

UNIVERSITY OF MUMBAI

No.UG/429 of 2009

CIRCULAR: -

The Directors/Heads of the recognized Science Institutions concerned and the Principals of the affiliated Colleges in Science are hereby informed that the recommendation made by the Faculty of Science at its meeting held on 3rd August, 2009 has been accepted by the Academic Council at its meeting held on 7th August, 2009 vide item No.4.47 and subsequently approved by the Management Council at its meeting held on 21st August, 2009 vide item No.18 and that, in accordance therewith, the Five Year Integrated Course in M.Sc. in Bioanalytical Sciences has been introduced by the University from the academic year 2009-2010.

Further that in exercise of the powers conferred upon the Management Council under Section 54(1) and 55(1) of the Maharashtra Universities Act, 1994, it has made **Ordinances 5882 and 5883 and Regulations 8136, 8137, 8138, 8139, 8140, 8141, 8142, 8143, 8144, 8145, 8146, 8147, 8148, 8149 and 8150** including scheme and syllabus relating to the Five Year Integrated Course in M.Sc. in Bioanalytical Sciences is as per Appendix and that the same has been brought into force with effect from the academic year 2009-2010.

MUMBAI-400 032
17th November, 2009

PRIN. K. VENKATARAMANI
REGISTRAR

To,

The Directors/Heads of the recognized Science Institutions concerned and the Principals of the affiliated colleges in Science.

A.C./4.47/07.08.2009

M.C./18/21.08.2009

No. UG/429-A of 2009,

MUMBAI-400 032

17th November, 2009

Copy forwarded with compliments for information to :

- 1) The Dean, Faculty of Science.
- 2) The Controller of Examinations.
- 3) The Co-Ordinator, University Computerization Center.


(D. H. KATE)
DEPUTY REGISTRAR
(U.G./P.G. Section)

7.8.2009

UNIVERSITY OF MUMBAI



Ordinances & Regulations

Including Scheme & Syllabus Relating to

Five Year Integrated Course in
M.Sc.

In

Bio-analytical Sciences

(Introduced w.e.f. the academic year 2009-2010)

FIVE-YEARS INTEGRATED PROGRAMME FOR M.Sc. IN BIOANALYTICAL SCIENCES

with Specialization in Bioanalysis, Bioinformatics and Nutraceutical Sciences.

Preamble

Objectives

- 1) To impart high quality Science education in a vibrant academic ambience with a faculty of distinguished Teachers and Scientists.
- 2) To prepare students for the country who will take up challenging research and teaching assignments in colleges, universities and industrial research and development in the field of bioanalysis, bioinformatics and Nutraceuticals.
- 3) To amalgamate classical analytical chemical techniques with modern genomic and proteomic technologies of manufacturing and analysis

Purpose:

The world is evolving and is in a continual state of flux. The application of science to real world problems is becoming more complex, needing a thorough multidisciplinary approach.

In this age of plurality, application of pure science is *sine qua non*! One dimensional approach is redundant and this holds true in varied areas of scientific endeavour. This is reflected in the field of Astronomy, Biochemistry, Bioinformatics, Environmental Science, Forensic Science, Nanotechnology *et al*.

Background:

A post graduate course in Bioanalytical Sciences is already being conducted in four colleges and the course has gained credence and acceptability amongst the student community. The industry has responded positively in this regard by absorbing fresh talent in the corporate domain.

Feedback:

Furthermore, the regular interaction with the pharmaceutical industry and research institutes have provided ample evidence to the qualitative changes that have been brought about by the introduction of the course in M Sc Bioanalytical Sciences. The industry is experiencing a paradigm shift, and the gap between expectation and reality has been somewhat bridged to some extent.

But the catch, however, is the absence of academic cohesion at the UG and PG level. The specialization at the graduation level has been purely unidimensional, but the compulsion is multidimensional. This *reality bite* is our guiding force in conceptualization of the five years integrated programme. For instance, though students of Biology have studied Chemistry and vice versa unto the penultimate year of their graduation, the notion persists that they have specialized in the subject opted for graduation.

This is the *raison d'être* for the deep desire to offer a Five Year Integrated Course in Bioanalytical Sciences.

Salient Features:

The uniqueness of this course dovetails a modular learning with credit based evaluation. The program is designed by distinguished professionals and experts drawn from varied professional backgrounds. There have been people of experience from the world of academia, research and industry that forms the integrated triad in contemporary learning process.

The design of the course affirms the conviction that the students passing this course will help meet the demand for reliable and well informed bioanalysts in the areas of Analytical Sciences, Biotechnology, Clinical Research, Immunology, Molecular Biology and Pharmaceutical industry would be met immaculately.

Back to Basics:

The program will encompass the basics of Biology, Chemistry and Computational Sciences together in the First Three years of the Five year Program.

The First Three Years:

The B Sc in Bioanalytical Science will afford a clear knowledge of the underlying concepts of modern Bioanalytical techniques. It will be backed by the experience in application of these techniques in the field of Biology as well as Chemistry. The course is really designed for the aspirants of PG studies or research, albeit, there is an *exit proviso* after graduation. The student at the end of the first three years will be confident enough to understand the underlying *mélange* of the three subject areas. It would propel them to choose Bioinformatics, Biosciences or Nutraceuticals as specialization at the PG level.

Intent:

The program aims to broaden, heighten and deepen the extent and scope of the learner. This course is largely composite and combinative to blend the rigorous study involved in the multifarious disciplines of Biology, Chemistry, Computational Science and Physics. The implicit skill sets needed for operations across the disciplines and the industry wide compulsions will thus be imbibed by the student, through the completion of the five year integrated program.

Vision:

The program envisions the use of modern sophisticated equipment and state of art instrument like HPLC, HPTLC, PCR, DNA sequencer *et al.* The practical sessions are designed to utilize the advanced instrumentation and to train students in the realm of Analytical Techniques, Applied Practical Analysis, Bioanalytical Techniques, Biopharmaceuticals, Industrial Processes, Quality Systems and Regulatory Affairs of the Food and Pharmaceutical Industries. Furthermore, the allied modules include the Data Analysis, Entrepreneurship, Management of Intellectual Property, Quality Assurance, Quality Control and Research Project. The student will carry out an extensive research project during the fifth year of the course, developing essential practical research skills, strengthening the presentation and communication skills acquired in previous years.

Prospects:

Past placement records of the current MSc course in Bioanalytical Sciences is privy to the abundant employment opportunity that abounds for the students with the M Sc degree in Bioanalytical Sciences. Five years of intensive and all round training will be a definite recipe to find a *job fit* in Analysis, Quality Assurance and R&D. This would further give impetus in the domain of innovation and product development in the core areas of Biotechnology, Food, Health Care, Nutraceutical, and Pharmaceutical industry. There is excellent prospect for the biotechnology and pharmaceutical applications globally.

The end result is forthcoming for Corporates, MNCs' and TNCs' to offer responsible positions to our students' vis-à-vis the holders of traditional PG qualification.

Hence, the need to introduce the Five Year Integrated course in Bioanalytical Sciences with specialization in Bioinformatics, Biosciences and Nutraceutical Sciences with a perspective to serve the student community, academia and the industry in the larger interest of attaining global competency.

The University of Mumbai has been in the vanguard of imparting quality education. And, it is in the fitness of things that the University rises up to the occasion to *raise the bar* of academic progression.

O. ⁵⁸⁸²----- TITLE

1. The degree shall be titled as Five Year Integrated M.Sc. degree Course in Bioanalytical Sciences with specialization in Bioanalysis, Bioinformatics OR Nutraceutical Sciences.
2. The B.Sc. degree will be awarded to students in Bioanalytical sciences who will complete a total of 144 credits (24 X 6 semesters) in three years.

The degree of B.Sc in Bioanalytical Sciences be instituted.

3. The M.Sc. degree will be awarded to students in Bioanalytical sciences who will complete a total of 100 credits (25 X 4 semesters) in subsequent two years (a Total of 244 credits in ten semesters). Except practical credits wherever applicable, student may be allowed to complete less courses/credits per semester on a condition that they complete B.Sc. degree in maximum of 4 years and M.Sc. degree in a maximum of three years. This facility will be available subject to the availability of concerned courses in a given semester and with a maximum variation of 18 credits in case of fresh credits) per semester.

The Five Year Integrated M.Sc. Degree in Bioanalytical Sciences be instituted.

4. The students completing this course will be eligible for NET/SET examination in life sciences / chemical sciences
5. The students will be entitled to a maximum of 24 credits per semester in the first 6 semesters and 25 credits per semester in the last 4 semesters (total of 244 credits in ten semesters).
6. Each credit will be equivalent to 15 hours of Theory lectures and 30 hours of Laboratory work.

O. ~~5833~~ ELIGIBILITY

A candidate for being eligible for admission to the 5 year Integrated M.Sc. degree course in Bioanalytical Sciences must have passed Standard XII after 10 + 02 schooling (or equivalent) examination from any recognized board in India with minimum of 50% marks for students belonging to general category and 45% marks for students belonging to Reserved Category in aggregate or equivalent grade with Science, subjects- Math and Stats, Biology, Chemistry and Physics.

R. ~~8136~~ ADMISSION PROCEDURE

- a) Student seeking admission to Five year integrated M.Sc. degree course in Bioanalytical Sciences will first appear for entrance test of two Hours duration, based on Objective type questions, General Knowledge and XIIth Standard syllabus.
- b) Students will be selected for admission strictly on basis of merit list derived on the scores at the entrance examination and as per the reservation policy of the University of Mumbai and the Government of Maharashtra. Students featuring in the merit may be called for an interview and counseling session at the respective institution so that they may be acquainted about the teaching - training programme as envisaged in the syllabus.

R. ~~8137~~ TERM

1ST Term : 1st August to 30th November
2nd Term 1st January to 30th April

R.8138 DURATION:

The course shall be a full time course. The course shall be covered in Five Years in Ten Semesters.

R.8139 Fee Structure

Fee as per Undergraduate Biotechnology for first three years and as per Bioanalytical Sciences for the 4th and 5th year.

R.8140 NUMBER of STUDENTS

First Year – 60 students.
(NO lateral Entry allowed at ANY POINT)

Practical Batch Size –

First three years – Batch of 20 students each.
Fourth and Fifth year – Batch of 10 students each.

R.8141 WORK LOAD

Semester I & II:

Six lecture periods per week per subject where each period is of One hour duration. Two lecture periods per week for FC.

Practical- two lecture periods per week per subject where each period is of One hour duration.

Semester III & IV

Six lecture periods per week per subject where each period is of One hour duration. Two lecture periods per week for Environmental Science and Technical Communication Skill.

Practical- two lecture periods per week per subject where each period is of One hour duration.

Semester V & VI

Six lecture periods per week for Chemical Sciences where each period is of One hour duration.

Three lecture periods per week for Biological Sciences where each period is of One hour duration.

Three lecture periods per week for Computational Sciences where each period is of One hour duration.

Four lecture periods per week for Entrepreneurship Skills (AC 1) where each period is of One hour duration.

Practical- two lecture periods per week per subject where each period is of One hour duration. Two lecture periods per week for projects/ assignments/ case studies where each period is of One hour duration.

Semester VII & VIII

Four lecture periods per week per subject where each period is of One hour duration.

One lecture period per week for Seminar/field visits where each period is of One hour duration.

Practical- Two lecture periods per week per subject where each period is of One hour duration.

Semester IX & X (Workload is the same for each specialization.)

Four lecture periods per week per subject where each period is of One hour duration.

One lecture period per week for Seminar/field visits where each period is of One hour duration.

Practical- Two lecture periods per week per subject where each period is of One hour duration. Two lecture periods per week for industrial training and two lecture periods per week for project work.

R. 8142 STAFFING

The following will be the **staffing pattern** for the course;

- Instrument technician – 01 – B.Sc./ diploma engineer
- Technical Assistant – 02 – XIIth (Science) Passed
- Lecturers – 04 (full time)
02 (part – time)
and remaining workload to be completed using guest faculty.
- Lab attendant : - 02 SSC passed
- Lab Assistant : - 02 XIIth Passed

Core Faculty

Post-graduate with B+ and NET / SET degree in the subject of Chemistry / Botany / Zoology, Microbiology / Biochemistry / Biotechnology/ Biophysics and life sciences

Visiting Faculty from Industry & Research Institutes

The visiting Faculty will be from a post equivalent to that of Senior Lecturer level with Ph. D and not less than 5 years of research experience or with experience in industry not below Assistant Manager Level in a reputed organization.

R. 8143 MARK-LIST

- The mark-list of the students must indicate titles of papers in the syllabus

R. 8144 CONDUCT of THE COURSE

The conduct of the course will be supervised and coordinated by specific committees as explained below;

Department means University department, College or Institution conducting the course. M.Sc. means five years integrated programme in master of Sciences.

I. Coordination Committee

1. There shall be a Coordination committee for Five years integrated master's program, consisting of at least three Heads of Department teaching the course. One of them will be the chairperson decided by the committee. The coordination committee shall consider suggestions with reference to the overall functioning of the M.Sc. course received from Heads, Faculty, Students and the Examination Section, and shall recommend new rules, modifications in the existing rules or clarifications thereof to the faculty and BCUD.
2. The duration of Coordination Committee shall be for a maximum of three years.
3. Any issue arising out of the implementation of the M.Sc. course which is of the specific nature relating to any particular department shall be resolved by the concerned Institutional committee and will be reported to the coordination committee for further approval.

II. Institutional Committee

1. The Institutional Committee shall consist of
 - All teachers participating in the teaching program at the Institute.
 - one head of the department
 - Chairperson appointed by the Head of the Institution.
2. Duties of Institutional Committee
The Institutional committee will
 - a) Nominate the faculty for each course to be taught in the Institution;

- b) Evolve the norms for evaluating oral examinations whenever necessary in relation to term paper/assignments etc;
- c) Be the board of examination and to nominate the faculty concerned as the paper setter and examiner for the semester-end examination (40 percent component);
- d) Take appropriate decisions in the cases of readmissions of students during transition from old to Revised Syllabus by deciding which credits from the Revised syllabus are equivalent to credits from the old Syllabus
- e) To assist and undertake all actions / procedures for revision of syllabus. To nominate and constitute an examination committee from among faculty members for every academic year where the total existing faculty strength is more than ten;

III. General Points

- a) The syllabus may be revised at the undergraduate level and postgraduate level at least every three years but must be revised every five years;
- b) Students will not be allowed to change over from credit system to non-credit or external examination or vice versa.

