Preamble

The Handbook for Students contains information about Institute of Science (IS), Nirma University (NU).

It also contains a summary of the Rules and Regulations regarding academic requirements, and academic and personal conduct of the students at the University.

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

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. Sonal Bakshi
Assistant Professor

Prof. Sarat K. Dalai
Director

Institute of Science
Nirma University
Sarkhej Gandhinagar Highway
Ahmedabad

NIRMA UNIVERSITY
INSTITUTE OF SCIENCE
NAAC ACCREDITED 'A' GRADE

Volume-I
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Sr. No. **Contents**

Volume-II

Our Motto

तमसो मा ज्योतिर्गमय

From Darkness, lead me to light

A. Vision & Mission:

Vision

Shaping a better future for mankind by developing effective and socially responsible individuals and organizations.

Mission

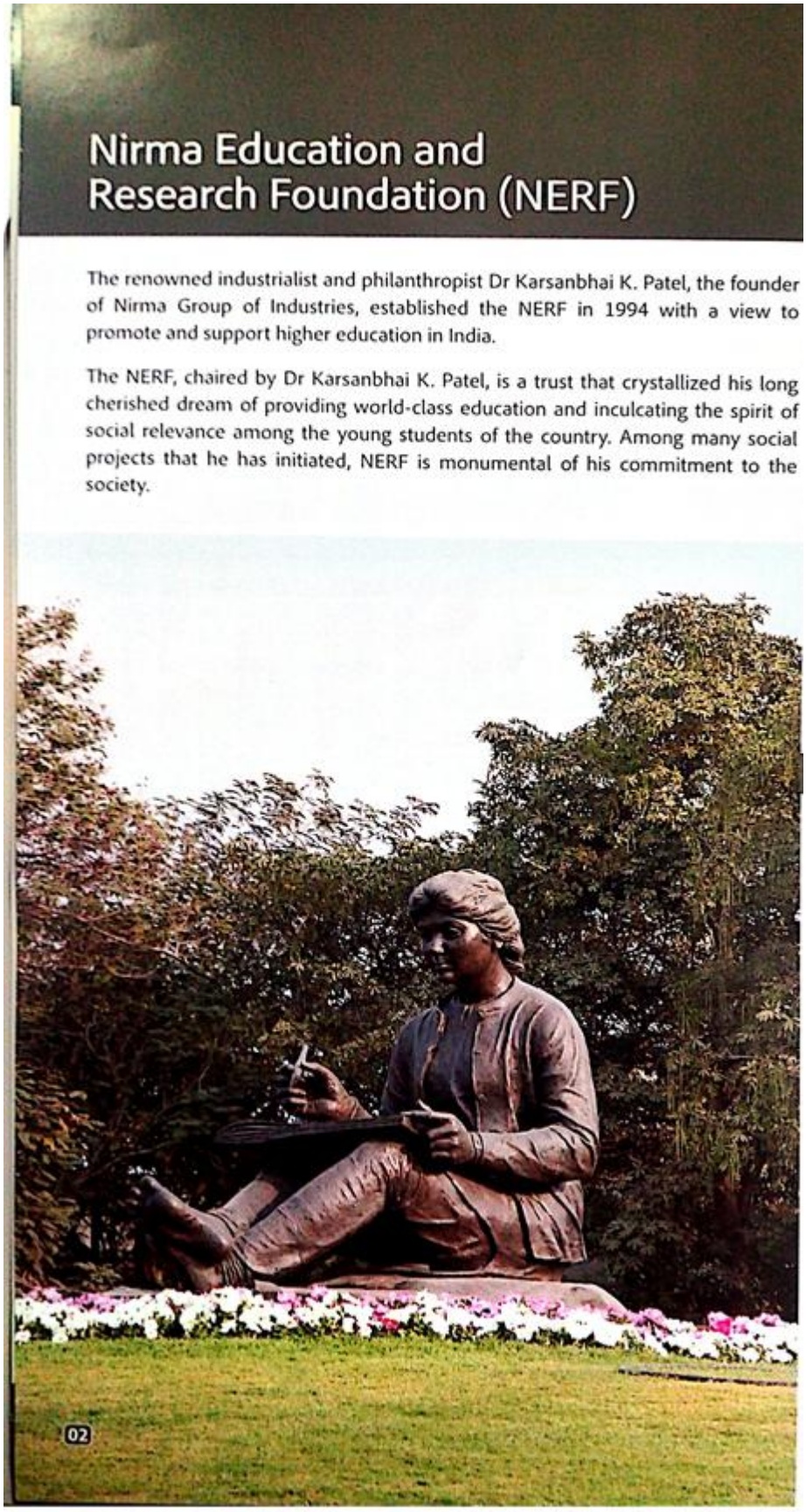
Nirma University emphasizes on the all-round development of its students. It aims at producing not only good professionals but also good and worthy citizens of a great country, aiding in its overall progress and development.

It endeavors to treat every student as an individual, to recognize their potential and to ensure that they receive the best preparation and training for achieving their career ambitions and life goals.

Quality statement

To develop high quality professionals who reflect and demonstrate values that the university stands for, through innovation and continuous improvement in facilitation of learning, research and extension activities

B. A brief about NERF:



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C. NIRMA UNIVERSITY

Dr Karsanbhai K. Patel **Chairman, Nirma Limited,** **Chairman, Nirma Education and Research Foundation,** **President, Nirma University**	
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Shri Kamalbhai Trivedi Advocate General Gujarat High Court, Ahmedabad	**Dr Pankajbhai Patel** Chairman and Managing Director Zydus Cadila Health Care, Ahmedabad

Shri Vipinbhai S. Parikh Advocate	**Prof Purvi Pokhariyal** Dean, Faculty of Law, Nirma University
Dr. Manjunath Ghate Dean, Faculty of Pharmacy, Nirma University	**G. Ramachandran Nair** Executive Registrar (Secretary) Nirma University

Nirma University was established by the initiative of the NERF. The University was established in the year 2003 as a statutory university under a special act passed by the Gujarat State Legislative Assembly. It is recognized by the University Grants Commission (UGC) under Section 2 (f) of the UGC Act. The University is duly accredited by National Assessment and Accreditation Council (NAAC) with 'A' grade. The University is a member of Association of Indian Universities (AIU) and the Association of Commonwealth Universities (ACU).

Functioning under the aegis of **NERF**, the University consists of Faculty of Technology and Engineering, Faculty of Management, Faculty of Pharmacy, Faculty of Science, Faculty of Law, Faculty of Architecture & planning, Faculty of design, Faculty of Commerce and **Faculty of Doctoral Studies and Research**.

The University is identified with cutting edge research, robust academic programs, quality teaching- learning process and over-all personality development interventions of its students. The 115 acres sprawling state of art campus provides refreshing environment and stimulates intellectual growth and creativity.

The University has been awarded under the category of 'Excellence in Technology for Education Delivery' during the FICCI Education Awards 2015, as a part of the Eleventh FICCI Higher Education Summit 2015 held during November 3-4, 2015 organized by FICCI in association with the Ministry of Human Resource Development, Government of India.

In addition to above the University has also been accorded recognition as Scientific and Industrial Research Organization by the Department of Scientific and Industrial Research, Department of Science and Technology, Government of India since 2014.

CONSTITUENT INSTITUTES

The eight constituent institutes being run under the faculties are: **Institute of Technology**, **Institute of Management**, **Institute of Pharmacy**, **Institute of Science**, **Institute of Law, Institute of Architecture & Planning, Institute of Commerce and Department of Design.** The under-graduate, post-graduate and doctoral level programs offered by these institutes are rated highly by accreditation agencies, industry, business magazines and students.

INSTITUTE OF TECHNOLOGY

Presently offers different under-graduate, post-graduate and PhD programs in various branches of engineering in addition to MCA program.

The Institute is renowned for imparting quality education, active research and also in nurturing the students for holistic development, accomplished through Students' Engagement Tools like Continuous Evaluation, Outcome Based Education, Blended Learning, Active use of MOOCs, Departmental and Institute Electives, Industrial Visits, Industrial Projects, Expert Lectures, Soft Skills Development, Critical Thinking Training, Yoga Classes and many more.

INSTITUTE OF MANAGEMENT offers Five Year Integrated BBA-MBA program, two year residential MBA Program, MBA in Family Business and Entrepreneurship, and Doctoral Program in Management besides Executive Diploma Program, In-house Training Programs, Management Development Programs and Consulting Services.

INSTITUTE OF PHARMACY offers undergraduate and postgraduate programs in addition to doctoral program in various branches of Pharmaceutical Sciences. It has been established with a view to prepare young men and women to meet the challenges in the area of pharmaceutical industries, education, research and development and marketing.

Innovation, excellence and quality are the driving forces in the campus and the Institute has made its mark in the field of pharmacy education in a short period of time.

INSTITUTE OF SCIENCE was established with the intent of providing quality education to post-graduate students whose career objectives go beyond academics. The Institute currently offers Master of Science in Biochemistry, Biotechnology and Microbiology and provides broad training encompassing science and ethics to students enabling them to explore wide career opportunities. The Alumni are well placed in reputed Bio-pharma companies and academics.

A balanced mix of academicians and professionals with rich academic and research experience contributes to the Institute's academic excellence.

INSTITUTE OF LAW offers B.A./B.Com. - LL.B. (Hons.) Five year integrated programs, one year LL.M. program in different areas and Doctoral Program in law.

The Institute is committed to exploring multidisciplinary approaches through its unique curriculum and revolutionizing legal education through modern pedagogies thereby adapting to the changing world in which law professionals operate.

The Institute focuses on developing knowledge, skills and values amongst the students and they are nourished by the critical learning pedagogy and mentored and supported by the faculty and the staff so that they have the best experience possible to be successful in life.

INSTITUTE OF ARCHITECTURE & PLANNING offers five year graduate program in Architecture and four year graduate program in planning, doctoral program in Architecture, Planning and Design. The Institute has commenced its pioneer session from 2014 for B.Arch. The Institute aims to establish itself as one of the leading architecture & planning institutes of the country in line with the existing institutes of the University. It will be making all the efforts to develop national and international alliances with reputed institutions. This would provide platform to the students to have global exposure through updated architecture and planning pedagogy.

DEPARTMENT OF DESIGN offers four year graduate program in Industrial Design and Communication Design. The institute commenced in 2017 with a vision of the management, to build a holistic campus of varied disciplines. The mandate was to expand the innovative science and logic-based disciplines to include creative, disruptive and non-linear thinking disciplines. Being the youngest department on the University campus, our vision is to offer inter-disciplinary orientation that is necessary for today's industry demands.

INSTITUTE OF COMMERCE Offers B.Com (Hon.) three year under graduate program in commerce. The Institute of Commerce believes in serious academic pursuit by means of prudent mix of relevance and rigor in its curriculum design and delivery with regard to national and internationally relevant skills, knowledge and ideas through intellectually stimulating debates & discussions, innovative teaching pedagogies and exposure to relevant industry practice at all levels. The Institute is dedicated towards its goal of adding value to life and professional standards.

FACULTY OF DOCTORAL STUDIES AND RESEARCH

Nirma University started the Doctoral Program in the year 2003 with the aim to provide ample opportunities to the faculty and the students to hone their research skills, to actively participate in international and national research work and to patent the pioneering research.

The Faculty of Doctoral Studies and Research is the coordinating faculty for the PhD programs run by the constituent institutes of the University which offer Full-time and External PhD programs. The PhD programs are offered by the Institute of Technology, Institute of Management, Institute of Pharmacy, Institute of Science, Institute of Law and Institute of Architecture & Planning.

CENTRE FOR CONTINUING EDUCATION (CCE)

CCE has been setup with the objective to provide continuing education and training through various programs designed for the constituent institutes of the University and also for the working professionals in the industry. CCE program cater to a variety of needs of Industry,

Business and the Community and includes skill training or upgrading of skills and knowledge through competence based education.

The short and long duration programs organized by CCE comprise workshops, lectures, seminars, competency based skill development programs, vocational training etc.

CCE also aims to promote Industry-Institute Interaction and social amelioration through various activities for schools and villages in the vicinity of the University.

D. 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 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 and to develop novel technologies required for addressing the imposing problems of good health, food demand, and clean environment. Degree programs 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. programs have been developed to make you ready for the academic research and industry.

You will be guided by structured lectures, relevant laboratory practicals, self-directed and computer-assisted learning, review of literature, 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 yours 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 the period of two semesters. Active involvement of research scholars in 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 funding agencies of Govt. of India and Govt. of Gujarat in addition to NERF (Nirma Education and Research

Foundation), in form of research and infrastructure grants to address challenging biological problems, has catapulted our efforts to impart quality training to our students. As we have succeeded in imparting good 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 programs 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 of 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.

Prof. Sarat K. Dalai

Director , Institute of Science

E. ABOUT THE INSTITUTE

Established in 2004, Institute of Science although a new entity as compared to other institutes under the University, has grown in leaps & bounds in the last 16 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 and the Alumni are well placed in companies like Reliance Life Science, TCS Life sciences, Ranbaxy Ltd, Quintais, India, Lupin Pharmaceuticals, Pune, Intas Biopharmaceuticals and Zydus Cadila etc and in research Institutions pursuing their Ph. D. like NIPER, Chandigarh, JNCASR, Bangalore, TIFR, Bangalore, CCMB, Hyderabad, IISER, Bhopal, Institute of Science, Hyderabad, Texas A & M University, USA, Griffin University, Australia, Laval University, Quebec, Canada, Drexel University etc.

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.

F. 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 of a Sophisticated Instrumentation Facility which includes instruments like thermal cycler, gradient PCR, qPCR, HPLC, spectrofluorimeter, Denaturing gradient gel electrophoresis, BiologTM, Hybridization Oven, ELISA Reader, Gel Documentation system, Ultra sonicator, bath Sonicator, -80^{o}C and -20^{o}C freezers, CO_2 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 fermenter. 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, International Journal of Environmental Research, International Journal of Toxicology, Environmental International, Reproductive Toxicology, American Journal of Infectious Diseases, Expert Reviews and Asian Journal of Experimental Sciences to name a few.

EDUCATION PROGRAMS

♦ ***Master's Program***	♦ ***Doctor of Philosophy (Ph. D.)***
1. Biochemistry	1. Biochemistry
2. Biotechnology	2. Biotechnology
3. Microbiology	3. Microbiology

COURSE & ASSESSMENT

Nirma University has provided for a credit based assignment system. It is devised to motivate students for systematic and continuous study. Term assignments, laboratory and project work are given great importance and are continuously assessed. The system of continuous evaluation is followed in addition to Semester End Examination for theory subjects.

The institute has also initiated a number of measures to bring the curriculum and assessment system of these programs in 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. Summer internship is compulsory after Semester II. Projects are also undertaken in final semesters.

G. INFRASTRUCTURE

The Campus

The institute is situated on the Nirma University campus about 15 km from Ahmedabad city, on the Sarkhej-Gandhinagar Highway. It is spread over a 115 acre sprawling campus in picturesque surroundings providing a refreshing environment, stimulating intellectual alertness and creativity. The campus has facilities of canteen, bank, Student Store and gymnasium. The campus provides an ambience that motivates students to grow.

Classrooms & Laboratories

The Institute of Science has spacious classrooms which are well-equipped with modern furniture 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 6 Research laboratories, a central instrumentation facility, plant growth area, 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 fiber optic cables and 12 MBPS dedicated optic fiber leased line and wi-fi hotspots which enable round the clock internet connectivity. 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 Centre

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 the collection, development and dissemination of scientific and technical information to meet the present and future academic and research needs of varied users.

The library at Institute of Science houses more than 2551 volumes of books meticulously chosen for reading and reference in addition to 104 CDs, 384 Bound Volumes, 360 M.Sc. Dissertations and 60 PhD Theses. The Institute library has a subscription of 15 journals comprising print journals (6) and online journals (9) including Science Direct (8), Nature Weekly from Nature Publishing Group (1).

The Library and Resource Centre 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 Catalogue (OPAC) is also available on the internet for inquiring about the status of the resources. Bar-coding system is in use to computerize the bibliographic details of the resources.

The Library Resource Centre offers the following services:

- References
- Circulation
- Computerized Information Search
- Current Awareness Services

- New Arrival List of Books
- New Arrival List of Periodicals
- Content and Summary of selective newly arrived books
- Newspaper Clippings
- Selective Dissemination of Information (SDI)
- Reprography
- Inter-Library Loan (ILL)
- User Education Programmes
- Information Literacy
- Library Orientation

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

Medicinal Plants Garden

A medicinal plants garden covering a total area of 2000 sq. meters has been developed at the university campus. More than 150 Genus of various medicinal plants have already been planted. The plants grown in this garden are useful for tissue culture experiments.

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, mock interviews and workshops are organized by the placement cell for the students to prepare them for the campus interviews.

Industrial Collaborative Programs

Intas Pharmaceuticals Ltd. has signed a MoU with the University for Development of excellent clinical research Centre 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; B.V. Patel Pharmaceutical Research Centre, Ahmedabad; Forensic Science Laboratory, Gandhinagar; Dr. Reddy's Institute of Life Science, Hyderabad; JNU, Delhi; SGPGI, NIREH, Bhopal; etc.

Industries 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 and the faculty of the institute.
2. To foster activities to bring out creativity, promote the study and discussion talents of the students.
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 vacations to 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 Day and 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.

H. AMENITIES

Students Store

Students store is run on no profit and no loss basis and provides all the necessary materials like books, stationary, instruments etc. to students.

Bank and ATMs

A branch of the Kalupur Commercial Co-operative Bank Limited (KCCBL), a scheduled bank is located on the University campus in K block. The banking hours are from 9:30 am to 4:30 pm. The facility is open to all students, staff and faculty of Nirma University and its Institutes.
The bank has set up two ATMs in the campus, one in the K block and the other in the Food Court, near Institute of Law, Nirma University

Hostel

The Institute has separate hostel facilities for boys and girls. Both the hostels are located on the campus. The hostel rooms are spacious and well furnished. The hostels have sports and other recreational facilities, such as cable TV, common room for interaction, etc. All the hostel rooms

have intranet and internet connectivity round the clock. The hostel mess is operated by private contractor. Only vegetarian food is served in the mess. The hostel residents are expected to adhere to the hostel rules and regulations.

Canteens

Canteens are located within the university campus and within close proximity of the Institute, which provides hygienic and wholesome food, snacks and beverages, etc.

Play Grounds

The University campus has modern infrastructure to facilitate almost all outdoor sports activities.
It has a well-maintained cricket ground with three hard bowling pitches. Training nets are also provided during the practice sessions. Further, there is a running track, three lawn tennis courts, two volleyball courts, two basketball courts, football and kho-kho. Training camps for sports, adventure, mountaineering, etc are also planned for the overall development of the students.
The Students Activity Centre near the University hostels has ample space for a host of indoor sports activities. It has facilities for several indoor games, including carom, chess and table tennis. Students participate in various competitions, both at Intra-college and Inter-college level
Students are encouraged to make use of these facilities on a regular basis.

Gymnasium

The University has a well-equipped modern gymnasium. The gymnasium is open for students during 4:00 pm to 8:00 pm on all working days. A trainer is also available to provide guidance and assistance, wherever necessary. The gym facility is complimentary for students staying in University hostels and is provided at a very nominal fee to other students.

Value added Program

Within the context of emerging developments in the field of Science, future scientists will be required to function, communicate and work effectively in multidisciplinary teams. In order to be able to function confidently and effectively in such settings students must gain a sense of professional identity and pride over the course of their education. Professional identity must be considered crucial to the motivation of individuals and therefore the success of the profession.

To ensure this special emphasis is laid on:

- The development of communication skills
- Special orientation programs

- Interaction with the professionals from the industry and R & D centers
- Entrepreneurship development & visits to leading Biotech industries and R & D centers
- Special lectures, seminars, workshops and other programs for the students are regularly organized

I. 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 - 21 years, Teaching – 9.5 years

Email: ***sarat.dalai@nirmauni.ac.in***

Dr. Shalini Rajkumar, Professor

Ph.D. in Microbiology (IARI, New Delhi)

M. Sc. in Microbiology (IARI, New Delhi);

Area of Expertise: Molecular Physiology of Plant Growth Promoting Rhizobacteria (PGPR),

Experience: Research - 14 years, Teaching - 15 years

Email: ***shalini.rjk@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 - 21 years, Teaching - 10 years

Email: ***sonal.bakshi@nirmauni.ac.in***

Dr. Sriram Seshadri, Assistant 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 – 16 years, Teaching – 16 years

Email: **sriram.seshadri@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: Bioactive natural products, Bioacoustics, Biological effects & applications of microwaves.

