoxicity Testing for Cancer Risk Assessment
3SBC3S5 Applied Human Cytogenetics
3SBT3S2 Immunological Memory
3SMB3N1 Microbial Community Dynamics and Ecological Succession
3SMB3V1 Antimicrobial Agents
3SBT3S3 Tumor markers in cancer managemnet
3SBC3A2 Endocrinology & Immunology of Pregnancy
3SBT3K1 Immunology of Vaccine Adjuvants

Dr. Sriram Seshadri **Prof. Sarat Dalai**

SEMESTER I

Core Courses

L	T	P	C
3	-	-	3

Course Code	3SBC101
Course Title	Metabolism

Course Learning Outcomes (CLO):
At the end of the course, students will be able to-

1. Have an **understanding** of the metabolic pathways - the energy-yielding and energy requiring reactions in life; understand the diversity of metabolic regulation, and how this is specifically achieved in different cells
2. **Evaluate** the different metabolic process occurring in the cells
3. **Relate** the link between the metabolic processes and their regulation as a response to external and internal factors
4. **Analyze** the differences and similarities between the various anabolic and catabolic processes occurring in the body

Syllabus: **Teaching hours**: **45 Hours**

Unit 1: Metabolism of Carbohydrates: 5 Hours
Glycolysis, citric acid cycle, pentose phosphate pathways, glycogenesis and glycogenolysis and their regulation, Gluconeogenesis and its regulation. Metabolism of Fructose and Galactose. Hormonal regulation of carbohydrate metabolism.

Unit 2: Metabolism of Lipids: 8 Hours
Synthesis of various lipids, bile acids and cholesterol. Elongation of fatty acids, Desaturation of fatty acids in microsomes. Regulation of fatty acid synthesis, Cholesterol metabolism. Composition and synthesis of basic groups of Lipoproteins and their changes during transport in the body.

Unit 3: Metabolism of Amino Acids: 8 Hours
General reactions of amino acid metabolism: transamination, oxidative deamination and decarboxylation. Catabolic fate of -amino acids and their regulation, glucogenic and ketogenic amino acids. Urea cycle and its regulation. Amino acid biosynthesis.

Unit 4: Metabolism of Nucleotides: 8 Hours
Biosynthesis of purines and pyrimidines- De novo and salvage pathways and their regulation. Catabolism of purines and pyrimidines. Biosynthesis of ribonucleotides and deoxyribonucleotides.

Unit 5: Enzymes: Basic Bio-thermodynamics 8 Hours
Enzyme classification and nomenclature, Enzyme kinetics: Michaelis-Menten equation: Formula, Derivation and Significance; Alternate plotting procedures. Types of Inhibitors and their mode of action.

Unit 6: Enzyme Mechanisms and Regulation: 8 Hours
Different mechanisms of enzyme activity; Strategies for enzyme regulation; Allosteric Enzymes and their Kinetics. Isoenzymes and Multienzyme Complexes.

Suggested Readings:

1. Voet, D., Fundamentals of Biochemistry, J. Wiley, 2008.
2. Voet, D. and Voet, J. G. Biochemistry, 3rd Edition., John Wiley and Sons, 2004. 3. Boyer, R., Concepts in Biochemistry, Brookes, 1999.
3. Metzler, D. E., Metzler, C. M., Biochemistry: the chemical reactions of living cells. Vols. I and II, Academic Press, 2001.
4. Nelson, D. C. and Lehninger, Principles of Biochemistry, Mac Millan, 2000.
5. Murray, R. K., Granner D. K., Mayes, P. A., Rodwell, V. W., Harper's Biochemistry, 27th Edition, McGraw Hill, 2006.
6. Stryer, L., Bery, J. M., Dymoczko, J. L., Biochemistry Only. 6th edition, WH Freeman and Co. New York, 2006.

L	T	P	C
3	-	-	3

Course Code	3SBT102
Course Title	Cell Biology

Course Learning Outcomes (CLO):
At the end of the course, students will be able to-

1. Understand and appraise the fundamentals of cell as a unit of living organisms and their organelles in terms of structure and functions

2. Evaluate the cellular mechanisms of cell-cell interactions, cell communications, cell signalling pathways and cell division
3. Evaluate the molecular mechanisms and their cross-talk responsible for various diseases including cancer, diabetes and other diseases, articulate host-environment interactions
4. Demonstrate understanding of in vitro and in vivo isolation of cell, it's utility in various areas of research including stem cell

Syllabus: **Teaching hours: 45**

Unit 1: Plasma membranes: 5 Hours
Membrane Structure, Molecular Composition and function; Lipid bilayer and protein, diffusion, osmosis, ion channels, active and passive transport, membrane pumps and transporters

Unit 2: Cytoskeleton: 8 Hours
Microfilaments, Intermediate Filaments and Microtubules – Structure and Dynamics; Microtubules and Mitosis; Cell Movements. Intracellular Transport and the Role of Kinesin and Dynein

Unit 3: Intracellular Protein Traffic: 8 Hours
Protein Synthesis on Free and Bound Polysomes, Uptake into ER, Membrane Proteins, Golgi Sorting, Post- Translational Modifications

Unit 4: Cell Signaling: 8 Hours
Cell Surface Receptors; Signaling from Plasma Membrane To Nucleus, Map Kinase Pathways, G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, neurotransmission and regulation

Unit 5: Cell – Cell Adhesion and Communication: 8 Hours
Ca++ Dependent Cell-Cell Adhesion; Ca++ Independent Cell-Cell Adhesion. Cell Junctions and Adhesion Molecules, Movement of Leukocytes into Tissues, Extracellular matrix

Unit 6: Cell Cycle: 8 Hours
Mitosis, Meiosis, Cell Cycle, Role of Cyclins and Cyclin Dependent Kinases, Regulation of Cdk – Cycline Activity, Regulation of Cell cycle, senescence and apoptosis

Suggested Readings:

1. Pollard, T. D., and Earnshaw, W. C., Cell Biology 2nd Edition, Saunders Elsevier, 2008.
2. Gerald K., Cell and Molecular Biology, Concept and Experiment, 5th Edition, Wiley, 2007.
3. Kleinsmith, L. J. J. Principles of Cell and Molecular Biology, 2nd Edition, Benjamin Cummings, 1997.
4. Lodish, H., Berk A., Kaiser C. A., Krieger M., Scott M.P., Bretscher A., Ploegh H., and Matsudaira P., Molecular Cell Biology, 6th Edition, Freeman, W. H. and Co., 2008.
5. Roberts, K., Lewis J., Alberts B., Walter P., Johnson A., and Raff. M., Molecular Biology

L	T	P	C
3	-	-	3

Course Code	**3SBT103**
Course Title	**Molecular Biology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. understand a basic understanding of molecular events of discovery of science and it's biological implications
2. understand the role of each components of molecular events in prokaryotes as well as eukaryotes
3. Justify and correlate the importance of these molecular events in the gene expression as well as in the gene regulation
4. analyze and correlate the deregulation in any event leading to disorders and envisage probable strategies_

Syllabus: **Teaching hours: 45**

Unit 1: Genome organization in prokaryotes and eukaryotes: 5 Hours
Structure of DNA and RNA, physical properties of DNA- cot plot, kinetic and chemical complexity, satellite DNA. Organization of the Chromosome, structure of chromatin-nucleosomes, Chromatin domains and isochores, structure and functional organization of centromeres and telomeres.

Unit 2: DNA Replication: 8 Hours
Prokaryotic DNA polymerase I, II and III, Eukaryotic DNA polymerases, Fidelity and Catalytic Efficiency of DNA polymerases, Okazaki Fragments, Replication Origin, Primosomes, Concurrent Replication mechanism involving leading and copying strands of DNA.

Unit 3: Transcription: 8 Hours

Prokaryotic and Eukaryotic polymerases, Promotors, Enhancers, silencers, transcriptional activators. Mechanism of Prokaryotic and eukaryotic biosynthesis of rRNA, tRNA and mRNA. Transcriptional inhibitors, Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, elongation and termination

Unit 4: RNA Processing: 8 Hours

Prokaryotic and eukaryotic rRNA, tRNA, mRNA editing, Capping, Polyadenylation, splicing. Processing of poly A- mRNA, Mi and Si RNAs, Group I and II introns, alternate splicing, RNA transport.

Unit 5: Translation: 8 Hours

Prokaryotic and Eukaryotic Protein synthesis and processing: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetases, translational proof-reading, translational inhibitors, post- translational modification of proteins.

Unit 6: Gene Expression Regulation: 8 Hours

Control of gene expression at transcription and translation level, Regulation of prokaryotic and eukaryotic gene expression, phages and viruses, Operon concept, positive and negative regulation, catabolite repression, role of chromatin remodelling in regulating gene expression and gene silencing. Suggested

Suggested Readings:

1. Meyers, R. A. (1995). Molecular biology and biotechnology: a comprehensive desk reference. John Wiley & Sons..
2. Lodish, H. (2008). Molecular cell biology. Macmillan.
3. Brown, T. A. (1991). Essential molecular biology: volume II a practical approach. Oxford University Press.
4. Krebs, J. E., Lewin, B., Goldstein, E. S., & Kilpatrick, S. T. (2014). Lewin's genes XI. Jones & Bartlett Publishers.
5. Watson, J. D., & Levinthal, C. (1965). Molecular biology of the gene. Molecular biology of the gene.

L	T	P	C
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Course Code	**3SBT109**
Course Title	**General and Applied Microbiology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Get aquainted with the basic concepts of various fields of Microbiology, and also learn about growth pattern of microbes in different ecosystems.
2. Acquire experimental knowhow of essential microbiological techniques e.g. microscopy, cultivation of microbes, etc.
3. Develop an understanding of various facets of microbes and their applications e.g. medical microbiology, industrail microbiology, agricultural microbiology, etc.

Syllabus: Teaching hours: 45 Hours

Unit 1. Foundation in Microbiology: 7 hours A brief history of microbiology; Types and diversity of Microorganisms; Microbes in our lives

Unit 2. Microbial Growth: 8 hours

Theory and measurement of bacterial growth; Media used for bacterial growth; Overview on Biofilms **.**

Unit 3. Tools to study microbiology: 7hours

Methods for studying microbes; Methods of Culturing microorganisms; Culture preservation

Unit 4. Elements of Microbial Nutrition and Ecology: 7 hours

Environmental factors that influence microbes; Microbe-microbe interactions; Microbial interaction with plants and animals

Unit 5. Metabolic Diversity among microbes: 8 hours

Phototrophy, autotrophy, chemolithotrophy; Catabolism of organic compounds

Unit 6. Applied Microbiology: 8 hours

Overview of applications of microorganisms in Agriculture, Environment, Food, Industry and Medical Sciences e.g. Alternative energy sources and biofuels obtained through microbes; Role of microbes in food production and Food preservation

Suggested Readings:

1. Microbiology (2018). ASM Press: Openstax.

2. Tortora et al. (2019). Microbiology. Pearson Education.
3. Barton and Northup (2011). Microbial Ecology. Wiley-Blackwell.
4. KP Talaro (2008). Foundations in Microbiology. McGraw-Hill International Edition.
5. Brock Biology of Microorganisms (2009). Pearson International Edition.
6. Prescott, Harley, and Klein's Microbiology (2008). McGraw-Hill Higher Education.

L	T	P	C
3	-	-	3

Course Code	**3SBT111**
Course Title	**Basic Immunology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Develop good understanding on how immune system discriminate self-from non-self.
2. Design irnmunoassays based on the monoclonal antibodies
3. Evaluate the immune response of the host encountering the pathogen or upon vaccination

Syllabus: Teaching Hours: 45

Unit 1: Nature of Antigen and Antibody: 6 Hours
Antigen Vs Immunogen, Haptens, Structure and functions of immunoglobulins, Isotypic, allotypic and Idiotypic variations.

Unit 2: Structure and function of primary and secondary lymphoid organs. 8 Hours
MALT system; Lymphocyte circulation, Mechanisms of Migration of immune cells into primary and secondary lymphoid organs.

Unit 3: Complement System - Activation, regulation and abnormalities 8 Hours

Unit 4: Production of Antibodies and its Applications: 8 Hours
Production of polyclonal and monoclonal antibodies and its clinical applications. Abzymes. Measurement of Antigen – Antibody Interaction: Principles, techniques and applications, Agglutination and precipitation techniques, Radio immunoassay, ELISA, Immunofluorescence assays, Fluorescence activated cell sorter (FACS) techniques. Immuno PCR.

Unit 5: Generation of Diversity of Immunoglobulins and T cell Receptors 7 Hours

Unit 6: MHC structure and polymorphism: Antigen processing and presentation, T cell activation 6 Hours

Suggested Readings:

1.Janeway, C (2012) Janeway's immunobiology. Garland Science 8th Edition.
2.Kindt, T. J (2009). Kuby immunology. Macmillan. 7th Edition
3. Paul, W. E. .(2008). Fundamental immunology. Lipincott& Wilkins, . 6th Edition
4..Abbas, A. K., Lichtman, A. H., & Pillai, Shiva. (2012). Cellular and molecular immunology WB Saunders Co. Philadelphia, Pennsylvania, 186-204.7th Edition
5. Coico, R. (2015). Immunology: A Short course. John Wiley & Sons, 7th edition
6. Peter J. Delves, Seamus J. Martin, Dennis R. Burton and Ivan M. Roitt.(2017). Roitt's essential immunology John Wiley & Sons. 13th Edition

L	T	P	C
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Course Code	**3SBT112**
Course Title	**Laboratory I**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Perform fundamental microbiological, biochemical and cell culture techniques.
2. Analyze and interpret the results of biochemical estimations and microbiological experimental data.
3. Apply techniques to the advanced level practicals and dissertation carried out in further semesters.