R. 8145 SCHEME OF EXAMINATION

1. Each course will have:
60 % term work / internal assessment and 40 % external / University. Written examination of three hours and Practical examination wherever applicable of six hours duration. All examinations will be held at the end of each semester and will be conducted by the University as per the existing norms.
2. Term work (60 %) and University examination (40%) will be separate heads of passing.
3. The student has to obtain 40 percent aggregate marks in the term work and University examination taken together subject to 25 percent in each head of passing.
4. To pass, a student shall have to get minimum aggregate 40% marks (E and above on grade point scale) in each course.
5. If a student misses an internal assessment examination he/she will have a second chance with permission of the Institutional committee. Such a second chance shall not be the right of the students; it will be the discretion of the committee concerned to give or not to give second chance to a student to appear for internal assessment.
6. Student failing in semester-end exam may be allowed to appear for the supplementary semester-end exam. The semester end examination will be conducted within one month after declaration of the result. The student will be finally declared as failed if he/she does not pass in all credits within a total period

- of two years. After that, such students will have to seek fresh admission as per the admission rules prevailing at that time.
7. A student cannot register for the next semester, if she/he fails to complete 50% credits of the total credits in each subject including Foundation course, Environmental Science and Applied components expected to be ordinarily completed in previous semester.
 8. Internal marks will not change. A student cannot repeat Internal Assessment. In case she/he wants to repeat internal she/he can do so only by registering for the said courses as fresh students.
 9. There shall be Revaluation of the answer scripts of semester-end examination but not of internal assessment papers as per VCD.
 10. Internal Assessment answer books may be shown to the students concerned but not the end-semester answer books.
 11. While marks will be given for all examinations, they will be converted into grades. The semester end and final grade sheets and transcripts will have only credits, grades and grade points average.
 12. In subjects where project work is part of the credits, the project work will consist of not more than 02 credits for B.Sc. per semester and 06 credits for MSc per semester.
 13. Each credit will have an term work/internal (continuous) assessment of 60% of marks and a teacher must select a variety of procedures for examination such as:
 - i. Mid Term Test ;
 - ii. Short Quizzes / Viva / Presentations;
 - iii. Assignments / Seminars / Laboratory Journal Work ;
 - iv. Extension/Field/experimental Work;
 - v. Research Project by individual students or group of students; or
 - vi. An open Book Test / Review of Research Papers (with the concerned teacher deciding what books / scientific publications / research papers / Chapters from Reference books are to be allowed for this purpose.)
 14. The system of evaluation will be as follows; Each term work module mentioned above will be evaluated in terms of marks first and then to letters grades as shown in the following table.

Marks Out Of 100	Grade	Grade Point
Greater than or equal to 90	O	10
Greater than or equal to 80 but less than 90	A	09
Greater than or equal to 70 but less than 80	B	08
Greater than or equal to 60 but less than 70	C	07
Greater than or equal to 55 but less than 60	D	06
Greater than or equal to 50 but less than 55	E	05
Greater than or equal to 40	P	04
Less than 40	F	0

15. Grade Point Average (GPA) = Total of product of grade points earned and credits hrs for each course divided by total credit hours.

$$GPA = \frac{\sum G_k * C_k}{\sum C_k}$$
16. 'D' Grade is equivalent to at least 55% of the marks as per circular No.UGC-1298/[4619] UNI-4 dated December 11, 1999.

17. The formula for GPA will be based on Weighted Average. The final GPA will not be printed unless a student passes courses equivalent to minimum 72 credits for B.Sc. and 122 credits for M.Sc.
18. A ten point grade system [guided by the Government of Maharashtra Resolution No.NGV-1298/[4619]UNI.4 dt. December 11, 1999] will be followed. The corresponding grade table is detailed in 14 above.
19. If the GPA is higher than the indicated upper limit in the three decimal digit then the student be awarded higher final grade (e.g. a student getting GPA of 3.491 be awarded 'B')
20. GPA calculation will be done by the Institute. The existing VCD guidelines will be followed for verification and revaluation. The evaluation result will be adopted if there is a change of at least 10% GPA marks and in the grade of the course.
21. For grade improvement minimum 24 credits (two papers) should be taken by the student for grade improvement. Grade improvement programme will be implemented at the end of the first semester after declaration of the final result. A student can opt for the grade improvement programme only after the declaration of final semester examination.

R. 8146 SYLLABUS

• Distribution of Papers

- 1) First year – Biological Sciences (Two Papers)
Chemical Sciences (Two Papers)
Computational Sciences (Two Papers)
Foundation Course
- 2) Second year - Biological Sciences (Two Papers)
Chemical Sciences (Two Papers)
Computational Sciences (Two Papers)
Foundation Course
- 3) Third Year - Biological Sciences (One Paper)
Chemical Sciences (Two Papers)
Computational Sciences (One Paper)
Entrepreneurship Skills
Projects / Assignments / Case Studies

Biological Sciences – Botany, Zoology, Microbiology and Molecular Biology

Chemical Sciences – Analytical Chemistry, Physical Chemistry, Organic Chemistry and Biochemistry

Computational Sciences – Mathematics, Biostatistics and Computer Sciences

Foundation Course / Environmental Science – As per UGC guidelines.

Entrepreneurship Skills – Business Economics, Knowledge Management, Innovation, & Principles of Corporate Management.

- 4) Fourth Year – 4 papers

- 5) Fifth Year – There will be three specializations. There will be two special papers in semester IX and Industrial Training and projects of 12 credits each in Semester X in each specialization. Specialization will be in one of the following:

- 1) Bioanalysis
- 2) Bioinformatics or
- 3) Nutraceuticals

• Syllabus In a Nutshell

CHEMICAL SCIENCES

FIRST YEAR

PAPER I

Semester I	Semester II
- Bonding and structure of organic compounds (20 L) - IUPAC Nomenclature (10 L) - Thermodynamics (15 L)	- Biomolecules and their interactions (25L) - Classical methods of analysis (20 L)

PAPER II

Semester I	Semester II
- Reactions of aliphatic and aromatic compounds (20 L) - Electrodes and electrochemical reactions (20 L) - Nuclear Chemistry (5L)	- Ionic Equilibrium (15 L) - Chemical kinetics (15L) - Biostatistics in analytical Chemistry (15 L)

SECOND YEAR

PAPER III

Semester III	Semester IV
- Stereochemistry (25 L) - Reaction mechanism of organic reactions (20L)	- Bioorganic chemistry (20L) - Spectroscopic methods of analysis, Part I (25 L)

PAPER IV

Semester III	Semester IV
- Heterocyclic compounds (25 L) - Photochemistry (20 L)	- Metabolism and dietetics (25 L) - Electrochemical, thermal and radiochemical methods of analysis (20 L)

THIRD YEAR

PAPER V

Semester V	Semester VI
- Chemistry of natural products (20 L) - Separation techniques Part I (25 L)	- Spectroscopic methods of Analysis Part II (10 L) - Séparation Techniques Part II (20 L) - Pharmaceutical biochemistry (15 L)

PAPER VI

Semester V	Semester VI
- Polymers (15 L) - Coordination compounds and Organometallics (15 L) - Biochemical methods of analysis (15 L)	- Microanalysis (15 L) - Surface analysis (15 L) - Hyphenated techniques (15 L)

Chemical Sciences

FIRST YEAR

PAPER I

Semester 1

- Bonding and structure of organic compounds**
 - Ionic bond: Formation of ionic solids, lattice energy, salivation energy, Born-Haber cycle and Kapustinskii's equation (numerical problems expected) structures of some simple ionic solids like alkali halides and stability of ionic structures based on radius ratio rules.
 - Covalent bond: Single and multiple bonding, co-ordinate bond, sigma and pi-bonds. Theory of hybridization, energetics of hybridization: sp, Sp², sp³, sp³d, sp³d², sp³d³ with illustration of BeCl₂, BF₃, SiCl₄, PCl₅, SF₆, IF₇, NO₃, CO, CO₂, SO₂ and SO₃.
 - Shapes of molecules: V.S.E.P.R. theory for NH₃, ClF₃, BrF₅, ICl₂, TeF₅, PX₃ (halides). Structure of group 15 and 16 hydrides.
 - Valence bond theory
 - Molecular orbital theory
 - Chemical bonding
 - Molecular symmetry
- IUPAC Nomenclature**
 - IUPAC nomenclature of aliphatic polyfunctional compounds, including monocyclic compounds, on the basis of IUPAC priority order
- Thermodynamics**
 - First law of thermodynamics, internal energy, enthalpy, isothermal and adiabatic processes. Second law of thermodynamics. Carnot's cycle, mechanical efficiency, concept of entropy, entropy changes of system and surroundings for reversible and irreversible processes.

2. Physical significance of entropy, entropy changes for an ideal gas in isothermal, isobaric and isochoric changes. Entropy changes accompanying fusion vaporization and transition.
3. Helmholtz free energy, Gibbs free energy, Inter-relation between them. Calculation of free energy change with temperature and pressure. Gibb-Helmholtz equation. Chemical potential. Activity and activity coefficient, fugacity. Thermodynamics derivation of equilibrium constant, K_p and K_c and their inter-relation. Van't-Hoff isotherm and Van't-Hoff isochore.
4. Phases in equilibria: Variation in vapour pressure of a liquid with temperature, Clapeyron equation, Clapeyron – Clausius equation.
5. Colligative properties of solutions: Study of lowering in vapour pressure – Raoult's law (derivation not expected), thermodynamics derivations for elevation in boiling point and depression in freezing point.
6. Partial molal quantities, Gibbs-Dhem equation.

PAPER I Semester II

• Biomolecules and their interactions

1. Amino Acids: Building blocks of proteins, structure, classification, physical and chemical properties of amino acids, peptides.
2. Proteins: Physical and chemical properties, levels of structural organization, stability of protein structures, classification, Ramachandran Plot, domains, motif, folds
3. Carbohydrates: classification, Monosaccharides:- isomerism, reactions and derivatives, Disaccharides:- properties, Homopolysaccharides:- structure(starch, inulin, glycogen, cellulose) and functions, Heteropolysaccharides:- examples and functions.
4. Nucleic acids: chemistry of nucleic acids, pyrimidines and purines, nucleosides, nucleotides, structure and properties of DNA, stability of nucleic acid structures, Chargaff's rules, Watson and Crick model, structure and function of RNA, types of RNA, Conformations of DNA- A,B,Z forms of DNA.
5. Lipids: classification of fatty acids and lipids, physical and chemical properties, functions of fatty acids, glycolipids, phospholipids, cholesterol:- structure and function.
6. Vitamins: definition, nomenclature, classification, provitamins (precursors), occurrence, properties, structure, functions, daily requirements, deficiency diseases.
7. Role of Water: Properties of water, law of mass action, dissociation of water, pH, Bronsted theory of acids, ionization of weak acids and bases, Henderson and Hasselbach equation, titration curves, buffering action, pK values, physiological buffers.
8. Functional Groups and Chemical Bonding: Major aliphatic and aromatic groups with respect to important biomolecules. Bonding: covalent, dipoles, dipole interactions, ionic bonding, hydrogen bonding, hydrophobic and hydrophilic interactions, bond energies.
9. Bioenergetics: Redox reactions, components of ETC- Flowsheet with redox potential values of each carrier sites of ATP formation ad the action of inhibitors and uncouplers. Glycerol-phosphate shuttle, malate- aspartate shuttle. Role of membrane bound ATP synthetase. Substrate level phosphorylation

- **Classical methods of analysis**

1. Volumetric analysis:
Calibration of glass apparatus, weights and analytical balances.
Primary and secondary standards.
Standard solutions: preparation of standard solutions of HCl, H₂SO₄, phosphoric acid and ammonia from commercial samples.
Principles and basic criteria of volumetric analysis, classification of titrations, theoretical aspects of titration curves, choice of indicators and end point determination in acid – base titration viz.
 - I. Strong base Vs. strong base
 - II. Weak acid Vs. strong base
 - III. Strong acid Vs. weak base
 - IV. Weak acid Vs. weak baseTitration curves of dibasic acid Vs. strong base and tribasic acid Vs. strong base.
2. Gravimetric analysis:
Conditions of precipitation, nucleation, particle size, crystal growth, colloidal state, ageing, coprecipitation, precipitation from homogeneous solutions, drying and ignition of precipitate.

PAPER II
Semester 1

- **Reactions of aliphatic and aromatic compounds**

1. Reactions of alkanes
2. Reactions of alkenes and cycloalkenes: Epoxidation, potassium permanganate oxidation, ozonation, halogenation, addition of HX - Markovnikov's rule and peroxide effect (mechanism), formation of halohydrins
3. Reactions of alkynes: Acidity of terminal alkynes and formation of metal acetylides, hydration, addition of HX, selective hydrogenation to cis- and trans- alkenes, alkylation of acetylide anions.

- **Electrodes and electrochemical reactions**

1. The nature of electrolytes in solution: Variation of molar conductance with concentration for weak and strong electrolytes (derivation of equation is not expected)
2. Kohlrausch's law and its application to determine
 - I. Molar conductance at infinite dilution of a weak electrolyte,
 - II. Dissociation constant of a weak electrolyte,
 - III. Solubility of sparingly soluble salts.
3. Migration of ions, ionic mobilities.
4. Transport number and its determination by
 - I. Hittorf's method and
 - II. Moving boundary method
5. Relation between ionic mobility, ionic conductance and transport number.
6. Conversion of chemical energy to electrical energy. Galvanic cells, reversible and irreversible cells.
7. Types of reversible electrodes:
 - I. Electrodes of first type: Metal – metal ion electrode
 - II. Electrodes of second type: Metal – insoluble salt electrode

- III. Redox electrodes
- IV. Gas electrode
- V. Glass electrode
8. Classification of cells – Chemical and concentration cells, concentration cells with transference, concentration cells without transference, liquid junction potential, use of salt bridge.
9. Determination of thermodynamic parameters from EMF measurements – free energy change, enthalpy change, entropy change and equilibrium constant for the cell reaction.
10. Ionic strength, variation of activity coefficient with concentration, Debye-Huckel limiting law.
11. Application of EMF measurements in the determination of:
 - I. activity coefficient
 - II. pH using quinhydrone and glass electrodes
 - III. solubility and solubility product of sparingly soluble salts using chemical cells and concentration cells
 - IV. formula of Ag-NH_3 complex ion.
12. Reference electrode:
 - I. Primary standard hydrogen electrode (SHE) and
 - II. Secondary calomel electrode
13. Activity and mean activity, activity co-efficient and mean activity co-efficient of electrolytes. Nernst theory of electrode potential. Nernst equation for potential of galvanic cells and for electrode potential.
14. Applied aspects: Different types of cells and their uses,

• Nuclear Chemistry

1. Detection and measurement of nuclear radiation
2. Radio active equilibrium and half life period.
3. Measurement of Half life period using different relations
4. Nuclear transmutation and artificial radioactivity
5. Q value in nuclear reactions
6. Nuclear fission and Nuclear Fusion.