Experience: Research – 4 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 - 10 years, Teaching - 11 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 - 7 years, Teaching - 7 years

E-mail: ***ameenair@nirmauni.ac.in***

Dr. DabluLal Gupta, Assistant Professor

Ph.D. in Biochemistry, All India Institute of Medical Sciences, New Delhi

Experience: Post -Ph.D. Research: - 03 years, Teaching: 1 year.

Area of Expertise: Analysis of innate and adaptive immune responses.

Experience: Research - 3 years, Teaching - 2 years

Email: **dablulal.gupta@nirmauni.ac.in**

Dr. Kuldeep Verma, Assistant Professor

Ph. D. in Biotechnology, Indian Institute of Soybean Research, Indore

Experience: Postdoctoral Research - 7 years, Teaching – 1.5 years

Area of expertise: Membrane Trafficking, and Genetic Manipulation in Plants

Experience: Research - 7 years, Teaching -2.5 years

Email: **kuldeep.verma@nirmauni.ac.in**

J. MANAGEMENT AND STAFF

[I] University Management

Name	Designation
Dr. Karsanbhai K. Patel	President, NU
Shri K. K. Patel	Vice President, NU
Dr. Anup Singh	Director General, NU
Shri G. R. Nair	Executive Registrar
Prof. Rajesh N. Patel	Dean(I/C), Faculty of Technology Director, Institute of Technology
Prof. Mallikarjun M	Dean, Faculty of Management Director, Institute of Management
Prof. Manjunath Ghate	Dean, Faculty of Pharmacy Director, Institute of Pharmacy
Prof. Sarat Dalai	Dean, Faculty of Science Director, Institute of Science
Prof. Purvi Pokhariyal	Dean, Faculty of Law Director, Institute of Law
Prof. Utpal Sharma	Dean, Faculty of Architecture Director, Institute of Architecture
Prof. P. N. Tekwani	Dean, Faculty of Doctoral Studies and Research
Prof. Udai Paliwal	Dean, Faculty of Commerce

[II] Officers

Name	Designation
Shri Ashishbhai Desai	Hon. Head of the Dept. of Students' Activities
Mr. Nilesh Patel	Deputy Registrar, Examination Section , NU
Mr. Tushar Patel	Placement Officer

[III] Staff Members

Name of the staff	Designation
Mr. Dinesh Patel	Office Superintendent
Dr. Svetal Shukla	Assistant Librarian
Mr. Hasit Trivedi	Assistant – Administrative Office
Mr. Sachin Prajapati	Laboratory Assistant
Mr. Rajendra Patel	Laboratory Assistant
Dr. Sweta Patel	Laboratory Assistant
Mr. Parthiban S. Mudaliyar	PA cum Stenographer
Mrs. Zankruti Dholakiya	Teaching and Research Associate

Contact places for students for different purposes

Name of Department	Name	Contact number
Student Section	Mr. Hasitbhai	079 71652756
Library	Dr. Shvetal Shukla	079 71652754
Director office-PA	Mr. Parthiban S. Mudaliyar	079 71652753
Examination Section	Dr. A. S. Patel	079 71652672
Account Section	Account officer	079 71652675
Academic Section	Dr. Ravindra Sen	079 71652680

K. Student Representative of various committees

Committees	Faculty Co-ordinator	Student's Representative
Library Committee	Dr. Sonal Bakshi	One PhD Student One representative from Sem-III
Website Committee	Dr. Nasreen Munshi	Representatives from staff and Ph.D.
Social Media Committee	Dr. Nasreen Munshi	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. Sriram Sheshadri	Representatives from Alumni
Student's Welfare Committee	Dr. Amee Nair Dr. Nasreen Munshi	Two representative from Sem-I Two representative from Sem-III
INSSA (Institute of Science Students Association)	Dr. Amee Nair Dr. Nasreen Munshi Dr. Sonal Bakshi Dr. Vijay Kothari	Nikunj Tandel (Ph.D) Priya Patel (Ph.D) Elected Sem-III students
Women Development Cell	Prof. Shalini Rajkumar Dr. Amee Nair	Two representative from Ph.D
Placement Committee	Mr. Tushar Patel Dr. Sonal Bakshi Dr. Nasreen Munshi	Two representative from Sem-III
Social Extension Activity	Dr. Sonal Bakshi	Representative from Sem-II

L. Holidays & Vacation calendar

Sr. No.	Festivals	Date & Month	Day
1.	Makar Sankranti	14 January, 2020	Tuesday
2.	Maha Shivratri	21 February, 2020	Friday
3.	Holi 2Il^{d} Day - Dhuleti	10 March. 2020	Tuesday
4.	Ram Navmi	2 April, 2020	Thursday
5.	Mahavir Jayanti	6 April. 2020	Monday
6.	Dr. Babasaheb Ambedkar’s Birthday	14 April, 2020	Tuesday
7.	Ramzan-Eid (Eid-ul-Fitra)	25 May, 2020	Monday
8.	Bakri-Eid (Eid-ul-Adha)	1 August, 2020	Saturday
9.	Rakshabandhan	3 August, 2020	Monday
10.	Janmashtami	12 August, 2020	Wednesday
11.	Independence Day/ Parsi new year	15 August, 2020	Saturday
12.	Mahatma Gandhi's Birthday	02 October, 2020	Friday
13.	Bhai Bij	16 November, 2020	Monday
14.	Guru Nanak's Birthday	30 November, 2020	Monday
15.	Christmas Day	25 December , 2020	Friday

M. GENERAL RULES & REGULATIONS

1 Attendance

2 Class Conduct

3 Discipline Rules

4 Academic Dishonesty at Examinations/Tests/Assignments, etc.

5 Library Rules

6 Computer Laboratory Rules

7 Plagiarism Zero tolerance

8 Prevention & Prohibition Of Ragging

9 Anti-Drug Squad

10 Complaint Committee for prevention of Sexual Harassment

11 Women Development Cell

12 Nirma Alumni Association Forum

13 Mechanism For Redressal Of Students' Grievances

14 Equal Opportunity Cell

15 Scholarship

[1] Attendance

The University requires regular attendance and punctuality in all classes. The students under extraordinary circumstances may request for leave of absence under the following rules and procedures:

- Prior permission of the Director shall be obtained for availing of leave. Leave applications must be submitted normally prior to the commencement of the leave. Leave applications on the ground of sickness must be accompanied by a medical certificate. In case, a student has not taken prior leave, she/he shall inform Director within 48 hours about his/her absence. Grant of the leave, however, shall remain the prerogative of the Director.
- The Institute will not be responsible for the student losing any component of assessment on account of his leave. Substitute quizzes or tests or examinations may be given to the student only if the student was on leave with the prior permission of the Director.
- Absence without leave will be considered a serious breach of discipline and the University will take appropriate action in such cases.
- The Director can grant the leave of maximum 15% in a course or courses in a Term.
- If the competent authority does not condone the absence of the student in a course. He/she will be awarded NT grade in that particular course and the student has to repeat all the components of the course under the arrangement to be made by the Director.

[2] Class Conduct

- The students are expected to be in the class room at least five minutes prior to the commencement of the class. Unpunctuality is not acceptable.
- Students are expected to come prepared to the class with the readings/ chapters and cases mentioned in the course outline for the session. The student may be asked to leave the class if he/she is not fully prepared for the session.
- Use of mobile phones is strictly prohibited in the class rooms, corridors and inside the blocks. Violation would imply confiscation of the mobile phone.
- Students are expected to behave in a responsible manner and abstain from chatting amongst themselves while the class is in progress.
- Activities like video shooting, photography, playing musical instruments and listening to radio and tape recorders are prohibited in the campus.
- Any indiscipline or misbehavior in class would warrant disciplinary action against the student.

[3] Discipline Rules to be observed in and outside the Institute or the University

1 Every student must carry his/her I' Card and produce the same when asked by the authority.

2 It is mandatory for the students to attend the classes, sessions, prayer, co-curricular activities etc. on all working days from the start to the end of the term/ semester/ trimester. Absence due to illness or unavoidable circumstances shall be considered only if the application is supported with medical certificate in case of illness and / or leave application form from the parent is submitted to the Head of the Institution.

3 Students are expected to behave in a responsible manner and abstain from chatting amongst themselves while the class is in progress;

4 Students are expected to be polite individually or in groups and show respect to the faculty/staff of the Institute/University;

5 Any indiscipline or misbehaviour in class, or on the campus, or in the bus/vehicle, or even outside the campus, would warrant disciplinary action against the student(s);

6 Any action of any individual, group or a wing in the hostel, which amounts to interference in the regular administration of the Institute, is prohibited. Disciplinary actions will be initiated against such student(s);

7 Causing disfiguration or damage to the property of the University or belongings of staff members or students is prohibited.

8 No student shall indulge in any activity that might be illegal or may lead to disorderliness;

9 No student shall be in possession of liquor, prohibited drugs or any intoxicating materials, nor would consume such things.

10 Smoking cigarettes/chewing pan or tobacco or gutkha on the campus is strictly prohibited.

11 Indecent behavior, in any form, will not be tolerated.

12 Use of mobile phone is strictly prohibited in the classrooms, corridors, or inside the blocks.

13 Activities like video shooting, photography, playing musical instruments and listening to radio, tape recorder, etc. are prohibited on the Campus except with the permission of the Director of the Institution.

14 The students are expected to be in the classrooms or any place of study on time before the commencement of the study.

15 Use of helmets is compulsory for everyone who rides a two-wheeler to and from the campus.

16 Students should follow a decent dress code when they come to the University.

17 Any kind of ragging in the class, campus or in the bus or even outside the campus is strictly prohibited.

18 Any kind of misuse of Internet, intranet or computer software, mobile, etc. is strictly prohibited.

19 Disobedience of any instructions of the competent authority will be considered as indiscipline and action will be taken as per the rules.

20 The points which are not covered above and which the Head of Institution considers as in-disciplinary action will be dealt with, under these rules.

Penalties

For disobeying any disciplinary rules, the competent authority as defined under relevant regulations will take disciplinary action against the student concerned. There shall be separate procedure for imposing minor penalty and major penalty. The following indiscipline on the part of the student shall be subjected to the major penalties:

1. Damaging the property of the University/Institutions (moveable or immoveable)
2. Involving in violence on and outside the campus including instigating violence.
3. Involving himself/herself in criminal act like using alcoholic beverages, drugs, gambling on or outside the campus including instigating the other students for such action.
4. Ragging in and outside the campus.
5. Any act which deteriorate the overall atmosphere in the campus or the Institute.
6. Theft of University property or the property of the other students, staff or any other person on the campus.
7. Any other act which the Head of the Institution feels as gross misconduct, which are not covered under the above category.

Type of Major Penalty: The Major Penalty includes the following:

- In case of criminal act or moral turpitude, the initiation of police action against the student(s).
- Prohibiting the student concerned from appearing in the course or courses in Mid-term and/or End-Term examinations.
- Detention of the student(s) for a trimester or more.
- Rustication from the University or from the Institute for a period of one year or more.
- Permanent rustication from the Nirma University or from the Institute.
- Any other major penalty, which the Director feels appropriate to impose.

- If the individuals committing or abetting 'ragging' are not identified, collective punishment could be executed to act as a deterrent punishment and to ensure collective pressure on potential 'raggers'. In case the student is involved in any kind of ragging and is punished for the same, the mention of the same will be incorporated in his / her migration certificate.

Procedure for imposing Major Penalties

For Imposing the Major Penalty as Defined above, the following Procedure will be followed.

- As soon as the information about a case of indiscipline is brought to the notice of the Head of the Institution concerned, the Head of the Institution will suspend the student concerned from attending the classes/practical or any other academic activities.
- He/she will at his discretion constitute the fact finding committee from within the people working in the institute and the fact finding committee will submit the report at the earliest but within a week's time after inquiring the details by inviting student(s), parent(s) and will record the statements. They will also examine the other witnesses and record their statement. The Committee will also examine the circumstantial evidences. On the basis of the report of the fact finding committee, if the Head of the Institution concerned feels that the charges leveled against the student fall under the major penalty and these are prima-facie proved then the report of the committee will be submitted to the committee constituted by the Director at University level and after further investigation by the University level committee, if it feels that the student(s) is/are involved in indiscipline which amounts to gross misconduct then they will make recommendations for the major penalty to be imposed which will be submitted to the Director and on the decision of the Director, a show cause notice shall be issued to the student concerned and after the reply received from the student concerned, the final decision about imposing the penalty will be taken by the Director.

Minor Penalty

For any disciplinary action, other than the in-disciplinary act covered under major penalty, the Head of the Institution will be competent to take action against the student concerned and impose minor penalty after hearing the student concerned and also the other persons, who the Head of the Institution feels appropriate or the person designated by the Head of the Institute.

Types/Nature of Minor Penalties

The types/natures of minor penalties are:

- Warning.
- Giving special assignments of the nature for which the Head of the Institution will be competent to decide.

- Imposing fine.
- Putting the student on conduct probation for the period, which the Head of the Institution feels appropriate.
- Prohibiting the student to appear in limited to two subjects in In-Semester Examinations/End-Semester Examinations.
- Suspending student for attending classes for a period not more than one week.
- Any other minor penalty the Head of the Institute feels appropriate.

Notwithstanding anything contained in these rules, the above provisions will not be made applicable to the students who have used unfair means in the Examinations or for the purpose for which the separate provisions are provided in different academic regulations.

[4] Academic Dishonesty at Examinations/Tests/Assignments, etc. and punishment in case of using unfair means

(1) Before, during or after the sessional or term / semester end examination, if it is found that a candidate is or has been guilty o

i. Misconduct-including misbehavior, committing acts of indiscipline, disobeying instructions of Examination officials, committing breach of any of the rules laid down for the proper conduct of the Examinations, etc. **OR**

ii. Copying or having attempted to copy or using or attempting to use other unfair means at the examination.

(2) In case of misconduct, the student concerned will be forthwith expelled with the approval of the Senior Supervisor or an Officer in Charge of the conduct of Examination or by Head of the Institution concerned from the Examination hall and the matter describing the incident will be reported to the Deputy Registrar (Examination)

(3) In cases involving malpractice, the Senior Supervisor or an Officer in Charge of the conduct of examination shall seize the answer books and all incriminating material / evidence from the candidate, and then obtain a written statement, duly signed by the candidate. Senior Supervisor or Officer in Charge will then issue a new answer book and allow the student to continue to write his answers for the remaining period of that examination. The matter shall also be reported to the Deputy Registrar (Examination) with all relevant documents on the same day.

(4) The candidate reported will then be allowed to appear in subsequent examinations of that session. However, in case the same candidate is again found guilty of indulging in misconduct or malpractice during any of the subsequent examinations of that session, he will

be expelled from all remaining examinations of that session after taking appropriate action for the second act of misconduct / malpractice.

(5) The cases of im-personification, violence or intimidation involving outsiders shall immediately be reported to the Senior Supervisor or the Officer in Charge and action as per the concerned law including filing a police complaint will be taken.

(6) Examiners, who would detect or suspect cases of copying or use of unfair means in examination, shall immediately report such cases to the Deputy Registrar (Examination).

(7) The Deputy Registrar (Examination) shall make a full report about each case to the Examination Reforms Committee.

(8) The Examination Reforms Committee to be appointed by the Director General, NU will determine its own procedure of enquiry in each case and after necessary investigation/inquiry will submit the detailed report to the Head of the Institutions, alongwith recommended punishments and the concerned Head of the Institutions will issue the necessary orders of punishment. The Order of punishment, which amount to debarring the students for the period of more than one academic year will be issued with the approval of the Director General, NU.

(9) The punishment in each case would depend on the circumstances of that case. The Examination Reforms Committee may evolve certain general guidelines for specifying punishments for different types of using unfair means/malpractices. As far as possible, the Examination Reforms Committee should follow these guidelines. However, in peculiar cases, which cannot be covered under the guidelines can be dealt with judiciously but firmly to preserve the integrity of the system of Examinations.

The Head of the Institutions shall have the powers to exclude any candidate from any examination on being satisfied that he is suffering from an infectious or contagious disease. Whenever any candidate is excluded, the fee paid by him to the University shall be refunded to him.

The punitive measures in the cases of using unfair practices in the different Examinations.

Guidelines framed by the Examination Reforms Committee under #1R.18(9) for recommending the punitive measures in the cases of using unfair practices in the different Examinations.

[1] # R.18 of Academic Regulations for admission to the University, eligibility criteria, conduct of examinations etc.

1. The cases involving in unfair practices in any examination shall be referred to the Examination Reforms Committee (ERC). This committee, after proper inquiry and judicious evaluation of all available documents and after giving fair and reasonable opportunity of being heard in each case, will recommend the punitive measures for further action to the concerned competent authority.
2. The cases of unfair practices may vary in culpability so as per the gravity of culpability the different kinds of punitive measures are provided in this guidelines and Examination Reforms Committee may recommend appropriate and proportionate punitive measures with recorded reasons.
3. The Examination Reforms Committee while following the guidelines shall have corrective rather than punitive approach at the same time protecting the sanctity of the Examination System.
4. The effect of the punitive measures recommended by the Examination Reforms Committee is to be read in consonance with the Academic Regulation of a particular programme notified from time to time by the University.
5. Explanations:

The following explanations will apply to the various provisions of guideline no. 6 and terms which are not defined are to be interpreted as per the regulations notified by the university from time to time.

a. Unfair practices shall mean indulgence in any activity as mentioned in #R.18(1) read with clause 6.1 to 6.8 mentioned here below.
b. Reference to a male student implies similar reference to a female student.
c. Reference to certain words in singular form implies reference to their plural form also, where the context is obvious e.g. answer-book / answer-books, note/notes, chit/chits, page/pages etc.
d. Reference to answer-book implies reference to main answer-book, supplementary answer-sheet, drawing-sheet, papers used in preparing the term assignments, reports of Projects, Internship Training, Dissertations etc. authenticated by the Examiner concerned by putting his signature including digital form.
e. "Examination" means an examination in any form of evaluation conducted by the university or by constituent institute of the university.
f. Supplementary Examination is not a separate Examination but it is a part of Semester End Examination and hence whenever the punitive measures is imposed for Supplementary Examination it should be same as of Semester End Examination.
g. Cancellation of result shall mean evaluation in examination becomes null & void
h. When more than one punitive measures is imposed, the effect of these measures will follow in chronological order.
i. Obtainable marks means maximum marks allotted to the concerned examination i.e, CE/LPWPW

Punishment / Penalties.