Syllabus Teaching Hours: 192hrs

1. Introduction to human chromosome complement using Giemsa stained metaphase cells.
2. Observation of mitotic cell division stages in onion root tip
3. Observation of meiosis stages using fixed slides
4. Demonstration of Short term blood culture for metaphase chromosome preparation

5. Measurement of microscopic structures using micrometre
6. To study the effect of various parameters viz. inoculum size, aeration, etc. on bacterial growth through the growth curve experiment
7. Estimation of bacterial load in various environmental/ food samples through viable counting
8. Gram-staining
9. Bacteriophage isolation from sewage sample
10. Enzyme assay for Amylase under various conditions
11. Sample Preparation and Separation of Amino Acids, Lipids and Sugars by TLC.
12. Estimation of bio-molecules (Sugar, Protein, Cholesterol, Urea) by spectrophotometer

Suggested Reading:

1. Patel, RJ. Experimental Microbiology. Vol-1, Aditya Publishers, India, pp: 60-61, 2009
2. Sherma, Joseph, and Bernard Fried, 2nd eds. Handbook of thin-layer chromatography. CRC press, 2007.
3. Stahl, Egon, 2nd eds. "Thin-layer chromatography: a laboratory handbook." Thin-layer chromatography: a laboratory handbook. 2007.
4. Cappuccino, James G., and Natalie Sherman, 7th eds. "Microbiology: A laboratory manual." Addision-six 1999 2007.
5. Mu, Plummer, and David T, 3rd eds. Plummer. Introduction to practical biochemistry. Tata McGraw-Hill Education, 2007.
6. Bates, Steven E. "Classical cytogenetics: karyotyping techniques." Human Pluripotent Stem Cells. Humana Press, 177-190, 2011..
7. Rao, Beedu Sashidhar and Deshpande, Vijay, Experimental Biochemistry, A student Companion, I. K. International Pvt. Ltd, 2005
8. Tom Maniatis, E. F. Fritsch, Joseph Sambrook, Molecular cloning-a laboratory manual, 3rd eds, Cold Spring Harbor Laboratory, 2001
9. Primrose, S. et.al., 7th eds. Principles of Gene Manipulation. Oxford: Blackwell Science, 2008 2001.
10. Prescott.L.M, 7th eds. Microbiology, McGraw Hill Publication, 2008
11. Mitosis, Meiosis and Genetics, J. L. Stein Carter & D. B. Fankhauser, Genetics, 2010.
12. Alberts, Bruce, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter. Molecular Biology of the Cell. 6th ed. New York: Garland Science, Taylor and Francis Group, LLC, 2015.

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Course Code	**3SBT113**
Course Title	**Seminar**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand and present scientific concepts
2. Analyze the scientific idea and concept of the given topic

Suggested Syllabus:

The students have to give seminars on a scientific topic of their interest from any of the biological fields which will be open for discussion. The students will have to submit the hardcopy of the selected topic along with a summarised write up in their own words. This course has been designed to provide a platform for the students to develop their communication, presentation and confidence to face the audience.

Supplementary Courses

L	T	P	C
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Course Code	**3SBC1S2**
Course Title	**Basics of Animal Physiology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Refresh understanding of basic principles of biochemistry, and Physiology.
2. Be at par with other students who are already well versed with the subject

Syllabus

Unit 1: Organisation of Vertebrate Body 3 Hours

Structural organization of body; Overview of structure and functions of an animal cell; Structure and functions of various tissues; Metabolism and Homeostatic State; Regulation of body temperature.

Unit 2: Cardiovascular System 4 Hours

Blood composition; Formed elements; physiology of blood coagulation, blood grouping & RH factor;

basic structure of heart, conduction system and cardiac cycle; Organisational structure of blood vessels and lymphatic vessels.

Unit 3: Respiratory System and Digestive System 3 Hours

Structural Organisation of Respiratory System; Physiology of Respiration, Transportation of respiratory gases. Structural organisation of GI tract; role of major and accessory organs; Digestive Processes, Physiology of digestion, absorption and elimination.

Unit 4: Urinary System 3 Hours

Structure of nephron and kidney; Physiology of urine formation (glomerular filtration, tabular reabsorption, tabular secretion) and its homeostatic regulation.

Unit 5: Nervous System 3 Hours

Organisation of Nervous System-CNS & PNS; Neurons and glial cells; Nerve impulse propagation. Brain, Spinal Cord and their Functions; Structure and functions of Autonomic Nervous System

Monitoring & Assessment:

The students will be monitored and assessed by regular quizzes, term assignments.

SEMESTER II

Core Courses

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Course Code	**3SMB201**
Course Title	**Industrial Microbiology and Fermentation Technology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Get aquainted with the industrial aspect of the field of Microbiology, and also learn about growth pattern of microbes in different industrial systems.
2. Acquire experimental knowhow of microbial production of various industrail products such as alcohol, exopolysaccharides, enzymes, etc.
3. Develop an understanding of process control, upstream and downstrem process.

Syllabus: **Teaching hours**:**45**

Unit 1: Introduction to Fermentation Processes 7 Hours

Range of fermentation processes.. Media and materials required for industrial microbiological processes - sources, formulation, anti-foams and optimization.

Unit 2: Microbial Growth Kinetics 7 Hours

Batch culture, Continuous culture, Fed-batch culture, Applications and examples, Scale up of fermentation processes, Sterilization of media, fermentor and feeds.

Unit 3: Design of a Fermentor 8 Hours

Functions, construction, and maintenance of aseptic conditions. Types of fermentors, Aeration and agitation (Non-Newtonian fermentations).

Unit 4: Industrial products produced by microorganisms: 8 hours

e.g. Enzymes, organic acids, amino acids. Production of antibiotics, vitamins, alcohol fermentation, Glycerol-based fermentations.

Unit 5: Process Control: 7 Hours

Enzyme probes - Bio sensors, Control of various parameters, Computer applications in fermentation technology.

Unit 6: Downstream processing: 8 Hours

Unit operations, Recovery and purification of fermentation products.

Suggested Reading:

1. Biochemical Engineering, Aiba, S., Humphrey,A.E. and Millis, N.F. Univ. of Tokyo Press.
2. Process engineering in Biotechnology, Jackson, A. T. Prentice Hall, Engelwood Cliffs.
3. Biochemical Reactors, Atkinson, B., Pion Ltd, London.
4. Fermentation Microbiology & Biotechnology, E L - Mansi and Bryce, Taylor & Francis, 1999.
5. Industrial Microbiology, Prescott & Dunn, Fourth Edition.
6. Industrial Microbiology by Casida. LE, New age International (P) Limited, Publishers.
7. Industrial Microbiology by Prescott & Dunns, AVI Publishing Company Inc.
8. Industrial Microbiology by A.H. Patel.
9. Principles of Fermentation Technology by P.F. Stanbury, A. Whitaker and S.J. Hall, Butterworth Heineman, Aditya Books (P) Ltd.
10. A text book of Industrial Microbiology by Wulf Crueger and Anneliese Crueger, Panima Publishing Corporation.

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Course Code	**3SBT202**
Course Title	**Bioanalytical Techniques**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand the principles and applications of various techniques used in the isolation, purification and analysis of biomolecules
2. Apply the concepts of modern anlaytical and instrumental techniques relevant to quantitative measurements in biology
3. Justify and relate the selection of bioanalytical methods to characterize a given sample
4. Critically evaluate the advantages, limitations and future prospects of various bioanalytical techniques

Syllabus: Teaching hours: 45

Unit 1: Separation and characterization of macromolecules: 8 Hours

Principles and applications of ultracentrifugation, ultrafiltration, precipitation and equilibrium dialysis; Horizontal and vertical electrophoresis. Native and SDS Polyacrylamide gel electrophoresis, 2 D electrophoresis

Unit 2: Chromatography: 9 Hours

Basic principles and applications of Paper chromatography, TLC, Gas Chromatography, Size exclusion chromatography, Ion-exchange chromatography, Affinity chromatography, Reverse phase chromatography, HPLC, FPLC

Unit 3: Spectroscopy: 7 Hours

Basic Principles and Applications of UV/Visible absorption, CD, Raman, Infrared, Fluorescence and Atomic Absorption Spectroscopy

Unit 4: Radioisotope Techniques: 6 Hours

Radioactive decay, half life, Types of radiations, properties of α, β and γ rays, radioisotope tracer techniques, Measurement of radio activity, autoradiography, radiation protection and measurements, Applications of radioisotopes for analysis of biological samples

Unit 5: Structural determination of Biomolecules: 8 Hours

Basic Principle, instrumentation and applications of Nuclear Magnetic Resonance & ESR, X-Ray Crystallography, Mass Spectrometry

Unit 6: Microscopy: 7 Hours

Principles and applications of bright field, dark field, phase contrast, DIC etc., fluorescence, confocal, deconvolution, super-resolution, multiphoton, SEM,TEM and various types.

Suggested Readings:

1. Pattabhi, V. and Gautham, N. Biophysics, Kluwer Academic Publishers, 2002.
2. Cooper, A, Biophysical Chemistry, Royal Society of Chemistry, 2004.
3. Christian, G. D., Analytical Chemistry, John Wiley & Sons (Asia) Pvt. Ltd., 2004.
4. Hammes, G. G., Spectroscopy for Biological Sciences, John Wiley & Sons, 2005.
5. Westmeier, Reiner, Electrophoresis in Practice;Wiley-VCH Verlag Gmbh. 2005
6. Michael Hoppert;Microscopic Techniques in Biotechnology, John Wiley & Sons, Inc. 2006

7. Skoog, D. A., Holler, F. J. and Crouch, S. R., Instrumental Analysis, Brooks/Cole Cengage Learning, 2007.
8. Roberts, K., Lewis J., Alberts B., Walter P., Johnson A., and Raff. M., Molecular Biology of the Cell, 5th Edition, Garland Publishing Inc., 2008.
9. Wilson, K. and Walker, J. ; Principles and Techniques of Biochemistry and Molecular Biology, 7th edition, Cambridge University press., 2010
10. Robert L. Wixom and Charles W. Gehrke, Chromatography: A Science of Discovery.John Wiley & Sons, Inc. 2010
11. Bhasin, S. K.;, Pharmaceutical Organic Chemistry; Elsevier India Pvt. Ltd.. 2012
12. Monk, Paul, Physical Chemistry: Understanding our Chemical World; John Wiley and Sons. 2013
13. Peter Jomo Walla.; Modern Biophysical Chemistry: Detection andanalysis of Biomolecules: WileyPyblishing. 2014

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Course Code	**3SBT203**
Course Title	**Genetic Engineering**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand the fundamental concept of genetic engineering.
2. Analyse the technique of genetic engineering.
3. Apply the concept and techniques in designing and conducting experiments and research.

Syllabus: **Teaching hours**: **45**

Unit 1: Fundamental Tool and Technique in Recombinant DNA Technology: 5 Hours

Restriction enzymes: types, mode of action and nomenclature, RE independent cloning strategies, DNA modifying enzymes rnethylases, DNA polymerases, Klenow-enzyme, reverse transcriptase, terminal transferase, alkaline phosphatase, polynucleotide kinase. Ligase, DNase, RNase and Sl nuclease. Blunt end ligation with linkers. Adapter and homo-polymer tailing, Nick translation, Random priming. Polymerase-Chain-Reaction. Real Time PCR (SYBR and Taqman-based chemistry), Principles and application of nucleic acid hybridizations, Preparation of nucleic acid probes. Radioactive and nonradioactive procedures, DNA sequencing (Maxam and Gilbert method and Sanger method) including automated DNA sequencing.

Unit 2: Cloning Vehicles and their Application: 8 Hours

Cloning vectors, Definition and properties of cloning vectors - plasmids, bacteriophage lambda and M13 - based vectors, cosmids, and shuttle vector, YAC and BACs, viral vector (SV40, retrovirus and Adinovirus), Ti and Ri Plasmids, cloning of PCR product, TA and TOPO cloning, subcloning and GATWAY cloning.

Unit 3: Genomic and cDNA Library: 8 Hours

Strategies for Construction of Genomic library, Construction of cDNA library- mRNA enrichment, Reverse transcription, Selection and screening of recombinant clones- screening of genomic and cDNA libraries.

Unit 4: Cloning interacting genes and in vitro mutagenesis: 8 Hours

Gel ratardation assay, DNA footprinting, Yeast Two System and Yeast Three Hybrid System. ChIP-chip split hybrid and reverse hybrid, Phage display and transposon tagging, Site-directed mutagenesis and Protein Engineering, Transcript analysis techniques, Protein- protein interactions by GST- pull down, Western-blot, Far western, co-immunoprecipitation etc.

Unit 5: Expression Strategies for Heterologous Genes: 8 Hours

DNA Transfection methods, Reporter gene assays, Expression in Bacteria, Yeast, Insect and mammalian systems

Unit 6: Application of DNA Recombinant Technology: 8 Hours

Generation of transgenic organism, Gene knockdown and knockout (TALEN, CRISPR/Cas9, RNAi, and antisense). Artificial chromosomes, gene therapy, Recombinant DNA technology in medicine,

agriculture and industry.

Suggested Readings:

1. Watson JD., Caudy AA. Myers RM., Witkowski JA. (2007) Recombinant DNA: Genes and Genomes—A Short Course 3rd
2. Hardin, C., Pinczes, J., Riell, A., Presutti, D., Miller, W., & Robertson, D. (2001). Cloning, gene expression, and protein purification (pp. 196-384). Oxford: Oxford University Press.
3. Sambrook, J., Fritsch, E. F., & Maniatis, T. (1989). Molecular cloning: a laboratory manual, Vol I, II and III. Cold spring harbor laboratory press. 3rd revised edition.
4. Glover, D. M., & Hames, B. D. (1995). DNA cloning 3: a practical approach. IRL Press Ltd.
5. Walker, M. R., & Rapley, R. (1997). Route Maps in Gene Technology. Blackwell Science Ltd., Oxford.
6. Kingsman, S. M., & Kingsman, A. J. (1988). Genetic engineering: an introduction to gene analysis and exploitation in eukaryotes. Blackwell Scientific Publications.
7. Glick, B. R., & Pasternak, J. J. (1998). Principles and applications of recombinant DNA. ASM, Washington DC, 683.
8. Primrose, S. B., & Twyman, R. (2013). Principles of gene manipulation and genomics. John Wiley & Sons.
9. Nicholl, D. S. (2008). An introduction to genetic engineering. Cambridge University Press.
10. Singrer M., & Berg, P (1991). Genes & Genomes, a Changing perspective. University Scicnce Books, Mill Valley, California
11. Horve, C. (2016), Gene Cloning and Manipulation. Cambridge: Cambridge University cross. doi: 10. 1017/CB0978051180.
12. Tererrce A. (T.A.) Brown (2017) Genomes 4, Fourth edition. Garland Science: New York, NY.
13. Terence A (T. A) Brown T.A. (2016) Gene cloning and DNA analysis: an introduction 6th ed. Wiley-Blackwell UK.