PAPER II Semester II

• Ionic Equilibrium

1. Basic principles
2. Introduction to Ionic equilibrium
3. Faraday's Laws,
4. Classification of Electrolytes
5. Ostwald's Dilution Law
6. Absolute Velocities and Mobilities of Ions
7. Activity coefficient
8. Strong acids and bases
9. Mono and polyprotic acids and bases
10. Solubility
11. Complex formation and organic complexes
12. oxidation and reduction equilibria
13. Hydrolysis of salts
14. pH and buffer solutions
15. Solubility product

- **Chemical Kinetics**

1. Rate of Reaction, definition and units of rate constant
2. Measurement of reaction rates
3. Integrated rate equation for zero, first and second order reactions
4. Kinetic characteristics of first and second order reactions
5. Pseudo-unimolecular reactions
6. Methods of determining order of reaction

- **Biostatistics in analytical Chemistry**

1. Outline of basic statistics
2. Importance of statistics in Analytical chemistry
3. Statistical measures such as mean, variance and standard deviation
4. Difference between sample and the population, sampling techniques
5. Calculation of errors and definition of residuals
6. The normal distribution of random set of data and its implication on data analysis
7. Definition of confidence level
8. Degree of freedom
9. Linear regression and the calibration curve, correlation coefficient
10. The regression equation
11. Limits of detection
12. Q test
13. Data evaluation and Comparison
14. t-test for comparing the means of different data sets
15. F-Test for testing differences between standard deviations of data sets for comparing precision

PAPER III
Semester III

- **Stereochemistry**

1. Idea of configuration. Stereochemistry of carbon compounds with one and two asymmetric carbon atoms (Wedge-dot formula). Study of enantiomers.
2. Diastereoisomers, racemates and meso compounds.
3. Diastereoisomerism (Geometrical isomerism) due to restricted rotation around C-C double bond.
4. Projection formulae: Fischer, Newman and Sawhorse. The interconversion of the formulae of compounds with two stereogenic centres.
5. Diastereomers: Threo, erythro, meso diastereomers. Geometrical isomerism in cycloalkanes (3- and 4- membered) and oximes.
6. Absolute configuration: Sequence rules for specification of configuration – assigning of stereochemical descriptors R/S to Fischer projection and wedge-dot formulae and E/Z to double bonds.
7. Conformation: conformational analysis of ethane and butane.
8. Structure of cycloalkanes (upto C=6)
9. Molecular chirality and elements of symmetry
10. Regioselectivity
11. Stereo selectivity and stereo specificity
12. Circular dichroism (CD) and optical rotatory dispersion (ORD)

- **Reaction mechanism of organic reactions**

1. Electronic effects and tautomerism:
Basics and effects of the following on the reactivity of organic compounds – Inductive effect, electromeric effect, resonance effect, hyperconjugation and tautomerism.
2. Reaction intermediates:
Structure and stability of the following: carbocation, carbanion and free radical
3. Classification of reactions:
Kinds of organic reactions: Addition, elimination, substitution, rearrangement; polar, radical – illustrated with suitable examples.
4. Methods of generation, and general reactions of the following reactive intermediates: Carbocation, carbanion, carbon free radical.
5. Carbenes: Generation, structure and reaction with olefins.
6. Methods of determining reaction mechanism – product analysis, trapping of intermediates, isotopic labeling, kinetic and stereochemical studies.

**PAPER III
Semester IV**

- **Bioorganic chemistry**

1. Enzymes: chemical nature, properties, nomenclature, classification, specific activity, katal, activation energy, mechanism of enzyme action, active site, enzyme specificity, enzyme kinetics, application of Michaelis-Menton equation, line weaver Burk plot, other plots, enzyme activators and inhibitors, types of inhibition, immobilized enzymes, isoenzymes, abzymes, synzymes, ribozymes, applications of enzymes
2. Coenzymes: co enzymes in hydrogen transfer reactions- nicotinamide nucleotide, flavin nucleotide, lipoic acid. Co enzymes involved in group transfer- biotin, pyridoxal phosphate, thiamine pyrophosphate, coenzyme A, cobalamine, tetrahydro folic acid.
3. Cell signaling: Hormones and plant growth substances: classification of hormones, hormone secreting glands, organization of endocrine system, physiological role of – pancreatic hormones-(insulin, glucagon), thyroxine, glucocorticoids, epinephrine, signal transduction pathways, 2nd messengers, bacterial chemotaxis.
4. Chemistry of alkaloids: occurrence, classification, properties, biological functions, biosynthesis of important alkaloids
5. Chemistry of plant pigments: structure and functions of chlorophylls, carotenoids, phycobilins, flavanoids, anthocyanins.

- **Spectroscopic methods of analysis Part I**

1. Interaction of EMR with matter
Nature of radiation, electromagnetic spectrum, energy of molecules- electronic, vibrational and rotational. Absorption of radiation by molecules. Beer-Lambert's law, deviation of Beer-Lambert's equation and its limitations. Terms used – absorbance, transmittance and molar absorptivity. Single beam colorimeter – principle, components and working. Quantisation of energy, Bohr frequency condition, interconversion of units, regions of electromagnetic spectrum and process associated with each

region.

2. Rotational spectra of diatomic molecules
3. Vibrational spectra of diatomic molecules
4. Vibration – rotation spectra of diatomic molecules
5. Raman spectroscopy
6. UV-Visible spectroscopy
7. IR spectroscopy
8. Atomic spectroscopy
9. AAS and ICP for elemental analysis
10. Scattering of light
11. Turbidimetry and nephelometry

PAPER IV **Semester III**

- **Heterocyclic compounds**

1. Introduction, electronic structures, aromaticity, reactivity and general methods of synthesis of – pyrroles, furans, thiophenes and pyridines
2. Reactions: Furans: Halogenation, nitration, sulphonation, ring opening, Vilsmeier reaction, Diels-Alder reaction
Thiophenes: Halogenation, nitration, sulphonation, Vilsmeier reaction, Friedel-Crafts reaction.
Pyrroles: Halogenation, nitration, sulphonation, basicity/acidity, Acid catalyzed polymerization, Vilsmeier reaction, Friedel-Crafts reaction.
Pyridines: Basicity, Quaternization, reduction, oxidation of alkyl pyridines.
Preparation and important reactions of pyridine N-oxide

- **Photochemistry**

1. Laws of Photochemistry: Grotthuss – Draper law,
2. Stark – Einstein's law of photochemical equivalence.
3. Quantum yield and its determination using actinometer, primary and secondary photochemical reactions, reasons for low and high quantum yields.
4. Photochemical reactions:
 - I. Combination of H_2 and Cl_2
 - II. Dissociation of HI and HBr
5. Photosensitized reactions: Photosynthesis
6. Photo-physical processes: Fluorescence and
7. Phosphorescence, chemiluminescence, photochemical smog, formation and depletion of ozone layer in stratosphere.

PAPER IV **Semester IV**

- **Metabolism and dietetics**

1. Carbohydrate metabolism: Glycolysis, Glycogenesis, Glycogenolysis, Gluconeogenesis, EM Pathway, reactions, characteristics, Fate of carbon, Interconversion of hexoses, pyruvate to acetyl CoA reaction, TCA cycle – detailed reaction, energetics, labeling of carbon, amphibolic pathway, anapleurotic reactions, HMP pathway.
2. Lipid metabolism: lipolysis, lipogenesis beta oxidation pathway for fatty acids, energetics, biosynthesis of saturated fatty acids, ketone bodies- acetone, aceto

acetic acid, beta hydroxy butyric acid- their formation, utilization, and physiological significance.

3. Protein metabolism: oxidative and non oxidative deamination, reactions, mechanism, examples., transamination, reactions, mechanism, GOT, GPT metabolic significance., decarboxylation reactions and mechanism , formation and transport of ammonia, urea cycle, mechanism and significance, protein synthesis
4. Interconversion of carbohydrates, proteins and lipids
5. Nucleic acid synthesis
6. Regulation of metabolism at cellular level
7. Energy requirements and allowances, RQ, basal metabolism, SDA, quantitative and qualitative requirements of constituents of food, biological value of proteins, Protein quality
- 8 .Nutritional disorders- Marasmus, kwashiorkor, vitamin deficiency disorders Starvation, Obesity.

- **Electrochemical, thermal and radiochemical methods of analysis**

1. Basic Electrochemistry
2. Conductometry / Conductometric titrations
3. Potentiometry and potentiometric titrations
4. pH measurements and pH electrode and combination electrode
5. Ion selective electrodes
6. Polarography / voltametry / coulometry
7. Applications, strengths and limitations of electrochemical analysis
8. Concepts of thermal analysis and calorimetry
9. TGA, DTA, DSC, TMA
10. Applications, strengths and limitations of thermal analysis
11. Concepts of radiochemistry
12. Neutron activation analysis
13. Isotope dilution analysis
14. Radio immuno assay
15. Radiation and safety
16. Applications, strengths and limitations of radiochemical analysis

PAPER V
Semester V

- **Chemistry of natural products**

1. General idea, including classification, structures and commercial importance of terpenes, alkaloids, vitamins, hormones, steroids.
2. Structure determination of – α – pinene, atropine
3. The following commercial synthesis: α – pinene to camphor, α – pinene to menthol, isopentene to citral, citral to β -ionone, pNA to thyroxine; total synthesis (including part synthesis) of - α – terpeneol, atropine.

- **Separation techniques Part I**

1. Separation science and importance of separation in analytical chemistry
2. Distillation
3. Zone refining, floatation
4. Vacuum distillation
5. Lyophilisation and freeze drying
6. General concept of solvent extraction
7. Batch extraction, continuous extraction, counter-current extraction, solid phase

- Spectroscopic methods of analysis Part II
- **Nuclear magnetic resonance and EPR.**
 1. General Introduction
 2. Theory of NMR, Chemical shift, H-H coupling
 3. Instrumentation and concept of FT-NMR
 4. Applications to Biological and organic compounds
 5. Concepts of 2D and 3D NMR
 6. Structural elucidation using proton NMR
 7. Theory of EPR
 8. Para magnetism and absorption of radiation
 9. Instrumentation
 10. Use of free radicals as probe
 11. Imaging of free radicals in biological systems
 12. Paramagnetic oxygen and determination of it
- **X-ray Diffraction(XRD) and X-ray Fluorescence(XRF)**
 1. Theory of XRD and XRF
 2. Crystal structure of solids and concept of crystallography
 3. Bragg's law of diffraction
 4. Instrumentation of powdered XRD
 5. Application in the determination of polymorphs in pharmaceutical compounds
 6. Percent crystallinity
 7. Single crystal XRD
 8. Determination of the 3D structure
 9. Wavelength dispersive (WD) and energy dispersive (ED) XRF
 10. Instrumentation of WD and EDXRF
 11. Applications of XRF for elemental analysis
- **Separation techniques part II**
 1. Chromatographic separation techniques
 - a) Definition of chromatography and its importance in Analytical chemistry
 - b History of chromatography
 - c) Classification of chromatographic techniques and their principles
 - d) Theory of chromatography, band broadening, rate and plate theory
 - e) Factors responsible for separation
 - f)) Liquid Chromatography and its development to HPLC and its applications
 - g) HPLC Instrumentation, Pumps, solvent delivery system, isocratic and gradient programming modes, Sample introduction system, Columns, Detectors. Reversed phase and normal phase chromatography
 - h) Gas Chromatography, Gas Solid and Gas liquid Chromatography and its applications

- i) Gas Chromatography Instrumentation, Carrier gas supply, Injectors, Columns, Packed and capillary columns, Column oven and temperature programming, different detectors,
- j) Thin layer Chromatography (TLC), and High Performance TLC and its applications
- j) Other chromatographic techniques like: Ion exchange, Gel permeation or size exclusion chromatography, Super critical fluid chromatography, paper chromatography, counter current chromatography etc.

- **Pharmaceutical Biochemistry**

1. General pharmacology: types of drugs, dosage forms, routes of administration, factors influencing dosage and drug action, absorption, distribution, metabolism, excretion of drugs.
2. Biological assays and development of new drug: selection of assay methods, applications, principles, methods.
3. Physico chemical properties of drugs: ionization, hydrogen bonding, chelation, redox potential, surface activity.
4. Development of drug therapy: Modes of action of anti infective agents, classification of anti microbial drugs, types of bacterial resistance, mechanisms of resistance to antimicrobial drugs, Adverse reactions to anti infective agents, dynamics of combined antibiotic action, indications for combination anti microbial therapy, causes of failure of chemotherapy, antibiotic abuse.
5. Drugs acting on CNS: narcotic analgesics, psycho-pharmacological agents, nature of psychosis, neuroleptics, phenothiazines, antidepressants- classification of depression, hallucinogenic drugs, CNS stimulant, problem of drug dependence.
6. Drugs acting on CVS: anti hypertensive drugs (rennin-angiotensin-aldosterone), pharmacotherapy of hypertension.
7. Hemopoietic systems: hematinics, anticoagulants, homeostatic agents, mechanism of homeostasis, classification of anti coagulant hypolipidemic agents.
8. Chemotherapy of viral diseases: anti viral agents, anti viral drugs- thiosemicarbazones, thymidine inhibitors, amantadine and derivatives, immunopotentiating agents.
9. Chemotherapy of cancer: purine pyrimidine analogues, enzymes, hormones, radioactive isotopes.

PAPER VI
Semester I

- **Polymers**

1. Introduction: General idea of structure, namings, types of polymers, tacticity, polymerization processes with examples, radical and ionic mechanisms of polymerizations. Characteristic properties of polymers. General ideas of resins, plastics, rubber, idea of plasticizers, stabilizers, stabilizers, fillers.
2. Structure, preparation and applications of PE (types and Ziegler – Natta process), PP, Teflon, PVC, PC, polyacrylates, PAN, Neoprene, Terylene, Nylons, Phenol/Melamine/Urea-formaldehyde Resins, polyurethane, polycarbonate, epoxy resins (structures of the monomers and those of the polymers are expected).

- **Coordination compounds and Organometallics**

1. Transition metal chemistry and coordination compounds
2. Valence bond theory, ligand field theory and Molecular orbital theory
3. Organometallic compounds in biological sciences
4. Nature of carbon metal bond, nomenclature.
5. Organolithium compounds
6. Organozinc compounds
7. Oxymercuration-demercuration and solvomercuration of alkenes

- **Biochemical Methods of Analysis**

1. Biochemical investigations: approaches to biochemical investigations using whole animal and plant, organ, tissue slices, isolated tissue and cell. Cell fractionation, protein purification, membrane separations, use of radioisotopes
2. Isolation, Purification of RNA, DNA, Proteins, Separation methods analysis, 1D, 2D gel electrophoresis, IEF,
3. Cloning, expression of recombinant proteins, Gene protein sequencing, Microarray based techniques,
4. Isolation, separation, analysis of carbohydrates and lipid molecules,
5. RFLP, RAPD, AFLP techniques.
6. Electrophysiological methods: ECG, PET, MRI, fMRI, CAT.
7. Histochemical and Immunological techniques: Antibody generation, ELISA.
8. Western blot, in situ localization by FISH.
9. Radiolabelling techniques: safety guidelines, RIA, IRMA.
10. Microscopic techniques: fixation, staining, EM, freeze etch, freeze fracture, image processing.

PAPER VI
Semester II

- **Microanalysis**

1. Problems associated with trace analysis
2. Special extraction procedures for separating analyte/s from the complex matrix
3. Extraction of organic/inorganic analyte from organic/inorganic matrix
4. Special techniques and care to be taken during micro analysis.
5. importance of automation in micro analysis

- **Surface analysis**

1. Surface chemistry, Phenomenon of adsorption, Adsorption isotherms,
2. Surface area by BET method
3. Pore size distribution
4. Particle size analysis
5. Catalysis, Heterogeneous and homogeneous catalysis
6. Other methods of surface analysis at micro level.