6.	Nature of Unfair Practices in Examination	Nature of Punitive measures	
		CE/LPW/PW	SEE/TEE
6.1	If a student, (i) disobeys the instructions of the block supervisor/officer of the Institute/University in examination. (ii) Writes any matter / content on the question paper in minor form. (iii) attempts communication with another student. (iv) changes the allocated seat without permission. (v) found with irrelevant written or printed material during examination	Written Warning;	Cancellation of the result of SEE/TEE of the concerned course
6.2	If a student, (i) is found with relevant written / printed material in any form of minor nature during examination. (ii) is found with relevant written / printed material in any form from his/her answer-book in minor nature during assessment. (iii) is found with relevant matter / content in minor form on his/her body / inside the clothes or under his/her implements like Calculator-Compass etc. or in his/her immediate vicinity (iv) has copied from the answer-book of another student in minor form without his/her knowledge during examination (Award the punitive measure/s to the student who had copied the answer).	Deduction of 10% marks of maximum obtainable marks from the obtained marks by the student concerned in CE/LPW/PW of the concerned Course	Cancellation of the result of SEE/TEE of the concerned Course
6.3	If a student, (i) is found with relevant written / printed material in any kind in extensive form during examination. (ii) is found with relevant written / printed material in any kind from his/her answer book in extensive form during assessment. (iii) is found possessing any kind of electronics devices including mobile phone/smart watch except simple calculator (wherever allowed) during examination inspective of whether it is used or not used. (iv) has copied from the answer-book of another student in extensive for without his/her knowledge during	Deduction of 20olo marks of maximum obtainable marks from the obtained marks by the student concerned in CE/LPW/PW of the concerned course	Cancellation of the result of all examinations (CE, LPW/PW, SEE/TEE) of the concerned Course

	examination (Award the punitive measure/s to the student who had copied the answer). (v) has copied the answer from the other student with his/her knowledge. (Award the punitive measure/s to both the students) (vi) writes relevant matter / content in extensive form on his/her body / inside the clothes or under his/her implements like Calculator-Compass etc. or in his,/her immediate vicinity. (vii) is found kept or referring any kind of notes, material, book etc. in washroom/toilet/corridor etc. out-side of the examination hall. (viii) exchanges / borrows / takes any article / documents with relevant minor content of a course (Award the punitive measure/s to the guilty student/s).		
6.4	If a student is found second time, (i) indulging unfair practices in any examination (CE/LPWSEE/TEE) under 6.1and penalized previously under 6.1 (ii) indulging unfair practices in any Examination (CE/LPW/SEE/TEE) under the guideline no. 6.2/6.3/6.4 and penalized previously under 6.1 (iii) indulging unfair practices in any Examination (CE/LPW/SEE/TEE)) under the guideline no. 6.1 and penalized previously under the	(i) Deduction of 10% marks of maximum obtainable marks from the obtained marks by the student concerned in CE/LPWPW of the concerned course (ii) Punitive measure will be awarded to the student concerned as per Guideline no. 6.2/6.3/6.4 respectively under which the student is reported for unfair practices in examination. (iii) Deduction of 20% marks of maximum obtainable marks from the obtained marks by the student concerned in CE/LPW/ PW o	(i) Cancellation of the result of SEE/TEE of the concerned course (ii) Punitive measure will be awarded to the student concerned as per Guideline no. 6.2/6.3/6.4 respectively under which the student is reported for unfair practices in examination. (iii) Cancellation of the result of SEE/TEE of the concerned course

	guideline no. 6.2/6.316.4. (iv) indulging unfair practices in any Examination (CE/LPW/SEE/TEE) under the guideline no. 6.2/6.3/6.4 and penalized previously under 6.2/6.3/6.4	the concerned course. (iv) Cancellation of the results of CE/ LPW/PW of two*courses [for all the programmes except MBA (FT and FB&E)] Cancellation of the result of CE/PW of concerned course + Deduction of l0% marks of maximum obtainable marks from the obtained marks by the student concerned in CE/PW of other one course*[for MBA (FT and FB&E)]	(iv) Cancellation of the result of all examinations (CE, LPW/PW,SEE/TE E of all the courses of concerned semester.
6.6	(i) If the student is found for undue advantage of writer facility. (ii) lf another student of the Institute of Nirma University or outsider impersonates as a student on behalf of a student of any Institute of Nirma University is found appearing in the examination in place of eligible student of the Institute of Nirma University.	Cancellation of the result of all examinations (CE, LPW/PW,SEE/TEE of all the courses of concerned semester Cancellation of the result of all examinations (CE, LPW/PW,SEE/TEE of all the courses of concerned semester and disallowing the student of Nirma University from registering the courses (IR and RPR) up to two subsequent semesters and initiate the criminal proceeding including filing FIR for the student / Person involved in this case.	
6.7	(i) If the student is caught in unfair practices in examination and threatens - the authorized person for conduct of examination/ member/s of the Examination Reforms Committee/ Examiner concerned for seeking his favour. - the Jr. Supervisor or Sr. Supervisor for not reporting the case or the examiner for	Cancellation of the result of all examinations (CE, LPW/PW, SEE/TEE) of all the courses of concerned Semester and disallowing him/her from registering the courses (IR and RPR) up to Two subsequent semesters depending upon the nature and gravity of the unfair practices.	

	seeking his favours either by bribing, hiding currency notes in the answer-books or threatens any of the authorized officers for conduct of examination. (ii) If the student violates the norms of disciplined behavior or indulges in violent behavior inside or outside the examination hall by act or acts such as : - Obstructing the process of examination in any way or instigating other students or - Assaulting the Block Supervisor / any other person appointed to conduct the examination or threatening the staff or - Carrying and/or using tools / weapons for intimidation /causing injuries or - Any other act/acts similar in nature to those mentioned under this category.	Cancellation of the result of all examinations (CE, LPW/PW, SEE/TEE) of all the courses of concerned Semester and disallowing him/her from registering the courses (IR and RPR) up to Three subsequent semesters depending upon the nature and gravity of the unfair practices and/or initiate the criminal proceeding including filing FIR for the student / Person involved in this case.
6.8	During or after the examination. if ary student is found to have indulged in any other form of unfair practices, misconduct, misbehaviour, committing act of indiscipline, committing breach of any of the rules laid down for the proper conduct of examinations etc., which are not, covered in categories 6.1 to 6.7 in the above guidelines having bearing on the examination or result of the student and/or of any other student.	The Examination Reforms Committee shall recommend the punitive measure depending upon the nature and gravity of the unfair practices.

- Whenever punitive measure is awarded to the concerned student for Two courses, then the one course is the concerned course in which student is caught for using unfair practices in examination and the other course will be decided by the student concerned at his/her option from the courses (IR/RPR of any semester) in which the student appeared and passed the Examination. When other course is not available at all then the Committee shall recommend appropriate punitive measure depending upon the nature and gravity of the unfair practices.

[5] Library Rules

- *Institute of Science Students can borrow three books at a time for the period of 07 days on their Identity Card. Books will be renewed once only if there is no reservation for it.*
- *Students will have to return the borrowed books on time. The overdue charge is Rs.2/- per day.*
- *Library Issue/Return counter will be open from 11.15 am to 5.45 pm only.*
- *If any student's card is lost, he has to report to the Librarian immediately and operation of account will be in abeyance until he gets new.*
- *Before borrowing the book, he/she has to verify the physical condition of the books. If he/she finds physical condition of the books bad, he/she must inform Librarian's immediately.*
- *Borrower will be responsible for any damage found while returning books.*
- *If students are going on Short-term industrial visit or project, they have to maintain the schedule of returning the books. This rule can be relaxed on the recommendation of the HOD for borrowing books for his project, when student is deputed for project for the entire semester out of Ahmedabad.*
- *If any student caught, stealing books or tearing pages will have to pay the entire cost of the books plus Rs.500/'-. And Library Account will be suspended for two months in addition to the disciplinary action to be initiated.*
- *If any book lost by any student, not available in the market, he/she is required to pay three times of the original cost. The A/c has to be cleared within two weeks at least.*
- *If any student misplaced/loses any complimentary copy, the HOD will decide the amount to be paid by student after consulting the subject expert.*
- *It will be the sole responsibility of the borrower to preserve the book and return to the Library, however if any student loses/or misplaced the book, he has to report to the Librarian on the same day. He will have to clear his Library account either replacing the book or by paying the cost within a week. If he fails to do so, not only the cost of the book, but also overdue will be recovered from the student.*
- *If students disobey Library rules, Identity Card will be collected, reported to the Head of the Institution for initiating disciplinary action.*
- *Library resources like reference books, periodicals, bound volumes, standards, CD's, audio/video cassettes are to be referred within the library premises.*
- *To maintain Discipline and Silence in the library is mandatory. If any student fails then he/She will be penalized/punished.*

Rules for Book Reservation for Students (Also refer Annexure II)

- *The book you wish to have and not available in the Library, you may reserve that title so whenever it arrives, you may get that title without waiting any long*
- *The reservation forms can be obtained from the Library Check Counter.*
- *Student can reserve only one title at a time.*
- *Books can be collected within a five days after arriving.*
- *Reserved books will be given on loan for 07 days.*
- *You may find the status of your reserved title at the Library Notice Board.*
- *If you do not collect books within said period, Reservation may be treated as cancelled.*

Library Suggestion

- *Suggestions are for the library improvement.*
- *You are free to give your valuable suggestions to us.*
- *Library Suggestion Register available at the Library check counter.*
- *You may see the status of your suggestion at the Library Notice Board / in the suggestion register.*

Rules for Library User:

- *Keep Silence in the Library.*
- *Mobile Phone is prohibited within the Library premises.*
- *Put Library books properly on its place.*
- *Not to spoil the Library Material.*
- *Not to bring their own Reading Material and Issued Books in the Library.*
- *Not to bring personal floppies/CDs/DVDs in the Library. Students can copy Library CDs and DVDs with the permission of Library Staff.*
- *Frequent defaulting of the above rules will lead to termination of Library Membership.*
- *Contact Library Staff anytime if they face any problem.*
- *Give Suggestions to Improve the Library Services.*

Library Timings

Opening – Closing Hours:	09.00 am - 06.00 pm
Issue/Return Counter:	11.15 am - 05.45 pm
Photocopying Service:	11:30 am to 12:30pm

Library Homepage: https://pharmscilibrary.nirmauni.ac.in/

In addition to the Institute of Science Library resources students and faculty could access the digital resources of the University from the same homepage.

[6] Computer Laboratory Rules

- **General**

  Misuse of Internet/Intranet mail service will invite strict disciplinary action.

- **For the usage of Computer Lab**

❖ Students should make an entry in the log register.

❖ Students should not change properties/configuration of the client machines.

❖ Students should keep silence and observe discipline while working.

❖ Students should not leave rough papers on desks.

❖ Students should not eat or drink in the computer centre

[7] Plagiarism zero tolerance

Nirma University offers conducive and inspiring academic environment where ethics and honesty are integral to the education system. In order to establish Zero Tolerance against plagiarism, students are facilitated to understand what plagiarism is, how to detect it, and what the expectations from them are. Awareness to this issue helps avoid plagiarism which may be done either willfully or unknowingly. Well defined policy including issue of plagiarism in the syllabus helps to prepare M.Sc. and potential Ph.D. students who are well educated and trained to implement highest standards of academic integrity and honesty in academic and research practices.

[8] Prevention /Prohibition of Ragging

Directives of the Hon'ble Supreme Court of India, to prevent and eliminate the scourge of ragging, at different times, have been implemented by the University. Ragging in the hostel and on the campus is strictly prohibited. Any student indulging in this will be liable to be expelled not only from the hostel but also from the institute/university.

What Constitutes Ragging

Ragging constitutes one or more of any of the following acts: a) Any conduct by any student or students whether by words spoken or written or by an act which has the effect of teasing, treating or handling with rudeness a fresher or any other student. b) Indulging in rowdy or undisciplined activities by any student or students which causes or is likely to cause annoyance, hardship, physical or psychological harm or to raise fear or apprehension thereof in any fresher or any other student. c) Asking any student to do any act which such student will not in the ordinary course do and which has the effect of causing or generating a sense of shame, or torment or embarrassment so as to adversely affect the physique or psyche of such fresher or any other student. d) Any act by a senior student that prevents, disrupts or disturbs the regular academic activity of any other student or a fresher. e) Exploiting the services of a fresher or any other student for completing the academic tasks assigned to an individual or a group of students. f) Any act of financial extortion or forceful expenditure burden put on a fresher or any other student by students g) Any act of physical abuse including all variants of it: sexual abuse, homosexual assaults, stripping, forcing obscene and lewd acts, gestures, causing bodily harm or any other danger to health or person; h) Any act or abuse by spoken words, emails, post, public insults which would also include deriving perverted pleasure, vicarious or sadistic thrill from actively or passively participating in the discomfiture to fresher or any other student. i) Any act that affects the mental health and self-confidence of a fresher or any other student with or without an intent to derive a sadistic pleasure or showing off power, authority or superiority by a student over any fresher or any other student.

Administrative Action in the Event of Ragging

The institution shall punish a student found guilty of ragging after following the procedure and in the manner prescribed here in under:

The Anti-Ragging Committee of the institution shall take an appropriate decision, in regard to punishment or otherwise, depending on the facts of each incident of ragging and nature and gravity of the incident of ragging established in the recommendations of the Anti-Ragging Squad.

The Anti-Ragging Committee may, depending on the nature and gravity of the guilt established by the Anti-Ragging Squad, award, to those found guilty, one or more of the following punishments, namely; a) Suspension from attending classes and academic privileges. b)

Withholding/ withdrawing scholarship/ fellowship and other benefits. c) Debarring from appearing in any test/ examination or other evaluation process. d) Withholding results. e) Debarring from representing the institution in any regional, national or international meet, tournament, youth festival, etc. f) Suspension/ expulsion from the hostel. g) Cancellation of admission. h) Rustication from the institution for period ranging from one to four semesters. i) Expulsion from the institution and consequent debarring from admission to any other institution for a specified period.

Provided that where the persons committing or abetting the act of ragging are not identified, the institution shall resort to collective punishment.

An appeal against the order of punishment by the Anti-Ragging Committee shall lie, (i) in case of an order of an institution, affiliated to or constituent part, of a University, to the Vice-Chancellor of the University; (ii) in case of an order of a University, to its Chancellor. (iii) in case of an institution of national importance created by an Act of Parliament, to the Chairman or Chancellor of the institution, as the case may be.

Where in the opinion of the appointing authority, a lapse is attributable to any member of the faulty or staff of the institution, in the matter of reporting or taking prompt action to prevent an incident of ragging or who display an apathetic or insensitive attitude towards complaints of ragging, or who fail to take timely steps, whether required under these Regulations or otherwise, to prevent an incident or incidents of ragging, then such authority shall initiate departmental disciplinary action, in accordance with the prescribed procedure of the institution, against such member of the faulty or staff. Provided that where such lapse is attributable to the Head of the institution, the authority designated to appoint such Head shall take such departmental disciplinary action; and such action shall be without prejudice to any action that may be taken under the penal laws for abetment of ragging for failure to take timely steps in the prevention of ragging or punishing any student found guilty of ragging.

Why should I & How can I use On Line affidavits? Why?

1. It is mandatory for every student and his/her parents to submit an anti-ragging affidavit at the time of first admission and there after each year at the time of annual registration. These are UGC's regulations.

2. It is the order of the Hon. Supreme Court that contact details of students must be collected from these affidavits and stored electronically at a central location.

3. Until now each college collected such information. But it was not stored in any central location. But this year the Ragging Prevention Program developed an ON LINE procedure for downloading anti ragging affidavits. As a result college authorities do not have to collect information separately and compile it. It will save a lot of their time and energy. How?

4. It is a simple procedure comprising 3 steps

Step 1: Log on to www.ANTIRAGGING.in or www.AMANMOVEMENT.org. Click on the button called – On line affidavits.

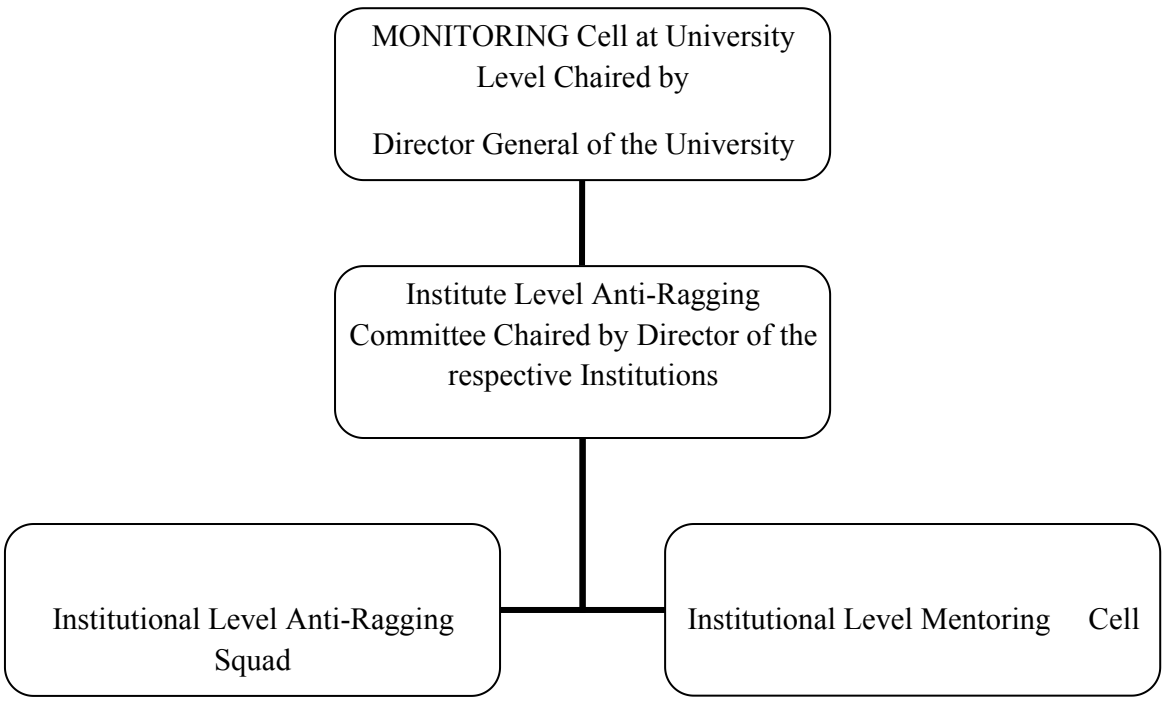
Step 2: Fill in the information as desired and submit the form.

Step 3: On successful completion you will receive affidavits, both for Students and Parents, through E mail.

5. If you do not have an E mail address please create one before you log in. If your parents do not have an E Mail/Mobile/ Landline Phone number please do not panic. You can give those of your friends or relatives. There is absolutely nothing to worry. If you make a mistake while submitting your form you can start a fresh and submit the information again. There is no problem. It is a very easy process.

The structure of Anti Ragging mechanism of the Institute is as follows:

Organization/Structure of Anti Ragging Committee



University Level Committee

Monitoring Cell of Anti Ragging Measures

At the University Level there is a Monitoring Cell of Anti-Ragging Measures, which is chaired by the Director General of the University. The cell consists of all the Head of Institutions, Chief Operating Officer and Executive Registrar of the University as members and the Chief Warden [Hostels] as Member Secretary. This body coordinates with the constituent Institutions of the University in implementing the Anti-Ragging measures and achieving its objectives.

Institution Level Committees

There are three committees constituted at the Institutional Level and all the Institutions under the university has constituted three committees viz. Anti-Ragging Committee (Institute Level Statutory Committee), Anti Ragging Squad and Mentoring Cell (Ragging)

1. Anti-Ragging Committee (Institute Level Statutory Committee)

This is a Institute Level Statutory Committee with Director of the Institute as **Chairperson**, two Senior Faculty Members, Chief Warden [Hostels], representatives of civil and police administration, local media, non-Government Organizations involved in youth activities, representatives of faculty members, representatives of parents, representatives of students and non-teaching staff as members.

This committee ensures compliance with the provisions of Regulations of Anti-Ragging.,

2. Anti-Ragging Squad

The Squad consists of one senior faculty member as Co-coordinator and the Chief Warden [Hostels] as Co-coordinator. The committee consists of teaching and non-teaching staff and students` representatives as its members. The squad makes surprise visits at hostels and spots vulnerable to incidences of ragging on the campus.

3. Mentoring Cell (Ragging)

The cell is headed by a Senior Faculty member and consists of teaching staff as well as Students representatives. The Mentoring Cell promotes the objective of Anti-Ragging among the students.

Help Line No(s).