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Course Code	**3SBT204**
Course Title	**Microbial Genetics**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to -

1. Identify types of mutations including spontaneous and induced mutations and understand mechanisms of mutagenesis, DNA damage repair and DNA recombination pathways.
2. Understand molecular mechanisms of gene transfer in microbes and phages and relate the role of these mechanisms for fine structure mapping of genes.
3. Apply the knowledge on the results of genetic experiments to find out number of genes involved in a process, gene order, distance between genes and fine structure mapping of genes.
4. Integrate the role of extrachromosomal elements including plasmids and transposons in genetic analysis and their roles in evolution.

Syllabus: **Teaching hours: 45 Hours**

Unit I: Principles of Microbial Genetics: 7 Hours Basic procedure and terminology, selection and classification of variations, Mutations – Types and screening; Mechanism of mutagenesis, Directed mutations, Use of mutations.

Unit 2: Genetic Analysis of Bacteria: 9 Hours Genetic mapping, Linkage and Multifactor Crosses, Deletion mapping, Complementation, Gene transfer mechanisms—transformation, conjugation, transduction.

Unit 3: Phage Genetics: 8 Hours Genetics of temperate and virulent phage, Lytic phage - Phage mutants, genetic recombination in phages; Fine structure mapping of T4 *rII* locus.

Unit 4: DNA Damage and Repair: 6 Hours Types and mechanisms of DNA repair.

Unit 5: Recombination: 7 Hours Models of recombination - homologous, site-specific and non-homologous or illegitimate recombination. Transposons in bacteria and yeast; Mechanism of transposition.

Unit 6: Extra-chromosomal Genetic Elements: 8 Hours

Plasmids – Classification, Incompatibility, copy number control; Genetics of restriction modification systems.

Suggested Readings:

1. Brown, T.A. Genetics - A Molecular Approach, 3rd edition, BIOS Scientific Publishers, 2004.
2. Brown, T.A. Genomes 3, G.S. Garland Science, 2007.
3. Dale, J.W. and Park, S.F. Molecular Genetics of Bacteria, 5th edition, Wiley-Blackwell, 2010.
4. Das, H.K. Textbook of Biotechnology, 2nd edition, Wiley Dreamtech, 2005.
5. Gardner, E.J. Simmons, M.J. and Snustad, D.P. Principles of Genetics, 8th edition, John Wiley and sons, 2004.
6. Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. (Eds.), Lewin's Genes X, 10th edition, 2011.
7. Maloy, S.R., Cronan Jr., J.E. and Freifelder, David. Microbial Genetics, 2nd edition, Narosa Publishing House, 2009.
8. Snustad, D.R. and Simmons, M.J. Principles of Genetics, 5th edition, John Wiley and sons, 2010.

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Course Code	**3SBT211**
Course Title	**Laboratory II**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1.Understand the basics of bioinformatics tools, immunological techniques and experiments related to molecular biology, microbial genetics, microbial fermentation and clinical biochemistry.

2.Analyze the data obtained from molecular analysis of RNA, DNA and protein, clinical biochemistry, genetics and fermentation experiments and interpret the results.

3.Apply the techniques based on requirement in analysis of biomolecules and in conducting research.

Syllabus: **Teaching hours: 224 hrs**

1. Pubmed searches, Scopus and Biological databases
2. Structure visualization and statistical methods, sequence similarity search, Introduction to Metagenomics, Pairwise and multiple sequence alignment
3. Docking of protein and ligand, protein-protein docking and its interpretation for clinical targets.
4. Prediction of protein structure, 2D-3D protein structure and prediction
5. Use of UCSC genome browser to find locations of a sequence in a particular genome
6. Phylogeny and its evolutionary analysis
7. Lead generation and optimization
8. Drug docking and its analysis, Use of Computer simulation, In-silico cloning
9. Isolation of Plasmid DNA, Genomic DNA and RNA, Agarose gel electrophoresis
10. Perform Restriction digestion
11. Perform PCR and qPCR
12. UV Survival curve
13. UV mutagenesis, Isolation of drug resistant mutants
14. Determination of MIC and MBC of streptomycin for bacteria
15. Induction of the lac operon in E. coli
16. Microbial production, recovery and estimation of Exopolyaccharide/ Alcohol/ Citric acid in shake flask/ lab-scale fermentor
17. Solid-state fermentation
15. Purification of Immunoglobulin from normal serum/ anti- sera using affinity and ion-exchange chromatography
16. SDS-PAGE and immunoblot for isolated IgG
17. Perform ELISA for serum antigen

Suggested Reading:

1. Mount, David W., and David W. Mount. Bioinformatics: sequence and genome analysis. Vol. 1. Cold Spring Harbor, NY: Cold spring harbor laboratory press, 2001.
2. Andreas D.Baxevanis, B.F. Francis Ouellette, "Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins", Third edition, 2005 2006, ISBN : 978-81-265-2192-0, published by John Wiley & Sons INC. , U.K.

3. Vittal R.Srinivas, "Bioinformatics - A Practical Guide to the analysis of Genes and Proteins" , 2005, ISBN : 978-81-203-2858-7, published by PHI Learning Private Limited, New Delhi.
4. Current Protocols in Immunology (1995) 1.0.3-1.0.6,Contributed by John Donovan and Patricia Brown.
5. Jain, S. Mohan and Saxena, Praveen K. Methods in Molecular Biology: Protocols for In Vitro Cultures and Secondary Metabolite Analysis of Aromatic and Medicinal Plants. Humana Press, 2009.
6. Pollack, Robert A.; Mondschein, Walter; Modesto, R. Ronald and Findlay, Lorraine, Laboratory Exercises in Microbiology, 3rd eds. John Wiley & sons Inc. 2009
7. Casida, Lester Earl. "Industrial microbiology." Industrial microbiology. 2016.

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Course Code	**3SBT212**
Course Title	**Seminar II**

Course Learning Outcomes (CLO):
At the end of the course, students will be able to-

1. Understand the concepts of scientific paper presentation.
2. Analyze the scientific writing and data presented in Research papers.
3. Apply the knowledge and skill for structured writing and presentation of technical research reports.

Syllabus: **Teaching Hours: 30**

The students have to give seminars on a research paper of their interest from any of the biological fields which will be open for discussion. The students will have to submit the hardcopy of the selected manuscript along with a summarised write up of the paper in their own words. This course has been designed to provide a platform for the students to develop their communication, presentation and confidence to face the audience.

Supplementary Course:

L	T	P	C
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Course Code	**3SBT2E2**
Course Title	**Professional English**

Course Learning Outcomes (CLO):
At the end of the course, students will be able to-

1. Understand the basics of English grammar, phonetics and mechanics of language.
2. Use appropriate English vocabulary for fluent and confident communication in English.
3. Demonstrate communication capacities in speaking, writing, listening and narrating in English.

Syllabus: **Teaching Hours: 15**

Unit 1: Introduction to communication: Idioms & Phrases, Basic Nonverbal communication, Barriers to Communication,

Unit 2: Business Communication at work place: Letter components and layouts, planning a letter, Process of Letter writing, Email Communication, Employment Communication, Notice Agenda and Minutes of Meeting

Unit 3: Report Writing: Effective Writing, Types of Business Reports, Structure of Reports, Gathering Information, Organization of Material, Writing Abstract and Summaries, Writing Definitions, Meaning of Plagiarism and Precaution.

Unit 4: Required Skill: Reading Skill, Note-Making, Precise Writing, Audio visual Aids, Oral Communication.

Unit 5: Mechanics of Writing: Transition, Spelling Rules, Hyphenation, Transcribing Numbers, Abbreviating Technical and Non Technical Terms, Proof Reading.

Suggested readings:

1. Technical Communication: Principles and Practice, by Meenakshi Raman and Sangeeta Sharma, Oxford University Press, IInd Edition

Final Syllabus of Microbiology for the Academic year 2022-23

Institute of Science
Nirma University

Value Added Course:

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Course Code	**3SBT2S1**
Course Title	**Professional Development and Resume Writing**

Course Learning Outcomes (CLO):

At the end of the course, the students will be able to:

Design their CV which will evoke interest and help them in their summer internship; will provide an attitude of professionalism and empower them with decision making abilities.

Syllabus:

Unit 1:Interview Etiquettes and CV writing: 8 hour

Right approach to interview, Preparation for interview, Do's and Don'ts in Interview. Making Effective CV and understanding essential do's and don'ts.

Unit 2: Professional development: 8 hour

Understanding Professionalism. Aspects of professionalism. Traits of effective and successful professionals. Professional Ethics.

Unit 3:Decision Making: 8 hour

Process of decision making, Factors to consider while making a decision, Tools for making good decisions, Win-Win approach to decision making. 8 hours

Unit 4: Self Study and Group Discussion 6 hour

Elective Courses I

L	T	P	C
3	-	-	3

Course Code	**3SBC203**
Course Title	**Advanced Immunology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand how MHCs play critical role in shaping specific adaptive immune responses
2. Select target antigen or immunogen against which immune response is generated
3. Design adjuvant to induce B and T cell responses
4. Develop strategies to regulate immune response against the self

Syllabus: **Teaching hours**: **45**

Unit 1: Major Histocompatibility Complex (MHC) Genes and Products: 9 Hours

Polymorphism of MHC genes, Role of MHC antigens in immune responses, MHC antigens in transplantation.

Unit 2: 10 Hours

Antigen processing and presentation, Cytokines and Chemokines; Microbial Associated Molecular Patterns – TLR, NLRs.

Unit 3: B Lymphocyte Development and Differentiation: 6 Hours

B cell differentiation in Bone marrow, B cell signal transduction, Antigen dependent B cell differentiation - primary and secondary follicles.

Unit 4: T lymphocyte development and Differentiation: 10 Hours

Thymus – Negative and positive selection. T lymphocyte Activation and differentiation - subtypes of Th cells, CD8 T cell activation, γδ T lymphocytes, T and B cell memory.

Unit 5: Tolerance: 7 Hours

Peripheral tolerance, Immunosuppression, Transplantation

Unit 6: Clinical Immunology: 7 Hours

Hypersensitivity - Types I, II, III and IV; Autoimmunity; Cancer immunology.

Suggested Readings:

1. Murphy, K., & Weaver, C. (2016). Janeway's immunobiology. Garland Science.
2. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2007). Kuby immunology. Macmillan.
3. Greenberg, S., Silverstein, S. C., & Paul, W. E. (1993). Fundamental immunology. Fundamental Immunology, 509.
4. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2014). Cellular and molecular immunology. Elsevier Health Sciences.
5. Coico, R., & Sunshine, G. (2015). Immunology: a short course. John Wiley & Sons.

   Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2016). Roitt's essential immunology. John Wiley & Sons.

Final Syllabus of Microbiology for the Academic year 2022-23

Institute of Science
Nirma University

L	T	P	C
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Course Code	3MB2E2
Course Title	Microbial Ecology

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand principles of ecology and interactions among microorganisms and their environment
2. Analyze beneficial and pathogenic interactions of microorganisms with plants and animals
3. Comprehend role of microorganisms in biogeochemical cycling of elements

Course Content;

Unit 1: Fundamentals of ecology: 5 Hours

The ecosystem, energy in ecological systems, energy partitioning in food chains and food webs, history and scope of ecology

Unit 2: Interactions among microbial populations: 7 Hours

positive and negative interactions, interactions between diverse microbial populations

Unit 3: Interactions between microorganisms and plants: 8 Hours

Interaction with plant roots – rhizosphere and mycorrhizae, interactions with aerial plant structures, microbial diseases of plants

Unit 4: Microbial interactions with animals: 9 Hours

Microbial contribution to animal nutrition, fungal predation on animals, other symbiotic relationship eg. Symbiotic light production and novel prokaryotic endosymbionts, ecological aspects of animal diseases.

Unit 5: Biogeochemical cycling I: 8 Hours

Carbon cycle, Hydrogen cycle, Oxygen cycle

Unit 6: Biogeochemical cycling II: 8 Hours

Nitrogen cycle, Sulphur cycle, Phosphorus cycle, cycling of other elements

Suggested Readings:

1. Atlas, R.M. and Bartha, R. Microbial Ecology, 4th edition, Pearson Education, 2009.
2. Maier, R.M., Peppper, I.L. and Gerba, C.P. Environmental Microbiology, 2nd edition, Elsevier Academic Press, 2009.
3. Paul and Clerk, Soil Microbiology and Biochemistry, 2007.
4. Paul, E.A. (Ed.). Soil Microbiology, Ecology and Biochemistry, 3rd edition, Academic Press, 2007.
5. Pepper, I.L. and Gerba, C.P. Environmental Microbiology – A Laboratory Manual, 2nd edition, Elsevier Academic Press, 2005.
6. Manahan, S.E. Environmental Chemistry, 9th edition, CRC Press, 2010.
7. Odum, E.P. and Barrett, G.W, Fundamentals of Ecology, 5th edition, Cengage Learning, 2005

L	T	P	C
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Course Code	3SBC2E1
Course Title	Human Genetics

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand and appraise the fundamental principles of inheritance, structural and functional aspects of cellular genetic material, will learn collecting and interpreting genetic related history, making pedigree chart, and linkage and association prediction studies
2. Evaluate various laboratory approaches of study of genetic material including conventional and updated methods of genomic studies for nuclear and mitochondrial genetic elements, coding and non-coding DNA and RNA
3. Demonstrate understanding regarding various models of study of genetic aetiology involved in various single gene, complex, and multifactorial disease conditions; Evaluate the molecular mechanisms and their cross-talk responsible for various diseases including cancer, diabetes and other dreadful diseases, articulate host-environment interactions
4. Demonstrate understanding of available knowledge and can employ them by making use of various updated databases related to human genetic, genomic, phenotypic, and genetic conditions related databases

Syllabus: **Teaching hours**:**45**

Unit 1: Mendelian principles of inheritance: 10 Hours

Dominance, segregation, independent assortment; alleles, multiple alleles, pseudo-allele, complementation tests; Extensions of Mendelian principles: Codominance, incomplete dominance, gene

interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters; extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance, mitochondrial mutations and myopathies.