- **Hyphenated techniques**

1. Introduction to Hyphenated techniques
2. History
3. Combination of Chromatography – Spectroscopy
4. Advantages of Hyphenated techniques
5. GC-MS and LC-MS and MS/MS
6. Speciation techniques
7. Other hyphenated technique
8. Applications of Hyphenated techniques for bioanalysis

BIOLOGICAL SCIENCES

FIRST YEAR

PAPER I

Semester I	Semester II
• Classification of living systems(15L) • Type specimens (15 L) ◦ Rat ◦ Sunflower • Basic Microbiology (15 L)	• Overview of organ systems in plants & animals (15 L) • Type specimens (15 L) ◦ Bacteriophage ◦ E. coli. • Pathogenic and other organisms (food and Pharma industry) (15 L)

PAPER II

Semester I	Semester II
• Water – the universal solvent (15 L) • Structure and function of cell organelles in bacteria, plants and animals (15 L) • Comparative physiology of prokaryotes and eukaryotes (15 L)	• Macromolecules and their building blocks (15 L) • Electron Transport system (15 L) • Physiology (15 L)

SECOND YEAR

PAPER III

Semester III	Semester IV
• Comparative Physiology of living systems and Genetics (15 L) • Photosynthesis and Photorespiration in plants. (15 L) • Introduction to central dogma in biology and the genetic code (15 L)	• Comparative account of Circulatory, nervous, and reproductive systems in major phyla of animals. (15 L) • Anabolic, Catabolic and amphibolic pathways (15 L) • Synthesis of Protein, DNA and RNA (15 L) •

PAPER IV

Semester III	Semester IV
• Mutations, recombination and gene expression, Study of plasmids and transposons, Gene expression in prokaryotes (15 L) • Enzymes: classification, kinetics, inhibition, coenzymes. (15 L) • Hormones, metabolic regulation, chemical signals in microbes like bioluminescence (15 L)	• Structures and life cycles of bacteriophages, plant and animal viruses (15 L) • Chemical signals at cellular level – concept of receptors. (15 L) • Introduction to immunology – concept of antigen, antibody, types of immunity, graft rejection and hypersensitivity (15 L)

THIRD YEAR

PAPER V

Semester V	Semester VI
• Basic Molecular biology – concept of Restriction enzymes, Vectors and cDNA library. (15 L) • Techniques of isolation of chromosomal DNA, plasmid DNA and mRNA. (15 L) • Cloning of genes and application of genetic engineering in bacterial, plant and animal systems with examples like insulin production, pest resistant plant varieties, transgenic animals, etc. (15 L)	• Embryogenesis in animals, Development of organ system – limb, Developmental signals – polarity, differentiation, Concepts of ageing and regeneration. (15 L) • Microsporogenesis and megasporogenesis in plants, pollen germination, seed dormancy, plant hormones and development. (15 L) • Applied techniques – In vitro fertilization techniques, Gamete collection and storage, artificial seeds. (15 L)

BIOLOGICAL SCIENCES

First Year:

Paper I : Diversity of Life and Living Systems

SEMESTER I

- Classification of living systems (Classification systems)
 - Concept of Biodiversity and its significance,
 - Classification systems (till Order for Bacteria, plants and animals)
- Evolution of Life
 - Darwinism and Neo-darwinism
 - Chemical and Biochemical evolution
 - Coaccervates and Evidences of evolution
- Type specimens
 - Cockroach and Rat
 - Sunflower and Maize
 - Morphology, anatomy, fruit and seed germination.
- Basic Microbiology
 - Microbes and their environment,
 - Types of microbes,
 - Microscopy and staining techniques,
 - sterilization and disinfection techniques
 - Pathogenic and other organisms (food and Pharma industry)

SEMESTER II

- Overview of organ systems in plants & animals
 - Cells to Tissues to Systems in animals
 - Morphology of plants with suitable examples
 - Specialization of cells and tissues.
- Type specimens
 - Bacteriophage
 - E. coli.

- Ecology and Ecosystems
 - Concept of Biosphere, biomes and energy flow
 - Plant communities and Forest types of India.
 - Population Ecology (Natality, Mortality and Migration)
 - Ecological Crisis and its management, Global Warming and the idea of Carbon Credit.

Paper II : Chemistry and functionality of Living Systems

SEMESTER I

- Water – the universal solvent
 - Structure and properties of water
 - Role of water in cells and cellular systems
 - Diffusion and osmosis
 - Electrical properties of membrane
- Structure and function of cell organelles in bacteria, plants and animals
 - Types, Gross structure and Ultrastructure, Function and physiology of
 - Plasma membrane, cell wall and cell membrane
 - Mitochondria
 - Chloroplast
 - Golgi bodies
 - ER – smooth and rough
 - Lysosomes
 - Nucleus and nucleolus
 - Ribosomes
- Comparative physiology of prokaryotes and eukaryotes:
 - Introduction to basic metabolic pathways ,
 - Catabolism and anabolism restricted to glycolysis and citric acid cycle. Electron Transport system and its bioenergetics.

SEMESTER II

- Macromolecules as building blocks of living systems : Structure and functional relationship
 - Proteins,
 - Nucleic acids ,
 - Carbohydrates and
 - Lipids.
- Photosynthesis
 - Bacteria
 - Blue green algae
 - Plants
- Physiology related to storage of reserved food in plants and animals.
 - Brown Fat and Blubber
 - Storage of carbohydrates
 - Storage compounds in bacteria
 - Oil seeds

Second Year :

Paper III : Comparative Physiology of living systems and Genetics :

SEMESTER III

- Comparative account of the following major phyla of animals ;
 - Respiratory,
 - Digestive,
 - and excretory systems.
- Muscle structure, Physiological and biochemical basis of muscle contraction.
- Photorespiration (C3, C4 plants)
- Introduction to central dogma in biology and the genetic code

SEMESTER IV

- Comparative account of following systems in major phyla of animals.
 - Circulatory system
 - Nervous system
 - Reproductive system
 - **Donnan Membrane Equilibrium and Physiology of nerve conduction, Synapse & Synaptic conduction, Neurotransmitters, Drug addiction, Neuropeptides**
 - Haemopoiesis and its regulation
- Anabolic, Catabolic and amphibolic pathways
 - Secondary metabolites in plants- Arabinose, Xylose, Phytosterols, Taxol, etc.
 - Secondary metabolites in Bacteria
 - Polyhydroxy butyric acid
 - Biosurfactants
 - Antibiotics
 - Biopolymers
 - Flavors
 - Vitamins
 - Inborn Metabolic errors with examples
- Genetics
 - Cell cycle- G and S Phases, Control of cell cycle
 - Concept of genes, chromosomes, Mitosis and Meiosis
 - Mendelian and non-Mendelian inheritance, Linkage and crossing over
 - Sex determination in animals, sex linked, sex limited and sex influenced genes
 - Variations in chromosome number and structure (e.g. Rice, wheat, Brassica, etc. and Syndromes in Human)
 - Multiple alleles and pseudoalleles
 - Gene expression in prokaryotes and eukaryotes, Genetics of Cancer.

SEMESTER III

- Mutations
 - Types of mutation – Point and gross, Spontaneous and Induced
 - Recombination and gene expression,
 - Study of plasmids and transposons,
 - Gene expression in prokaryotes
- Enzymes:
 - Classification,
 - Enzyme kinetics,
 - Enzyme inhibition,
 - coenzymes.
- Chemical regulation
 - Hormones,
 - metabolic regulation,
 - chemical signals in microbes like bioluminescence

SEMESTER IV

- Structures and life cycles of bacteriophages, plant and animal viruses
- Chemical signals at cellular level – concept of receptors, Carrier ions, active and passive transport across cell membrane.
- Introduction to immunology – concept of antigen, antibody, types of immunity, graft rejection and hypersensitivity.

Third Year

Paper V: Blue print of Living systems and developmental Biology

SEMESTER V

- Basic Molecular biology –
 - Concept of Restriction enzymes,
 - Vectors and
 - cDNA library.

- Molecular Biology Techniques

- Isolation of chromosomal DNA, plasmid DNA and mRNA.
- Recombinant DNA technology
- Gene Therapy
- Stem cells and their applications

- Genetic engineering

- Cloning of genes and application of genetic engineering in bacterial, plant and animal systems with examples like insulin production, pest resist plant varieties, transgenic animals, etc.

- Medicinal Botany – Ethanobotany and Pharmacognosy

SEMESTER VI

- Gamatogenesis and fertilization

- Embryogenesis in animals,

- Development of organ system – limb ,
- Developmental signals –
 - polarity, differentiation, apoptosis
- Ageing, regeneration and wound healing.

- Plant embryology ;

- Microsporogenesis and megasporogenesis in plants,
- Fertilization and embryo development
- Pollen morphology, viability and germination
- Plant hormones and development,

- Applied techniques –

- In vitro fertilization techniques,
- Gamete collection and storage (artificial insemination),
- Seed dormancy, Artificial seeds.

- Environmental Regulation of living systems

- Biological Clock and Circadian rhythm;
- Photoperiodism
- Vernalization

- Temperature and sex determination (eg. reptiles)
- Hibernation, aestivation, awaking in animals

Computational Sciences

FIRST YEAR PAPER I

Semester I

- Mechanics (10 L)
- Optics I (10 L)
- Optics II (10 L)

Semester II

- Material science & Crystal geometry (10 L)
- Nuclear physics (10 L)
- X-ray techniques (10 L)

PAPER II

Semester I

- System of linear equations and Matrices (10 L)
- Calculus (10 L)
- Ordinary differential equations and applications (10 L)

Semester II

- Data representation and Measures (10 L)
- Probability, standard discrete and continuous distribution (10 L)
- Sampling theory (10 L)

SECOND YEAR PAPER III

Semester III	Semester IV
• Testing of hypothesis (10 L) • Test of significance (10 L) • Analysis of variance and correlation and regression (10 L)	• Algorithm (10 L) • Graphs (10 L) • Numerical methods (10 L)

PAPER IV

Semester III

- Introduction to computers (10 L)
- Computer components and organization of computers. (10 L)
- Database management system (10 L)

Semester IV

- Introduction to algorithms and C (10 L)
- Arrays, strings, and sorting algorithms (10 L)
- Pointers and file handling (10 L)

THIRD YEAR PAPER V

Semester V	Semester VI
• Introduction to various databases (10 L) • Heuristic algorithm (10 L) • Taxonomy and phylogeny (10 L)	• Data mining (10 L) • Hidden Markov model (10 L) • Pattern matching (10 L)

FIRST YEAR
PAPER I
FUNDAMENTALS OF PHYSICS

SEMESTER I

60L

10L

UNIT -I

1. Applications of Newton's laws of motion, conical pendulum, motion of a particle in a vertical circle, scope of classical physics, conservative and non-conservative forces.
2. Elastic module, Poisson's ratio, limiting values of Poisson's ratio, elastic constants and their relationship.
3. Surface tension and surface energy, pressure difference across curved surface film, angle of contact.

UNIT -II

10L

1. Image formation: coaxial system of two thin lenses in contact and separated by a distance, cardinal points and qualitative description of image formation by a thin lens, aberration of optical images (spherical aberration, distortion, chromatic aberration), methods reducing aberrations, Ramsden eyepiece.
2. interference by division of amplitude: interference in thin films (reflected system only) a wedge shaped film in monochromatic light, Newton's rings, determination of wavelength and the refractive index of a liquid using Newton's rings.
3. Fraunhofer diffraction: expression for the resultant of N simple harmonic vibrations of equal amplitude, the same period and phases increasing in an arithmetic progression, use of this expression to study a single slit, a double slit, and a plane diffraction grating(transmission type), comparison of prism and grating spectra.

UNIT -III

10L

1. Resolving power of optical instrument: Rayleigh's criterion, R.P. of a telescope, a microscope, prism and grating spectrometers.
2. introduction to polarization: pictorial representation of polarized light, polarization by scattering and by reflection, Brewster's law, Malus's law, double refraction in calcite and quartz, experimental determination of μ_o and μ_E of a quartz or a calcite prism.
3. lasers and application: operating principles of laser (resonance, optical pumping/excitation, population inversion, stimulated emission), spectral characteristics of lasers, overview of types of lasers, ruby laser and He-Ne laser, holography, application of lasers in medicine and industry.

SEMISTER II

UNIT IV

10L

1. Material science: classification of materials, organic, inorganic and biological materials, semiconductor materials, current trends and advances in materials, materials structure and examination, selection of materials
2. crystal geometry and structure: crystals, single crystal, whiskers, lattice point and space lattice, unit cell, primitive cell, atomic radius, density of crystal, direction lattice planes, miller indices, interplanar spacing, crystal planes in cubic unit cells, common planes in simple cubic structure, Co-ordination number, crystal growth.

UNIT -V

10L

1. Nuclear properties: Nuclear mass and binding energy, stability of nucleus, mass defect and packing fraction, nuclear size, B/A Vs. A curve, nuclear magnetic moments, electric quadruple moment, nuclear parity.
2. Radioactivity: mean life, successive radioactive transformation $A \rightarrow B \rightarrow C$ type, radioactive equilibrium, radioactive series and carbon dating, nuclear radiation detectors(ionization chamber, proportional counter, GM counter, cloud chamber, bubble chamber, single lens magnetic β ray spectrometer, photographic emulsions.
3. Heisenberg's uncertainty principle, its physical justification, uncertainty principle for energy and time, complementary nature of waves and particle aspects.

UNIT -VI

10L

1. X-rays: production, continuous and characteristic X- ray spectra, Bragg's law and intensity of X- rays, Mosley's law.
2. Compton Effect and its experimental verification, energy dependence of photoelectric effect and Compton Effect.

PAPER II

Applied Mathematics

SEMESTER I

60L

UNIT I: System of linear equations and Matrices:

10L

1. Systems of homogenous and non homogenous linear equation
2. Matrices over R , The matrix representation of systems of homogenous and non homogenous linear equation.
3. Finding solutions of homogeneous and non-homogeneous 'm' linear equations in 'n' variables; matrices and its properties.

UNIT II: Calculus

10L

1. Statement of rules for finding limits, sum rule, difference rule, product rule. Constant multiplier rule, quotient rule, Sandwich theorem of limits (without proof), Continuity of a real valued function at a point in terms of limits and two sided limits.

2. Definition of derivative of a real valued function at a point, notion of differentiability, geometric interpretation of a derivative of a real valued function at a point, differentiability of a function over an interval, statement of rules of differentiability, chain rule of finding derivative of composite differentiable functions.
3. Applications of derivatives: Mean value theorems: Rolle's Mean Value Theorem, Lagrange Mean Value Theorem, Cauchy's Mean Value Theorem (Without proof), Extreme values of function using first and second derivative test for extreme value, graphing functions using first and second derivatives. the second derivative test for concavity, points of inflections

UNIT III: Ordinary Differential Equations and Applications

10L

1. First order differential equations:
 - Review of separable differential equations, homogeneous and non-homogeneous differential equations.
 - Linear differential equations and Bernoulli differential equations.
 - Modeling with first order equations. Examples from financial mathematics, chemistry, environmental science, population growth and decay.
2. second order linear differential equations:
 - The general second order linear differential equation. Existence and uniqueness, theorem for the solutions of a second order initial value problem(statement only)

SEMESTER II

Descriptive Statistics

UNIT IV: Data Representation and Measures

10L

1. Frequency polygon, histograms, pie diagrams, bar diagrams
2. Measure of Central tendency: Arithmetic mean, mode, median
3. Measure of Dispersion: Range, mean deviation, Standard deviation, Variance

UNIT V: Probability, Standard discrete and continuous distributions

10L

1. Random variable, Probability distribution
2. Important discrete distribution such as Bernoulli, Binomial, Uniform, Geometric, Negative binomial, Poisson
3. Moments – mean, Variance
4. Important continuous distribution
 - Uniform, Normal, Exponential, Gamma, Beta, Normal approximation to various distributions.

UNIT VI: Sampling Theory

10L

1. Introduction to Sampling: Population, Sample Random Sampling.
2. Methods of sampling :stratified sampling, cluster sampling
3. Errors: sampling error, non-sampling error, standard error
4. Statistical approach to biological samples & their Statistical treatment.

**SECOND YEAR
PAPER III
COMPUTATIONAL MATHEMATICS AND STATISTICS
SEMESTER III**

UNIT I: Testing of Hypothesis

60L

1. Estimation : Point estimation and interval estimation
2. Null Hypothesis and Alternate hypothesis, Simple and composite hypothesis
3. Level of significance
4. Type I and type ii errors
5. Critical region
6. Power of the test
7. P-value

10L

UNIT II: Test of significance

1. One sample test:
2. Test of Significance of population mean: Z-test and t-test
3. Test of significance of population variance
4. Test of significance of two proportions
5. Two samples test:
6. Test of significance of two means
7. Test of significance of two proportions
8. Chi square test, contingency table
9. Non Parametric test: Sign test, Wilcoxon test, Mann Whitney test, kruskal- wallis, Fridman test.