National Anti-Ragging Helpline 1800-180-5522 [24x7 toll free]

1. Constitution of Anti-Ragging Committee at Institute Level

Committee for 2019-20. [new committee will reform after new admission]

Chairman		Prof. Sarat Dalai Director, Institute of Science Nirma University Ahmedabad
Civil / Police Administration	(1)	Shri D. H. Gadhavi Police Inspector, Sola Area (M) 9825652041
Local Media	(1)	Nilesh Dholakiya Indian Express Pvt. Ltd M:9426601929
Representative of Faculty Members	(1)	Dr. Vijay Kothari, Member Secretory Asst. Professor, Institute of Science
	(2)	Dr. Sriram Seshadri Asst. Professor, Institute of Science
	(3)	Dr. Sonal Bakshi Asst. Professor, Institute of Science
N.G.O. (For youth activities)	(1)	Mrs. Pratima Pandya Kasturba Trust, Gujrat Branch, P.O. Kasturba Vidyalaya, Koba, Sector-9, Gandhi Nagar-382 009 pratima.pandya@reddiffmail.com 09898722407
Representative of Parents		Mrs. Ida Cordeiro (Mother of Denielle Cordeiro of M.sc. I) Mobile: 9824336087 Idacordeiro14@gmail.com

	(1)	Mr. Ummedsingh Rathod (Father of Bharat Rathod of Semester-IV) Mo. No. 9426056775 Ummedsinghrathore8109@gmail.com
Representative of Students	(1)	Bakul Patel (sem III)
	(2)	Hiral Shah (sem III)
	(3)	Dhwani Makawana (sem III)
	(4)	Aakansha Sinha (Sem-I)
	(5)	Divya Tailwani (Sem-I)
	(6)	Dinkal Danani (Sem-I)

2. **Constitution of Anti-Ragging Squad**:

Faculty Members	**:**	Vijay Kothari, Sriram Seshadri, Sonal Bakshi, Amee Nair, Nasreen Munshi, Dablulal Gupta,
Non-teaching Members	**:**	Rajendra Patel, Sweta Patel, Parthiban Mudaliyar. Hasit Trivedi, Zankruti Hathi

3. **Constitution of Mentoring Cell**:

Composition of the Cell

Senior Student representatives	:	(1)	Hiral Shah (Sem-III)
		(2)	Bakul Patel (Sem-III)
		(3)	Dhwani Makwana (Sem-III)
		(4)	Pooja Patel (Ph.D. Students)

[9] Anti-Drug Squad to check drug menace on University Campus

With reference to the details mentioned in the preamble, to prevent the use of drugs/alcohols by the students on the University campus, the following decision are taken by the Coordination Committee:

(i) The Anti-drug Squads be formed at the Institute as well as University level in line with the Anti Ragging squad and the security personnel also be included in the Squads

(ii) The respective Heads of the Institute will constitute the Anti-drug Squad at the Institute level and submit the report to the Executive Registrar/Director (A&GA)/Director General and Vice President

(iii) The functions of the Anti-drug Squads will be as under:

a. To carry out surprise checks/visits of the hostels and monitor the activities of the students
b. To organize awareness programs in the institutes and hostels
c. To educate students about ill effects of drugs and alcohol
d. To motivate students to refrain from consumption of drug and alcohol
e. To encourage students for reporting any noticed use of drug/alcohol by any one on the campus
f. To educate students regarding laws and rules about the use/possession of such narcotic drugs and the punishment thereto

(iv) The Anti-drug Squads should watch various locations on the University Campus frequently including the hostels as well as day scholars

(v) The students should be encouraged to be a part of entire campaign to have drug free campus. The Anti-drug squads of students should also be formed at the institute level and for the hostels

(vi) The details regarding menace of drug use should be provided in the Student Handbook also. The students should be informed about this in the admission offer letter itself

(vii) Similar to the undertaking with regard to Anti-Ragging, an undertaking for the preventing drug menace should be taken from the students and parents at the time of admission

(viii) Poster depicting the ill-effect of drug menace in large size should be developed and displayed on the prominent locations

Constitution of Anti-drug squad at Institute of Science

1. Dr. Vijay Kothari
2. Dr. Sriram Seshadri
3. Dr. Sonal Bakshi
4. Dr. Nasreen Munshi
5. Mr. Rajendra Patel
6. Security Person, ISNU

[10] Complaint Committee for prevention of Sexual Harassment

In pursuance of the directions issued by the Hon'ble Supreme Court in the judgement of Vishaka & Others v/s. State of Rajasthan & Others reported in 1997 (6) SCC 241, the Nirma University has constituted a complaint committee for prevention of Sexual Harassment

Objectives

- To prevent discrimination and sexual harassment against women, by promoting gender amity among students and employees
- To lay down procedures for the prohibition, resolution, settlement and prosecution of acts of discrimination and sexual harassment against women, by the students and the employees;
- Deal with cases of discrimination and sexual harassment against women, in a time bound manner, aiming at ensuring support services to the victimized and termination of the harassment;
- Recommend appropriate punitive action against the guilty party to the Chair/Director General of NU.

Complaints Committee for Prevention of Sexual Harassment		
Name	**Designation**	**Contact No.**
Prof. Madhuri Bhavsar, ITNU	Chairperson & Counselor	079-71652212
Dr. Nina Munchargi, IMNU	Member	079-71652635
Dr. G.V. Narasimha Rao, ILNU	Member	079-71652823
Dr. Nilesh Patel, Dy. Registrar Examination	Member	079-71652671
Ms. Nisha Dave, O.S. IAPNU	Member Secretary	079-71652343
Ms. Prita Jha, Founder and President of Peace and equality cell (PEC)	External Member	9586060807
Ms. Palak Jain, B.A, LLB, ILNU	Member (U.G Student)	17bal034@nirmauni.ac.in
Ms. Yashodhara Khadiya, Intigrated BBA-MBA, IMNU	Member (P.G Student)	Ykhadiya_16@nirmauni.ac.in
Ms. Krishna Bhalodi, Ph.D. Full time, IPNU	Member (Research Scholar)	19ftphdp57@nirmauni.ac.in

The Committee will deal with issues relating to sexual harassment at Nirma University. It is applicable to all students, staff and faculty. A complaint of discrimination or sexual harassment may be lodged by the victim or a third party. A written complaint may be addressed to the Chair of the Committee. If the complaint is made to any Head of Institute, they may forward it to the Convener of the Committee against Sexual Harassment.

Responsibilities of Internal Complaints Committee (ICC):

(a) to provide assistance if an employee or a student chooses to file a complaint with the police;

(b) to provide mechanisms of dispute redressal and dialogue to anticipate and address issues through just and fair conciliation without undermining complainant's rights, and minimize the need for purely punitive approaches that lead to further resentment, alienation or violence;

(c) to protect the safety of the complainant by not divulging the person's identity, and provide the mandatory relief by way of sanctioned leave or relaxation of attendance requirement or transfer to another department or supervisor as required during the pendency of the complaint, or also provide for the transfer of the offender;

(e) ensure that victims or witnesses are not victimized or discriminated against while dealing with complaints of sexual harassment; and

(e) ensure prohibition of retaliation or adverse action against a covered individual because the employee or the student is engaged in protected activity.

[11] Women Development Cell

In pursuance of the directions issued by the UGC and MHRD, the Nirma University has set up the Women Development Cell (WDC) and prescribed norms to sensitize the community with regard to gender related issues and create a gender friendly environment:

Objectives

To provide and maintain a dignified, congenial working environment for women employees (including teaching, non-teaching and contractual workers) and students, where they can work, study and explore their potential to the fullest, a committee of the following members has been constituted as “Women Development Cell”:

Women Development Cell	
Prof. Shalini Rajkumar	Chairperson
Prof. Jigna Shah, IPNU	Member [Faculty Co-ordinator]
Ms Vibha Gajjar, IAPNU	Member [Faculty Co-ordinator]
Ms. Ritu Agrawal, Publication Officer, NU	Staff co-ordinator
Dr. Neha Patni, ITNU	Member
Dr. Amee Nair, ISNU	Member
Ms. Sreya Shrivastava, ILNU	Member
Dr. Krishna Patel, Department of Design	Member
Dr. Praneti Shah, IMNU	Member
Dr. Nagja Tripathi, IPNU	Member
Ms. Pratima Singh, IAPNU	Member
Dr Avani Shah, ICNU	Member
Dr Nilesh Patel, Nirma University	Member
Dr Ravindra Sen, Nirma University	member
Ms A P Parshya, Asst. Registrar (PhD Section), Nirma University	Member secretory
Student Representative	Ms. Priya Patel (18FTPHDS45)
Student Representative	Mr. Devang Trivedi (19FTPHDS47)

ROLE AND FUNCTIONS

1. To sensitize all members of Nirma University community towards the Supreme Court and statutory mandate prohibiting gender discriminations and sexual harassment at the work place and encourage involvement through academic, cultural and outreach activities such as talks, seminars, workshops, community action, drama, street theatre, poster-making etc.
2. To provide for dialogue, discussion, and deliberation on women's rights and gender-related issues.
3. To encourage from participation from NGOs and law enforcement agencies in this area.

4. To become a resource centre for women and provide a forum for exchange of ideas.
5. To review safety and security measures for female employees and girl students at Nirma University campus.

WHO CAN APPROACH THE CELL

Any employee including faculty, staff, contractual, temporary, casual and student of Nirma University can approach the Women Development Cell.

[12] Nirma University Alumni Forum

We at Nirma University are proud of our Alumni and the difference they have made to the world around them. Their contributions have been acknowledged by organizations and institutions as they have marched ahead creating value and opportunities on the way. With more than 2000 members joining the group every year, the alumni network with about 15000 members currently is growing stronger year on year.

The University has constituted 'Nirma University Alumni Forum' with the objective to foster continuous engagement of the alumni with their Alma mater and to draw their expert knowledge in the relevant fields to further enhance, strengthen and reinforce the over-all quality of the constituent Institutes of the University.

Objectives of Nirma University Alumni Forum:

- To establish and maintain contact between the past students of the University
- To pursue and sustain excellence in education by interaction between the alumni, the faculty and the present students of the University
- To strengthen Industry-Institute-Interaction and operate related activities for the benefit of the students of the University
- To extend all assistance and co-operation to the University in its endeavors for the growth and development of education and research in the field of Technology, Pharmacy, Law, Management etc.
- To institute scholarships and awards for deserving past and present students of the University for educational and research purposes as per the terms and conditions to be laid down by the Board of Directors
- To encourage and assist the students of the University in various academic and cultural activities

- To establish endowments by donation to extend financial and other assistance to deserving past and present students of the University for educational and research purposes as per terms and conditions mutually decided with the Board of Directors
- To establish endowments by donation to create Chair/s of Professor/s Emeritus in the University in professional and related areas
- To generate funds for conducting activities for achieving the objectives of the University
- To create fellowships for the Alumni to pursue post-graduate studies or research
- To project constructive activities of the University in India and abroad
- To provide a common platform for exchange of ideas and disseminating knowledge in professional areas
- To perform any other constructive activities leading towards the enhancement of the skill and knowledge of the members of the Association
- To conduct lectures twice or thrice a year to motivate the students of each institute
- To invite our alumnus to impart knowledge and encourage the students along with training them to pursue IAS and IPS

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.

[13] Mechanism for Redressal of Students' Grievances

The students are the main stakeholders in any institution imparting education, and its our endeavour to make all efforts to ensure transparency in all the activities at different stages. Taking this spirit in consideration the University has decided to provide mechanism to students for redressal of their grievances as under:

- The Grievances may broadly include the following complaints of the aggrieved students

  a. Academic
  b. Non-Academic
  c. Grievance related to Assessment

d. Grievance related to Victimization
e. Grievance related to Attendance
f. Grievance related to charging of fees
g. Grievance regarding conducting of Examinations
h. Harassment by colleague students or the teachers etc.

- There will be Grievance Redressal Committees at the Department/Institutes/University level to deal with the grievances of the students:

a. Department/Area Level committee will be as under:

1. Head of the Department/Area Chairperson – Chairman

2. Up to 3 (three) faculties to be nominated by the Head of Department/Area Chairperson

This committee will deal with the Grievance related to Academic and Administrative matters of the Department/Area concerned.

b) Institute Level committee will be as under:

i. Head of Institute – Chairman
ii. Head of the concerned Department
iii. Up to 2 (two) faculty members to be appointed by the Head of Institute
iv. Dy. Registrar – Member Secretary

This committee will deal with all the Grievances directly which is related to the common problems at Institute level both Academic and Administrative. In addition, this committee will also entertain the appeal filed by the student against the decision of the Department level committee.

c) University Level committee will be as under:

i. Chief Operating Officer - Chairman
ii. Dean of the Faculty concerned
iii. Head of Department concerned
iv. Executive Registrar
v. Dy. Registrar/Assistant Registrar as the case may be from Institute concerned will be Member Secretary.

This committee will deal with all the Grievances directly which is related to the common problems at University level both Academic and Administrative. In addition, this committee will also entertain the appeal filed by the student against the decision of the Institute level committee.

- Procedure for Redressal of Grievances (RoG)

a. An aggrieved student who has the Grievance or Grievances at the Department/Area level shall make an application first to the HoD/Area Chairperson. The Head of Department/Area Chairperson, after verifying the facts will try to redress the grievance within a reasonable time, preferably within a week of the receipt of application of the student. If the student is not satisfied with the verdict or solution of the HoD/Area Chair, then the same should be placed before the Department/Area level committee.

b. If the student is not satisfied with the decision of Department/Area level committee, he/she can submit an appeal to the Institute level committee within a week from the date of the receipt of the reply from the Department level committee.

   The Head of Institute, after verifying the facts and the papers concerned and having discussion with the Chairman of the Department/Area level committee will place the matter before the Institute level committee which shall either endorse the decision of the Department level committee or shall pass appropriate order in the best possible manner within a reasonable time, preferably within 10 days of receipt of application.

c. If the student is not satisfied with the redressal offered by the Institute level committee and feel that his/her Grievance is not redressed, he/she can submit an appeal to the University level committee within a week from the date of receipt of decision with the relevant details.

d. The University level committee should consider the appeal of the student and make appropriate recommendations to the Director General within a reasonable time, preferably within 15 days. On approval by the Director General the final decision is to be communicated to the student through the respective Head of Institute.

e. The University level Committee, if needed, may recommend to the Director General, necessary corrective action as it may deem fit, to ensure avoidance of recurrence of similar grievance at any of the Institute under the University.

f. While dealing with the complaint the committee at all levels will observe law of natural justice and hear the complainant and concerned people.

g. While passing an order on any Grievance at any level the relevant provisions of Act/Regulations should be kept in mind and no such order should be passed in contradiction of the same.

   The student will submit the application of Grievance or appeal to the Institute level committee or University level committee, as the case may be, through the Head of Department and Head of Institute concerned.

Equality at Campus

The University provides a level playing field for all students in respect of entitlement and opportunity for enjoyment of all legimate rights.

Non-Discrimination

The University strictly follows the non-discrimination guidelines as suggested by the UGC. It does not discriminate the students based on their caste, creed, religion, language, ethnicity, gender and disability.

Member of Institute level Grievance Redressal Committee, Appeal Committee and Disciplinary Committee are:

1. Prof. Sarat K. Dalai – Chairmen
2. Dr. Shalini Rajkumar- Member
3. Dr. Sonal Bakshi – Member
4. Dr. Sriram Seshadri- Coordinator

[14] Equal Opportunity Cell

Indian Society has rich diversity in terms of religion, caste and culture which is characterized by social division and this may lead to inequalities and create barriers to access the important resources to disadvantaged section of the society. These sections include Scheduled Caste, Scheduled Tribes, other backward classes, women minorities and differently abled persons. Education is an important instrument of social control which enriches human life materially as well as culturally. Education at grassroots level means freedom from ignorance which leads to freedom from exploitation and oppression. In this way, education is an important resource which must be distributed equally in terms of opportunities as its acquisition opens up other material resources such as wealth, status and excellence. So it is highly desirable to make education system inclusive and should be responsive to the needs and constraint of the disadvantaged social groups. To cater this larger goal, Equal Opportunity Cell is set up under the aegis of Nirma University.

Aims and Objectives:-

- Identify the issues amongst the disadvantaged sections on the campus and to provide an enabling and non-discriminative environment for them.
- To promote inclusive policies and practices on the campus
- To ensure equality and equal opportunities to disadvantaged group on campus through proper implementation of policies, skills and programs.

<u>Functions of EOC:-</u>

I. To create a socially congenial atmosphere for academic interaction and for the growth of healthy interpersonal relationships among the students coming from various social backgrounds.

II. To make efforts to sensitize the academic community regarding the problems associated with social exclusion as well as aspirations of the marginalized communities

III. To help individuals or a group of students belonging to the disadvantaged section of society to contain the problems related to discrimination.

IV. To look into the grievances of the weaker section of society and suggest amicable solution to their problems.

V. To disseminate the information related to schemes and programs for the welfare of the socially weaker section as well as notifications/memoranda, office orders of the Government, or other related agencies/organizations issued from time to time

VI. To prepare barrier free formalities/procedures for registration of students belonging to the disadvantaged groups of society for various programs in respective semester/terms as per University rules. (subject to the norms applicable to the respective programs)

Advisorv Committee:-

1. Chairman	Director General
2. Executive Registrar	Member Secretary
3. All HOIs	Member
4. HOD - Student Welfare Activities	Member
5. Chief Coordinator Student Welfare Board	Member

Functions of Advisory Committee:-

1. To frame the guidelines to fulfill, monitor and implement the aforementioned functions of EOC.

2. To review the implementation of various schemes and programs for the welfare of the disadvantaged and marginalized groups of the society and other related activities undertaken by the Institutes.

3. To review the grievance received and action taken by the concerned Institute level committee as per the mechanism developed to deal with such grievance.

4. To device the related activities for the welfare of the above referred group to be undertaken by the Institute and the University.

5. The advisory committee will meet atleast once in 4 (four) month of duration and record the decision in the meeting and to review on the decisions taken in the previous meeting.

Mechanism for dealing with the Grievances/Problems :-

In each Institute the HoI will constitute a committee for EOC at the Institute level as under;

i) Head of Institute Chairman

ii) Up to 3 HoD or Professor/Associate Professor as the case may be, to be nominated by the HoI.

iii) Co-coordinator - students activities

iv) Dy. Registrar/Assistant Registrar

v) Advisor (Member Secretary) - A faculty to be nominated by the HoI

Functions of Advisor:-

i) To oversee/monitor various welfare schemes/programs sponsored by the Government of India/State Government, UGC or any agency/organization as well as those devised by the University for the disadvantaged groups for their effective implementation

ii) To work as member secretary for Institute level EOC

iii) To prepare the agenda within the framework of EOC

iv) To review the problems of different groups as mentioned under the functions of EOC and process the same at appropriate level

v) To prepare report of action taken by the Institute level committee and to report the same to University level Advisory committee through HoI concerned

vi) To maintain the record of Grievance, action taken including the final conclusion arrived at the Grievance concerned

vii) To convene the meetings of in-charge of other committees/programs dealing with social issues such as Gender Sensitization Committee against sexual harassment (GSCASH), National Service Schemes (NSS) etc. To review their activities

viii) The Advisor shall submit the progress/review report to the committee. The coordinators of SC/ST Cell, Remedial Coaching and other schemes/women's study Centre, Population Education Cell etc. shall be closely associated with the EOC

[15] Scholarship

Students eligible for scholarships under various Central and State Govt. schemes for higher education can apply and avail the amount via Direct Benefit Transfer scheme as per the Government notification of February 2016. Students getting the scholarship should submit details of their bank account number and Adhaar Card to ISNU student section to enable direct transfer of amount. Following Govt. schemes are under Direct Benefit Transfer scheme, (the list is only representative and can be updated later);

1. Higher Education Scholarship
2. Research scholarship
3. Scholarship to economically backward students
4. National Fellowship for Person with Disability
5. **“Earn while U learn” scheme by Nirma University**

"Earn While U Learn" scheme for the students of Nirma University [This portion is copied from NU circular]

1. Objective of the scheme

1. Enable meritorious and needy student to earn a reasonable amount every month to meet their expenses
2. Explore the potential of student as a valuable human resource.
3. Gives students hands on experience and develop them for future job.
4. Encourage students for diversification of activities beyond syllabus to needy students.

2. Job Description

The incumbent student can be given work in the following areas

1. Library (arrangement and display of books /issue and return of books etc.)
2. Laboratory (equipment handling/maintenance /conduct of practical (only for post graduate students)
3. Office administration/student section (data handling /data preparation /filing work /drafting work)
4. As a Teaching assistant (Post Graduate Student)
5. Any other work to be determined by a committee of concerned.

3. Eligibility/Condition

1. He/she must be a student of the Institutes under the Nirma University
2. Not getting other benefits/scholarship/stipend/fellowship from the university or from the government also. Family income of the student should not be more that 10 lakhs rupees per annum.
3. He/She is required to do the job before/after the college hours (i.e. normal study of the student should not be suffered) (9tol1 or 4 to 6 depending on the shift of the student).
4. Student is required to maintain good academic and conduct record for continuation of the scheme.
5. Student should not remain absent from the work assigned without prior permission. The attendance sheet will be maintained which will be signed by HOD/Section Head concerned.
6. The certificate of performance of work to be obtained from the concerned HOD before the process of payment.