Unit 2: Organization of human genome and genes: 9 Hours

General organization of human Genome-Nuclear and Mitochondrial, Mitochondrial Genome organization, distribution of tandems and interspersed repetitive DNA, Gene distribution and density in human nuclear genome, Organization of genes: rRNA encoding Genes, mRNA encoding Genes, small nuclear RNA genes, Overlapping genes, genes within genes, multigene families, pseudo genes, truncated genes and gene fragments.

Unit 3: Gene mapping: 10 Hours

Pedigree analysis, LOD score for linkage testing, linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids; strategies in identifying human disease genes in pre and post Human Genome project; low and high resolution mapping; principles and strategies for identifying unknown disease or susceptibility genes

Unit 4: Animal Models For Human Diseases: 6 Hours

Potential of using animal models for human diseases, Types of animal models, transgenic animals, procedures of production and application in the study of different diseases; Gene editing and gene therapy**,** Induced pluripotent stem cells; transgenic animals to model complex diseases.

Unit 5: Cytogenetics and other methods of detection of genetic aberrations: 6 Hours

Human chromosomes structure, number and classification, methods of chromosome preparation, banding patterns. Structural and numerical alterations of autosomes and sex chromosomes; Molecular cytogenetic techniques, Fluorescence in situ hybridization using various types of probes, Multiplex FISH and spectral karyotyping, comparative genomic hybridization, microarray, Whole Exome and Whole Genome sequencing.

Unit 6: Data Mining in Genetics Research & Clinical Management: 4 Hours

Introduction to Internet based cataloguing of Genetic Aberrations in various diseases including Cancer, OMIM, Mitelman database of chromosome aberrations in cancer, Borgaonkar database of chromosomal variations in man, London Dysmorphology Database, Human Variome project, Human Phenome project, Encode project, Phenomizer and other automation approaches in phenotyping.

Suggested Readings:

1. ISCN 2016, Jean McGowan-Jordan, A. Simons, M. Schmid; Karger, 2016
2. Rooney D. E., and Czepulkowski, B. H., Human Cytogenetics: A Practical Approach (Vol. I & II), 1992 Edition, Oxford University Press, 1992.
3. Griffith A. J.F., Wessler S.R., Carroll, S.B., and Doebley J., Introduction to Genetic Analysis, 10th Edition, W. H. Freeman, 2010.
4. Benjamin P., Genetics: A Conceptual Approach & Problem Solving, 2008, W. H. Freeman, 2008.
5. Hedrick, P. W. (2011) Genetics of Populations, 4th Edn., Jones & Bartlett Publ.
6. Vogel and Motulsky's Human Genetics: Problems and approaches, Michael R. Speicher, Stylianos E. Antonarakis, Arno G. Motulsky, Springer; 4th ed. 2010 edition.
7. The AGT Cytogenetics Laboratory Manual, M.J.Barch, T.Knutsen, and J.Spurbeck.,Third Edition,Lippincott-Raven Publishers, Philadelphia (1997)
8. Genomic Imprinting and Uniparental Disomy in Medicine by Eric Engel, Stylianos E. Antonarkis, Wiley-Liss, Inc. ISBNs: 0-471-35126-1 (Hardback); 0-471-22193-7
9. Ricki Lewis Human Genetics Concepts and Applications 10th Edition, 2011, McGraw-Hill Science.
10. The Science of Genetics, Atherly et al (1999), Saunders
11. Robbins & Cotran, Pathologic Basis of Disease, 8th Edition, Elsevier, 2010.
12. Strachan Tom and Read Andrew P. (2011) Human Molecular Genetics, 4th Edition, Garland Science (Taylor and Francis Group), London and New York

Institute of Science
Nirma University

L	T	P	C
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Course Code	**3SBC2E2**
Course Title	**Reproductive Physiology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Demonstrate an understanding of structure and function of reproductive systems.
2. Apply the basic knowledge to understand the molecular mechanisms of gametogenesis and its regulation.
3. Analyze the functional modulation and establish a relationship between various functional aspects of reproductive physiology
4. Evaluate and interpret the cause of pathogenicity or dysfunction and critically identify the mode of action.
5. Create and develop therapeutic or preventive strategies for reproductive irregularities.

Syllabus **Teaching hours**: **45**

Unit 1: Human Reproductive System 8 Hours

Structure, function of male and female reproductive function; Functional assessment of male and female functioning; Mechanism and molecular events of fertilization, Preembryonic Development, Pregnancy, Labour and Lactation.

Unit 2: Gamatogenesis 10 Hours

Spermatogenic Cycle; Its Molecular changes, Hormonal Regulation, Spermiation and Spermiogenesis; Sperm capacitation; Molecular and Biochemical changes, decapacitation. Process of folliculogenesis and its hormonal control. Recruitment, selection, dominance of follicle and signaling for ovulation. Follicle wall: Theca, differentiation, steroid hormone synthesis, menstrual cycle and Menopause. Mechanism and hormonal control of ovulation; Histogenesis, function, maintenance and luteolysis during Corpus Luteum. Prostaglandins and their role in reproduction.

Unit 3: Gonadal Steroidogenesis 9 Hour

Autocrine, Paracrine and Endocrine Regulation of Gonadal Steroidogenesis, Regulation of Expression of Genes Encoding Steroidogenic Enzymes.

Unit 4: Molecular Aspect of Sex Differentiation 5 Hours

Location of Sry -Gene and its Critical Period of Expression, Specfic Cell Type Engaged in SRY -Gene Expression, Downstream Genes Regulation by SRY -- Gene Like Amh Gene, Arometase Gene, Ar-Gene, 5a-Reductase Gene, Sox -9 gene and Z-Gene.

Unit 5: Stress and Reproduction 5 Hours

Stress and Pituitary Gonadotropin, Stress and Cytokines, Oxidative Stress and Reproductive Activities

Unit 6: Reproductive Immunology 8 Hours

Role of immunological cells in the male and female reproductive system, understanding the normal and abnormal physiological events influenced by reproductive immune cells.

Suggested Readings:

1. Knobil, E. and Neil, J. D., The Physiology of Reproduction, Vol 1 and 2, Raven Press, 1988.
2. Wang, C., Male Reproductive Function, Kluwer Academic Publishers, 1999.
3. Zuckerman, B. S. Z., Weir, B. J. and Baker, T. G., The Ovary, Academic Press, 1977.
4. Leung, P. C. K. and Adashi, E. Y. (Ed), The Ovary, Elsevier (Academic Press), 2004.
5. Desjardins, C. and Ewing, L. L., Cell and Molecular Biology of Testis, Oxford University Press, USA, 1993
6. Yen, S. S. C., Jaffe, R. B., and Barbieri, R. L. (Ed), Reproductive Endocrinology: Physiology, Pathophysiology, and Clinical Management, Saunders Publisher. USA, 1999.
7. Chedrese, P. J., Reproductive Endocrinology: A Molecular Approach, Springer Publishers, 2009.
8. Carrell, D. T. and Peterson, C. M., Reproductive Endocrinology and Infertility, Springer Publishers 2010.

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3	-	-	3

Course Code	**3SBC211**
Course Title	**Neurobiology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to

1. To understand basic concept of organisation of

human nervous system, its components and their interrelationship along related theories and principles
2. To comprehend and analyse how brain exerts its functional regulation on physiologocial function via down stream molecular signalling.
3. To discuss and relate brain's dynamic changes over time during physiological functions.
4. To discuss and analyze biochemical events and pathophysiological changes leading to mental & behaviuoral disorders and critically evaluate new possible therapies being investigated to treat neurological disease.

Syllabus: **Teaching hours**:**45**

Unit 1: Physiology of Nervous System: 9 Hours
Components of the Nervous System, Neuron and Glial Cells - Different Types, Structure, Function. Synapse: Nerve Impulse, Neurotransmitters. Organization of Nervous System- CNS, PNS. PNS- Somatic Nervous System; Autonomic Nervous System-Sympathetic and Parasympathetic System; Enteric Nervous System

Unit 2: Brain and Spinal Cord 9 Hours
Embryological development, protection, blood brain barrier, CSF, structural and functional organization, Spinal cord anatomy, Spinal Nerves, Spinal Meninges, Grey and White Matter of Spinal Cord, Joint Reflexes.

Unit 3: Neurotransmitters 9 Hours
Chemistry, Synthesis, Storage and Release of Neurotransmitters, Transmitter Action, Neurotransmitter Receptor types-Ionotropic and Metabotropic, Classification for Glutamate, GABA, Acetylcholine, Serotonin, Epinephrine and Norepinephrine Receptors, Synaptic Modulation and Mechanism of Neuronal Integration.

Unit 4: Synaptic Transmission 6 Hours
Transmission across the Synapse, Pre and Post Synaptic Events, Membrane Potential in the Steady State Action, Action Potential and propagation of Nerve Impulse, Mechanism of Action of cAMP, cGMP, IP3, DAG, Calcium as second messengers, Neurotransmitter Sensitive second messengers and their role in Neuronal Function.

Unit 5: Psychopharmacology and Biochemical theories of Mental Disorders: 9 Hours
Chemistry of Neuroleptics and Anxiolytics, Antidepressants, Hallucinogenic Agents, Biochemical theories of Mental Disorders and Neurodegenerative Disorders like Parkinson's, Alzheimer's disease, Amyotrophic lateral sclerosis and Senile Dementia.

Unit 6: Sleep, Learning and Memory: 6 Hours
Mechanism of Sleep- Intrinsic rhythms, SCN & pineal gland, States of sleep, pathway and its physiology- REM & NREM sleep, Wakefulness, Functions of Sleep. Definition & Types of learning, Long term Potentiation & Long term Depression, Memory consolidation and priming, Agents affecting Learning and Memory.

Suggested Readings:

1. Purves, D, Augustine, G., Neuroscience, Sinauer, 2000.
2. Tortora, G. J. and Derrickson, B. H., Principles of Anatomy and Physiology, Weily and Sons, 2009
3. Breedlove, M. C., Watson, N. V., Rozenzweig M. R., Biological Psychology: An Introduction to Behavioural, Cognitive and Clinical Neuroscience. Sinauer Associates, 6th Edition, 2010.
4. Gross C. G. A Hole in Head- More tales in the history of neuroscience. Cambridge MIT Press, First edition, 2012.
5. Amthor Frank, Neuroscience for dummies. USA John Wiley & Sons Canada Ltd. 2012.
6. Kolb, Bryan; Whishaw, Ian Q. An Introduction to Brain and Behavior, New York Worth Publishers 2011
7. Longstaff, A. Developmental Biology. Sinauer Associates, 6th Edition, 2010.
8. Hell, J. W., Ehlers, M. D., (Editors), Structural and functional organization of the synapse, Springer, 2008
9. Turkingtons, C., The Brain and Brain Disorders, Viva Books, 2009
10. Kandel, E., Schwartz, J. and Jessell T., Essentials of Neural Science and Behaviour, McGraw-Hill, 2003.
11. Levitan, I. B., Kaczmarek L.K., The Neuron, Cell and Molecular Biology, Oxford University Press, 2001

Final Syllabus of Microbiology for the Academic year 2022-23

Institute of Science
Nirma University

SEMESTER III

Core Courses

L	T	P	C
3	-	-	3

Course Code	3SBT301
Course Title	Molecular Microbial Physiology

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Describe` the principles of the energy-yielding and -consuming reactions, the various catabolic and anabolic pathways, the transport systems and the mechanisms of energy conservation in microbial metabolism
2. Recognize the extent of metabolic diversity present in this microbial world and identify various physiological groups of bacteria with their metabolic special features.
3. Analyze microbial physiology related topics by working on assignments and to compose a concise report
4. Critically think and integrate conceptual information into an understanding of signal transduction, adaptation to stress and differentiation of microbial systems

Syllabus: **Teaching hours**: **45**

Unit 1: Central Metabolism: 10 Hours

Glycolysis, ED pathway, phosphoketolase pathwayoxidative pentose phosphate pathway TCA cycle, glyoxalate cycle, gluconeogenesis, regulatory aspects, Metabolism of sugars other than glucose

Unit 2: Electron transport chains and Phototrophy: 9 Hours

Mitochondrial and bacterial electron transport chains, Aerobic respiration and anaerobic respiration, Bacteriorhodopsin and energy generation, oxygenic and anoxygenic Photosynthesis. Mechanism of photosynthesis in bacteria, cyanobacteria and algae

Unit 3: Chemolithotrophy and CO_2 fixation: 10 Hours

Nitrate reduction: assimilatory vs. dissimilatory, nitrification, denitrification, electron transport in iron bacteria, sulphur bacteria, Calvin cycle, reductive TCA cycle

Unit 4: Signal Transduction in Prokaryotes: 6 Hours

Two component system, Phosphorelay, Chemotaxis-Genes and Proteins involved in chemotactic response to attractant and repellent.

Unit 5: Microbial Adaptation to stress: 6 Hours

Temperature, salt and osmotic stress and oxidative stress, Quorum sensing.