10L

UNIT III: Analysis of variance and Correlation and regression

1. ANOVA:
2. One-way classification
3. Two – way classification model with and without interaction effects, one observation per cell and r observations per cell
4. Mutiway classification model
5. Correlation and Regression analysis
6. Types of Correlation: positive and negative
7. Correlation coefficient 'r'
8. Regression analysis, its types
9. Regression coefficient

10L

SEMESTER IV

UNIT I: Algorithms

10L

1. Definition and characteristics of an algorithm, selection and interactive constructs in pseudocode. Data structures like array.
2. Sorting and searching algorithms; algorithms on integers, algorithm on matrices,

UNIT II: Graphs

10L

1. Introduction to graphs: types of graph(simple graph, multigraph, pseudograph, directed graph, with an example of each), some special simple graphs(complete graph, cycle, wheel in graph, bipartite graph, regular graph),
2. Representing graphs and graph isomorphism;
3. Elementary combinatorics: Sets; functions; relations; permutations; combinations;

UNIT III: Numerical Methods:

10L

1. Finding roots of equations
2. Finding solutions of linear equations and numerical approximations.

**SECOND YEAR
PAPER IV
COMPUTERS**

SEMESTER III

UNIT I: INTRODUCTION TO COMPUTERS

**60L
10L**

- History of computers and their classification
1. Basics of modern computer system (view of a computer as an integrated system, Neumann machine, block diagram of a computer system)
2. Number systems (binary, decimal, octal, hexadecimal and their inter-conversions)
3. Computer arithmetic (binary addition and subtraction using signed magnitude, 1's complement and 2's complement, binary multiplication and division)
4. Codes for character representation (hexadecimal, BCD, excess-3, gray code etc)

UNIT II COMPONENTS AND ORGANIZATION OF COMPUTERS

10L

1. Memory- primary, secondary, optical, virtual, cache
2. Input-output devices (devices, interfaces etc)
3. Internal memory (DRAM, SRAM, ROM types, cache, memory principles, elements of cache design etc)
4. External memory (magnetic disk, RAID, optical memory, magnetic tape)
5. Input-output devices (DMA, I/O processors, I/O modules etc)

UNIT III: DATABASE MANAGEMENT SYSTEM

10L

1. basics of relational model (overview, entity relation model, schema refinement and normal forms)
2. query languages (relational algebra, creating and altering tables, handling data using SQL etc)
3. implementing indexes, views and procedures (file organization and indexing, views, stored procedures, triggers)

SEMESTER IV

UNIT I: INTRODUCTION TO ALGORITHMS AND C

10L

1. Fundamentals of algorithms (notion of an algorithm, pseudo-code conventions like assignment statements and basic control structures)
2. Algorithmic problems (develop fundamental algorithms for exchange the values of 2 variables with and without temporary variable, counting positive numbers from a set of integers, summation of set of numbers etc)
3. Analysis of algorithms (running time of an algorithm, worst and average case analysis)
4. Different approaches in programming (procedural approach object oriented approach, event driven approach)
5. Types of operators (arithmetic, relational, logical, compound assignment, increment and decrement, conditional or ternary etc)
6. Type conversions (automatic and explicit type conversions)
7. Data input and output functions (formatted I/O, printf (), scanf () etc)
8. Iterations (control statements for decision making: branching, looping, jump statements)



UNIT II: ARRAYS, STRINGS AND SORTING ALGORITHMS

10L

1. Arrays (declaring array variables, initialization of arrays, accessing array elements)
2. Strings (declaring and initializing string variables, character and string handling functions)
3. Sorting algorithms (bubble, selection, insertion and merge sort, efficiency of algorithms etc)
4. Functions (global and local variables, calling a function by value, difference in functions and macros)
5. Storage classes (automatic variables, external variables etc)
6. Recursion (definition, recursion functions algorithms for factorial, Fibonacci sequence, tower of Hanoi)
7. Structure (declaration of structure, reading and assignment of structure variables, arrays within structures etc)
8. Union (defining and working with union)

UNIT III: POINTERS AND FILE HANDLING

10L

1. Pointers (fundamentals, pointer variables, referencing and de-referencing, pointer arithmetic, chain of pointers, pointers and arrays, pointers and strings, array of pointers etc)
2. File handling (different types of files etc)
3. Linear link lists (representation of link list in memory, algorithms for traversing a link list, insertion into and deletion from a link list)
4. Stacks (definition, array representation of stacks, algorithms for basic operators to add and delete an element from the stack, implement using C)
5. Queues (representation of queue, algorithms for basic operators to add and delete an element from the queue, implement using C)

THIRD YEAR PAPER V PRINCIPLES OF COMPUTATIONAL BIOLOGY SEMESTER V

UNIT I

10L

- Introduction to the course. Overview of computational biology and genomics. Introduction to molecular biology for non-biologists: DNA basics, replication, transcription, translation, splicing. DNA sequencing technology. Whole-genome shotgun sequencing strategies.
- Major Bioinformatics resources NCBI, EBI, ExPASy
- Open access bibliographic resources and literature Databases
- Nucleic acid : GeneBank, EMBL, DDBJ
- Protein sequence: SWISS – PROT, TrEMBL, PIR.
- Genome Database at NCBI, EBI, TIGR, SANGER

UNIT II

10L

- BLAST algorithms
- PSI BLAST algorithm
- FASTA algorithms
- Various versions of basic BLAST and FASTA. Online use of the tools and interpretation of the results
- Strings and graphs. Sequence alignment. Global and local alignment using the Smith-Waterman algorithm. PAM matrices. Sequence alignment using BLAST
- Large-scale sequence alignment using MUMmer. Sequence assembly: shortest superstring, greedy assembly algorithms. Algorithms for sequencing by hybridization

UNIT III

10L

- Phylogenetic analysis
- Basic concepts in Systematics, taxonomy and phylogeny.
- Nature of data used in taxonomy and Phylogeny.
- Definition and description of Phylogenetic trees and various methods
- Clustering method -UPGMA
- Cladistic method - Parsimony
- Phylogenetic Analysis software Phylip,

SEMESTER VI

UNIT IV

10L

- Concept of Data mining and definition of sequence patterns, motifs, blocks.
- Various types of pattern representation
- Applying Data mining to global database
- Applying Microarray Data
- Data warehousing
- Gene finding using HMMs, Markov chains, neural nets, and decision trees
- Computational gene finding in prokaryotes. Frame shift analysis, database search, identification of ribosome binding sites, terminators, and operon structure

UNIT V

10L

- Applications of HMMs: profile HMMs (HMMer, PFAM).
- Gene finding.
- Multiple sequence alignment and ortholog management.
- Biological background on the structure of genes: exons, introns, and splicing.
- Description of the gene finding problem for prokaryotes and eukaryotes

UNIT VI

10L

- Analysis and design of combinatorial libraries.
- Chemo-informatics tools for drug discovery
- Combinatorial chemistry
- Chemical Database Preparation for Compound Acquisition or Virtual Screening
- Preparing a Dataset for Compound Acquisition using Similarity and Diversity

FOURTH YEAR

Paper I : Advanced Microbiology, Genomics and Nutraceuticals

Semester VII	Semester VIII
- Advanced Microbiology: Concept of microbial contamination and its control in manufacturing (10 L) - Culture media and their uses & Cell line and their maintenance (10 L) - Nutraceuticals- Basics (10 L)	- DNA Sequencing (10 L) - DNA fingerprinting principles and instrumentation (10 L) - Application of Genomics and DNA finger printing (10 L)

SEMESTER VII

Paper I

Advanced Microbiology: Concept of microbial contamination and its control in manufacturing

- Introduction to microbial nutrition and media in the context of mass production (e.g. Industrial fermentations) Choice of media components like C sources, N sources and its relationship with primary and secondary metabolite production,
- Sterilization techniques - Definition of sterilization, wet and dry sterilization, Death curve of microbial population, Quality of steam, Autoclave and sterilization *in situ*, filter sterilization, Radiation sterilization, terminal sterilization
- Aseptic filling in pharmaceutical industry, Classification Clean rooms / Clean areas

Culture media and their uses & Cell line and their maintenance

- Introduction to nutritional requirements of plants and animal cells for cultivation in laboratory and on commercial scale,
- Media components and their role in production of metabolites and other products,
- Media for Aerobic and anerobic microbial cultivation, Maintenance and use of type cultures and cell lines.
- Process conditions for cultivation of animal and plant cells, Concept of contamination of cell lines and methods to prevent contamination, Use of cell lines in research and for production of commercially important Products

Nutraceuticals – Basic concepts and ideas.

- Introduction to Nutraceuticals science and functional foods: Historical perspective, classification, sources of Nutraceuticals, Relationship of Nutraceuticals Science with medicine, human physiology, Genetics, Food Technology, Chemistry and Nutrition.
- Functional Foods : Definition, Relation of functional foods and Nutraceuticals to food and drugs, Application of herbs as functional foods, Concept of free radicals and antioxidants, Nutritive and Non-nutritive food components with potential health effects, Effect of Processing on nutrients.

Semester VIII

• DNA Sequencing (10 L)

- Principles of DNA sequencing
- DNA & RNA probes
- Concepts of Gene manipulation (briefly only for explaining the basics needed for sequencing)
 - Restriction enzymes & their uses
 - Vectors & their uses
 - Producing Transgenic organisms
 - Polymerase Chain Reaction (PCR)

• DNA fingerprinting principles and instrumentation (10 L)

- Principles of Thermal Cycler
- DNA Amplification using PCR technology
- cDNA production & its use
- Gene libraries & their uses

• Application of Genomics and DNA finger printing (10 L)

- Production of oligotides.
- DNA fingerprinting in human
- Applications of DNA fingerprinting.

Paper II : Patents, Drug Act and Quality Management

Semester VII	Semester VIII
- Intellectual Property rights I (20L) - Drug Act & Regulations(10)	- Qc and QA (20 L) - Concept of GMP, GLP and GCP (10 L)

SEMESTER VII

• Intellectual Property rights I

- Definition and implication of Intellectual Property rights
- Origin of WTO
- WTO, Membership & Its implications for trade and pharmaceutical industry
- Paris convention, Budapest Convention, PCT
- CITIS, TRIPs & IPR issues in traditional formulations
- Types of intellectual properties other than patents: Trademark and service mark, Logo, Copy right, Geographical Indicator, Trade secret
- Patents : Definition, importance of owning patents, Requirements to be fulfilled for filing of patents, Important patent granting authorities :India, USA, Europe, etc. , Patent servicing, challenging and infringement
- Documentation for patent filing
- Secrecy Agreements related to Intellectual Property: Disclosure agreement, Secrecy agreement, employment agreement, Technology Transfer agreement.
- Indian Patent Laws and International patent laws: Introduction
- Issues in registering new ASU drugs?
- Examples of patent infringements and successful litigations: Basmati Rice, Haldi and Neem patents and examples from Pharma drugs

• Drug Act & Regulations(10)

- Indian Drugs and Cosmetics Act
- ICMR guidelines
- Registration requirements for a new drug
- Guidelines regarding Bioanalytical studies
- Introduction to foreign guidelines
- CFR 21 part 11

SEMESTER VIII

• QC and QA

◦ Quality Assurance (QA)

- Introduction
 - What is QA?
 - Requirements for implementing QA
 - Guidelines for QA
- Support work & documentation
- Audit requirements
- Personnel Responsibility in QA

- **Quality Control (QC)**

- Introduction
 - What is QC?
 - Requirements for implementing QC
- Standardizing an Analytical method
 - Preliminary requirements of a discriminatory quantization
 - Detection of the analyte of interest
 - Separation of analyte from the matrix components
 - Sample preparation for quantitation
- Validation
- Support work & documentation
- Pharmacopeias and their uses
- Packaging standards and their compliances
- Stability Studies :Factors that influence stability of drug formulations, Guidelines on Stability evaluations

- **Concept of GMP, GLP and GCP**

- **Good Laboratory Practice (GLP)**

- What is GLP?
- Practicing GLP
- Guidelines to GLP
- Documentation of Laboratory work
- Preparation of SOPs
 - Calibration records
 - Validation of methods
 - Transfer of methods
 - Documentation of results
- Audits
- Audit reports

- **Good Manufacturing Practice (GMP)**

- What is GMP?
- Requirements of GMP implantation
- Documentation of GMP practices
- Regulatory certification of GMP
- Harmonization of SOP of manufacture
- Audit for GMP compliances

- **Good Clinical Practice (GCP) –**

- What is GCP?,
- Origin of GCP
- Earlier Guidelines for GCP
- Requirements of GCP compliance

Paper III : Tissue Culture Techniques (Plant & Animal) and Toxicology.

Semester VII	Semester VIII
• Plant and Animal Tissue culture techniques (10 L) • Tissue culture techniques (Hybridoma technology, callus production, micro propagation etc.) (10 L) • Applications of Plant & Animal tissue culture techniques (10 L)	• Toxicity and toxicity indices (10 L) • Types of toxicity studies (10 L) • Regulatory toxicology (10 L)

Semester VII

- **Plant Tissue culture techniques**
 - Media and role of plant hormones (Natural and synthetic media)
 - Callus Production
 - Shooting and rooting
 - Hardening and further propagation
 - Design and requirements of green house/polyhouse
- **Animal Tissue culture techniques**
 - Media and role of serum (Natural and synthetic media)
 - Primary and secondary cell lines, Established cell lines
 - Trypsinization, evaluation of viability and maintenance of cell lines, CO₂ incubator
 - Specialized cell lines-HeLa cell line, Mouse cell line, CHK cell Lines, etc.
- **Tissue culture techniques**
 - Hybridoma technology: Historical account including Ben Jones proteins, Production of Hybridoma cells, fusogens, selection techniques (e.g. HGPRT system), Propagation of hybridoma cells,
 - Design and working of bioreactors.
 - Micropropagation of plants, anther cultures, Culture of Haploid plants, Hairy Root culture, Mass culture of plant cells
- **Applications of tissue culture technique**
 - Production of better yielding plants, production of transgenic plants (e.g. B.t. cotton), Secondary metabolite production, propagation of ornamental species (Floriculture, Orchids),
 - Production of Monoclonal antibodies, vaccines, applications in research and diagnostics, Hybrid cell lines (e.g. mouse and human)

Semester VIII

- **Toxicity and toxicity indices (10 L)**
 - Introduction, scope and types of toxicological studies.
 - Toxicants, their route of entry, distribution
 - Metabolism & elimination of toxicants
 - Concept of LD₅₀, ED₅₀, NOEL etc.
- **Types of toxicity studies (10 L)**
 - Acute, subacute, chronic toxicity studies
 - Reproductive, behavioral and toxicity studies
 - Alternatives to animal toxicity studies
- **Regulatory toxicology (10 L)**
 - Types of toxicity studies
 - Design considerations.
 - Evaluation of results
 - Extrapolation to man.
 - OECD Guidelines on Toxicological studies
 - Schedule Y and its interpretation.