7. Daily worksheet should to be maintained which is to be endorsed by the Concerned HOD/HOI.

8. Such Engagement will be semesterwise, then a review will be taken. After review the further course of action with regard to extension /appointment be decided.

4. Process of Selection of student under earn while u learn scheme

1. At the start of the academic year application is to be invited for the earn while u learn

2. Also invite requirement of such services from each institution/section and then number will be decided by Vice President, Director General, Director (A&GA) & Executive Registrar. However it cannot be more than two or 10% of the total number of supporting /administrative staff in the Library/Laboratory/Section concerned whichever is less.

3. Following can be the member of the committee for selection of the students under earn while u learn scheme

   a) Concerned Head of Institution(Chair Person)

   b) Executive Registrar

   c) Concerned Head of the Department

   d) Concerned Deputy Registrar/Administrative Officer(Member Secretary)

   e) Internal Auditor

5. Payment

a) In a week maximum 10 hours work can be assigned to the student and payment can be done on hourly basis, normally it can be **Rs. 150** per hour. However rate will be determined depending upon the nature of work. Payment will be done on monthly basis.

b) Payment of students under the scheme can be meet normally against the vacant post at the level of Assistant in library, Assistant in laboratory or Assistant in the administration. However, where such thing is not possible due to non -availability of vacant post ,then expenditure can be against needy student/scholarship fund as to be decided

Undertakings

NIRMA UNIVERSITY

INSTITUTE OF SCIENCE

NAAC ACCREDITED 'A' GRADE

UNDERTAKING

I, Mr./Ms. _____ son/daughter of _____ have secured admission at the Institute of Science, Nirma University in the year 2020-21 for the M.Sc. Programme. 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

NIRMA UNIVERSITY
INSTITUTE OF SCIENCE
NAAC ACCREDITED 'A' GRADE

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:_____

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 up to the one additional semester for cases falling under (i), (ii) and upto two additional semesters for case falling under (iii) for 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,

Name: _____

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: _____

_____

Signature of the Parents/ Local Guardian: _____

Name of the Parents/ Local Guardian: _____

NIRMA UNIVERSITY
INSTITUTE OF SCIENCE
NAAC ACCREDITED 'A' GRADE

Undertaking for not involving himself/herself for Ragging

UNDERTAKING

I, _____, admitted in _____ of the Institute of Science, Nirma University, Ahmedabad 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: _____

_____

Signature of the Parents/ Local Guardian: _____

Name of the Parents/ Local Guardian: _____

Appendix-I

AFFIDAVIT BY THE STUDENT

I,_____*(full name of student with Roll No.)* s/o d/o Mr./Mrs./Ms._ _____, having been admitted to _____***M.Sc. / Ph.D. Programme at the Institute of Science, Nirma University,***_____have received a copy of the UGC Regulations on Curbing the Menace of Ragging in Higher Educational Institutions, 2009, (hereinafter called the "Regulations") carefully read and fully understood the provisions contained in the said Regulations.

1) I have, in particular, perused clause 3 of the Regulations and am aware as to what constitutes ragging.

2) I have also, in particular, perused clause 7 and clause 9.1 of the Regulations and am fully aware of the penal and administrative action that is liable to be taken against me in case I am found guilty of or abetting ragging, actively or passively, or being part of a conspiracy to promote ragging.

3) I hereby solemnly aver and undertake that

   a) I will not indulge in any behaviour or act that may be constituted as ragging under clause 3 of the Regulations.

   b) I will not participate in or abet or propagate through any act of commission or omission that may be constituted as ragging under clause 3 of the Regulations.

4) I hereby affirm that, if found guilty of ragging, I am liable for punishment according to clause 9.1 of the Regulations, without prejudice to any other criminal action that may be taken against me under any penal law or any law for the time being in force.

5) I hereby declare that I have not been expelled or debarred from admission in any institution in the country on account of being found guilty of, abetting or being part of a conspiracy to promote, ragging; and further affirm that, in case the declaration is found to be untrue, I am aware that my admission is liable to be cancelled.

Declared this _____ day of _____ month of _____ year

_____
Signature of deponent
Name:

VERIFICATION

Verified that the contents of this affidavit are true to the best of my knowledge and no part of the affidavit is false and nothing has been concealed or misstated therein.

Verified at ___(Place)__ on this the ___(day)__ of __(month)__, ___(year)___.

_____
Signature of deponent

Solemnly affirmed and signed in my presence on this the ___(day)__ of __(month)__ , (year)___ after reading the contents of this affidavit.

_____
OATH COMMISSIONER

Appendix-II

AFFIDAVIT BY PARENT/GUARDIAN

1. Mr./Mrs./Ms. _____ (full name of parent/guardian) father/mother/guardian of _____ (full name of student with admission/registration/enrollment number) having been admitted to ***M.Sc. / Ph.D. at Institute of Science, Nirma University*** have received a copy of the UGC Regulations on curbing the menace of ragging in Higher Educational Institutions, 2009, (hereinafter called the "Regulations"), carefully read and fully understood the provisions contained in the said Regulations.
2. I have, in particular, perused clause 3 of the Regulations, and am aware as to what constitutes ragging.
3. I have also, in particular, perused clause 7 and clause 9.1 of the Regulations and am fully aware of the penal and administrative action that is liable to be taken against my ward in case he/she is found guilty of or abetting ragging, actively or passively, or being part of a conspiracy to promote ragging.
4. I hereby solemnly aver and undertake that:
   (a) My ward will not indulge in any behaviour or act that may be constituted as ragging under clause 3 of the Regulations.
   (b) My ward will not participate in or abet or propagate through any act of commission or omission that may be constituted as ragging under clause 3 of the Regulations.
5. I hereby affirm that, if found guilty of ragging, my ward is liable for punishment according to clause 9.1 of the Regulations, without prejudice to any other criminal action that may be taken against my ward under any penal law or any law for the time being in force.
6. I hereby declare that my ward has not been expelled or debarred from admission in any institution in the country on account of being found guilty of, abetting or being part of a conspiracy to promote, ragging; and further affirm that, in case the declaration is found to be untrue, the admission of my ward is liable to be cancelled

Declared_____ day of _____ month of _____ year

Signature of Deponent

Name:
Address:
Phone/Mobile No.:

VERIFICAITON

Verified that the contents of this affidavit are true to the best of my knowledge and no part of the affidavit is false and nothing has been concealed or misstated therein.

Verified at_____(Place) on this the _____(day of)_____ Month) _____(year).

_____
Signature of deponent

Solemnly affirmed and signed in my presence on this the _____ (day) of _____ (month) _____ (year) after reading the contents of this affidavit.

_____
OATH COMMISSIONER

Nirma University, Ahmedabad
Institute of _____
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

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 _____, 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

Photograph of candidate duly attested by the Medical Officer

Dated:

NIRMA UNIVERSITY

INSTITUTE OF SCIENCE

NAAC ACCREDITED 'A' GRADE

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)
X 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:

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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)

(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
4. [9] M.Sc. in Cosmetic Technology

Here, Attached Syllabus are of 2019-20 academic year.
New syllabus for the academic year 2020-21 will be updated after approval.

[9] Amended by addition vide notification no. NU-100 dated 16.10.2014, BoG Mtg. Reso.8(d) - Fur. Info.

ANNEXURE-I

M.Sc. Biochemistry

APPENDIX-A

Institute of Science
Nirma University

Teaching & Examination Scheme of M.Sc. Biochemistry (2019-20)

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	-	14	-	7	-	10.0	1.00	-	-
7	3SBT113	Seminar I	-	1	-	1	-	-	1.00	-	-
		Total	**15**	**15**		**23**					
Supplementary Courses											
8	3SBT1S2	Basics of Biological Sciences	-	2	-	-	-	-	1.00	-	-
9	3SBT1C1	Cyber Security	1	-	-	-	-	-	1.00	-	-
		Total	**1**	**2**		**-**					
Semester-II											
1	3SBC201	Neurobiochemistry	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
6	3SBC204	Laboratory II	-	14	-	7	-	10.0	1.00	-	-
7	3SBT212	Seminar II	-	2	-	2	-	-	1.00	-	
		Total	**12**	**16**		**21**					
Supplementary Courses											
1	3SBT2H1	Introduction to Professional Ethics, Rights & Duties	1	-	-	-	-	-	1.00	-	
2	3SBT2E2	Professional English	1	-	-	-	-	-	1.00	-	-
3	3SBT2H2	Social Extension Activities	-	2	-	-	-	-	1.00	-	-
		Total	**2**	**2**		**-**					
		Institute Elective									
1		Elective I	3	-	-	3	3.0	-	0.60	-	0.40
		Total	**3**	**-**		**3**					
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
		Total	**15**	**14**		**22**					
Supplementary Courses											
1		Dissertation Tutorial	-	-	1	-	-	-	1.00	-	
		Total	**-**	**-**	**1**	**-**	-				
		Institute Elective									
1		Elective II	3	-	-	3	3.0	-	0.60	-	0.40
		Total	**3**	**-**		**3**					
Semester-IV											
1	3SBC402	Dissertation	-	-		26	-	-	0.60	0.40	-
2	3SBC404	Comprehensive Viva Voce	-	2		2	-	-	1.00	-	-
3	3SBT405	CV Writing & Interview Preparation	-	1		-	-	-	1.00	-	-
		Total	-	**3**		**28**					

Compulsory summer training following semester II for 21 working days

L: Lectures, P/T: Practicals/Tutorial, C: Credits
MSE: Mid Semester Examination
PRE: Practical Examination
LPW: Laboratory / Project Work
SEE: Semester End Examination
TA: Term Assignment

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

Elective II *(Semester III)*
3SBC3E1 Structural Biology
3SBT3E1 Genomics & Proteomics
3SMB307 Microbial Diversity and systematics
3SBT309 Vaccinology

Supplementary Courses

Semester I **3SBT1S2 Basics of Biological Sciences**
3SBT1C1 Cyber Security

Semester II **3SBT2E2 Professional English**
3SBT2H1 Introduction to Professional Ethics, Rigths & Duties
3SBT2H2 Social Extension Activities

Semester III **Dissertation Tutorials**
3SBC3A1 Neuroendrocrine Regulation of Behavior
3SBC3S1 Understanding Gastrointestinal Hormones and Gut associated cancer
3SBC3S2 Molecular Mechanisms of Infertility
3SBC3S3 Pathogenesis of Diabetes
3SBC3S4 Genotoxicity Testing for Cancer Risk Assessment
3SBC3S5 Applied Human Cytogenetics
3SBT3S1 Carbon Catabolite Repression
3SBT3S2 Immunological Memory
3SBT3M1 Protein Stability
3SMB3N1 Microbial Community Dynamics and Ecological Succession
3SMB3V1 Antimicrobial Agents

Semester IV **3SBT405 CV Writing & Interview Preparation**

Dr. Shalini Rajkumar **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. **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	**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 sytems 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 dicuss, interpret and analyze biochemical alterations and evaluate the pathophysiological changes during diseased condition.

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

Unit 1: Digestive Syatem: 9 Hours

Food Intake and Regulation, Digestive Processes, Enzymes and Secretions in the Oral Cavity and their Functions, Stomach and Intestine, Digestive Glands and their Regulation, Disorders and Homeostatic Imbalances.

Unit 2: Cardiovascular System 9 Hours

Formed Elements of Blood, Blood Plasma, Blood Groups, Blood Coagulation, Homeostasis, Heart and Cardiac Cycle, Origin, Conduction and Regulation of Heart Beat, Cardiac Disorders, Lymphatic System.

Unit 3: Respiratory System 6 Hours

Exchange of Gases, Transport of Gases, Control and Regulation of Respiration, Disorders

Unit 4: Urinary System 9 Hours

Structure and anatomy of Kidney, Histology, type and function of nephrons and collecting duct, Mechanism of Urine Formation and Regulation, Haemodialysis and Homeostatic Imbalances in Excretion.

Unit 5: Skeletal System 6 Hours

Components of Skeletal System, Skeletal Organization; Axial and Appendicular System; Bone Structure and Function, Development and Growth

Unit 6: Health and Disease 6 Hours

Diabetes, Hepatitis, Fatty liver, obesity and anorexia nervosa, Hypertension, Myocardial Infarction, Atherosclerosis, Upper and lower respiratory tract disorders, Urinary tract Infection, Renal failure, Herniated Disc, Scoliosis, Spina Bifida.

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 Torotra 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 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. Bruce Alberts, Molecular Biology of Cell, 6th Edition, 2015.
2. Bruce Alberts, Molecular Biology of Cell, A Problem Approach, 2015
3. R. Phillips et. Al, Physical Biology of the cell, 2nd Edition, 2013.
4. M. L. Casem, Case studies in Cell Biology, 2016.
5. R. Shrivastava, Apoptosis, Cell Signalling and Human Diseases, Molecular Mechanisms, Volume:1 & 2.
6. Robert Lanza (Editor), Essentials of Stem cell biology, 2nd Edition, 2009.
7. Cell Biology: Translational impact in cancer biology and bioinformatics. Maika G. Mitchell, Academic Press, 2016.
8. Pollard, T. D., and Earnshaw, W. C., Cell Biology 2nd Edition, Saunders Elsevier, 2008.
9. Gerald K., Cell and Molecular Biology, Concept and Experiment, 5th Edition, Wiley, 2007.
10. Kleinsmith, L. J. J. Principles of Cell and Molecular Biology, 2nd Edition, Benjamin Cummings, 1997.
11. 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.
12. 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 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
-	-	14	7

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

Course Learning Outcomes (CLO):

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

1. Develop a basic understanding of good lab practice and record keeping
2. Learn handling of microscope, pH meter, spectrophotometer type of common instruments
3. Have a reasonable experimental foundation for remaining semesters

Syllabus **Teaching Hours: 210**

Microscopy, Mitosis, Meiosis, Simple and differential staining procedures, Chromosome analysis, CFU determination and bacteriophage isolation from soil and sewage sample, Growth curve of bacteria, Sample Preparation and Separation of Amino Acids, Lipids and Sugars by TLC, Estimation of biomolecules; Enzymatic Assays.

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

Course 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.

Supplementary Courses

L	T	P	C
-	2	-	-

Course Code	**3SBT1S2**
Course Title	**Basics of Biological Sciences**

Course 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

Introduction to Biochemistry, water as a biological solvent. Molarity, Normality, Molality, Molar, Normal and % solutions. Weak acids and bases, pH, pKa, buffers, Handerson-Hasselbalch equation, buffering capacity, physiological buffers, Chemical interactions, Structure and functions of cell organelles, Basic Principles of Thermodynamics.

Nucleic acids as genetic information carriers, Primary structure of nucleic acids and their properties, salient features of eukaryotic, prokaryotic and viral genomes, Secondary and tertiary structure of DNA, Basics of DNA replication, transcription and translation.

Introduction to prokaryotic and eukaryotic life forms, evolution and basic classification of Bacteria, Archaea, Fungi, Algae, Protozoa and Viruses.

Monitoring & Assessment:

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

L	T	P	C
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Course Code	**3SBT1C1**
Course Title	**Cyber Security**

Course Learning Outcomes (CLO):

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

1. Realize the need for Cyber Security
2. Understand the need for Security in day to day co mmunications
3. Understand the vulnerabilities in the Network and Computer System
4. Protect themselves from the attacks

Syllabus **Teaching Hours: 15**

1. Need for Information and Cyber Security: Role of Cyber Security Professionals, Role of novices in Cyber Security
2. Basics of Internet: How TCP/IP and the World Wide Web works?
3. Hackers Community: Invading PCs, Script Kiddies, Personal Hacker Protection
4. Impact of Spyware, Worms and Viruses: Spyware, Morphing Spyware, Home Page and Search Page

Hijackers, Introduction to Dialers, Keyloggers and Rootkits, Protection against Spyware
5. Zombies: Zombies and Bots, Trojan Horses, Protection against Zombies and Trojans
6. Websites and Privacy: Cookies, Web Bugs, Activity Tracking
7. Internet Search: Working of Google and Knowledge of Google
8. Phishing Attacks: Working of Phishing, Protection against Phishing Attacks
9. Security in browsers: Exploiting Browsers, Protection against Browser Based Attacks
10. Wi-Fi Protection: Working, Invading Wi-Fi Networks, Role of Hotspots, Evil Twin Attacks, War Drivers, Working of Wireless Network Protection
11. Spam: Dangers of Spam, hiding spam identity, Anti-Spam Software
12. Denial of Service Attacks and Protection: Working of DoS Attacks, Protection against Denial-of-Service Attacks
13. Hacking Cell Phones: Dangers of Cell Phone Hacking, Bluesnarfing
14. Case Study: Financial Implications of Zombies, Spyware, Phishing, Nigerian 419 Spam, Money Trails of Internet Access
15. Note: The duration for engagement of this course is 9 sessions with each session of one hour. The sessions will include both theory and practical

Suggested Readings:

1. Gralla, P. (2006). How Personal & Internet Security Works (How It Works). Que Corp..
2. Basta, A., & Halton, W. (2007). Computer Security: Concept, Issues, and Implementation. Cengage Learning publication.

SEMESTER II

Core Courses

L	T	P	C
3	-	-	3

Course Code	**3SBC201**
Course Title	**Neurobiochemistry**

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 Moleculer Biology, Oxford University Press, 2001

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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.

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 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, 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 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
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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: 210

Pubmed searches, Scopus and Biological databases, Structure visualization and statistical methods, sequence similarity search, Prediction of protein structure, Docking of protein and ligand, In-silico

cloning, phylogenetic analysis; Nucleic acid isolation and estimation, Horizontal gel electrophoresis; Antibody production and isolation, ELISA, Immunoglobulin purification; Female and male Reproductive physiology assessment; Study of Various Parts of the Brain, Study of neurodegeneration using animal models, Functions related to Cranial nerves, Neurobiology of Broca's and Wernicke's disorder, Histological examination.

L	T	P	C
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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	**3SBT2H2**
Course Title	**Social Extension Activities**

Course Learning Outcomes (CLO):

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

1. Get sensitized to contribute to the needs of the less privileged in the society
2. Develop sense of social responsibility, team-spirit, and empathy
3. Demonstrate proactiveness in terms of identifying and contributing to the needs of the society especially in the areas of their expertise

Syllabus:

The On-Going extension activities in coordination with identified NGOs at Nirma University will be explored. The students will be assigned social activites for at least 30 hours before the end of the second semester. Students will prepare the report of the work done which will be certified by the concerned NGOs along with time duration. In addition to the field activities the students will be encouraged to read inspirational literature by arranging various competitions, inviting persons wellknown in the field for a lecture etc.students will be passed on fulfilling the requirement of 30 hours of certified work.

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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.

Books Recommended

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

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. A short history of Medical Genetics – Peter Harper, Oxford Uni. Press, 2008
2. ISCN 2016, Jean McGowan-Jordan, A. Simons, M. Schmid; Karger, 2016
3. Rooney D. E., and Czepulkowski, B. H., Human Cytogenetics: A Practical Approach (Vol. I & II), 1992 Edition, Oxford University Press, 1992.
4. Peter Russell, iGenetics, A molecular approach, Third Edition, 2010.
5. H-J. Muller & T. Roder, Microarrays, The Experiment series, 2006.
6. Klug et.al, Concepts of Genetics, 10th Edition, 2012.
7. P.W. Hedrick, Genetics of populations, 4th Edition, 2011.
8. D. Peter Snustad & M.J. Simmons, Principles of Genetics, 5th Edition.2010.
9. Griffith A. J.F., Wessler S.R., Carroll, S.B., and Doebley J., Introduction to Genetic Analysis, 10th Edition, W. H. Freeman, 2010.
10. Benjamin P., Genetics: A Conceptual Approach & Problem Solving, 2008, W. H. Freeman, 2008.
11. Hedrick, P. W. (2011) Genetics of Populations, 4th Edn., Jones & Bartlett Publ.
12. Vogel and Motulsky's Human Genetics: Problems and approaches, Michael R. Speicher, Stylianos E. Antonarakis, Arno G. Motulsky, Springer; 4th ed. 2010 edition.
13. The AGT Cytogenetics Laboratory Manual, M.J.Barch, T.Knutsen, and J.Spurbeck.,Third Edition,Lippincott-Raven Publishers, Philadelphia (1997)
14. 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
15. Ricki Lewis Human Genetics Concepts and Applications 10th Edition, 2011, McGraw-Hill Science.
16. The Science of Genetics, Atherly et al (1999), Saunders
17. Robbins & Cotran, Pathologic Basis of Disease, 8th Edition, Elsevier, 2010.
18. 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.