Unit 6: Differentiation in Microbial Systems 4 Hours

The model of Sporulation in Bacillus, the two component signalling system, stages of Sporulation, Proteins and genes involved in Sporulation.

Suggested Readings:

1. White, D., Physiology and Biochemistry of prokaryotes, 3rd Edn. Oxford Univ. Press, 2007.
2. Moat, A. G. and Foster, J. W., Microbial Physiology, 3rd Edition, Wiley-Liss Publ, 1995.
3. E. L. Sharoud, Bacterial Physiology – A Molecular Approach, Springer, 2008.
4. Byung Hong Kim, Geoffrey Michael Gadd, Bacterial Physiology and Metabolism, Cambridge University Press, Cambridge, 2008.
5. Doelle HW, Bacterial Metabolism, Elsevier India Pvt. Ltd., New Delhi, 2005.
6. Gerhard Gottschalk, Bacterial Metabolism, 2nd edn., Springer-Verlag, New York, 2006.

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Course Code	3SMB303
Course Title	Medical Microbiology and Virology

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Get aquainted with the molecular basis of pathogenesis and virulence of different microbial pathogens, and would also be sensitized to the social impact of most dreadful infections like tuberculosis, malaria, HIV, etc.
2. To acquire experimental knowhow of antimicrobial susceptibility assays, biochemical characterization of medically important microorganisms, etc.

3. Develop an understaffed go the problem of drug-resistance, and the mechanism underlying its development and spread among pathogenic populations.

Syllabus: **Teaching hours: 45 Hours**

Unit 1. Principles of virulence and Pathogenicity: **7 hours**

Host-Parasite interaction with respect to major human diseases caused by bacteria, protozoa and viruses, Pathogenesis, Diagnosis, Prevention and treatment of diseases caused by bacteria (representative groups).

Unit 2. Normal microbial flora of human body: **7 hours**

Microbiome of human system, Gnotobiology, Probiotics & prebiotics.

Unit 3. General characteristics of Rickettsia/ Mycoplasma/Chlamydia, and Prions: **7 hours**

Pathogenesis, diagnosis, prevention and treatment of their disease. Mycoses - Superficial, Subcutaneous and Systemic mycosis.

Unit 4. Viral and protozoal diseases: **8 hours**

General characteristics, Pathogenesis, Diagnosis, Prevention and treatment of diseases caused by viruses (representative groups), and protozoans - Malarial parasite etc.

Unit 5. Molecular Pathogenesis: **8 hours**

Horizontal gene transfer, Pathogenicity islands and virulence determinants, Molecular mechanisms of pathogen invasion, Secretion of virulence factors, Evolution of pathogen, Regulation of virulence genes. Principles of chemotherapy, Mode of action of antibiotics, Antibacterial, Anti-fungal and Antiviral agents. Problems of drug resistance and drug sensitivity, Multiple drug resistance in bacteria.

Unit 6. Microbial bio-films, quorum sensing, and efflux pumps: **8 hours**

Role of efflux pumps in antimicrobial resistance of bio-films. Steps involved in development of novel antimicrobial drugs. Novel targets (e.g. riboswitches, iron-scavenging machinery, etc.) in the pathogens

Suggested Readings:

1. Sasakawa S (2009). Molecular mechanisms of bacterial infection via the gut. Springer.
2. Greenwood D, Slack R, Peutherer J, Medical Microbiology 15th Edn., Churchil and Livinstone. 2007.
3. Schaechter M,. Engleberg, N C, . Einstein B and Mendoff G, Mechanism of Microbial Diseases, 3rd Edition., Williams and Wilkins, 1998.
4. Wilson M (2005). Microbial inhabitants of humans. Cambridge University Press.

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Course Code	3SMB304
Course Title	Agriculture & Environmental Microbiology

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Describe role of microorganism in recycling soil nutrients, biodegradation of complex plant polymers, sustaining and improving plant growth through improving nutrient availability, production of plant growth promoting substances and inhibiting pathogens.
2. Critically discuss the need for environmental microbiology and agricultural microbiology and explain their limitations.
3. Clarify application of microorganisms in varied fields of agricultural and environmental microbiology like bioremediation, biofertilizers and waste water treatment.
4. Analyse various aspects of N_2 fixation, P solubilization, PGPR, biodegradation and bioremediation mechanisms provided by microbes

Syllabus: **Teaching hours:45**

Unit 1: Biological Nitrogen fixation: 10 Hours

Physiology and Biochemistry of Nitrogen fixing organisms, Genetics and regulation of nif gene expression, Signalling factors and molecular interaction in establishing Rhizobia legume symbiosis

Unit 2: Phosphate Biofertilizers: 6 Hours

PSMs, Inorganic phosphate solubilization and its mechanisms, Phosphate mineralizers – phytate and organic phosphate hydrolyzing bacteria, and Ecto- and Endo- Mycorrhizae

Unit 3: Plant Growth Promoting Rhizobacteria: 6 Hours

PGPR in improving plant growth, Mechanism in plant growth promotion, Factors affecting rhizosphere colonization.

Unit 4: Environmental Problems and Monitoring: 8 Hours

Pollution and its classification, Effluent standards: examination of waste water characteristics, municipal and industrial waste water, Global environmental problems: global warming, acid rain, ozone depletion, Sampling and analysis, Environmental monitoring and audit, Environmental laws and policies in India.

Unit 5: Bio-Treatment Kinetics and Reactor Design: 8 Hours

Principals of biological treatments, Biological treatments: Composting, Suspended growth systems, Attached growth systems, Bioreactor design: Activated Sludge Process, Tickling Filters, Fluidised bed and Packed bed reactor, Rotating Biological Contractors, Oxidation Ponds and Ditches, Lagoons, Anaerobic Reactors.

Unit 6: Bioremediation and Biodegradation: 7 Hours

Bioremediation principles and Processes: Biosorption, Bioaccumulation, Bioconversion, Biotransformation, Bioleaching, Biodegradation, Detoxification, Activation, Acclimatisation and Co-metabolism, strategies and techniques of bioremediation: in situ and ex situ, of Hydrocarbons, Pesticides and Dyes, GMO's in bioremediation and biodegradation.

Suggested Readings:

1. Alexander, M. Biodegradation and Bioremediation, Academic Press, 1994.
2. Arceivala, S.J. and Asolekar, S.R., Wastewater treatment for Pollution Control and Reuse, 3rd edition, Tata McGraw Hill, 2007.
3. Atlas, R.M. and Bartha, R. Microbial Ecology, 4th edition, Pearson Education, 2009.
4. Bhatia, S.C. Handbook of Environmental Microbiology, Vol. III, Atlantic Publishers, 2008.
5. Das, H.K. Textbook of Biotechnology, 2nd edition, Wiley Dreamtech, 2005.
6. Dworkin, M., Falkow, S., Rosenberg, E., Schleifer, K.H., Stackebrandt, E. (Eds.). The Prokaryotes. Vol .I – VII, Springer, 2006.
7. Evans, G.M. and Furlong, J.C. Environmental Biotechnology – Theory and Application, John Wiley and Sons, 2004.
8. Hurst Christon J., Manual of Environmental Microbiology, ASM Press, Washington DC, 2007 .
9. Khan M. S., Zaidi A. and Musarrat J,. Microbes for legume improvement, Springer Wien, New York, 2010.
10. Maier, R.M., Peppper, I.L. and Gerba, C.P. Environmental Microbiology, 2nd edition, Elsevier Academic Press, 2009.
11. Paul and Clerk, Soil Microbiology and Biochemistry, 2007.
12. Paul, E.A. (Ed.). Soil Microbiology, Ecology and Biochemistry, 3rd edition, Academic Press, 2007.
13. Pepper, I.L. and Gerba, C.P. Environmental Microbiology – A Laboratory Manual, 2nd edition, Elsevier Academic Press, 2005.
14. Rao, N. S. Subba, Soil Microbiology, 4th edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 2008.
15. Thakur, I.S. Environmental Biotechnology – Basic concepts and Applications, I.K. International, 2006.
16. Varma A., Oelmuller R. Advanced Techniques in Soil Microbiology, Springer (India) Pvt. Ltd, 2007.

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Course Code	**3SMB307**
Course Title	**Microbial Diversity and Systematics**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to -

1. Recognize the extent of microbial diversity present in this world including prokaryotic and eukaryotic microbes and the importance of microbial diversity in different habitats including extreme environments.
2. Understand conventional and molecular methods used for studying microbial diversity and problems and limitations in microbial diversity studies.
3. Describe the microbial classification schemes and methods used for taxonomy, distinguish and differentiate the use of various taxonomic tools apt for classification and identification of microorganisms.
4. Apply the knowledge of biochemistry and physiology of extremophiles for their application potentials in Biotechnology.

Syllabus: **Teaching hours: 45 Hours**

Unit 1: Principles of Microbial Diversity: 9 Hours
Evolution of life, Principles and concepts of microbial diversity, Ecological diversity, Structural and Functional Diversity. Methods of studying microbial diversity – microscopy, nucleic acid analysis, physiological studies, CLPP, FAME.

Unit 2: Issues of Microbial Diversity: 7 Hours
Problems and limitations in microbial diversity studies, Diversity Indices, Loss of diversity, Sustainability and Resilience, Indicator species, Exploitation of microbial diversity, Conservation and economics.

Unit 3: Microbial Classification and Taxonomy: 9 Hours
Phenetic, Phylogenetic and Genotypic classification, Numerical Taxonomy, Taxonomic Ranks, Techniques for determining Microbial Taxonomy and Phylogeny – classical and molecular characteristics, phylogenetic trees; major divisions of life, Bergey's Manual of Systematic Bacteriology, Prokaryotic Phylogeny and major groups of bacteria.

Unit 4: The Archaea: 7 Hours
Ecology, Archaeal cell walls and membranes, genetics and molecular biology, metabolism, archaeal Taxonomy, Phylum Crenarchaeota, Phylum Euryarchaeota.

Unit 5: Eukaryotic Diversity: 7 Hours
Physiological variation, identification, cultivation and classification of important groups of fungi, algae and protozoa.

Unit 6: Microbial Diversity in Extreme Environments: 6 Hours
Habitat, diversity, physiology, survival and adaptation, and biotechnological potentials of: Cold and thermal environment, Saline and deep sea environment, Anaerobic environment, Osmophilic and xerophilic environment, Alkaline and acidic environment.

Suggested Readings:

1. Cavicchioli, R. Archaea – Molecular and Cellular Biology, ASM Press, Washington, 2007.
2. Dworkin, M., Falkow, S., Rosenberg, E., Schleifer, K.H., Stackebrandt, E. (Eds.). The Prokaryotes. Vol. I – VII, Springer, 2006.
3. Garrity, G.M. and Boone, D.R. (Eds.), Bergey's Manual of Systematic Bacteriology, 2nd edition, Vol. I, Springer, 2001.
4. Garrity, G.M., Brenner, D.J., Kreig, M.R. and Staley, J.T. (Eds.), Bergey's Manual of Systematic Bacteriology, 2nd edition, Vol. II, Springer, 2005.
5. Gerday, C. and Glansdorff, N. Physiology and Biodiversity of Extremophiles, ASM Press, Washington, 2007.
6. Hurst, C.J, Crawford, R.L., Garland, J.L., Lipson, D.A., Mills, A.L. and Stetzenbach, L.D. Manual of Environmental Microbiology, 3rd Edition, ASM Press, Washington, 2007.
7. Madigan, M.T. and Martinko, J.M. Brock Biology of Microorganisms, 11th edition, Pearson Prentice Hall, 2006.
8. Mueller, G.M., Bills, G.F. and Foster, M.S. Biodiversity of Fungi – Inventory and Monitoring Methods, Elsevier Academic Press, 2004.
9. Willey, J.M., Sherwood, L.M. and Woolverton, C.J. Prescott, Harley and Klein's Microbiology, 7th edition, McGraw Hill, 2008.

L	T	P	C
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Course Code	**3SMB306**
Course Title	**Laboratory III**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1.Demonstrate the skill to design controlled experiments for performance of standard practicals to understand the physiology and adaptation of microbial systems in different environments.

2.Record and report experimental results in standard format and derive coherent conclusions of results stating their significance.

3.Correlate the theoretical concepts to appreciate and evaluate results obtained through scientific enquiry.

Syllabus: **Teaching hours: 128 Hours**

1. Plotting diauxic growth of E. coli, establishing catabolite repression in E.coli through β-galactosidase activity
2. Enumeration of free living nitrogen fixing population in soil by most probable number (MPN) method
3. Estimation of the most probable number (MPN) of sulphate reducing bacteria in soil samples

4. Estimating soil microbial activity through soil respiration
5. Estimating soil microbial activity by dehydrogenase enzyme
6. Isolation and enumeration of Rhizobium, phosphate solubilizers and Actinomycetes,
7. Establishing Rhizosphere effect
8. Demonstration of flow cytometer using Florescently labeled bacteria
9. Estimation of BOD
10. Testing for microbiological quality (Coli-form test) for potable water
11. Physico-chemical characterization of wastewater.
12. Biosorption of Metals
13. Perform Protein purification by size exclusion chromatography and HPLC

Suggested Reading:

1. Prescott M. Lansing, Harley P. John, Klein A. Donald, Microbiology, 7th ed., McGraw-Hill Higher Education, 2008
2. Cappuccino G .James, Sherman Natalie, Microbiology A laboratory manual, 10th ed., Pearson Education, 2014
3. Environmental Microbiology -A Laboratory Manual. 2nd ed. Ian Pepper Charles Gerba Jeffrey Brendecke 2005
4. Soil Microbiology: Ecology and Biochemistry Ed by Eldor A. Paul, 3rd ed. Burlington Academic Press, 2007
5. Principles and Practice of Soil Science: The Soil as a Natural Resource, 4th Edition, Robert E. White, 2005
6. Bailey & Scott's Diagnostic Microbiology by Patricia Tille. 12th ed. , Mosby Publisher, 2007
7. Clescerl, L., A. Greenberg, and A. Eaton. "Standard Methods for Examining Water and Wastewater." American Public Health Association (APHA)/the American Water Works Association (AWWA)/the Water Environment Federation (WEF), Washington, DC 1999.