Paper IV: Proteomics, Bioinformatics and Pharmacokinetics

Semester VII	Semester VIII
• Proteomics (10 L) • Enzymes as markers in diagnosis, Application of enzymes in Diagnostics, Drug, food and other industries, (10 L) • Electrophoresis and its applications (10 L)	• Immunoassays and ELISA (10 L) • Bioinformatics : Applications (10 L) • Pharmacokinetics (10 L)

- **Proteomics**
 - Protein separation and identification
 - Protein fingerprinting techniques
 - Endogenous peptides and concepts of post transitional modifications
 - Chemical modification of proteins.
- **Enzymology**
 - Enzymes like sGPT, SGOT as markers for diagnosis
 - Enzymes used in diagnostics
 - Enzymes in drug industry
 - Enzymes in food industry and Nutraceutical industry
 - Enzymes in dairy, leather and other industries

- **Electrophoresis and its applications**
 - Principles of electrophoretic separation
 - Equipment and process
 - Agarose gel electrophoresis
 - PAGE – Native & SDS
 - Introduction to Capillary Electrophoresis
- **Immunoassay & ELISA**
 - Introduction
 - Definitions
 - Theory
 - Requirements for immunoassay
 - Practical aspects
 - Data handling
 - Advantages of immunoassay
 - Principles and instrumentation in ELISA
 - Applications of ELISA
- **Bioinformatics**
 - What is bioinformatics ?
 - Databases and Search Tools
 - Different Search Engines
 - Applications of bioinformatics
 - Using various libraries
 - Internet Applications in bioinformatics
 - Inter protocols & Search tools
 - Genome & Proteome Analysis
- **Basic Pharmacokinetics**
 - Basic concepts of Pharmacokinetics
 - Different pharmacokinetic parameters and their meanings
 - Basic techniques of evaluating Pharmacokinetic parameters
 - Basic types of models in pharmacokinetics

FIFTH YEAR

SPECIALIZATION (BIOANALYSIS)

Paper V : Different Medicinal Systems, Pharmacognosy and Standardization of ASU drugs

Semester IX	Semester X
• Indian systems of Medicines (05 L) • Pharmacognacy (05 L) • Principles of Extractions including Solid Phase Extraction and Isolation of Analytes (20 L)	• Modern Medicine (05 L) • Standardization of Ayurvedic, Unani and Siddha Drugs (10 L) • Regulatory issues and Good Manufacturing Practice i (10 L)

SEMESTER IX

- **Indian systems of Medicine (ASU)**
 - Principles and practice
 - Types of Drug Formulation
 - Methods of Manufacture – Raw Material To Finished Product
- **Pharmacognacy**
 - Introduction, Plants and their medicinal uses
 - Plant identification & Authentication
 - Concepts of ethanobotany
 - Medicinal plants in India, Indian Phyto-geographical regions, Plant collection techniques, Herbaria and its evaluation, Anatomical studies on plant material
 - Anatomical, Raw material characterization, Proximate evaluation
 - Introduction to Cultivation & production of Natural Drug substances
 - Photomicrography
- **Principles of Extractions including Solid Phase Extraction and Isolation of Analytes**
 - Introduction
 - Physico-chemical properties of drugs and solvents
 - Concept of partition & Partition Coefficient
 - Solvent properties
 - Selection of solvent
 - Extraction efficiency
 - Solid Phase Extraction (SPE)
 - Introduction
 - General properties of bonded silica sorbents
 - Sorbent/analyte interactions

- Sample pretreatment of different biological matrices
- Developing SPE methods
- Example of an SPE method
- Isolation of analytes
 - Ionisation and its effect on the extraction of drugs
 - The 'First law of drug metabolism'
 - Matrix components & analyte isolation
 - Concentration of extracts
 - Isolations of fractions
 - Purification of isolates

SEMESTER X

• Modern Medicine

- Principles and practice
- NCE and its evolution into a Drug Molecule
- API and concept of its formulation into a dosage form
- Different types Drug Formulations
- Excipients in various dosage forms

• Standardization of ASU drugs

- Need of standardization of Ayurvedic drugs
- What does standardization involve?
- Bioanalytical tools for standardization
- Clinical studies in Standardization
- Approaches to standardization;
 - Raw materials
 - In-process materials
 - Finished products
- Developing standardized QC methods
- Shelf life studies on finished products

• Regulatory Aspects of drugs

- National initiatives for regulation of drugs
- Schedule T and Schedule Y of Drugs and Cosmetics Act
- International initiatives for regulation of traditional medicine with special reference to
 - WHO guidelines on traditional medicine
 - Approaches of US and EU to traditional medicine

Semester IX	Semester X
• GMP, GCP, GLP • Method Validation (10 L) • BA/BE Studies-I(10 L)	• MS applications (10 L) • Metabolite Studies (10 L) • Thermal Analysis and Tracer Techniques (10 L)

SEMESTER IX

- GMP, GLP and GCP
 - Introduction to GMP, GLP and GCP
 - **Good Manufacturing Practice –**
 - Requirements of GMP implantation, Documentation of GMP practices,
 - Regulatory certification of GMP, Harmonization of SOP of manufacture ,
 - Audit for GMP compliances
 - **Good Laboratory Practice (GLP) :**
 - Practicing GLP , Guidelines to GLP, Documentation of Laboratory work,
 - Preparation of SOPs, Calibration records, Validation of methods,
 - Transfer of methods, Documentation of results, Audits, Audit reports
 - **Good Clinical Practice (GCP) –**
 - Origin of GCP , Requirements of GCP compliance, Guidelines for GCP, guidelines of ICH, guidelines of ICMR
 - Ensuring GCP, Documentation of GCP practice, Audit of GCP compliance
- **Method Validation**
 - Strategies for Method development
 - What and Why of method validation
 - Regulatory requirements of validation
 - IQ, OQ and PQ of analytical instruments
 - Use of Reference standards
 - Issues of Method transfer
 - Intra and inter lab – Validation

• **BA/BE Studies**

- What is BA?
- Parameters to evaluate BA of a drug
- Factors that influence BA of a drug
- Evaluating BA of a drug
- Estimating BA parameters of a drug
- What is BE?
- Parameters to evaluate BE of a drug
- Factors that influence BE of a drug
- Evaluating BE of a drug
- Estimating BE parameters of a drug

SEMESTER X

• **MS applications**

- Introduction, Inlets, Ion sources
- Analysers, Detectors
- Data acquisition and processing
- LC/MS Application :Quantification of analyte, Internal standardisation , Developing a quantitative method ,
- An example of thermospray LC/MS ,Example of API LC/MS ,
- Impurity profiling

• **Metabolite Studies**

- Principles of Metabolite identification
- Use of Biological systems for Metabolite studies (Liver homogenate assays, Cell line assays, P450 studies etc.)
- Use of Tandem mass spectrometry (MS-MS)
- Isotopically labeled compounds in metabolite identification
- Practical aspects for the identification of metabolites by mass spectrometry

• **Thermal Analysis and Tracer Techniques**

- Principles of Thermal Analysis
- Instrumentation Requirements
- Applications of Thermal Analysis
 - Concept of Radioactivity & Half life
 - α , β , γ emitters and their biological applications
 - Using tracers in assays
 - Detectors and counters
 - Concept of autoradiography
 - Radio labeled probes and their uses

Paper VII : Industrial Training

Paper VIII : Project, report writing and Industrial Visits

SPECIALISATION (NUTRACEUTICALS)

Paper V : Nutraceuticals and Functional foods, Food as remedy in Human nutrition & Nutritional Genomics

Semester IX	Semester X
• Structure, Function and property of Nutraceuticals (10 L) • Functional Foods-I (10 L) • Human Nutrition (10 L)	• Functional Foods-II (10 L) • Nutritional Genomics (10 L) • Clinical Dietetics (10 L)

SEMESTER IX

- **Structure, Function and property of Nutraceuticals:**
Glucosamine, Octacosanol, Lycopene, Carnitine, Melatonin, Ornithine, Alpha Keto glutarate. Use of proanthocyanines, Grape Products, Flaxseed oil as Nutraceuticals
- **Functional Foods-I:**
Sources and role of isoprenoids, isoflavones, flavonoides, caretonoids, Tocotrienols, Polyunsaturated fatty acids, sphingolipids, lecithin, choline, Terpenoids, Vegetable cereals, milk, dairy products as functional foods, Health effects of common beans, Capsicum annum, Mustards, Ginseng, garlic, Grapes, Citrusfruits, fish oil and sea foods.
- **Human nutrition**
Nutraceuticals bridge the gap between food and drugs, role of Nutraceuticals in treatment of cognitive decline, arthritis, bronchitis, Circulatory problems, hypoglycemia, Nephrological disorders, liver disorders, Osteoporosis, Psoriasis, Ulcers, etc. Role of Nutraceuticals rich supplements like bee pollen, caffeine, green tea, Lecithin, Mushroom Extract, chlorophyll, Kelp, Spirulina, etc.

SEMESTER X

- **Functional Foods-II:**
Soy proteins and soy isoflavones in human health, Role of Nuts in cardiovascular disease Prevention, Functional foods from wheat and rice and their health effects, Dietary fibers- occurrence, structures and role in disease prevention.
- **Nutritional Genomics**
Nutritional genomics as a tool for production of Nutraceuticals, Plants as bioreactors, Tailor made carbohydrates and lipids of plant and non-plant origin, Transgenic plants for the large scale production of proteins for pharmaceutical and industrial uses, plants as alternative for biotransformation of raw materials into special chemicals, production technology for recombinant products using microbes with examples like insulin, growth hormones, erythropoietin, interferons, etc.

• Clinical Dietetics:

Nutritional requirements in terms of recommended dietary allowances, Balanced diet, alterations in normal metabolism and changed nutritional needs, factors affecting Basic Metabolic Rate (BMR) and energy requirements for different activities, Nutrient interactions, Nutritional requirements for different age, physical activity and sports, special needs before and after intensive sports, Nutritional requirements of geriatric population, etc.

Paper VI : Nutraceuticals: Evaluation, instrumentation, Product Development label claims, Marketing, Future prospects

Semester IX	Semester X
- Instrumentation in Nutraceuticals (10 L) - Biological testing, organoleptic response and Bioassays (10 L) - Preclinical testing and clinical trials (10 L)	- QA QC and Process control (10 L) - Product development and label claims and marketing (10 L) - Future prospects and new technologies in development of Nutraceuticals and foods (10 L)

SEMESTER IX

- **Instrumentation for Nutraceuticals:**
Evaluation of quality of Nutraceuticals, Centrifugation- Zonal, density gradient, Ultra-centrifugation, Electrophoresis- Paper, gel, agarose, Polyacrylamide, isoelectric focusing, 2-D gel, Spectroscopy, Colorimetry, UV_visible, Flame Photometry, IR, NMR, X-Ray diffraction, Radio-isotopic techniques, chromatography, ion-exchange chromatography gel and affinity chromatography, etc.
- **Biological testing, organoleptic response and Bioassays**
Testing in vitro and in vivo, sampling for assays, Laboratory setup for microbiological testing, microbiological assays, microbiological testing for Nutraceuticals, basics of organoleptic responses, evaluation methodologies for taste, aroma, etc.. Evaluation of toxicity and safety of new products, emerging models for testing the claims
- **Preclinical testing and clinical trials**
Need for evaluation of toxicity for Nutraceuticals, acute toxicity studies, multiple exposure studies, pharmacology and pharmaceutical in testing of Nutraceuticals, Phases of clinical trials, Metabolism studies, Clinical trials and regulatory aspects

SEMESTER X

- **Quality Assurance (QA) & Quality Control (QC)**

Introduction, What is QA? Requirements for implementing QA, Guidelines for QA, Support work & documentation, Audit requirements, Personnel Responsibility in QA, Requirements for implementing QC, concept of Validation of Analytical methods Packaging standards and their compliances, Stability Studies, Guidelines on Stability evaluations

- **Product development and label claims and marketing**

Increasing role of Nutraceuticals in management of health and diseases, concept of designer foods for chronic diseases, degenerative diseases, sports, Effect of globalization on food preferences and choice of Nutraceuticals, Overview of packaging and labeling, Various packaging strategies, need of specific regulation governing dietary supplements, outline of compliance label review, Nutritional contents claims, health claims and regulatory agencies' views on label claims. Marketing techniques, consumer behavior, basics of communication process, advertising and legislation, the art and science of consumer persuasion,

Future prospects and new technologies in development of Nutraceuticals:

New technologies for product development like supercritical fluid extraction, membrane technology, bioprocess technology, etc.

Food industries role in promoting Nutraceuticals, Changing federal laws, Role of regulatory agencies, Intellectual property rights, Impact of Chemi-informatics and Pharma-informatics, biotechnology, etc. on future of Nutraceuticals sciences.

Paper VII : Industrial Training

Paper VIII : Project, report writing and Industrial Visits

SPECIALISATION (BIOINFORMATICS)

PAPER V –Computational Skills and Operating Environments.

Semester IX	Semester X
• C++ (10 L) • HTML & XML (10 L) • Introduction to OOPs concept and JAVA (10 L)	• JDBC (10 L) • Introduction to Perl and data types (10 L) • Regular Expressions in Perl (10 L)

PAPER VI - Molecular Modeling and Drug Design Applications

Semester IX	Semester X
• Introduction to Molecular Modeling (10 L) • Medical Informatics (10 L) • Combinatorial Chemistry (10 L)	• Drug Designing (10 L) • Drug Delivery systems (10 L) • Orphan receptors and reverse pharmacology (10 L)

Paper VII : Industrial Training

Paper VIII : Project, report writing and Industrial Visits

FIFTH YEAR

PAPER V

Computational Skills and Operating Environments. SEMESTER IX

60L

UNIT:C++

10L

- Basics of object oriented programming.
- Concept of Object, class, Constructor and Destructors,
- Inheritance, Data encapsulation,
- Polymorphism.
- Virtual function and friend function

UNIT II:HTML & XML

10L

- Introduction to HTML and XML, basic HTML tags:
- Tables , hyperlinks, Image Insertion, marquee image mapping, Frame set,
- HTML forms, Get and Post methods,
- Basics of XML
- XML syntax and semantics
- XML Programming (in Java)
- XML software & its applications

UNIT III: Introduction to OOPs concept and JAVA

10L

- An introduction to object-oriented programming
- Object-oriented programming and Java
- Introduction to Java basics.
- Working with objects, Arrays, Conditionals and Loops
- Creating Classes and Applications in Java, methods
- Java Applets Basics, Graphics, Fonts and Color
- Simple Animation and Threads
- Managing Simple Events and Interactivity
- Creating User Interfaces with AWT
- Modifiers, Access Control and Class Design
- Packages and Interfaces
- Exception, Multithreading, Streams and I/O
- Using Native Methods and Libraries
- Using Biojava

SEMESTER X

UNIT I: JDBC

10L

- Introduction to JDBC
- Client Server Application
- Java Drivers
- java.sql Package
- Executing SQL Statements

UNIT II: Introduction to Perl and data types

10L

- Introduction: What is Perl? Why use Perl in Bioinformatics? History of Perl, Availability, Support, Basic Concepts
- Scalar Data: What Is Scalar Data?, Numbers, Strings, Scalar Operators, Scalar Variables, Scalar Operators and Functions
- Arrays and List Data: What Is a List or Array? Literal Representation, Variables, Array Operators and Functions, Scalar and List Context
- Control Structures: Statement Blocks, basic I/O.
- Hashes, Hash Variables, Literal Representation of a Hash, using Hashes.
- Subroutines, System and User Functions, The local Operator
- Using Bioperl.