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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

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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 -

5. Identify types of mutations including spontaneous and induced mutations and understand mechanisms of mutagenesis, DNA damage repair and DNA recombination pathways.
6. Understand molecular mechanisms of gene transfer in microbes and phages and relate the role

of these mechanisms for fine structure mapping of genes.
7. 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.
8. 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	3SBT2H1
Course Title	Introduction to Professional Ethics, Rights & Duties

Course Learning Outcomes (CLO):

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

1. Understand the importance of values and ethics in their professional life and career.
2. Recognize various human rights and develop holistic perspective towards profession, life and happiness based on a correct understanding of values.
3. Set up standards for code of conduct and ethics of scientific profession.

Syllabus: Teaching Hours: 15

Unit 1: Ethics: Introduction to Ethics, Institutional, professional and Scientific ethics, ethics in reporting, plagiarism, confidentiality, Conflict of interest, Ethical use of Patents & Trademarks, Ethical breach, dilemma and problems.

Unit 2: Rights and Duties: Introduction to Fundamental Rights and Duties, Classification of Rights and Duties, Values, Freedom, Social Responsibilities, Morals, Rights of Aged, Disabled, Women and Children, Introduction to Human Rights Law .

Suggested Readings:

1. Deborah L. Rhode, Teaching Legal Ethics, St. Louis Law Journal.
2. Ross Cranston, Legal Ethics and professional Responsibilities.
3. Eleanor W. Myers, Simple Truths about Moral Education, American University of Law Review.
4. Michael Sandel: What Money can`t Buy?
5. Alasdair Maelntyre: A short history on ethics

SEMESTER III

Core Courses

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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. Analyze 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

IIntroduction, Dose Response Relationship, Determination of ED5O and- 'EDSO, Acute and Chroni`c Exposures, Chemical and Biological Facto,rs, Regulatory Guidelines and Toxicity Testing Protocols .

Unit 2: Toxicants and Toxicity 7 Hours

Insectisdes, Organochlorides, Anti-Cholinesterases, Organophosphates and Carbamates, Consequences ofPesticide Toxicity,` Toxicology of Food Additives and Heavy Metal Toxicity.

Unit 3: Structure, Mechanism and Regu.lation 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 6 Hours

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 Defense systems, Signaling systems and Antioxidant Defense, Enzymes involved in Bioactivation.

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. Analyze 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 10 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 Behaviour 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 Catechols and their correlation with microbial endocrinology, Modulation of interaction of Enteric bacteria with intestinal Mucosa, Stress, Immunity and indigenious 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- interkingdom 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.

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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 120

Tissue Biochemistry, Tissue Oxidative stress assessment, In vitro assessment of Genotoxicity, Cancer cytogenetics, Liver and Kidney Function Tests, Analysis of Blood and Urine, Lipid Profile, Preparation of RBC Ghost Cells, Histology of Endocrine Glands, Estimation of Endocrine Hormones and Histological studies; Hepatocytes, Pancreatic, and Lymphocyte – isolation, cell preparation, cell viability, counting, and culture.

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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. Demonstrate skills for literature review and understanding of research and review articles.
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:

Unit 1: Research:

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:

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:
Contents-Preamble, The Problem, Objectives, Hypothesis To Be Tested, 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 Writing of Books and Research Papers, Report Writing- Prewriting Considerations, Thesis Writing, Formats of Report Writing, Formats of Publications in Research Journals.

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. Kothari, C.K., 2/E, Research Methodology-Methods and Techniques, New Age International, New Delhi, 2004.
9. Besterfield, Dale H. 3/E, Total Quality Management, Pearson Education, New Delhi, 2005.

Practical

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

Supplementary Course: Dissertation Tutorials

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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.

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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.

L	T	P	C
1	-	-	1

Course Code	3SBC3S2
Course Title	Molecular Mechanisms of Infertility

Course Learning Outcomes (CLO):

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

1. Understand the causes for the initiation of reproductive infertility.
2. Determine the probable targets for the treatment.
3. Analyse and evaluate the molecular mechanism and probable role of stress and immunology in infertility.

Syllabus:

Incidences and etiology of Male and female infertility, molecular mechanism of induction of infertility, role of mitochondria, hormones and immunological mediators, identification of molecular markers for male and female infertility.

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	3SBT3S1
Course Title	Carbon Catabolite Repression

Course Learning Outcomes (CLO):

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

1. Understand the physiological and molecular mechanisms that regulate preferential utilization of carbon source
2. Learn the strategies of preferential C utilization in multisubstrate environment like soil and its impact on microbial physiology

Syllabus:

Response to Carbon sources: Catabolite repression, Inducer Expulsion, Permease synthesis, repression models in *E. coli* and *Pseudomonas*, Reverse Catabolite repression, Catabolite repression and Mineral phosphate solubilization.

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	3SBT3M1
Course Title	Protein Stability

Course Learning Outcomes (CLO):

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

1. Describe the factors affecting the chemical and physical stability of proteins.
2. Comparative Analysis of stability of extremophilic and mesophilic proteins and application of techniques to measure stability.
3. Propose hypothesis for dissertation using literature survey, case studies and group presentation.

Syllabus:

Chemical and Physical stability of Proteins; Thermodynamic aspects of stability; Factors affecting protein stability; Two-state model of protein stability; Protein denaturation and denaturants; Stability of extremophilc proteins and comparative analysis with mesophilic proteins; Role of different amino acid residues in protein stability, Techniques to study and measure protein stability.

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-

9. Identify role of microorganisms and microbial community shifts in ecological succession. They will understand aspects of sustainability, resilience and importance of indicator species.
10. 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.

Elective Courses II

L	T	P	C
3	-	-	3

Course Code	3SBC3E1
Course Title	Structural Biology

Course Learning Outcomes (CLO):

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

1. Demonstrate the understanding of architecture and building blocks of proteins.
2. Apply the thermodynamic concepts of protein stability and relate structure to its function.
3. Analyse the significance of protein misfolding and associated disorders.
4. Evaluate macromolecular complexes and their biological complexity.

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

Unit 1: Introduction: **6 hours**

Overview of structural biology - Levels of structures in Biological macromolecules; Noncovalent forces determining biopolymer structure; Principles of minimization of conformational energy.

Unit 2: Protein Structure: **9 hours**

Proteins primary, secondary and tertiary structures - Structural implications of the peptide bond; Ramachandran Diagram; Structural classification of proteins, structural motifs, profiles and protein families; Methods and techniques for study of protein structure and its perturbations.

Unit 3: Protein Folding: 7 **hours**

Folding in vivo and in vitro; protein stability, thermodynamics and kinetics; Effect of various factors on folding; Folding intermediates- kinetic, equilibrium and molten globule intermediates; Techniques for studying the structure and folding of proteins; chaperones, peptidyl prolyl isomerase (PPI), Protein disulfide isomerase (PDI); Protein structure and disease; Therapeutic approaches; Comparison of the structure and stability of proteins of mesophilic and extremophilic origin.

Unit 4: Biomolecular Interactions: **9 hours**

Molecular recognition, supramolecular interactions, Protein-protein interactions and their importance.

Unit 5: Nucleic Acids Structure and Protein-Nucleic Acid Interaction: **7 hours**

Structural parameters for A-, B-, C-, D- and Z-DNA, Structure of RNA; Specific and non-specific nucleic acid-protein complexes and the functional importance

of protein-nucleic acid interactions; Macromolecular assemblies.

Unit 6: Membrane Structure: **7 hours**

Lipid structure and their organization; Comparison between different membrane models; carrier transport, ion transport, active and passive transport, ion pumps, water transport, use of liposomes for membrane models and drug delivery systems.

Suggested reading;

1. Branden, C. and Tooze, J., Introduction to Protein Structure, Garland Publishing Inc., 1999.
2. Tinoco, I., Sauer, K., Wang, J. C., and Puglisi, J. D., Physical Chemistry: Principles and Applications in Biological Sciences, 4th ed., Prentice Hall, 2001.
3. Grisshammer, R. K., Buchanan, S. K., Structural Biology of Membrane proteins, Royal Society of Chemistry, 2006.
4. Rice, P. A. and Correl, C. C., Protein-Nucleic Acid Interactions: Structural Biology, RSC Publishing, 2008.
5. Blackburn, M. G., Gait, M. J., Loakes, D. and Williams, D. M., Nucleic Acids in Chemistry and Biology, RSC Publishing, 2006.
6. Creighton, T. E. Proteins: Structure and Molecular Properties, W. H. Freeman, 1995.
7. Creighton, T. E. (Editor), Protein Function: A Practical Approach, Oxford University Press, 2002.
8. Lesk, A. M., Introduction to Protein Architecture: The Structural Biology of Proteins, US Oxford University Press, USA, 2001.

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 genome 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 genome mapping: 8Hours

Different databases, Alignment and homology tools, Origin of genomics, the first DNA genomes, microcolinearity, DNA based phylogenetic trees, 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, EST and transcript maps, functional maps, comparative genomics and colinearity, synteny in maps.

Unit-2 Whole Genome sequencing and analysis: 5Hours

Genome sequencing methods review, analysis of the genomes of viruses, bacteria, archae, eukaryotic – fungi, parasites, insects, plant genomes (Arabidopsis and rice), Animal genomes (fruit fly, mouse, human)

Unit-3 Annotation of whole genome sequence and functional genomics: 8Hours

In Silico methods, insertion mutagenesis (T-DNA and transport insertion), Targeting Induced Local Lesions in Genomes (TILLING), management of data, gene expression and transcript profiling, EST contigs and unigene sets, use of DNA chips and microarrays.

Unit-4 Pharmacogenomics: 8Hours

Use in biomedicine involving diagnosis and treatment of diseases, genomics in medical practice, personalized medicine, DNA polymorphism and treatment of diseases, application of SNP-technology-mapping genes underlying monogenic and multigenic disorder, use of SNP in pharmacogenomics, pharmacogenomics and industry.

Unit-5 Proteomics 8Hours

Introduction and overview of tools used in proteomics studies, protein - protein interaction, DNA- Protein interaction, application of quantitative proteomics for the analysis of protein - protein interactions and protein linkage maps, understand yeast two-hybrid and mass spectrometry based techniques for the analysis of protein complexes and their significance and limitations.

Unit-6 Drug Discovery and Development: 8Hours

Structure prediction and human proteomics, mutant proteins, use of computer simulations and knowledge-based methods in the design process, proteomic methods for the detection and analysis of protein

biomarkers for the detection and classification of disease, De-novo design; making use of databases of sequence and structure, protein structure and drug discovery, proteins in disease, current issues, drug targets, drug efficacy, protein chips and antibody microarray, techniques and future approaches of proteomics in cancer research.

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.]

L	T	P	C
3	-	-	3

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.

SEMESTER IV

Core Courses

L	T	P	C
-	-	-	26

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	**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.

L	T	P	C
-	-	1	-

Course Code	**3SBT405**
Course Title	**CV Writing and Interview Preparation**

Course Learning Outcomes (CLO):

Course Learning Outcomes (CLO):

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

1. 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:

This course will be guiding the students to prepare their CV as per the requirement of the employer both at the academic as well as industrial sector. This will also help the students to prepare for job interviews with the help of Mock Interviews, Group Discussions and interpersonal communication skills.

ANNEXURE-I

M.Sc. Biotechnology

APPENDIX-A

Institute of Science
Nirma University

Teaching & Examination Scheme of M.Sc. Biotechnology (2019-20)

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	3BC101	Metabolism	3	-	-	3	3.0	-	0.60	-	0.40
2	3BT102	Cell Biology	3	-	-	3	3.0	-	0.60	-	0.40
3	3BT103	Molecular Biology	3	-	-	3	3.0	-	0.60	-	0.40
4	3BT109	General & Applied Microbiology	3	-	-	3	3.0	-	0.60	-	0.40
5	3BT111	Basic Immunology	3	-	-	3	3.0	-	0.60	-	0.40
6	3BT112	Laboratory I	-	14	-	7	-	10.0	1.00	-	-
7	3BT113	Seminar I	-	1	-	1	-	-	1.00	-	-
		Total	**15**	**15**		**23**					
Supplementary Course											
8	3BTSC1S2	Basics of Biological Sciences	-	2	-	-	-	-	1.00	-	-
9	3BTSC1C1	Cyber Security	1	-	-	-	-	-	1.00	-	-
		Total	**1**	**2**		**-**					
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	**11**	**16**		**21**					
Supplementary Courses											
2	3SBT2H1	Introduction to Professional Ethics, Rights & Duties	1	-	-	-	-	-	1.00	-	-
7	3SBT2E2	Professional English	1	-	-	-	-	-	1.00	-	-
8	3SBT2H2	Social Extension Activities	-	2	-	-	-	-	1.00	-	-
		Total	**2**	**2**		**-**					
		Institute Elective									
1		Elective I	3	-	-	3	3.0	-	0.60	-	0.40
		Total	**3**	**-**		**3**					
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
		Total	**15**	**14**		**22**					
Supplementary Courses											
1		Dissertation Tutorial	-	-	1	-	-	-	1.00	-	-
		Total	**-**	**-**	**1**	**-**	-				
		Institute Elective									
1		Elective II	3	-	-	3	3.0	-	0.60	-	0.40
		Total	**3**	**-**		**3**					
Semester-IV											
1	3SBT402	Dissertation	-	-		26	-	-	0.60	-	0.40
2	3SBT404	Comprehensive Viva Voce	-	2	-	2	-	-	1.00	-	-
3	3SBT405	CV Writing & Interview Preparation	-	1	-	-	-	-	1.00	-	-
		Total	-	**3**		**28**					

Compulsory summer training following semester II for 21 working days

L: Lectures, P/T: Practicals/Tutorial, C: Credits
MSE: Mid Semester Examination
PRE: Practical Examination
LPW: Laboratory / Project Work
SEE: Semester End Examination
TA: Term Assignment

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

Elective II *(Semester III)*
3SBC3E1 Structural Biology
3SMB304 Agricultural & Environmental Microbiology
3SBT309 Vaccinology
3SMB307 Microbial Diversity and systematics

Supplementary Course

Semester I
3SBT1S2 Basics of Biological Sciences
3SBT1C1 Cyber Security

Semester II
3SBT2E2 Professional English
3SBT2H1 Introduction to Professional Ethics, Rights & Duties
3SBT2H2 Social Extension Activities

Semester III
Dissertation Tutorials
3SBC3A1 Neuroendrocrine Regulation of Behavior
3SBC3S1 Understanding Gastrointestinal Hormones and Gut associated Cancer
3SBC3S2 Molecular Mechanisms of Infertility
3SBC3S3 Pathogenesis of Diabetes
3SBC3S4 Genotoxicity Testing for Cancer Risk Assessment
3SBC3S5 Applied Human Cytogenetics
3SBT3S1 Carbon Catabolite Repression
3SBT3S2 Immunological Memory
3SBT3M1 Protein Stability
3SMB3N1 Microbial Community Dynamics and Ecological Succession
3SMB3V1 Antimicrobial Agents

Semester IV **3SBT405 CV Writing & Interview Preparation**

Dr. Shalini Rajkumar **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
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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 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. Bruce Alberts, Molecular Biology of Cell, 6th Edition, 2015.
2. Bruce Alberts, Molecular Biology of Cell, A Problem Approach, 2015
3. R. Phillips et. al, Physical Biology of the cell, 2nd Edition, 2013.
4. M. L. Casem, Case studies in Cell Biology, 2016.
5. R. Shrivastava, Apoptosis, Cell Signalling and Human Diseases, Molecular Mechanisms, Volume:1 & 2.
6. Robert Lanza (Editor), Essentials of Stem cell biology, 2nd Edition, 2009.
7. Cell Biology: Translational impact in cancer biology and bioinformatics. Maika G. Mitchell, Academic Press, 2016.
8. Pollard, T. D., and Earnshaw, W. C., Cell Biology 2nd Edition, Saunders Elsevier, 2008.
9. Gerald K., Cell and Molecular Biology, Concept and Experiment, 5th Edition, Wiley, 2007.
10. Kleinsmith, L. J. J. Principles of Cell and Molecular Biology, 2nd Edition, Benjamin Cummings, 1997.
11. 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.
12. 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.

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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, industrial microbiology, agricultural microbiology, etc.

Syllabus: Teaching hours: 45 Hours

Unit 1. Introduction: 7 hours

History of Microbiology; General and Salient features of Bacteria, Archaea, Fungi, Algae and Viruses. Principles of classification.

Unit 2. Microbial Growth and Measurement: 8 hours

Microbial growth, Methods of Cell Growth Determination, Growth Kinetics, Synchronous Growth, Basic Growth Media and Nutritional Requirement.

Unit 3. Microbiological Techniques: 7hours

Sterilization and Preservation techniques; Aseptic Work, Pure and Mixed Culture concept, Enrichment techniques.

Unit 4. Nutritional Diversity 7 hours

Nutritional diversity, oxygenic and anoxygenic, photosynthesis, respiration, fermentations, chemolithotrophy.

Unit 5. Microbial Ecology: 8 hours

Natural habitats, Interactions among microbial population, Plant-microbe interactions, Animal-microbe interactions.

Unit 6. Applied Microbiology: 8 hours

Overview of applications of microorganisms in Agriculture, Environment, Food, Industry and Medical Sciences.

Suggested Readings:

1. Atlas, R. M. (2001) Principles of Microbiology 3rd Edition, Wm. C. Brown Pub., Iowa, USA.
2. M. T. Madigan J. M. Martinko, & J. Parker Brock biology of microorganisms 9th Edn., Prentice Hall Int. Inc.
3. Sulia, General Microbiology, Oxford, 1999.
4. J. G. Cappuccino, Microbiology a Laboratory Manual, 4th Edn., Adison-Wesley, 1999.
5. Pelzar, Microbiology _ Concepts and Application, Mc Graw Hill.
6. A. Demain, Manual of Industrial Microbiology and Biotechnology, A. S. M., 1999.
7. Prescott & Klein Microbiology 5th Edn., Mc Graw Hill.
8. G. J. Tortora Microbiology: An Introduction. 9thEdn, Benjamin Cummings, 2006.

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

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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. Have a basic understanding on various tools of microscopy, cell biology and microbiology.
2. Apply microscope and perform cell biology, microbiology and biochemistry experiments required in all future semesters.

Syllabus Teaching Hour: 210

Microscopy, Mitosis, Meiosis, Simple and differential staining procedures, Chromosome analysis, CFU determination and bacteriophage isolation from soil and sewage sample, Growth curve of bacteria, Sample Preparation and Separation of Amino Acids, Lipids and Sugars by TLC, Estimation of biomolecules; Enzymatic Assays.

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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

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	3SBT1C1
Course Title	Cyber Security

Course Learning Outcomes (CLO):

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

1. Realize the need for Cyber Security
2. Understand the need for Security in day to day co mmunications
3. Understand the vulnerabilities in the Network and Computer System
4. Protect themselves from the attacks

Syllabus

1. Need for Information and Cyber Security: Role of Cyber Security Professionals, Role of novices in Cyber Security
2. Basics of Internet: How TCP/IP and the World Wide Web works?
3. Hackers Community: Invading PCs, Script Kiddies, Personal Hacker Protection
4. Impact of Spyware, Worms and Viruses: Spyware, Morphing Spyware, Home Page and Search Page Hijackers, Introduction to Dialers, Keyloggers and Rootkits, Protection against Spyware
5. Zombies: Zombies and Bots, Trojan Horses, Protection against Zombies and Trojans
6. Websites and Privacy: Cookies, Web Bugs, Activity Tracking
7. Internet Search: Working of Google and Knowledge of Google
8. Phishing Attacks: Working of Phishing, Protection against Phishing Attacks
9. Security in browsers: Exploiting Browsers, Protection against Browser Based Attacks
10. Wi-Fi Protection: Working, Invading Wi-Fi Networks, Role of Hotspots, Evil Twin Attacks, War Drivers, Working of Wireless Network Protection
11. Spam: Dangers of Spam, hiding spam identity, Anti-Spam Software
12. Denial of Service Attacks and Protection: Working of DoS Attacks, Protection against Denial-of-Service Attacks
13. Hacking Cell Phones: Dangers of Cell Phone Hacking, Bluesnarfing
14. Case Study: Financial Implications of Zombies, Spyware, Phishing, Nigerian 419 Spam, Money Trails of Internet Access
15. Note: The duration for engagement of this course is 9 sessions with each session of one hour. The sessions will include both theory and practical

Suggested Readings:

1. Gralla, P. (2006). How Personal & Internet Security Works (How It Works). Que Corp..
2. Basta, A., & Halton, W. (2007). Computer Security: Concept, Issues, and Implementation. Cengage Learning publication.