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Course Code	**3SBT312**
Course Title	**Research Methods**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand the various kind of research designs and their importance in conducting the research work.
2. Propose original research proposal and demonstrate skills for effective communication through its defence.
3. Application of biostatistical tools for evaluation of statistical relevance of results obtained.

Syllabus: **Teaching Hour: 45**

Unit 1: Research: **8 Hours**

Definition of Research, Applications of Research and Types, Validity, Literature Review, Develop a Theoretical and Conceptual Framework, Writing up the Review, Formulating and Research Problem: Sources, Considerations, Definition of Variables, Types, Research Modeling: Types of Models, Model Building and Stages, Data Consideration.

Unit 2: Research Design: **14 Hours**

Design of Experiments, Objectives, Strategies, Replication, Randomization, Blocking, Guidelines for Design of Experiments, Simple Comparative Experiments- Two Sample T-Test, P-Value, Confidence Intervals, Paired Comparisons, Single Factor Experiment: Analysis of Variance (ANOVA), Randomized Complete Block Design .

Unit 3: Research Proposal: **12 Hours**

Contents-Preamble, The Problem, Objectives, Hypothesis, Study Design, Setup, Measurement Procedures, Analysis of Data, Organization of Report; Displaying Data tables, Graphs and Charts, Writing a Research Report- Developing an Outline, Key Elements- Objective, Introduction, Design or Rationale of Work, Experimental Methods, Procedures, Measurements, Results, Discussion, Conclusion, Referencing and Various Formats for Reference.

Unit 4 Scientific Communication skills: **11 hours**

Importance of communication in science, Types of communications, Communicating with scientific and non-scientific audiences,

Writing skills: Writing of Books and Research Papers, Report & Thesis Writing, Formats of Publications in Research Journals.

Verbal and presentation skills: Oral and Poster Presentations, Graphical abstract

Unit 5: Ethics and Scientific Conduct:

Good Laboratory practice (GLP) – Data Documentation, SOP Plagiarism, Scientific conduct and misconduct, Ethical Guidelines, Biosafety; Principles of Human and Animal Research ethics.

Suggested Readings:

1. Central Drugs Standard Control Organization Http://CDSCO.NIC.IN/
2. Http://WWW.Patentoffice.NIC.IN/
3. WWW.OECD.ORG/DATAOECD/9/11/33663321.PDF
4. Http://WWW.FDA.GOV/FDAC/Special/Testtubetopatient/Studies. Html
5. Ranjit Kumar, Research Methodology- A Step-By-Step Guide for Beginners, Pearson Education, Delhi. 2006.
6. Trochim, William M.K., 2/E, Research Methods, Biztantra, Dreamtech Press, New Delhi, 2003.
7. Montgomery, Douglas C. 5/E, Design and Analysis of Experiments, Wiley India, 2007.
8. C.R. Kothari and Gag, Bravura, Research methodology- Method and Techniques, New Age International, New Delhi, 2019.
9. Besterfield, Dale H. 3/E, Total Quality Management, Pearson Education, New Delhi, 2005.
10. C. George Thomas, Research Methodology and Scientific Writing, New Delhi, 2015.
11. G Nageswara Rao, Bio-statics and Research Methodology, Hyderabad, 2018.
12. Kartikeyan, S. Chaturvedi, R.M and Bhosale, Comprehensive Textbook of Biostatics and Research Methodology, Mumbai, 2016.

Practicals

The students have to perform wet lab experimentation on the topic of project assigned to them such as standardization of the protocols.

L	T	P	C
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Course Code	3SBT3S6
Course Title	Summer Training

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

To provide an opportunity for the students to understand the laboratory need of industry and academics as well as research institutes and to prepare them for their goal.

Outline:

All the students undergo summer training during the summer break following their Semester II. This training has to be for minimum period of 21 days. The report and certificate should be submitted to library.

Elective Courses II

L	T	P	C
3	-	-	3

Course Code	3SBT309
Course Title	Vaccinology

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Have an idea about the history of various vaccines (subunit vaccines, peptide, DNA and RNA vaccines, live & killed vaccines and edible vaccines), composition of vaccines
2. Learn and develop understanding on the effective delivery of developed vaccine formulation to achieving robust immune responses
3. Understand the various methods to develop vaccines against viral diseases including, HIV, hepatitis, flu etc.
4. Learn and understand the basics of bacterial, protozoan vaccines with reference to malaria parasite
5. To design an efficacious vaccine based on our understanding of the immune response generated due to natural infection as well as the same induced by successful vaccines tried in human beings since 18th century.

Syllabus: **Teaching hours**:**45 Hours**

Unit 1: Introduction to Vaccinology and Classification: 7 Hours

History of vaccines, Immunological principles, Composition of vaccines: vaccine, adjuvant, conservative Concepts of vaccine development, types of vaccine (Conventional vaccines; Live and killed vaccines; New generaration vaccines; Sub unit vaccines; Synthetic peptide vaccines; Anti-idiotype vaccines; Recombinant DNA vaccines; Deleted mutant vaccines; Reassortment vaccines; DNA vaccines; Edible vaccines) vaccine, heat killed, X-irradiated, or live attenuated whole

pathogen., challenges and possibilities with new vaccines and vaccine strategies

Unit 2: Development of novel vaccines and Vaccine Delivery: 6 Hours

Novel adjuvants, vaccine formats (DNA, viral vectors, dendritic cells), vaccines in development (HIV, malaria, pandemic influenza), Adjuvants; Carriers; Haptens; Vaccine delivery using nano particles; Standardization of vaccines; Safety, sterility and potency testing.

Unit 3: Vaccines for viruses: 8 Hours

HIV, CMV, flu, Hepatitis, herpes viruses, Conventional vaccines killed and attenuated, modern vaccines—recombinant proteins, subunits, DNA vaccines, peptides, immunomodulators (cytokines), Antisense RNA, siRNA, ribozymes, in silico approaches for drug designing.

Unit 4: Vaccine for bacteria: 8 Hours

Shigella, vibrio cholera, diphtheria, tetanus, pertusis, pneumococcus meningitis, toxoplasma, mycobacterium (BCG)

Unit 5: Vaccine for protozoa and parasite: 8 Hours

Malaria, Leishmaniasis, Enamoeba histolitica, schistosomiasis and other helminthic infections.

Unit 6: Reverse vaccinology and immunoinformatics: 8 Hours

Databases in Immunology, B-cell epitope prediction methods, T-cell epitope prediction methods, Resources to study antibodies, antigen-antibody interactions, Structure Activity Relationship – QSARs and QSPRs, QSAR Methodology, Various Descriptors used in QSARs: Electronics; Topology; Quantum Chemical based Descriptors. Use of Genetic Algorithms, Neural Networks and Principle Components Analysis in the QSAR equations

Suggested Readings:

1. Plotkin, S. A., Orenstein, W. A., and Offit, P. A., Vaccines. 5th Editon, Elsevier, 2008.
2. Immunopotentiators in Modern Vaccines by Schijns and O'Hagen
3. Robinson, A., Hudson, M.J., Cranage, M.P. Vaccine Protocols, C Second Edition, Humana Press, NY, 2003.
4. Chimeric Virus like Particles as Vaccines. Wolfram H. Gerlich (Editor), Detlev H. Krueger (Editor), Rainer Ulrich (Editor), November 1996 Publisher: Karger, S. Inc
5. Kindt, Kuby-Immunology (complements)
6. Current protocols in Immunology
7. Complement regulators and inhibitory proteins. Nat immunology Review volume 9, Oct 2009, 729-40

L	T	P	C
3	-	-	3

Course Code	**3SBT3E1**
Course Title	**Genomics and Proteomics**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Describe the understanding of origin and evolution of genomics and gene mapping.
2. Apply the knowledge to establish new, molecular classification of the disease.
3. Evaluate the possibilities for application of pharmacogenomics and proteomics in drug discovery and development of personalized medicine.

Syllabus: Teaching Hours: 45hrs

Unit-1 Origin and Evolution of genomics and gene mapping 8 Hours

Origin of genomics, the first DNA genomes, genomes and human evolution, evolution of nuclear, mitochondrial and chloroplast genome, the concept of minimal genome and possibility of synthesizing it, genetic maps, physical maps, functional maps, comparative genomics and collinearity, synteny in maps.

Unit-2 Whole Genome sequencing technologies and genome assembly 8Hours

Principle of genome sequencing tools, automated Sanger sequencing, pyrosequencing, Illumina. oxford nanopore and PacBio Sequencing. Whole genome assembly pipeline. k- mer de bruijin graph. Human, Arabidopsis and Drosophila genome

Unit-3 Functional genomics 6 Hours

Concept of forward and reverse genetics, insertion mutagenesis (T-DNA and transport insertion), Targeting Induced Local Lesions in Genomes (TILLING), gene expression and transcript profiling, EST contigs, use of DNA chips and microarrays

Unit-4 Principle of basic protein preparation and separation 8 Hours

Preparation of protein isolates and fractionation /separation of proteins and peptides - basic methods of protein isolation from various sample types; electrophoretic separation techniques (IEF, SDS-PAGE, 2-D gel electrophoresis, DIGE, etc.); liquid chromatography (HPLC and FPLC); separation procedures for analysis of phospho-proteins and glycosylated proteins: multidimensional procedures for analysis of complex protein samples.

Unit-5 Strategies for protein identification 8 Hours

Mass-spectrometry of proteins - basic types of ionization techniques (ESI and MALDI) and hybrid instruments (TOF, ion trap and FTMS); protein identification methods; characterization of protein modifications. methods of protein quantification (relative and absolute quantification techniques)

Unit-6 Protein interactomes and protein modification in Proteomics and application 7 Hours

Methods of protein-protein interaction study (Y2H, tagging TAP, FLAG, His; ion mobility utilization); Phosphoproteomics, Glycoproteomics, protein microarray. Human proteome project. application of proteomics in diagnostic, drug development and agriculture.

Suggested Readings:

1.Pevsner, J., Bioinformatics and Functional Genomics, Second Edition, Wiley-Blackwell, 2009.
2.Mount, D. W., Bioinformatics: Sequence and Genome Analysis, CBS Publishers, 2004
3.Liebler, D., Introduction to Proteomics: Tools for New Biology, Human Press Totowa, 2002.
4.Campbell, A.M. & Heyer, L.J., Discovering Genomics, Proteomics and Bioinformatics. Benjamin/Cummings, 2002.
5. Twyman, R. Principles of Proteomics. London: Taylor & Francis, 2014.
6. Lovric J. Introducing Proteomics: From Concepts to Sample Separation. Mass Spectrometry and Data Analysis, published by Wiley, 2011

L	T	P	C
3	-	-	3

Course Code	**3SBC304**
Course Title	**Cancer Biology**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Describe and appraise the fundamentals of cellular processes involving molecular genetic basis of multistep process of carcinogenesis
2. Illustrate mechanisms of physical, biological, and chemical cancer causing agents as well as spontaneous cancer onset in terms of role of oncogenes and tumour suppressor genes, deregulation of cell cycle and differentiation in cancer cells
3. Articulate host-environment interactions including susceptibility factors in cancer predisposition; cancer classification systems; principles of cancer diagnosis, prognosis, and response to therapy and management in the laboratory
4. Demonstrate understanding of cancer control for disease-free, relapse-free, and metastasis-free longer survival using knowledge of molecular players and factors governing cancer spread from primary sites, metastasis cascade, and invasion.

Syllabus: **Teaching hours**: **45 Hours**

Unit 1: Introduction to Cancer Biology: 8 Hours

History of cancer and various theories of carcinogenesis, Warning signs of cancer; Hallmarks of cancer; Types of cancer; cancer classification systems: TNM, FAB, WHO; Cancer staging and Grading; Global Trends in cancer incidence and death rate; Baseline and environmentally induced cancer rate

Unit 2: Molecular Cell Biology of Cancer: 8 Hours

Proto-oncogenes and Oncogenes, Mechanisms of inactivation of proto-oncogenes and affected cellular pathways; modulation of growth factors, receptors, signal transduction, and cell cycle; Retroviruses and Oncogenes; Tumour suppressor genes, two-hit theory, Identification and detection of oncogenes and tumor suppressor genes, mi-RNA and other regulators of cellular pathways and cancer

Unit 3: Cancer Genetics, Cytogenetics and Genomics: 8 Hours

Constitutional and Acquired Genetic Determinants of Cancer; Genetic Predisposition to Cancer; Familial Cancers; Molecular pathogenesis of acquired chromosomal aberrations, fusion genes, gene amplification, whole genome, various approaches for detection of genetic changes and targeted therapy with examples of clinical importance

Unit 4: Principles of Carcinogenesis: 8 Hours

Physical, Chemical and Biological Carcinogenesis, Genotoxic and non-genotoxic Metabolism and Targets of Carcinogenesis, Molecular mechanism of Carcinogenesis. Cancer risk factors and differential susceptibility, Cancer metabolism

Unit 5: Cancer Metastasis: 8 Hours

Metastatic cascade; Basement Membrane disruption; Three-step theory of Invasion; Heterogeneity of metastatic phenotype; Epidermal Mesenchymal Transition, Molecular signatures and organ preference in metastasis, Proteinases and invasion

Unit 6: Therapeutic Approaches: 5 Hours

Strategies for cancer treatment; Tumor markers and molecular markers for cancer diagnosis, prognosis, and therapy decisions; Cancer Immunology and therapeutic interventions, Targeted drug delivery and drug delivery systems, Cancer vaccine, Clinical trials, Gene Therapy, Targeted therapy, personalized medicine, survival and response monitoring

Suggested Readings:

1. Weinberg R., Biology of Cancer, Garland Science, June, 2010
2. D. Liebler, Proteomics in cancer research, 2004
3. David M. Terrian, Cancer cell signalling, Methods and protocols, Volum 218 (Methods in Molecular Biology), 2003.
4. Strachan Tom and Read Andrew P. (2010) Human Molecular Genetics, 4th Edition, Garland Science (Taylor and Francis Group), London and New York
5. K.L. Rudolph, Telomeres and Telomerase in ageing, disease, and cancer, 2008.
6. Maly B.W.J., Virology: A practical approach, IRL Press, Oxford, 1987.
7. Dunmock N.J and Primrose, S.B., Introduction to modern Virology, Blackwell Scientific Publications. Oxford, 1988.
8. Knowles, M.A., Selby P., An Introduction to the Cellular and Molecular Biology of Cancer, Oxford Medical publications, 2005.
9. Vincent, T. De Vita, Lawrence T. S., Rosenberg, S. A., Cancer: Principles & Practice of Oncology, 10th Edition, Lippincot, 2011
10. http://atlasgeneticsoncology.org
11. http://cgap.nci.nih.gov/Chromosomes/Mitelman
12. http://www.humanvariomeproject.org
13. https://www.genome.gov/hapmap

Supplementary Course: Dissertation Tutorials

L	T	P	C
1	-	-	1

Course Code	**3SBC3A1**
Course Title	**Neuroendrocrine Regulation of Behavior**

Course Learning Outcomes (CLO)

At the end of the course, students will be able to -

1. To describe the role of various neuro- hormones involed in auditory and optical senses, feeding and emotional behavior
2. To discuss the pathophysiological changes associated with mental and behavioural disorders and debate the role and effect of available psychotic drugs..
3. To identify and relate various behavioural models to study cognitive and motor behaviour.