UNIT III Regular Expressions in Perl

10L

- Concepts of Regular Expressions, Simple Uses of Regular Expressions, metacharacters, quantifiers etc.
- Pattern matching, substitution,
- split and join Functions, Formatting Data, Sorting, Transliteration
- Finding a Substring, Extracting and Replacing a Substring, Variable-length Parameter Lists, Notes on Lexical Variables

**FIFTH YEAR
PAPER VI
Molecular Modeling and Drug Design Applications**

SEMESTER IX

60L

UNIT I Introduction to Molecular Modelling

10L

- Concepts of Molecular modeling,.
- Theory and Practice of Energy minimization, Monte Carlo and Molecular Dynamics simulations.
- Protein structure Prediction an overview. Introduction to ab- initio structure prediction.
- Fold family recognition or threading approaches
- Homology modelling.

UNIT II Medical Informatics

10L

- Ethics, patient confidentiality and data protection
- Sources of medical data
- Populations: ordination and population characterization: error and variance in populations
- Clinical data: application of linear based models, search algorithms, ANNs, SVMs to case study data.

UNIT III Combinatorial Chemistry

10L

- Analysis and design of combinatorial libraries.
- Chemo-informatics tools for drug discovery
- Combinatorial chemistry
- Chemical Database Preparation for Compound Acquisition or Virtual Screening
- Preparing a Dataset for Compound Acquisition using Simiilarity and Diversity

SEMESTER X

10L

UNIT I: Drug Designing

- Physicochemical properties of drugs&, Introduction to drug designing.
- Concept of receptor/target site.
- lead identification and structure modification
- Concepts in molecular recognition, Drug like properties and associated empirical rules, structure based drug design
- Conformational search technique
- Target structure based Drug Design (Active site identification), Characterization of target site.
- Small molecule libraries and the identification of novel drug targets (e.g. via the de-orphanisation of G-protein coupled receptors).

UNIT II Drug Delivery systems

10L

- Types of drug delivery system.
- Dendrimers
- Molecularly imprinted polymers(MIPs), MIPs in Drug delivery,
- Introduction to Biomedical micro- and nano-technology
- Liposomes: Enzyme-activated, Phototriggering, Thermosensitive

UNIT III Orphan receptors and reverse pharmacology

10L

- Orphan GPCRs
- Identification of Orphan GPCRs
- Reverse Pharmacology
- Reverse Pharmacology for Orphan GPCRs
- Deorphanisation

PRACTICAL

FIRST YEAR – CHEMICAL SCIENCES

PAPER I

SEMESTER I	SEMESTER II
• To determine the free energy change, ΔG and equilibrium constant – potentiometrically • To determine the heat of reaction and heat of neutralization • To determine the elevation in boiling point and depression in freezing point • Tutorials in bonding • Tutorials in IUPAC nomenclature	• Titration of HCl against NaOH • Titration of acetic acid against NaOH, verification of Henderson's equation and hence determination of pKa value of acetic acid • Estimation of Fe using internal indicator • Estimation of Cu using Iodometry and iodometric method • Calibration of glass apparatus – Burettes, pipettes and standard flasks • Acid base titrations involving NaOH Vs HCl, NaOH Vs Oxalic acid, HCl Vs Na_2CO_3 • Estimation of Fe and Ba • Preparation of osazone from glucose • Preparation of glucosopenta acetate from glucose • Estimation of glucose • Estimation of Vit. C

FIRST YEAR- CHEMICAL SCIENCES

PAPER II

SEMSTER-I

Potentiometry:-

- To determine the standard potential E° of a chemical cell (Daniel Cell/ Cu-Ag cell)
 - To determine the amount of Fe(II) and the formal redox potential of Fe (II)- Fe(III) by potentiometric titration of Fe(II) solution against Ceric sulphate/ Potassium dichromate solution.
 - To determine the standard potential of i) Al/ Al^{3+} and ii) Zn/ Zn^{2+}
 - Demo experiment on GM counter.
- Determination of transport number of Ag and Nitrate ions using Ag electrodes in a solution of $AgNO_3$
 - To determine the partition coefficient of I_2 between water and CCl_4
 - Tutorials on reactions of aliphatic and aromatic compounds.

SEMSTER-II

Conductometry:-

- To verify Oswald's dilution law using acetic acid.
- To determine λ_α of a strong electrolyte (HCl/ NaCl).
- Conductometric titration of HCl against NaOH.
- Conductometric titration of Acetic acid against NaOH.

Chemical Kinetics:-

- To determine the rate of acid hydrolysis of methyl acetate and determination of order by graphical method.
- To determine the order of the acid hydrolysis of methyl acetate by the method of equifractional time.
- Second order reaction between i) $K_2S_2O_8$ and KI (With equi-molar concentrations) ii) $K_2S_2O_8$ and KI (With unequal concentrations).

Tutorials in Biostatistics.

SECOND YEAR- CHEMICAL SCIENCES

PAPER III

SEMESTER III	SEMESTER IV
a) Complete identification of an organic compound Identification by micro-scale techniques following – Preliminary tests, solubility, Elemental detection, group tests, Physical constant determination b) Organic derivative preparation - Bromination of aniline - Iodoform of acetone 2,4-DNP of benzaldehyde - Picric acid derivative of naphthalene - Oxidation of benzaldehyde with KMnO_4 - Acetylation of salicylic acid - Nitration of salicylic acid - Hydrolysis of Ethyl benzoate c) Calibration of polarimeter using glucose/sucrose	a) To test the validity of the Beer-Lambert's Law (using methylene blue) and to determine λ_{max} - molar absorptivity constant b) Calibration of spectrophotometer in the visible range, using KMnO_4 c) Determination of the stability constant of Fe(III)- salicylic acid system by spectrophotometric method c) Determination of IR spectra of compounds d) Estimation of Fe using AAS e) Estimation of caffeine by UV spectrophotometry

PAPER IV

SEMESTER III	SEMESTER IV
a) Organic synthesis i) Nitration of nitrobenzene ii) Azo-coupling reaction (Diazotization of 4- Nitro aniline with α- naphthol) iii) p-Bromoacetanilide from acetanilide iv) Oxime of cyclohexane v) Reduction of benzophenone to Benzhydrol b) Tutotials in Photochemistry	a) Conductometry i) To study the kinetics of saponification of ethyl acetate ii) Titration of a mixture of strong acid and weak acid against strong base iii) To study the kinetics of saponifaction of ethyl acetate b)Potentiometry i) To determine the standard potential of Cu/Cu^{2+} or Ag/Ag^{+} c)pH-metry i) Identification of an acid by acid-base titration pH-metrically ii) pH titration of sodium carbonate against HCl to demonstrate the selection of indicators for two inflections. d) Quantitative analysis of biological samples

THIRD YEAR - CHEMICAL SCIENCES

SEMESTER – V	SEMESTER – VI
I) Separation of Organic mixtures a) Water soluble + Water insoluble (Solid + Solid) b) Water insoluble + Water insoluble (Solid + Solid) c) Volatile liquid + Non-volatile liquid (Liquid + Liquid) by fractional distillation method d) Volatile liquid + Water insoluble solid (Liquid + Solid) by distillation method II) Solvent Extraction a) Determination of Fe and Mg from their mixture	I) Demo experiment on NMR and XRD II) Separation technique A) PAPER CHROMATOGRAPHY Separation of natural pigments B) TLC Alkaloids C) HPTLC To develop the fingerprinting pattern of natural products D) HPLC Separation of modern drug (Diclofenac sodium) from their combination formulation. E) GC Separation of solvent mixtures (Methanol and Ethanol, Toluene and Methanol) F) ION- EXCHANGE a) Estimation of sodium using cation exchanger b) Estimation of Mg in a mixture of Mg and Zn solution using anion exchange resin column

THIRD YEAR- CHEMICAL SCIENCES

PAPER-VI / SEMSTER-V	PAPER-VI / SEMSTER-VI
I. Viscosity measurements:-To determine the molecular weight of polyvinyl alcohol using viscometer. II.Gravimetric Analysis: a) Estimation of Ni and Zn.	I. Inductively Coupled Plasma demonstratic II. Particle size analysis of active pharmacei ingredient (API) using pharmacopoeial st III. Demonstration of hyphenated techniques i) GC-IR, ii) GC-MS and iii) LC-MS.

FIRST YEAR

SEMESTER-I	SEMESTER-II
Practical I (related to theory paper- Biomolecules and their Interactions) 1) Qualitative analysis of Carbohydrates: Glucose, fructose, maltose, lactose, sucrose, starch, dextrin. Tests : Molisch, Anthrone, Iodine, Benedicts, Fehlings, Barfeods, Seliwanoffs, Osazone formation, etc 2) Qualitative analysis of Amino acids: Tests: Xanthoproteic, Millons, Sakaguchi, Hopkin Cole, Lead acetate, Ninhydrin. 3) Qualitative analysis of Proteins: (Casein, Albumin, Gelatin, Peptone). Tests: Biuret, Folin Ciocalteau, Coagulation by heat, Precipitation by acid, heavy metals, organic solvent, salt, SDS treatment, Neumans test, Confirmatory tests for proteins. 4) Qualitative tests for Nucleic acids: Orcinol, Diphenylamine	5) Qualitative analysis of lipids; Tests: Bromine water, saponification, etc, Estimation of saponification value, estimation of acid value 6) Qualitative tests for functional groups: Aldehydes, ketones, carboxylic acids, alcohol, phenol, ester, ether, amine, nitro, sulphonyl, sulphhydryl, phosphates. 7) Preparation of buffers: Acetate, Phosphate buffers. 8) Colorimetric methods of estimation of proteins by Biuret method, Folin Lowry method 9) Colorimetric method of estimation of Glucose by Folin Wu method and Maltose by DNSA method

FIRST YEAR

PAPER -I - ZOOLOGY PRACTICAL

SEMISTER-I	SEMISTER-II
- Classification from Protozoa till Chordata (specimens list will be attached) - Dissection of Cockroach showing Viscera and reproductive system & Rat showing Viscera and Circulatory system	- Animal Tissues-Different type (showing slide) - Population Count (with Reference to Daphnia)

FIRST YEAR

PAPER -II- ZOOLOGY PRACTICAL

SEMISTER-I	SEMISTER-II
1)Chemical Properties of water - Dissolved O₂ - CO₂ - Hardness 2)Cell organelles Observation of slides & Describe their structure Mitochondria, Golgi Bodies, ER, Ribosomes, Lysosomes.	1)Tests for Carbohydrates, Lipids, Proteins 2) Physical Properties of Water PH and Turbidity 2)DNA,RNA Extraction

SECOND YEAR

PAPER -III- ZOOLOGY PRACTICAL

SEMISTER-III	SEMISTER-IV
- Respiratory - Observation of Gills of Fish, Lungs of Frog, Air sacs of Birds, Lungs of Mammals - Digestive:-Ruminant Stomach - Excretory system:-Dissect Rat for Excretory system	Circulatory system- - Heart of Fish, Frog, Rat (Comparative Account) Nervous system- - Comparative Brain of Fish, Frog Rat

SECOND YEAR

PAPER -IV- ZOOLOGY PRACTICAL

SEMISTER-III	SEMISTER-IV
Demonstrate 1) Amylase Activity with Reference to pH & Temperature	

THIRD YEAR

PAPER -V- ZOOLOGY PRACTICAL

SEMISTER-V	SEMISTER-VI
	1) Slide of limb Bud Development 2) Study of Chick Embryo

FIRST YEAR

PAPER -I- BOTANY PRACTICAL

SEMISTER-I	SEMISTER-II
- Classification of plants (Thallophyta to Angiosperms) - Type Specimens Sunflower (Morphology, Floral formula, T.S of stem and flower, life cycle) Maize (Morphology, Floral formula, T.S of stem, inflorescence, life cycle)	Morphology of Plants:- - Root - Stem - Leaf - Inflorescence - Flower - Fruit - Seed & seed germination Anatomy of Plant Tissues - Simple - Complex

FIRST YEAR

PAPER -II- BOTANY PRACTICAL

SEMISTER-I	SEMISTER-II
Water-Role of Water in cells -Plasmolysis -Diffusion -Osmosis	Photosynthesis -Plants -Photosynthetic pigments in Algae Physiology -storage of carbohydrates -Chemical tests -Structure Oil Seeds -Saponification

SECOND YEAR

PAPER -III- BOTANY PRACTICAL

SEMISTER-III	SEMISTER-IV
	Anabolic ,Catabolic & amphibolic Pathway,S3econdary metabolites in plants -Phytosterol Genetics -Mitosis -Meiosis

THIRD YEAR

PAPER -V- BOTANY PRACTICAL

SEMISTER-V	SEMISTER-VI
Medicinal Botany -Pharmacognosy	Plant Embryology -Microsporogenesis -Megaspороgenesis -Pollen Biology -Seed dormancy

FIRST YEAR

PAPER -I- MICROBIOLOGY PRACTICAL

SEMISTER-I	SEMISTER-II
• Staining Techniques Monochrome, Negative Differential (Gram, Acid fast) • Use of Compound Microscope • Physical methods of Control: Heat, Bacteria proof filters, UV rays, Denaturation, Osmotic Pressure • Chemical methods of Control: Phenolics (phenol coefficient), Oligodynamic action, Surfactant Dyes, Antibiotics, alcohol. • Study of air, water and soil • Aseptic techniques and safety in a laboratory	• Normal flora of human body • Aerobic, anaerobic, microaerophilic, facultative organisms • Study of E.coli • Demonstration of phage plaques • Viable count with respect to food, soil, milk • Direct microscopic counts, Breeds count, Hemocytometer

FIRST YEAR

PAPER -II- MICROBIOLOGY PRACTICAL

SEMISTER-I	SEMISTER-II
• Cell wall staining • Nuclear staining • Blood staining • Media preparation and use • Nutrient agar, Sabouraud's agar • Mackonkeys agar • Blood agar • Sugar fermentation by E.coli, yeast	• Qualitative tests for Proteins, amino acids, lipids, nucleic acids, carbohydrates • Cultivation of Blue green algae, Photosynthetic bacteria and permanent slides of BGA • Staining of lipids, spore, capsule, metachromatic granules in bacteria

SECOND YEAR

PAPER -III- MICROBIOLOGY PRACTICAL

SEMISTER-III	SEMISTER-IV
paper III .semester III no practical in Micro.	• Isolation and extraction of PHB granule from bacteria • Effect of biosurfactants • Isolation of antibiotic producers • Extraction and analysis of biopolymers • Study of lactobacillus and Streptococcus, in flavor production from curd • Study of growth curve of <i>E.coli</i> • Antibiotic disc- Kirby Bauer Method • Antibiotic spectrum studies

SECOND YEAR

PAPER -IV- MICROBIOLOGY PRACTICAL

SEMISTER-III	SEMISTER-IV
• Isolation of UV induced mutants and characterization. Replica Plating Technique • Study of different enzymes. Qualitative- Kinetics, inhibition, effect of factors for any one enzyme • Study of bioluminescent bacteria	• Plaque count and morphology • Antigen antibody reactions • Blood groups, agglutination, precipitation, flocculation reactions • Isoagglutinin titre- Widal, VDRL tests • Preparation of Antigens • Use of diagnostic tests- ELISA, RIA demonstration

THIRD YEAR

PAPER -V- MICROBIOLOGY PRACTICAL

SEMISTER-V

- Isolation and quantification of chromosomal DNA- plasmid DNA, RNA and characterization
- Demonstration of Transformation conjugation, Restriction enzyme, PCR, Transduction
- Study of *E.coli*, *Pichia pastoris*, *Saccharomyces cerevisiae* as genetic systems

SEMISTER-VI

COMPUTATIONAL BIOLOGY

PRACTICAL I - COMPUTATIONAL BIOLOGY

SEMESTER I	SEMESTER II
Bar pendulum Y by bending Cauchy's constant Figure of merit LCR Parallel resonance Low pass filter High pass filter Surface tension Cylindrical obstacle	R.P of telescope. De Sauty's bridge Band pass filter Max power transfer theorem Stefan's law Demonstration on unit V and unit VI

PRACTICAL II & III - COMPUTATIONAL BIOLOGY

SEMESTER I & III	SEMESTER II & IV
Topics for tutorials and assignment linear equations and Matrices Calculus Ordinary Differential Equations and Applications Second order linear differential equations	Topics for tutorials and assignment Use of statistical packages such as SPSS, metlab etc. Population distribution studies Performing statistical tests such as chi square, ANOVA

PRACTICAL IV - COMPUTATIONAL BIOLOGY

SEMESTER III	SEMESTER IV
• Introduction and overview of general computer operation (Windows and Linux platforms). Use of various search engines, email etc. • Writing programs based on C ◦ Finding prime numbers, Fourier series ◦ Reading a DNA sequence, Translating into RNA sequence. ◦ From DNA or RNA to Polypeptide sequence..	• Use of SQL Server and mySQL, • Writing Basic SQL select queries. • Creating databases in SQL and Oracle, using various data types and granting privileges.