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Course Code	3SBT1S2
Course Title	Basics of Biological Sciences

Course Learning Outcomes (CLO):

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.

Syllabus

Introduction to Biochemistry, water as a biological solvent. Molarity, Normality, Molality, Molar, Normal and % solutions. Weak acids and bases, pH, pKa, buffers, Handerson-Hasselbalch equation, buffering capacity, physiological buffers, Chemical interactions, Structure and functions of cell organelles, Basic Principles of Thermodynamics.

Nucleic acids as genetic information carriers, Primary structure of nucleic acids and their properties, salient features of eukaryotic, prokaryotic and viral genomes, Secondary and tertiary structure of DNA, Basics of DNA replication, transcription and translation.

Introduction to prokaryotic and eukaryotic life forms, evolution and basic classification of Bacteria, Archaea, Fungi, Algae, Protozoa and Viruses.

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, antifoams 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 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

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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**

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:

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

18. Gardner, E.J. Simmons, M.J. and Snustad, D.P. Principles of Genetics, 8th edition, John Wiley and sons, 2004.
19. Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. (Eds.), Lewin's Genes X, 10th edition, 2011.
20. Maloy, S.R., Cronan Jr., J.E. and Freifelder, David. Microbial Genetics, 2nd edition, Narosa Publishing House, 2009.
21. 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

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**

Pubmed searches, Scopus and Biological databases, Structure visualization and statistical methods, sequence similarity search, Prediction of protein structure, Docking of protein and ligand, In-silico cloning, phylogenetic analysis; Nucleic acid isolation and estimation, Horizontal gel electrophoresis, UV Survival curve, UV mutagenesis, Isolation of drug resistant mutants, Lac Operon Experiments; Microbial production, recovery and estimation of Exo-polysaccharide, Alcohol and Citric acid, Solid state fermentation; Antibody production and isolation, ELISA, Immunoglobulin purification.

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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.

L	T	P	C
-	-	2	-

Course Code	3SBT2H2
Course Title	Social Extension Activities

Course Learning Outcomes (CLO):

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

1. Get sensitized to contribute to the needs of the less privileged in the society
2. Develop sense of social responsibility, team-spirit, and empathy
3. Demonstrate pro-activeness in terms of identifying and contributing to the needs of the society especially in the areas of their expertise

Syllabus:

The On-Going extension activities in coordination with identified NGOs at Nirma University will be explored. The students will be assigned social

activities for at least 30 hours before the end of the second semester. Students will prepare the report of the work done which will be certified by the concerned NGOs along with time duration. In addition to the field activities the students will be encouraged to read inspirational literature by arranging various competitions, inviting persons well-known in the field for a lecture etc. students will be passed on fulfilling the requirement of 30 hours of certified work.

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

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: 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. A short history of Medical Genetics – Peter Harper, Oxford Uni. Press, 2008
2. ISCN 2016, Jean McGowan-Jordan, A. Simons, M. Schmid; Karger, 2016
3. Rooney D. E., and Czepulkowski, B. H., Human Cytogenetics: A Practical Approach (Vol. I & II), 1992 Edition, Oxford University Press, 1992.
4. Peter Russell, iGenetics, A molecular approach, Third Edition, 2010.
5. H-J. Muller & T. Roder, Microarrays, The Experiment series, 2006.
6. Klug et.al, Concepts of Genetics, 10th Edition, 2012.
7. P.W. Hedrick, Genetics of populations, 4th Edition, 2011.
8. D. Peter Snustad & M.J. Simmons, Principles of Genetics, 5th Edition.2010.
9. Griffith A. J.F., Wessler S.R., Carroll, S.B., and Doebley J., Introduction to Genetic Analysis, 10th Edition, W. H. Freeman, 2010.
10. Benjamin P., Genetics: A Conceptual Approach & Problem Solving, 2008, W. H. Freeman, 2008.
11. Hedrick, P. W. (2011) Genetics of Populations, 4th Edn., Jones & Bartlett Publ.
12. Vogel and Motulsky's Human Genetics: Problems and approaches, Michael R. Speicher, Stylianos E. Antonarakis, Arno G. Motulsky, Springer; 4th ed. 2010 edition.
13. The AGT Cytogenetics Laboratory Manual, M.J.Barch, T.Knutsen, and J.Spurbeck.,Third Edition,Lippincott-Raven Publishers, Philadelphia (1997)
14. 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
15. Ricki Lewis Human Genetics Concepts and Applications 10th Edition, 2011, McGraw-Hill Science.
16. The Science of Genetics, Atherly et al (1999), Saunders
17. Robbins & Cotran, Pathologic Basis of Disease, 8th Edition, Elsevier, 2010.
18. 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. 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 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: 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 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.
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
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
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Course Code	3SBT2H1
Course Title	Introduction to Professional Ethics, Rights & Duties

Course Learning Outcomes (CLO):

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

1. Understand the importance of values and ethics in their professional life and career.
2. Recognize various human rights and develop holistic perspective towards profession, life and happiness based on a correct understanding of values.
3. Set up standards for code of conduct and ethics of scientific profession.

Syllabus: **Teaching Hours: 15**

Unit 1: Ethics: Introduction to Ethics, Institutional, professional and Scientific ethics, ethics in reporting, plagiarism, confidentiality, Conflict of interest, Ethical use of Patents & Trademarks, Ethical breach, dilemma and problems.

Unit 2: Rights and Duties: Introduction to Fundamental Rights and Duties, Classification of Rights and Duties, Values, Freedom, Social Responsibilities, Morals, Rights of Aged, Disabled, Women and Children, Introduction to Human Rights Law .

Suggested Readings:

1. Deborah L. Rhode, Teaching Legal Ethics, St. Louis Law Journal.
2. Ross Cranston, Legal Ethics and professional Responsibilities.
3. Eleanor W. Myers, Simple Truths about Moral Education, American University of Law Review.
4. Michael Sandel: What Money can`t Buy?
5. Alasdair Maelntyre: A short history on ethics

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 glucoseand 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: 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, Quroum 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:

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

L	T	P	C
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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.

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

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 genome 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 genome mapping: 8Hours

Different databases, Alignment and homology tools, Origin of genomics, the first DNA genomes, microcolinearity, DNA based phylogenetic trees, 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, EST and transcript maps, functional maps, comparative genomics and colinearity, synteny in maps.

Unit-2 Whole Genome sequencing and analysis: 5Hours

Genome sequencing methods review, analysis of the genomes of viruses, bacteria, archae, eukaryotic – fungi, parasites, insects, plant genomes (Arabidopsis and rice), Animal genomes (fruit fly, mouse, human)

Unit-3 Annotation of whole genome sequence and functional genomics: 8Hours

In Silico methods, insertion mutagenesis (T-DNA and transport insertion), Targeting Induced Local Lesions in Genomes (TILLING), management of data, gene expression and transcript profiling, EST contigs and unigene sets, use of DNA chips and microarrays.

Unit-4 Pharmacogenomics: 8Hours

Use in biomedicine involving diagnosis and treatment of diseases, genomics in medical practice, personalized medicine, DNA polymorphism and treatment of diseases, application of SNP-technology-mapping genes underlying monogenic and multigenic disorder, use of SNP in pharmacogenomics, pharmacogenomics and industry.

Unit-5 Proteomics 8Hours

Introduction and overview of tools used in proteomics studies, protein - protein interaction, DNA- Protein interaction, application of quantitative proteomics for the analysis of protein - protein interactions and protein linkage maps, understand yeast two-hybrid and mass spectrometry based techniques for the analysis of protein complexes and their significance and limitations.

Unit-6 Drug Discovery and Development: 8Hours

Structure prediction and human proteomics, mutant proteins, use of computer simulations and knowledge-based methods in the design process, proteomic methods for the detection and analysis of protein biomarkers for the detection and classification of disease, De-novo design; making use of databases of sequence and structure, protein structure and drug discovery, proteins in disease, current issues, drug targets, drug efficacy, protein chips and antibody microarray, techniques and future approaches of proteomics in cancer research.

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.]

L	T	P	C
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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. Understand the basics of primary cell and cell line culture, wastewater characterisation, microbial physiology of agriculturally and environmentally important microbes and bioremediation.
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: 120**

Hepatocytes, Pancreatic, and Lymphocyte – isolation, cell preparation, cell viability, counting, and culture; Diauxie growth of E. coli, Catabolite repression in E.coli, MPN of Azospirillum and sulphate reducers, Estimation of soil microbial activity and soil respiration, Isolation and enumeration of Rhizobium, phosphate solubilizers and Actinomycetes, Rhizosphere effect; Estimation of BOD, Testing for microbiological quality (Coli-form test) for potable water and physico-chemical characterization of wastewater, Biosorption of Metals.

L	T	P	C
3	-	6	6

Course Code	3SBT312
Course Title	Research Methods

Course Learning Outcomes (CLO):

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

1. Demonstrate skills for literature review and understanding of research and review articles.
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:

Unit 1: Research:

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:

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:

Contents-Preamble, The Problem, Objectives, Hypothesis To Be Tested, 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 Writing of Books and Research Papers, Report Writing- Prewriting Considerations, Thesis Writing, Formats of Report Writing, Formats of Publications in Research Journals.

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. Kothari, C.K., 2/E, Research Methodology-Methods and Techniques, New Age International, New Delhi, 2004.
9. Besterfield, Dale H. 3/E, Total Quality Management, Pearson Education, New Delhi, 2005.

Practicals

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

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	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	3SBC3S2
Course Title	Molecular Mechanisms of Infertility

Course Learning Outcomes (CLO):

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

1. Understand the causes for the initiation of reproductive infertility.
2. Determine the probable targets for the treatment.
3. Analyse and evaluate the molecular mechanism and probable role of stress and immunology in infertility.

Syllabus:

Incidences and etiology of Male and female infertility, molecular mechanism of induction of infertility, role of mitochondria, hormones and immunological mediators, identification of molecular markers for male and female infertility.

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	3SBT3S1
Course Title	Carbon Catabolite Repression

Course Learning Outcomes (CLO):

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

1. Understand the physiological and molecular mechanisms that regulate preferential utilization of carbon source
2. Learn the strategies of preferential C utilization in multisubstrate environment like soil and its impact on microbial physiology

Syllabus:

Response to Carbon sources: Catabolite repression, Inducer Expulsion, Permease synthesis, repression models in *E. coli* and *Pseudomonas*, Reverse Catabolite repression, Catabolite repression and Mineral phosphate solubilization.

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	3SBT3M1
Course Title	Protein Stability

Course Learning Outcomes (CLO):

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

1. Describe the factors affecting the chemical and physical stability of proteins.
2. Comparative Analysis of stability of extremophilic and mesophilic proteins and application of techniques to measure stability.
3. Propose hypothesis for dissertation using literature survey, case studies and group presentation.

Syllabus:

Chemical and Physical stability of Proteins; Thermodynamic aspects of stability; Factors affecting protein stability; Two-state model of protein stability; Protein denaturation and denaturants; Stability of extremophilc proteins and comparative analysis with mesophilic proteins; Role of different amino acid residues in protein stability, Techniques to study and measure protein stability.

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:

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.

Elective Courses II

L	T	P	C
3	-	-	3

Course Code	**3SBC3E1**
Course Title	**Structural Biology**

Course Learning Outcomes (CLO):

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

1. Demonstrate the understanding of architecture and building blocks of proteins.
2. Apply the thermodynamic concepts of protein stability and relate structure to its function.
3. Analyse the significance of protein misfolding and associated disorders.
4. Evaluate macromolecular complexes and their biological complexity.

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

Unit 1: Introduction: **6 hours**

Overview of structural biology - Levels of structures in Biological macromolecules; Noncovalent forces determining biopolymer structure; Principles of minimization of conformational energy.

Unit 2: Protein Structure: **9 hours**

Proteins primary, secondary and tertiary structures - Structural implications of the peptide bond; Ramachandran Diagram; Structural classification of proteins, structural motifs, profiles and protein families; Methods and techniques for study of protein structure and its perturbations.

Unit 3: Protein Folding: 7 **hours**

Folding in vivo and in vitro; protein stability, thermodynamics and kinetics; Effect of various factors on folding; Folding intermediates- kinetic, equilibrium and molten globule intermediates; Techniques for studying the structure and folding of proteins; chaperones, peptidyl prolyl isomerase (PPI), Protein disulfide isomerase (PDI); Protein structure and disease; Therapeutic approaches; Comparison of the structure and stability of proteins of mesophilic and extremophilic origin.

Unit 4: Biomolecular Interactions: **9 hours**

Molecular recognition, supramolecular interactions, Protein-protein interactions and their importance.

Unit 5: Nucleic Acids Structure and Protein-Nucleic Acid Interaction: **7 hours**

Structural parameters for A-, B-, C-, D- and Z-DNA, Structure of RNA; Specific and non-specific nucleic acid-protein complexes and the functional importance

of protein-nucleic acid interactions; Macromolecular assemblies.

Unit 6: Membrane Structure: **7 hours**

Lipid structure and their organization; Comparison between different membrane models; carrier transport, ion transport, active and passive transport, ion pumps, water transport, use of liposomes for membrane models and drug delivery systems.

Suggested reading;

1. Branden, C. and Tooze, J., Introduction to Protein Structure, Garland Publishing Inc., 1999.
2. Tinoco, I., Sauer, K., Wang, J. C., and Puglisi, J. D., Physical Chemistry: Principles and Applications in Biological Sciences, 4th ed., Prentice Hall, 2001.
3. Grisshammer, R. K., Buchanan, S. K., Structural Biology of Membrane proteins, Royal Society of Chemistry, 2006.
4. Rice, P. A. and Correl, C. C., Protein-Nucleic Acid Interactions: Structural Biology, RSC Publishing, 2008.
5. Blackburn, M. G., Gait, M. J., Loakes, D. and Williams, D. M., Nucleic Acids in Chemistry and Biology, RSC Publishing, 2006.
6. Creighton, T. E. Proteins: Structure and Molecular Properties, W. H. Freeman, 1995.
7. Creighton, T. E. (Editor), Protein Function: A Practical Approach, Oxford University Press, 2002.
8. Lesk, A. M., Introduction to Protein Architecture: The Structural Biology of Proteins, US Oxford University Press, USA, 2001.

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 O**ffit**, 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	**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
3	-	-	3

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.

SEMESTER IV

Core Courses

L	T	P	C
-	-	-	26

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	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.

L	T	P	C
-	-	1	-

Course Code	**3SBT405**
Course Title	**CV Writing and Interview Preparation**

Course Learning Outcomes (CLO):

Course Learning Outcomes (CLO):

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

1. 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:

This course will be guiding the students to prepare their CV as per the requirement of the employer both at the academic as well as industrial sector. This will also help the students to prepare for job interviews with the help of Mock Interviews, Group Discussions and interpersonal communication skills.

ANNEXURE-I

M.Sc. Microbiology

APPENDIX-A

Institute of Science
Nirma University

Teaching & Examination Scheme of M.Sc. Microbiology (2019-20)

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	-	14	-	7	-	10.0	1.00	-	-
7	3SBT113	Seminar I	-	1	-	1	-	-	1.00	-	-
		Total	**15**	**15**		**23**					
Supplementary Courses											
8	3SBT1S2	Basics of Biological Sciences	-	2	-	-	-	-	1.00	-	-
9	3SBT1C1	Cyber Security	1	-	-	-	-	-	1.00	-	-
		Total	**1**	**2**	-	**-**					
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											
1	3SBT2H1	Introduction to Professional Ethics, Rights & Duties	1	-	-	-	-	-	1.00	-	-
2	3SBT2E2	Professional English	1	-	-	-	-	-	1.00	-	-
3	3SBT2H2	Social Extension Activities	-	2	-	-	-	-	1.00	-	-
		Total	**2**	**2**	-	**-**					
		Institute Elective									
1		Elective I	3	-	-	3	3.0	-	0.60	-	0.40
		Total	**3**	**-**	-	**3**					
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
		Total	**15**	**14**	-	**22**					
Supplementary Courses											
1		Dissertation Tutorial	-	-	1	-	-	-	1.00	-	-
		Total	**-**	**-**	**1**	**-**	-				
		Institute Elective									
1		Elective II	3	-	-	3	3.0	-	0.60	-	0.40
		Total	**3**	**-**	-	**3**					
Semester-IV											
1	3SMB402	Dissertation	-	-		26	-	-	0.60	0.40	-
2	3SMB404	Comprehensive Viva Voce	-	2		2	-	-	1.00	-	-
3	3SBT405	CV Writing & Interview Preparation	-	1		-	-	-	1.00	-	-
		Total	-	3		**28**					

Compulsory summer training following semester II for 21 working days

L: Lectures, P/T: Practicals/Tutorial, C: Credits
MSE: Mid Semester Examination
PRE: Practical Examination
LPW: Laboratory / Project Work
SEE: Semester End Examination
TA: Term Assignment

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

Elective II *(Semester III)*
3SBC3E1 Structural Biology
3SBT3E1 Genomics & Proteomics
3SBC304 Cancer Biology
3SBT309 Vaccinology

Supplementary Course

Semester I **3SBT1S2 Basics of Biological Sciences**
3SBT1C1 Cyber Security

Semester II **3SBT2E2 Professional English**
3SBT2H1 Introduction to Professional Ethics, Rights & Duties
3SBT2H2 Social Extension Activities

Semester III **Dissertation Tutorials**
3SBC3A1 Neuroendrocrine Regulation of Behavior
3SBC3S1 Understanding Gastrointestinal Hormones and Gut associated Cancer
3SBC3S2 Molecular Mechanisms of Infertility
3SBC3S3 Pathogenesis of Diabetes
3SBC3S4 Genotoxicity Testing for Cancer Risk Assessment
3SBC3S5 Applied Human Cytogenetics
3SBT3S1 Carbon Catabolite Repression
3SBT3S2 Immunological Memory
3SBT3M1 Protein Stability
3SMB3N1 Microbial Community Dynamics and Ecological Succession
3SMB3V1 Antimicrobial Agents

Semester IV **3SBT405 CV Writing & Interview Preparation**

Dr. Shalini Rajkumar **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. Bruce Alberts, Molecular Biology of Cell, 6th Edition, 2015.
2. Bruce Alberts, Molecular Biology of Cell, A Problem Approach, 2015
3. R. Phillips et. Al, Physical Biology of the cell, 2nd Edition, 2013.
4. M. L. Casem, Case studies in Cell Biology, 2016.
5. R. Shrivastava, Apoptosis, Cell Signalling and Human Diseases, Molecular Mechanisms, Volume:1 & 2.
6. Robert Lanza (Editor), Essentials of Stem cell biology, 2nd Edition, 2009.
7. Cell Biology: Translational impact in cancer biology and bioinformatics. Maika G. Mitchell, Academic Press, 2016.
8. Pollard, T. D., and Earnshaw, W. C., Cell Biology 2nd Edition, Saunders Elsevier, 2008.
9. Gerald K., Cell and Molecular Biology, Concept and Experiment, 5th Edition, Wiley, 2007.
10. Kleinsmith, L. J. J. Principles of Cell and Molecular Biology, 2nd Edition, Benjamin Cummings, 1997.
11. 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.
12. 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
3	-	-	3

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. Introduction: **7 hours**

History of Microbiology; General and Salient features of Bacteria, Archaea, Fungi, Algae and Viruses. Principles of classification.