Syllabus: **Teaching hours**: **15**

Emotion and behaviour - Neuro-anatomy of limbic system; Behavioural control of hormonal secretion, feeding behaviour; drinking behaviour; emotional behaviour, Physiological changes associated with emotion and Integration of emotional behaviour; Physiology in brief of vision and auditory sense; Motivation, addiction and its neurobiology. Behavioural model of fear, anxiety and depression and related psychotic drugs.

Suggested Readings:

1. Purves, D, Augustine, G., Neuroscience, Sinauer, 2000.
2. Tortora, G. J. and Derrickson, B. H., Principles of Anatomy and Physiology, Weily and Sons, 2009
3. Breedlove, M. C., Watson, N. V., Rozenzweig M. R., Biological Psychology: An Introduction to

Behavioural, Cognitive and Clinical Neuroscience. Sinauer Associates, 6th Edition, 2010.
4. Amthor Frank, Neuroscience for dummies. USA John Wiley & Sons Canada Ltd. 2012.
5. Kolb, Bryan; Whishaw, Ian Q. An Introduction to Brain and Behavior, New York Worth Publishers 2011
6. Turkingtons, C., The Brain and Brain Disorders, Viva Books, 2009
7. Kandel, E., Schwartz, J. and Jessell T., Essentials of Neural Science and Behaviour, McGraw-Hill, 2003.

L	T	P	C
1	-	-	1

Course Code	3SBC3A2
Course Title	Endocrinology & Immunology of Pregnancy

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Comprehend the endocrine regulation of pregnancy.
2. Understand roles of specific immune system components during pregnancy.
3. Analyze the effects of imbalanced immune response and prenatal hormones in pregnancy complications.

Syllabus:

Overview of endocrinology (introduction to endocrinology, endocrine glands, hormone biosynthesis), their role in pregnancy (implantation, decidualization, placentation, placental hormones, parturition), hormonal interactions between mother, placenta and fetus. Overview of immunological aspects of pregnancy, roles of uterine immune cells during pregnancy (macrophages, natural killer cells, neutrophils, B cells, regulatory T cells), immunological aspects of decidua, placental regulation of immune cells. Immunological and endocrine imbalance effects during pregnancy leading to poor birth outcome. Flow cytometry (basics and application for diagnosis of pregnancy complications).

L	T	P	C
1	-	-	1

Course Code	3SBC3S1
Course Title	Understanding Gastrointestinal Hormones and Gut Associated Cancer

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand the diversity of G I Tract hormones and gastrointestinal associated cancers
2. Determine the probable targets and causes of hormonal modulation and cancer induction.
3. Analyse and evaluate the molecular mechanism and probable targets as therapeutic approaches

Syllabus:

Introduction to Gut associated cancers and their pathogenesis, Molecular markers identification, Genetic & Epigenetic markers, Mechanism of Induction, Existing therapies, New Trends in cancer therapy, Gut Hormones involved in metabolism and gastric cancer, Role of hormone in cancer, Identification of newer therapeutic targets.

L	T	P	C
1	-	-	1

Course Code	3SBC3S3
Course Title	Pathogenesis of Diabetes

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand the mechanisms of onset of diabetes and differentiating it from obesity.
2. Determine the role of triad i.e., interaction of gut, liver and pancreas in diabetes.
3. Analyse and evaluate the molecular mechanism and probable targets as therapeutic approaches.

Syllabus:

Type I and II Diabetes, Mechanism of induction, Metabolic Disturbances, Drug and Diet Induced Diabetes, Endocrine Disorders, Role of Gut microflora, Role of Liver and Pancreas in diabetes, Identification of Therapeutic strategies.

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Nirma University

L	T	P	C
1	-	-	1

Course Code	3SBC3S4
Course Title	Genotoxicity Testing for Cancer Risk Assessment

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand methods and mechanisms of laboratory tools for biological safety assessment
2. Apply cell culture techniques based cytogenetic and genetic damage assays
3. Appreciate regulatory guidelines and best practices in study of biological effect of environmental factors on genome

Syllabus:

Cell culture techniques for in vitro cytogenetics assays: Chromosome breakage, Cytokinesis blocked micronucleus assay, Comet assay, Sister Chromatid Exchange assay, in vitro metabolic activation systems, Regulatory guidelines and best practices of Genotoxicity studies; National and International regulations for establishing genotoxicity of a substance, application in safety studies of novel drugs, nanoparticles, and other environmental agents and exposed population; OECD, EPA guidelines for scoring and analysis

L	T	P	C
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Course Code	3SBC3S5
Course Title	Applied Human Cytogenetics

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Grasp methods and mechanisms of cell culture methods for karyotyping using various tissues
2. Apply ISCN guidelines for interpretation of genetics analysis
3. Understand normal and abnormal genetic constitution of human at chromosomal level and scope of molecular genetic analysis
4. Appraise genotype-phenotype correlation in various human genetic conditions

Syllabus

In vitro short term culture techniques for metaphase chromosome preparations from blood, bone marrow, and other tissue samples; chromosome banding, karyotyping, ISCN guidelines, Clinical applications in Prenatal Genetic Diagnosis, Pregnancy, Post-Natal, and Cancer; Introduction to molecular cytogenetics; FISH & m-FISH.

L	T	P	C
1	-	-	1

Course Code	3SBT3S2
Course Title	Immunological Memory

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Understand how memory T and B cells are generated following natural infection
2. Evaluate and analyse the immune response to provide long-term protection
3. Manipulate the antigenic exposure to immune system to generate memory T cells
4. Design immunomodulator(s) to induce long-term protection

Syllabus: **Teaching Hours: 15**

Generation of T cell and B cell memory, Requirement for maintenance of memory T cells, Interaction of memory B cells with memory T cells, Role of Innate Immunity in maintenance of memory T cells

L	T	P	C
1	-	-	1

Course Code	3SBT3S3
Course Title	Tumor markers in cancer management

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. To identify and analyse the factors influencing process of carcinogenesis for solid and haematological malignancies
2. To understand the role of various tumor markers for diagnosis, prognosis, selection of treatment modalities and disease monitoring
3. To discuss the treatment strategies that pave the way to personalized medicine.

Syllabus: **Teaching hours: 15**

Molecular pathogenesis of cancer, Historical overview of Tumor markers, Types of tumor markers, Alterations in solid tumors and haematological malignancies, Management of Cancer, Existing treatment modalities, Current and newer therapeutic approaches in cancer and their limitations, Personalized and Precision Medicine

Suggested Reading:

1. Vincent, T. De Vita, Lawrence T. S., Rosenberg, S. A., Cancer: Principle & Practice of Oncology, 10th Edition, Lippincot, 2011.
2. Weinberg R., Biology of Cancer, Gerland Science, June, 2010.

L	T	P	C
1	-	-	1

Course Code	3SBT3K1
Course Title	Immunology of Vaccine Adjuvants

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. To have a clear understanding of antigenicity and immunogenicity.
2. Currently available adjuvants and their mode of action.
3. Adjuvant-free vaccination strategies.

Syllabus

Antigen, Immunogen, methods to enhance immunogenicity of candidate antigens, currently available adjuvants for experimental and clinical use and their mechanism of action, cellular and molecular targets of available adjuvants, adjuvants that induce CD8+ T-cells, tissue-resident memory cells, adjuvants targeting pattern recognition receptors other than toll-like receptors, need for adjuvant free vaccination strategies and systems vaccinology.

L	T	P	C
1	-	-	1

Course Code	3SMB3N1
Course Title	Microbial Community Dynamics And Ecological Succession

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

5. Identify role of microorganisms and microbial community shifts in ecological succession. They will understand aspects of sustainability, resilience and importance of indicator species.
6. Understand various methods for microbial diversity estimations and multivariate statistical tools and to use them.

Syllabus: **Teaching hours: 15**

Principles and concepts of microbial diversity, Ecological diversity, Loss of diversity, Sustainability and Resilience, Indicator Species, Ecological Succession, Methods used for 'Microbial Diversity Analysis', Multivariate statistical tools for Microbial Diversity Analysis using SPSS.

L	T	P	C
1	-	-	1

Course Code	3SMB3V1
Course Title	Antimicrobial Agents

Course Learning outcomes:

At the end of the course, students will be able to-

1. Be familiar with currently available antimicrobial agents, their scope and limitations.
2. Learn evolution of drug-resistance, its molecular basis, and also be familiar with strategies for discovery and development of novel antimicrobials.
3. Understand the need for finding novel drug targets

Syllabus: **Teaching hours: 15**

A concise overview of currently available antimicrobial agents; Drug-resistance among pathogens, and its molecular basis; Strategies for development of novel antimicrobials; challenges involved; Antimicrobial susceptibility tests: Utility, limitations and challenges.

Institute of Science
Nirma University

SEMESTER IV

Core Courses

L	T	P	C
-	-	-	25

Course Code	3SBT402
Course Title	Dissertation

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Develop understanding in the field of scientific research at the academic as well as industrial sector. This will students to identify scientific problems and design proposals to address and implement ideas. This enables them to communicate the same to a greater audience.
2. This will benefit the students to perform well in their job interviews and to design their CV which can evoke interest in the employers to know more about the candidate.

Outline:

The students have to carry out their dissertation work. They have to perform wet lab experimentation on the topic of project assigned to them. The Viva will be conducted as intrim presentation as well as final presentations, where the students have to defend their dissertation work

L	T	P	C
-	-	2	2

Course Code	3SBT407
Course Title	Internship

Outline:

The students will be deputed to industry/academic institutes/laboratories have undertake training to enhance their skills in order to improve their employability in the field of interest. The students will have a guide allocated at the host institute and have to present their progress of training in the form of interim presentation. They will be submitting a comprehensive report as well as well as an final presentation, comprising of the training undertaken by them.

L	T	P	C
-	-	2	2

Course Code	3SBT404
Course Title	Comprehensive Viva Voce

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

1. Develop understanding in the field of scientific research at the academic as well as industrial sector. This will students to identify scientific problems and design proposals to address and implement ideas. This enables them to communicate the same to a greater audience.
2. Shape up their career in the field of research at the academic as well as industrial sector. This will be helpful to students in identifying scientific problems and design proposals to address and implement ideas, enables them to communicate the same to a greater audience.

Outline:

Viva voce will be conducted towards the end of the semester which will be covering the complete syllabus. This will test the student's learning and understanding during the course of their post graduate programme. In doing so, the main objective of this course is to prepare the students to face interview both at the academic and the industrial sector.

Supplementary Courses

L	T	P	C
-	-	1	-

Course Code	3SBT406
Course Title	Interpersonal and Networking Skills

Course Learning Outcomes (CLO):

At the end of the course, students will be able to-

Develop effective network and would be able to positively influence people; will be able to manage stress and failures and will show enhanced interpersonal skills

Syllabus:

Unit 1: Effective Networking and Influencing people: 8 Hour

Networking and its importance. Building and growing a network. Importance of collaboration and cross functional

networking. Use of LinkedIn and other Social media tools to grow networks. Importance of influence, How to positively influence people.

Unit 2: Stress Management and Facing Failures: 8 Hour

Introduction to Stress, Causes of stress and impact of stress. Managing Stress. Factors affecting Failure, Learning from Failures, Overcoming failures

Unit 3: Interpersonal Skills: 8 Hour

Defining Interpersonal relationship, human perceptions, understanding people and types of interpersonal relationships, conflict resolution, Negotiation skills.

Unit 4: Self Study and Group Discussion 6 Hour

Undertakings

NIRMA UNIVERSITY
INSTITUTE OF SCIENCE
NAAC ACCREDITED 'A' GRADE

(For Office use only)

ROLL NO ____

Details of Degree	Year of Passing	Result (%)	Board / Uni.	State
S.S.C				
H.S.C				
GRADUATION				
P.G				

1. Write your Name & Branch on back-side of photo
2. Paste your recent Passport size photograph.
3. Do not use Pin, Clips, Stapler

(1) FULL NAME OF THE APPLICANT (in Block Letters) (As per last Mark sheet)

Surname

Name

Father's Name

(2) Name of Course to which admitted

(3) Sex Male ☐ Female ☐

(4) Applicant's Full Address **(Present)**

Pin code

(Permanent)

Pin code

Tel. No. (O) _____

(R) _____

(M) _____

Fax No. _____

Tel. No. (O) _____

(R) _____

(M) _____

Fax No. _____

(5) E-mail Id of Student :- _____

(6) Date of Birth

Date	Month	Year

Birth Place

(7) Religion _____ Caste _____

Whether belongs to | SC | ST | NT | DNT | SEBC | OPEN |

(8) Information of Applicant's Father / Guardian

(A) Relation with Applicant _____ (B) Occupation _____

(C) Designation _____ (D) Yearly Income _____

(E) Name & Address with Tel. No.