Unit 2. Microbial Growth and Measurement: 8 hours

Microbial growth, Methods of Cell Growth Determination, Growth Kinetics, Synchronous Growth, Basic Growth Media and Nutritional Requirement**.**

Unit 3. Microbiological Techniques: **7hours**

Sterilization and Preservation techniques; Aseptic Work, Pure and Mixed Culture concept, Enrichment techniques.

Unit 4. Nutritional Diversity 7 hours

Nutritional diversity, oxygenic and anoxygenic, photosynthesis, respiration, fermentations, chemolithotrophy.

Unit 5. Microbial Ecology: **8 hours**
Natural habitats, Interactions among microbial population, Plant-microbe interactions, Animal-microbe interactions.

Unit 6. Applied Microbiology: 8 hours
Overview of applications of microorganisms in Agriculture, Environment, Food, Industry and Medical Sciences.

Suggested Readings:

1. Atlas, R. M. (2001) Principles of Microbiology 3rd Edition, Wm. C. Brown Pub., Iowa, USA.
2. M. T. Madigan J. M. Martinko, & J. Parker Brock biology of microorganisms 9th Edn., Prentice Hall Int. Inc.
3. Sulia, General Microbiology, Oxford, 1999.
4. J. G. Cappuccino, Microbiology a Laboratory Manual, 4th Edn., Adison-Wesley, 1999.
5. Pelzar, Microbiology _ Concepts and Application, Mc Graw Hill.
6. A. Demain, Manual of Industrial Microbiology and Biotechnology, A. S. M., 1999.
7. Prescott & Klein Microbiology 5th Edn., Mc Graw Hill.
8. G. J. Tortora Microbiology: An Introduction. 9thEdn, Benjamin Cummings, 2006.

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
-	-	14	7

Course Code	3SBT112
Course Title	Laboratory I

Course Learning Outcomes (CLO):

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

1. Have a basic understanding on various tools of microscopy, cell biology and microbiology.
2. Apply microscope and perform cell biology, microbiology and biochemistry experiments required in all future semesters.

Syllabus Teaching hours: 210

Microscopy, Mitosis, Meiosis, Simple and differential staining procedures, Chromosome analysis, CFU determination and bacteriophage isolation from soil and sewage sample, Growth curve of bacteria, Sample Preparation and Separation of Amino Acids, Lipids and Sugars by TLC, Estimation of biomolecules; Enzymatic Assays.

L	T	P	C
-	-	1	1

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
1	-	-	-

Course Code	**3SBT1C1**
Course Title	**Cyber Security**

Course Learning Outcomes (CLO):

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

1. Realize the need for Cyber Security
2. Understand the need for Security in day to day co mmunications
3. Understand the vulnerabilities in the Network and Computer System
4. Protect themselves from the attacks

Syllabus **Teaching Hours: 15**

Need for Information and Cyber Security: Role of Cyber Security Professionals, Role of novices in Cyber Security

1. Basics of Internet: How TCP/IP and the World Wide Web works?
2. Hackers Community: Invading PCs, Script Kiddies, Personal Hacker Protection
3. Impact of Spyware, Worms and Viruses: Spyware, Morphing Spyware, Home Page and Search Page Hijackers, Introduction to Dialers, Keyloggers and Rootkits, Protection against Spyware
4. Zombies: Zombies and Bots, Trojan Horses, Protection against Zombies and Trojans
5. Websites and Privacy: Cookies, Web Bugs, Activity Tracking
6. Internet Search: Working of Google and Knowledge of Google
7. Phishing Attacks: Working of Phishing, Protection against Phishing Attacks
8. Security in browsers: Exploiting Browsers, Protection against Browser Based Attacks
9. Wi-Fi Protection: Working, Invading Wi-Fi Networks, Role of Hotspots, Evil Twin Attacks, War Drivers, Working of Wireless Network Protection
10. Spam: Dangers of Spam, hiding spam identity, Anti-Spam Software
11. Denial of Service Attacks and Protection: Working of DoS Attacks, Protection against Denial-of-Service Attacks
12. Hacking Cell Phones: Dangers of Cell Phone Hacking, Bluesnarfing
13. Case Study: Financial Implications of Zombies, Spyware, Phishing, Nigerian 419 Spam, Money Trails of Internet Access
14. Note: The duration for engagement of this course is 9 sessions with each session of one hour. The sessions will include both theory and practical

Suggested Readings:

1. Gralla, P. (2006). How Personal & Internet Security Works (How It Works). Que Corp..
2. Basta, A., & Halton, W. (2007). Computer Security: Concept, Issues, and Implementation. Cengage Learning publication.

L	T	P	C
-	2	-	-

Course Code	**3SBT1S2**
Course Title	**Basics of Biological Sciences**

Course Learning Outcomes (CLO):

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.

Syllabus

Introduction to Biochemistry, water as a biological solvent. Molarity, Normality, Molality, Molar, Normal and % solutions. Weak acids and bases, pH, pKa, buffers, Handerson-Hasselbalch equation, buffering capacity, physiological buffers, Chemical interactions, Structure and functions of cell organelles, Basic Principles of Thermodynamics.

Nucleic acids as genetic information carriers, Primary structure of nucleic acids and their properties, salient features of eukaryotic, prokaryotic and viral genomes, Secondary and tertiary structure of DNA, Basics of DNA replication, transcription and translation.

Introduction to prokaryotic and eukaryotic life forms, evolution and basic classification of Bacteria, Archaea, Fungi, Algae, Protozoa and Viruses.

SEMESTER II

Core Courses

L	T	P	C
3	-	-	3

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, antifoams 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.

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 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

L	T	P	C
3	-	-	3

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.

L	T	P	C
3	-	-	3

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:

14. Brown, T.A. Genetics - A Molecular Approach, 3rd edition, BIOS Scientific Publishers, 2004.
15. Brown, T.A. Genomes 3, G.S. Garland Science, 2007.

16. Dale, J.W. and Park, S.F. Molecular Genetics of Bacteria, 5th edition, Wiley-Blackwell, 2010.
17. Das, H.K. Textbook of Biotechnology, 2nd edition, Wiley Dreamtech, 2005.
18. Gardner, E.J. Simmons, M.J. and Snustad, D.P. Principles of Genetics, 8th edition, John Wiley and sons, 2004.
19. Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. (Eds.), Lewin's Genes X, 10th edition, 2011.
20. Maloy, S.R., Cronan Jr., J.E. and Freifelder, David. Microbial Genetics, 2nd edition, Narosa Publishing House, 2009.
21. Snustad, D.R. and Simmons, M.J. Principles of Genetics, 5th edition, John Wiley and sons, 2010.

L	T	P	C
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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: 120**

Pubmed searches, Scopus and Biological databases, Structure visualization and statistical methods, sequence similarity search, Prediction of protein structure, Docking of protein and ligand, In-silico cloning, phylogenetic analysis; Nucleic acid isolation and estimation, Horizontal gel electrophoresis, UV Survival curve, UV mutagenesis, Isolation of drug resistant mutants, Lac Operon Experiments; Microbial production, recovery and estimation of Exopolysaccharide, Alcohol and Citric acid, Solid state fermentation; Antibody production and isolation, ELISA, Immunoglobulin purification.

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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.

Elective Courses I

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.
   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

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. A short history of Medical Genetics – Peter Harper, Oxford Uni. Press, 2008
2. ISCN 2016, Jean McGowan-Jordan, A. Simons, M. Schmid; Karger, 2016
3. Rooney D. E., and Czepulkowski, B. H., Human Cytogenetics: A Practical Approach (Vol. I & II), 1992 Edition, Oxford University Press, 1992.
4. Peter Russell, iGenetics, A molecular approach, Third Edition, 2010.
5. H-J. Muller & T. Roder, Microarrays, The Experiment series, 2006.
6. Klug et.al, Concepts of Genetics, 10th Edition, 2012.
7. P.W. Hedrick, Genetics of populations, 4th Edition, 2011.
8. D. Peter Snustad & M.J. Simmons, Principles of Genetics, 5th Edition.2010.
9. Griffith A. J.F., Wessler S.R., Carroll, S.B., and Doebley J., Introduction to Genetic Analysis, 10th Edition, W. H. Freeman, 2010.
10. Benjamin P., Genetics: A Conceptual Approach & Problem Solving, 2008, W. H. Freeman, 2008.
11. Hedrick, P. W. (2011) Genetics of Populations, 4th Edn., Jones & Bartlett Publ.
12. Vogel and Motulsky's Human Genetics: Problems and approaches, Michael R. Speicher, Stylianos E. Antonarakis, Arno G. Motulsky, Springer; 4th ed. 2010 edition.
13. The AGT Cytogenetics Laboratory Manual, M.J.Barch, T.Knutsen, and J.Spurbeck.,Third Edition,Lippincott-Raven Publishers, Philadelphia (1997)
14. 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
15. Ricki Lewis Human Genetics Concepts and Applications 10th Edition, 2011, McGraw-Hill Science.
16. The Science of Genetics, Atherly et al (1999), Saunders
17. Robbins & Cotran, Pathologic Basis of Disease, 8th Edition, Elsevier, 2010.
18. 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	**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.

Supplementary Course:

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Course Code	**3SBT2H2**
Course Title	**Social Extension Activities**

Course Learning Outcomes (CLO):

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

1. Get sensitized to contribute to the needs of the less privileged in the society
2. Develop sense of social responsibility, team-spirit, and empathy
3. Demonstrate proactiveness in terms of identifying and contributing to the needs of the society especially in the areas of their expertise

Syllabus:

The On-Going extension activities in coordination with identified NGOs at Nirma University will be explored. The students will be assigned social activites for at least 30 hours before the end of the second semester. Students will prepare the report of the work done which will be certified by the concerned NGOs along with time duration. In addition to the field activities the students will be encouraged to read inspirational literature by arranging various competitions, inviting persons wellknown in the field for a lecture etc.students will be passed on fulfilling the requirement of 30 hours of certified work.

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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

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Course Code	3SBT2H1
Course Title	Introduction to Professional Ethics, Rights & Duties

Course Learning Outcomes:

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

1. Understand the importance of values and ethics in their professional life and career.
2. Recognize various human rights and develop holistic perspective towards profession, life and happiness based on a correct understanding of values.
3. Set up standards for code of conduct and ethics of scientific profession.

Syllabus: **Teaching Hours: 15**

Unit 1: Ethics: Introduction to Ethics, Institutional, professional and Scientific ethics, ethics in reporting, plagiarism, confidentiality, Conflict of interest, Ethical use of Patents & Trademarks, Ethical breach, dilemma and problems.

Unit 2: Rights and Duties: Introduction to Fundamental Rights and Duties, Classification of Rights and Duties, Values, Freedom, Social Responsibilities, Morals, Rights of Aged, Disabled, Women and Children, Introduction to Human Rights Law .

Suggested Readings:

1. Deborah L. Rhode, Teaching Legal Ethics, St. Louis Law Journal.
2. Ross Cranston, Legal Ethics and professional Responsibilities.
3. Eleanor W. Myers, Simple Truths about Moral Education, American University of Law Review.
4. Michael Sandel: What Money can`t Buy?
5. Alasdair Maelntyre: A short history on ethics

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 glucoseand 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: 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, Quroum 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 charecterization of medically important microorganisms, etc.
3. Develop an understandinf og the problem of drug-resistance, and the mechanism underlying its development and spread among pathognic 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, Antifungal and Antiviral agents. Problems of drug resistance and drug sensitivity, Multiple drug resistance in bacteria.

Unit 6. Microbial biofilms, quorum sensing, and efflux pumps: **8 hours**

Role of efflux pumps in antimicrobial resistance of biofilms. 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.

L	T	P	C
3	-	-	3

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	**3SMB307**
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:

Diauxic growth of E.coli, Catabolite repression in E.coli, Isolation and identification of medically important microorganisms, Antimicrobial susceptibility testing, MPN of Azospirillum and sulphate reducers, Estimation of soil microbial activity and soil respiration, Isolation and enumeration of Rhizobium, phosphate solubilizers and Actinomycetes, Rhizosphere effect; Estimation of BOD, Testing for microbiological quality (Coli-form test) for potable

water and physico-chemical characterization of wastewater, Biosorption of Metals.

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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. Demonstrate skills for literature review and understanding of research and review articles.
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:

Unit 1: Research:

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:

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:

Contents-Preamble, The Problem, Objectives, Hypothesis To Be Tested, 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 Writing of Books and Research Papers, Report Writing- Prewriting Considerations, Thesis Writing, Formats of Report Writing, Formats of Publications in Research Journals.

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. Kothari, C.K., 2/E, Research Methodology-Methods and Techniques, New Age International, New Delhi, 2004.
9. Besterfield, Dale H. 3/E, Total Quality Management, Pearson Education, New Delhi, 2005.

Practicals

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

Elective Courses II

L	T	P	C
3	-	-	3

Course Code	3SBC3E1
Course Title	Structural Biology

Course Learning Outcomes (CLO):

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

1. Demonstrate the understanding of architecture and building blocks of proteins.
2. Apply the thermodynamic concepts of protein stability and relate structure to its function.
3. Analyse the significance of protein misfolding and associated disorders.
4. Evaluate macromolecular complexes and their biological complexity.

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

Unit 1: Introduction: 6 hours

Overview of structural biology - Levels of structures in Biological macromolecules; Noncovalent forces determining biopolymer structure; Principles of minimization of conformational energy.

Unit 2: Protein Structure: 9 hours
Proteins primary, secondary and tertiary structures - Structural implications of the peptide bond; Ramachandran Diagram; Structural classification of proteins, structural motifs, profiles and protein families; Methods and techniques for study of protein structure and its perturbations.

Unit 3: Protein Folding: 7 **hours**
Folding in vivo and in vitro; protein stability, thermodynamics and kinetics; Effect of various factors on folding; Folding intermediates- kinetic, equilibrium and molten globule intermediates; Techniques for studying the structure and folding of proteins; chaperones, peptidyl prolyl isomerase (PPI), Protein disulfide isomerase (PDI); Protein structure and disease; Therapeutic approaches; Comparison of the structure and stability of proteins of mesophilic and extremophilic origin.

Unit 4: Biomolecular Interactions: 9 hours
Molecular recognition, supramolecular interactions, Protein-protein interactions and their importance.

Unit 5: Nucleic Acids Structure and Protein-Nucleic Acid Interaction: 7 hours
Structural parameters for A-, B-, C-, D- and Z-DNA, Structure of RNA; Specific and non-specific nucleic acid-protein complexes and the functional importance of protein-nucleic acid interactions; Macromolecular assemblies.

Unit 6: Membrane Structure: **7 hours**
Lipid structure and their organization; Comparison between different membrane models; carrier transport, ion transport, active and passive transport, ion pumps, water transport, use of liposomes for membrane models and drug delivery systems.

Suggested reading;

1. Branden, C. and Tooze, J., Introduction to Protein Structure, Garland Publishing Inc., 1999.
2. Tinoco, I., Sauer, K., Wang, J. C., and Puglisi, J. D., Physical Chemistry: Principles and Applications in Biological Sciences, 4th ed., Prentice Hall, 2001.
3. Grisshammer, R. K., Buchanan, S. K., Structural Biology of Membrane proteins, Royal Society of Chemistry, 2006.
4. Rice, P. A. and Correl, C. C., Protein-Nucleic Acid Interactions: Structural Biology, RSC Publishing, 2008.
5. Blackburn, M. G., Gait, M. J., Loakes, D. and Williams, D. M., Nucleic Acids in Chemistry and Biology, RSC Publishing, 2006.
6. Creighton, T. E. Proteins: Structure and Molecular Properties, W. H. Freeman, 1995.
7. Creighton, T. E. (Editor), Protein Function: A Practical Approach, Oxford University Press, 2002.
8. Lesk, A. M., Introduction to Protein Architecture: The Structural Biology of Proteins, US Oxford University Press, USA, 2001.

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 O**ffit**, 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 genome 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: 45

Unit-1 Origin and Evolution of genomics and genome mapping: 8Hours

Different databases, Alignment and homology tools, Origin of genomics, the first DNA genomes, microcolinearity, DNA based phylogenetic trees, 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, EST and transcript maps, functional maps, comparative genomics and colinearity, synteny in maps.

Unit-2 Whole Genome sequencing and analysis: 5Hours

Genome sequencing methods review, analysis of the genomes of viruses, bacteria, archae, eukaryotic – fungi, parasites, insects, plant genomes (Arabidopsis and rice), Animal genomes (fruit fly, mouse, human)

Unit-3 Annotation of whole genome sequence and functional genomics: 8Hours

In Silico methods, insertion mutagenesis (T-DNA and transport insertion), Targeting Induced Local Lesions in Genomes (TILLING), management of data, gene

expression and transcript profiling, EST contigs and unigene sets, use of DNA chips and microarrays.

Unit-4 Pharmacogenomics: 8Hours

Use in biomedicine involving diagnosis and treatment of diseases, genomics in medical practice, personalized medicine, DNA polymorphism and treatment of diseases, application of SNP-technology-mapping genes underlying monogenic and multigenic disorder, use of SNP in pharmacogenomics, pharmacogenomics and industry.

Unit-5 Proteomics 8Hours

Introduction and overview of tools used in proteomics studies, protein - protein interaction, DNA- Protein interaction, application of quantitative proteomics for the analysis of protein - protein interactions and protein linkage maps, understand yeast two-hybrid and mass spectrometry based techniques for the analysis of protein complexes and their significance and limitations.

Unit-6 Drug Discovery and Development: 8Hours

Structure prediction and human proteomics, mutant proteins, use of computer simulations and knowledge-based methods in the design process, proteomic methods for the detection and analysis of protein biomarkers for the detection and classification of disease, De-novo design; making use of databases of sequence and structure, protein structure and drug discovery, proteins in disease, current issues, drug targets, drug efficacy, protein chips and antibody microarray, techniques and future approaches of proteomics in cancer research.

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.]

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

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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
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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	3SBC3S2
Course Title	Molecular Mechanisms of Infertility

Course Learning Outcomes (CLO):

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

1. Understand the causes for the initiation of reproductive infertility.
2. Determine the probable targets for the treatment.
3. Analyse and evaluate the molecular mechanism and probable role of stress and immunology in infertility.

Syllabus:

Incidences and etiology of Male and female infertility, molecular mechanism of induction of infertility, role of mitochondria, hormones and immunological mediators, identification of molecular markers for male and female infertility.

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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 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.

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Course Code	3SBT3S1
Course Title	Carbon Catabolite Repression

Course Learning Outcomes (CLO):

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

1. Understand the physiological and molecular mechanisms that regulate preferential utilization of carbon source
2. Learn the strategies of preferential C utilization in multisubstrate environment like soil and its impact on microbial physiology

Syllabus:

Response to Carbon sources: Catabolite repression, Inducer Expulsion, Permease synthesis, repression models in *E. coli* and *Pseudomonas*, Reverse Catabolite repression, Catabolite repression and Mineral phosphate solubilization.

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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	3SBT3M1
Course Title	Protein Stability

Course Learning Outcomes (CLO):

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

1. Describe the factors affecting the chemical and physical stability of proteins.
2. Comparative Analysis of stability of extremophilic and mesophilic proteins and application of techniques to measure stability.
3. Propose hypothesis for dissertation using literature survey, case studies and group presentation.

Syllabus:

Chemical and Physical stability of Proteins; Thermodynamic aspects of stability; Factors affecting protein stability; Two-state model of protein stability; Protein denaturation and denaturants; Stability of extremophilc proteins and comparative analysis with mesophilic proteins; Role of different amino acid

residues in protein stability, Techniques to study and measure protein stability.

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.

SEMESTER IV

Core Courses

L	T	P	C
-	-	-	26

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	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.

L	T	P	C
-	-	1	-

Course Code	**3SBT405**
Course Title	**CV Writing and Interview Preparation**

Course Learning Outcomes (CLO):

Course Learning Outcomes (CLO):

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

1. 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:

This course will be guiding the students to prepare their CV as per the requirement of the employer both at the academic as well as industrial sector. This will also help the students to prepare for job interviews with the help of Mock Interviews, Group Discussions and interpersonal communication skills.