(Resident)

Pin code | | | | | | |

Tel. No. (O) _____

(R) _____

(M)_____

Fax No. _____

(Organization)

Pin code | | | | | | |

Tel. No. (O) _____

(R) _____

(M)_____

Fax No. _____

(9) I hereby declare that,

(i) The information given by me in my application is true to the best of my knowledge and belief.

(ii) I shall abide by all rules and regulation prescribed by Institute of Technology currently in force and as amended from time to time.

(10) Place :- Ahmedabad

Date :- _____

_____ Signature of Parent / Guardian

_____ Signature of the Applicant

PERSONAL DATA

(1) Medium of instruction at H.S.C. Education — **ENGLISH** | **GUJARATI**

(2) The games / sports of your interest — Foot Ball | Vollev Ball | Cricket | Hockev | Basket Ball | Badminton | Athletics | Chess | Caroms | Bridge | Draft

(3) Hobbies — Music | Drama | Dance | Painting | Reading | Any Other

(4) Level of exposure in Computer

(a) In Software Packages (known) _____

(b) Computer Languages (known) (1)_____(2)_____(3)_____(4)_____

(5) Blood Group :- _____ (6) Willing to donate blood ? **YES** NO

NIRMA UNIVERSITY

INSTITUTE OF SCIENCE

NAAC ACCREDITED 'A+' GRADE

UNDERTAKING

I, Mr./Ms. _____ son/daughter of _____ have secured admission in the M.Sc. Programme at the Institute of Science, Nirma University in the year 2022-23. We hereby confirm that we have gone through the academic rules and regulations of the Institute very carefully and we assure you that we will abide by the same.

_____

Name & signature of student

_____

Name & signature of parent/guardian

Date:- _____

Place:_____

NIRMA UNIVERSITY

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CONDUCT AND DISCIPLINE RULES FOR THE STUDENTS

1. Every student must carry his / her identity card which should be produced when demanded.
2. It is mandatory for the students to attend the classes, prayer sessions etc. on all working days from the start to the end of the term/semester. Absence due to illness or unavoidable circumstances shall be considered only if application is supported with medical certificates and/or leave application from the parents is submitted to the Director.
3. Students are expected to be polite individually or in groups and show respect to the Faculty (teachers) as well as to the staff of the Institute. Instructions in connection with academic or other matters as may be given by the teachers from time to time must be followed scrupulously by the students. Students must not participate in activities that may cause harm to the academic environment or which harm the teacher-student relation.
4. The action of any individual, group or wing which amounts to interference in the regular administration of the college is prohibited. Disciplinary action will be taken against such students.
5. Causing disfiguration or damage to the property of the Institute or belongings of staff members or students is forbidden. In case of any such damage, the same will be recovered from the students, the parents or the guardians.
6. No student shall indulge in any activity in the college campus that might be illegal or may lead to disorderliness.
7. Neither student should be in possession of any intoxicant or intoxicating materials nor consume such things. If anyone is found to have violated this instruction, the admission of such student will be cancelled.

Whenever any student is found to be guilty or violating the instructions specified above or other specific instructions issued by the center or the institute, he / she will be liable to disciplinary actions such as fine, suspension or rustication as may be imposed by the Director. The disciplinary action taken by the Director in this regard shall be final and binding.

I have read above conduct and discipline rules and I shall abide by these rules.

Name of the Student _____

Roll No. _____ Signature of Student _____

Date : _____Signature of Parent/Guardian_____

NIRMA UNIVERSITY
INSTITUTE OF SCIENCE
NAAC ACCREDITED 'A+' GRADE

Institute of Science
Nirma University

UNDERTAKING

I, _____, Roll No. _____, studying Semester 1st of M. Sc. Degree course at Institute of Science in Nirma University, Ahmedabad give an undertaking that I have read and understood all the Rules & Regulations of the Examination at the Institute particularly the R. SCIENCE (PG) 12 and R. SCIENCE (PG) 17 as mentioned below and I shall observe, follow and abide these rules. If not, the Institute can take necessary action as per the said Provisions.

R. SCIENCE (PG) 12. GRANTING OF TERM

12.1 The Term will be granted course-wise.

12.2 The granting of Term for all the students (IR, RS) will depend on the compliance of the following condition

(i) Maintaining minimum 85 % attendance in all components of the course (as applicable). Regular approval for remaining absent up to 15 % is necessary.

(ii) Obtaining passing grades in LPW (as applicable)

(iii) Obtaining at least a conditional pass grade in CE (R 13.1) OR, if the limit of two Gracing given in (R.15.2) is exhausted in the case of a student, condition (iii) in his case will be as follows:

Obtaining passing grade in CE

The granting of Term will be categorized as under:

Category GT - Term granted – When all the three conditions are satisfied.

Category NT - Term not granted – When first condition is not satisfied.

Note: In the case of long duration training or project work, where final examination is not possible before the Term ends, a certificate by the course coordinator that the student's progress is satisfactory will be acceptable.

12.3 The student who has been given category NT may appeal to the Appeal Committee giving full reasons for his default. The decision of the Committee in all such cases will be final.

12.4 The student who is given NT category will not be permitted to appear in SEE of the concerned course. He will also be given grade FF in that course.
The student who fails in CE and or LPW will not be permitted to appear in SEE of the concerned course.

R. SCIENCE (PG) 17. CANCELLATION OF ADMISSION

The admission of following categories of students is liable to be cancelled:

17.1

(i) Failure to earn credits for all courses of Semester-I within two years of admission to the programme.

(ii) Failure to earn credits for all courses of Semester-II within two and a half years of admission to the programme.

(iii) Failure to earn requisite credits and CPI minimum 6.00 to pass the programme within three years of admission to the programme.

The student, whose admission is so cancelled, can appeal to the Appeal Committee. The Committee may grant an extension upto the one additional semester for cases falling under 17.1 (i), (ii) or (iii) for clearing the courses in deserving cases, provided the student gives a Viable assurance to make up the shortfall within that period.

"Notwithstanding anything contained above, the president may consider the cases of such students falling under category (i), (ii) and (iii), if the student has cleared all the courses and have earned the requisite number of credits except one course, on an appeal filed. The president will consider such appeal on the recommendation of the appeal committee prescribed under the regulation for the purpose and after considering the genuineness of the case may give one additional attempt to the student concerned to clear the remaining courses."

17.2 The student who satisfies R. 17.1 (i) and (ii) but is unable to satisfy R. 17.1 (iii) only because of delay in completing the Thesis work may apply, giving full reasons, to the HOD for an extension to submit his thesis. The HOD may recommend to the Appeal Committee to grant an extension of up to two years in addition to the limit specified R. 17.1 (iii). The decision of the Appeal Committee in the case will be final.

17.3 If a student avails of the benefit of 17.2 and he passes the Programme, his grade for passing the Programme will be pegged at C+ and CPI at 6.0.

Thanking you,
Yours Faithfully,

_____
Signature of student

Name of the student: _____

Address: _____

_____

Signature of the Parents:_____

NIRMA UNIVERSITY
INSTITUTE OF SCIENCE
NAAC ACCREDITED 'A+' GRADE

Declaration to be submitted by the Students admitted to different programmes of the University

DECLARATION

I, _____, admitted in _____ of the Institute of Science, Nirma University, Ahmedabad hereby declare and undertake that I will abide by the Disciplinary Rules of the University prescribed under Regulations which I have already gone through, failing which I know I am subjected to the Major/ Minor Penalties as the case may be.

_____

Date: _____ Signature of the Student

Place: _____

Name: _____

Address: _____

_____

_____

Name & Signature of the Parents/ Local Guardian:

NIRMA UNIVERSITY
INSTITUTE OF SCIENCE
NAAC ACCREDITED 'A+' GRADE

Undertaking for not involving himself/herself for Ragging

I,_____,admitted in _____ of the Institute of Science, Nirma University, Ahmedabad in the year 2022-23 hereby declare and undertake that I am aware of the University's approach towards Ragging and the punishment to which, I shall be liable, if found guilty of ragging.

_____

Date: _____ Signature of the Student

Place: _____

Name: _____

Address: _____

_____

_____

Name & Signature of the Parents/ Local Guardian:

Nirma University, Ahmedabad
Institute of Science
Application form for the Alumni Membership

Two latest stamp size photographs

1. Name _____

2. Contact Address _____

_____

_____

3. Telephone (Off) _____

(Res) _____

Mobile _____

4. Email _____

5. Institution/Organization serving in _____

_____

6. Alumni Association Membership Number: _____

I hereby certify the above person is a member of our alumni association

Signature with Date
(President /Secretary, Alumni Association)

I am aware of and undertake to abide by the rules for Alumni Membership. Enclosed is a Demand Draft / Cheque_____ dated_____for Rs_____ drawn in favour of the Institute of _____.

Date
Place

Signature

_____

For Official Use only

The Annual Membership is granted for the period from_____ to_____

Librarian

NIRMA UNIVERSITY
INSTITUTE OF SCIENCE
NAAC ACCREDITED 'A+' GRADE

UNDERTAKING

I _____ S/o./ D/o: _____am a regular student of the programme_____ (Roll No_____) admitted in the year _____, do hereby undertake the following;

1. That I hereby declare that on my own will & wish I participate all the educational outdoor visit as part of the curriculum of various courses.
2. That I will be traveling and undertaking the Educational Tours at my own risk & responsibility and in case of any accident / mishap I will not hold the Institute/University responsible for the consequences.
3. That I would sought permission of my parent / guardian for going for the tours.
4. That while on tour I will fully cooperate with faculty incharge and abide by instruction given.
5. That I will strictly follow the guidance / rules / regulations whatever Institute/University has framed for the successful conduct of the tours.
6. That I will not include/involve myself in any misbehaviour act amounting to indiscipline while I am on the tours.

Signature of the Student

Undertaking from the Parent / Guardian

I_____Father/Mother/Guardian of Mr./Ms._____ who is student of _____Institute of Science, Nirma University hereby declares the following in respect of my ward.

1. I permit my child / ward named above to go on the Educational Tours/Visit as per Academic requirements of the programme.
2. That my child / ward shall abide by the rules and regulations of Institute/University during the tour/visit.

Dated:_____

Counter Sign of the Parent/ Guardian

Mobile No. of Parent/Guardian_____

----------For Office Purpose only----------

Verified by Student Section_____

Dated: - _____Signature _____

NIRMA UNIVERSITY

FORM OF MEDICAL FITNESS CERTIFICATE
(To be produced at the time of reporting at the institute)

I / Dr._____ (Name & Designation) posted in _____(Name of Hospital & Place) certify that I have carefully examined _____(Name of Candidate) S/o. D/o. Shri_____whose photograph attested by me is affixed-here with. As a result of his/her medical examination, I have diagnosed nothing that may prevent him/her pursuing under graduate/post graduate degree courses.
I have to further report that;

He/She has no disease or mental or bodily infirmity making him/her unfit or likely to make him/her unfit in the near future for visits / training / internships / projects etc. at industries, and active outdoor duty, as professional.

Mark of identification:_____

Hence the candidate is fit for admission to professional course.

Signature of Candidate

Signature of Medical Officer

Seal of Designation and Hospital

Dated:

Photograph of candidate duly attested by the Medical Officer

NIRMA UNIVERSITY
INSTITUTE OF SCIENCE
NAAC ACCREDITED 'A+' GRADE

UNDERTAKING
[To refrain from consumption of Drug and Alcohol]

I; _____, bearing Roll No. _____ admitted in _____ of Institute of Scence, Nirma University, do hereby declare and undertake that I will refrain myself from consumption of Drug and Alcohol.

I have read the relevant instruction against the use of drugs & alcohol. I know that the use/possession of narcotics drugs and Alcohol is a punishable offence under the law of the Government of Gujarat and if I am found guilty of using such thing, then it will amount to a criminal offence and I am liable for the appropriate penalty as per laws. I hereby give an undertaking to the Institute that I will refrain myself from consumption of Drug and Alcohol.

Date: _____ _____
Signature of student

Place: _____

Name of Parent/Guardian: _____

I undertake that I will take utmost care to see that my ward does not get involved in any such incident.

Signature of Parent/Guardian: _____

Address of Parent/Guardian with contact nos.:

_____

_____

Academic Calender

Institute of Science
Nirma University

Academic Calendar for Year 2022-23 (Odd Term)
M.Sc. Biotechnology/Biochemistry/Microbiology, Semester I

Semester Commencement	**18/07/2022**
Orientation	**18/07/2022 to 22/07/2022**
Teaching Phase I (09 Weeks)	**25/07/2022 to 17/09/2022**
Attendance & Academic Review I	17/09/2022
Teaching Phase –II (09 Weeks)	**19/09/2022 to 03/12/2022**
Final Attendance & Academic Review II	03/12/2022
Semester Ends	**03/12/2022**
Semester End Examinations (IR)	**08/12/2022 to 17/12/2022**

Semester II starts on 19/12/2022

Diwali Vacation 17/10/2022 to 30/10/2022

Holidays
Muharram 9/08/22
Rakshabandhan 11/08/22
Independence Day 15/08/22
Janamashtami 19/08/22
Samvatsari 31/08/22
Guru Nanak Jayanti 08/11/22

Other Important days
Renaissance Sep.2022
Institute Foundation Day 06/09/22
Ramzat Oct, 2022
Annual Sports Day Oct, 2022

Prof. Sarat Dalai
Director