PRACTICAL V - COMPUTATIONAL BIOLOGY

SEMESTER III	SEMESTER IV
• Different types of search engines & important sites viz NCBI, EBI, Swiss-Prot, PDB etc. • Biological Databases: Study of different Biological databases (esp. the ones given below), Format, their distinguishing features, Uses and Applications. • Sequence databases: EMBL, DDBJ, GenBank, Uniprot, PIR, TrEMBL • Domain database: Prosite, PRINT, Pfam, BLOCK • Structure database: PDB, use of Rasmol, protein explorer. Specialized database: KEGG, PUBMED, OMIM	• Use of BLAST and its variants (especially Psi-BLAST) for the identification of very similar and divergent sequences. • Use of FASTA and its comparison with BLAST. • Multiple sequence alignment using ClustalW and preparation of simple phylogenetic trees using Tree View etc.

FOURTH YEAR

PRACTICAL I

SEMESTER VII	SEMESTER VIII
▪ Sterility testing (Microbial load) of drug formulations ▪ Zone of inhibition assay for penicillin (using spiked plasma and formulation) ▪ Zone of exhiotion assay for Vitamin B₁₂ ▪ Study of ANY TEN I P monographs and their identification using characteristic features of nutraceutically important plants like; <i>Phyllanthus emlica</i>, <i>Curcuma longa</i>, <i>Ginziber officinalis</i>, Solanaceae (<i>Withania somanifera</i>), <i>Aloe vera</i>, Lilliaceae (<i>Alium sativum</i>), Lamiaceae (<i>Ocimum sanctum</i>), Apiaceae (<i>Coriandrum sps</i>) and Liliaceae (<i>Asparagus sps.</i>) <i>Centella asiatica</i>. ▪ TLC separation of Plant pigments – Curcumin and carotene.	▪ Plant DNA extraction and separation using agarose Gel ▪ PCR (PCR Kit may be used) for Plant DNA and RFLP (RFLP kit may be used) (e.g. <i>Phyllanthus</i> sps.) ▪ DNA sequencing using sample from a suitable organism OR Identification of Genetically Modified Organism (GMO identification kit may be used) ▪ Estimation of crude fat contents of foods by Soxhlet's method (Butter, Margarine, edible oil). ▪ Microbial examination of water -- total and coliform count.

PRACTICAL II

SEMESTER VII	SEMESTER VIII
◦ Liquid – liquid extraction of a modern drug from plasma and formulations (e.g. Diclofenac sodium, Glimiperide, Aceclofenac, Metformin etc.) ◦ Separation of human serum / plasma proteins / egg white using PAGE (Protein molecular weight determination kit may be used) ◦ IR analysis of a modern drug (e.g. Diclofenac Sodium, etc.) ◦ Determination of percentage purity of $\text{CaCO}_3/\text{MgCO}_3$ by i) Titrimetry ii) Complexometry iii) IE chromatography	◦ Immunoassay for HCG in urine ◦ HPTLC fingerprinting of Herbal raw material (e.g. <i>Asteracantha longifolia</i>, <i>Ricinus cummunis</i>, <i>Calotropis gigantia</i>) ◦ Determination of Caffeine from a given sample by i) uv spectrophotometry ii) HPTLC iii) HPLC ◦ HPLC separation of modern drugs from their combination formulation (e.g. Diclofenac Sodium & Paracetamol, Metformin & Glimiperide etc.)

PRACTICAL III

SEMESTER VII	SEMESTER VIII
◦ Trypsinisation of suitable Rat / mice tissue and obtaining isolated cells and staining for viable count. ◦ Preparation of calibration graphs for Li, Na, and K by flame Photometry using their solutions of appropriate concentrations and studying interference of i) K in Na estimation OR ii) Na in Li estimation OR iii) Li in K estimation	◦ Gas Chromatographic separation of solvent mixtures (e.g. Menthol & Ethanol, Toluene & Methanol etc.) • LD₅₀ evaluation using a suitable model (e.g. Daphnia / rice weevil) • Mass Fingerprinting of peptides using a suitable sample. (DEMONSTRATION)

PRACTICAL IV

SEMESTER VII	SEMESTER VIII
• Prepare specific reagents and conduct qualitative test for the presence of alkaloids, tannins, lignans, steroids and glycosides using TLC. Compare the results using standards (if available). • Tertiary structure and function prediction using homology modelling and <i>ab initio</i> method. • Validation of predicted structure. • Visualization of 3D protein structure using Rasmol, VMD • LC/MS quantitation of a modern drug (e.g. Diclofenac Sodium, Ezetimibe etc.)	• Evaluate the given data of protein and nucleic acid sequence using a global database with appropriate search engine / software (e.g. BIOEDIT). Prepare a report stating the steps involved and a brief analysis of the findings. • Evaluate the given data of peptide sequence using a global database with appropriate search engine / software (e.g. BIOEDIT). Prepare a report stating the steps involved and a brief analysis on the functional annotation of the peptide

FIFTH YEAR PRACTICAL

BIOANALYSIS

PRACTICAL I

SEMESTER IX	SEMESTER X
- Preparation of Herbarium of following medicinal plants; <i>Asteracantha longifolia</i> <i>Trigonella forename</i> <i>Clitoris ternate</i> <i>Corundum sativa</i> <i>Achyranthus aspera</i> <i>Scoparia dulcis</i> <i>Amaranthus spinosa</i> <i>Phyllanthus amarus</i> <i>Calotropis gigantea</i> <i>Vitex nigundo</i> - Individual student must submit herbaria of ANY THREE from the above list but in each institution herbarium of all the listed plants must be prepared. - Microscopic evaluation of sections and powders of the following medicinal plants; <i>Embllica officinalis</i> – (Amla - dried fruit) <i>Glycerrhiza glabra</i> (Yeshtimadhu) - Rhizome <i>Vitex nigundo</i> - Leaves <i>Ricinus communis</i> - Leaves <i>Tinospora cordifolia</i> – Stem	- SPE of a modern drug from formulation (e.g. Atorvastatin, Diclofenac sodium, Sibutramine etc.) - SPE of a modern drug from plasma (e.g. Atorvastatin, Diclofenac sodium, Sibutramine etc.) - Immunoassay of HEPALISA in serum. - HPTLC separation of a modern drug from plasma and its formulations (e.g. Diclofenac sodium, Glimiperide, Aceclofenac, Metformin etc.) - HPTLC detection of herbal raw material from its formulations (e.g. <i>Asteracantha longifolia</i> from LUKOL / SPEMAN, <i>Vitex nigundo</i> from PANCHGUN TAILA, <i>Glycerrizha glabra</i> from ANU TAILA) - DNA fingerprint (Genomic DNA isolation kit may be used) of two bacterial strains (e.g. Resistant and wild strains of <i>E. coli</i>) - Study of matrix effect on IR spectra using solution IR technique and quantitate the solute from a given

6) *Asteracantha Longifolia* –

Whole plant

7) *Achyranthes aspera* –

Whole plant

8) *Calotropis gigantea* –

Leaves

9) *Colocasia* (Arum) –

Leaves

10) *Phyllanthus amarus* –

Whole plant

- Calculation in terms of percent occurrence of key anatomical characteristics in the powder to be recorded.
- Individual student must report findings of ANY THREE from the above list but in each institution evaluation on all the listed plants must be carried out.
- Gas Chromatographic separation of solutes from their matrix (e.g. Diclofenac sodium from its formulation, Methanol from plasma etc.)
- AAS of a suitable Ayurvedic metal bhasma preparation (e.g. *Tamara bhasma*)
- Determination of iron from a given sample / sample solution by
 - i) Redox titration
 - ii) Colorimetry
 - iii) Atomic Absorption Spectroscopy

sample. Identify solute from a given solution using IR library and carry out quantitative assay.

- IR patterns of an Ayurvedic Bhasma preparation (e.g. calcium containing shanka bhasma – comparison with pure CaCO_3 and formulations like Calcium supplement tablets)
- CE separation of a modern drug from plasma and its formulation (e.g. Diclofenac sodium)
- Carry out Friability Test, Hardness test & dissolution test on any one tablet preparation
- CE separation of peptides (e.g. erythropoietin as per E.P.)

PRACTICAL II

SEMESTER IX	SEMESTER X
◦ HPLC separation of a modern drug from plasma and its formulations (e.g. Diclofenac sodium, Glimiperide, Aceclofenac, Metformin etc.) ◦ HPLC separation of herbal raw material from its formulation (e.g. <i>Asteracantha longifolia</i> from LUKOL / SPEMAN, <i>Phyllanthus amarus</i> from LIV 52, <i>Tribulus terrestris</i> from Ghokshuradi guggul etc.) ▪ CCl₄ liver dysfunction in rats and evaluation using liver function tests (An experimental comparison using suitable groups of controls, natural recovery and treatment with known hepatoprotectants to be carried out)	• BA & BE of a modern drug (Demonstration – witnessing an actual trial) • LC/MS/MS quantitation of a modern drug from plasma (e.g. Diclofenac Sodium) • LC/MS/MS quantitation of metabolite of a modern drug from plasma (eg. Mycopenolic acid, metabolite of Mycophenolate mofetil) • GC/MS separation of plant essential oil (Demonstration)

5th Year Specialization
(Nutraceutical)

PRACTICAL I

Semester X

- Study of following Parasites/Vectors/pests: Identification, Habits and control measures (museum specimens / slides):
Entamoeba histolytica, *Taenia* sps, *Ascaris lumbricoides*, *Ancylostoma dueodenaei*, *Trichinella spiralis*, *Trichura trichuris*, Mosquito (*Culex* and *Anopheles*), House fly, Green bottle fly, Head Louse, Cockroach (*Periplaneta* & *Blatta*), bed bug, *Mus* sps. (Mouse) and *Rattus* sps. (House rat)
- Estimation of crude fiber/pectic substances from plant material.
- Determination of Acid value, Saponification and Iodine number of natural fats & oils.
- Estimation of ascorbic acid from lemon & amla juice by titration method.
- Estimation of Ca, Na and K in various foodstuffs by flame photometry.
- Detection and estimation of metals – ANY ONE from - Fe, Cu, Zn, Mg, Se, and ANY ONE from - As, Hg, Pb,
- Assessment of purity and quality using appropriate standard tests for the following;
 - a. Milk and Paneer, Butter/ ghee and hydrogenated fat (Vanaspati Ghee)
 - b. Spices and condiments Tea and coffee
 - c. Fruit juice
 - d. Pulses
- Estimation of total Nitrogen of foods by Kjeldahl and Micro Kjeldahl methods.
- To separate the Milk proteins on Native and SDS gels.
- Assessment of quality of beverages -- tea and coffee.
- Microbial Role in production of alcohol – (arishta / asavas) .
- Production of industrially important enzymes by micro-organisms
(Protease and amylase).

- Estimation of enzymatic browning in foods.
- Isolation and estimation of Vitamin B2 by HPLC
- HPLC estimation of Eugenol from Clove and clove oil.
- TLC estimation of piperine from Pepper.
- Estimation of choline.

PRACTICAL II

Semester X

- Estimation of total phenols and chlorogenic acid (Phenolic compound) in plant material.
- To estimate cholesterol content in given sample by Liebermann-Burchard method.
- Estimation of preservatives and antioxidants from food sample.
- Fractionation of proteins from given sample (milk / Soya milk / Liver homogenate) using ammonium sulfate precipitation.)
- To study the gluten formation and factors affecting them.
- To study the gelatinization and factors affecting them.
- Detection of food additives (list to be given – MSG, Flavours, Colours biological and non-biological etc.) in packaged food products.
- Study of comparative antimicrobial activity of the following: Penicillin and Curcuma / thyme.
- Microbial production of citric acid by *Aspergillus niger*.
- Preparation of traditional health products – e.g. Satavari kalp, Gulkand, Amla syrup, Bilwa jam.
- Extraction and identification of Isoflavones by TLC.

- Estimation of concentration of starch in a given sample.
- Estimation of volatile substances from food products / beverages using GC.
- Extraction and estimation of total sugars from food products (dairy product, Fruit juices, bread).
- To study nutritional composition (Proteins, carbohydrates, lipids, vitamin C and presence of secondary metabolites) of the following: Bee honey, Mushrooms, dairy products, Beans, Spinach, Carrot, Apple, Amia, Pineapple, Papaya, Lentil and Soya.
- Extraction and estimation of oil or crude fat content in oil seeds.

REPORT OF PROJECTS UNDERTAKEN

- The project should involve industrial training of 8 to 12 weeks period
- Project must involve application of knowledge and skills as prescribed in the syllabus and data evaluation must involve application of biostatistics.
- The project report and observations / data generated will be presented and defended before the panel of examiners.

Suggested plan for projects:

- Preparation of Functional food/ Nutraceutical product (Any Four)
 - Rich in Vitamins
 - Rich in Minerals
 - Rich in proteins
 - Rich in carotenoids and vitamin A
 - Rich in medicinally important secondary metabolites
 - Rich in antioxidants
- Prepare a market survey report on the any one Nutraceutical functional food product.
(Related to Paper IV of 4th year where there is a Project report writing/industrial visit.)

FIFTH YEAR

BIOINFORMATICS

PRACTICAL I

SEMESTER IX	SEMESTER X
• Preparing a sample WebPages for self in HTML .(self website) • Writing simple programs in Java like finding prime numbers, Fourier series etc. • Java applets and servelets. • JDBC: connecting to a database (mySQL)	• Using perl for writing small scripts like • Reading a DNA sequence, Translating into RNA sequence.from DNA or RNA to Polypeptide sequence etc. • Using Hashes • Retrieving and writing to databases (mySQL) using perl database connectivity.

BIOINFORMATICS

PRACTICAL II

SEMESTER IX	SEMESTER X
• Microarray and clinical data analysis • Use of ANN or SVM as a prediction server.	• Target Structure Based Drug Design • Active site identification, • Characterization of target site, • Docking • Analysis

R. 8147 Distribution of Credits (Semester I to X)

Paper	Code	Semester – I				Semester – II			
Foundation Course	FC	30	2	-	-	30	2	-	-
Biological Sciences	BS1	90	6	60	2	90	6	60	2
	BS2								
Chemical Sciences	CH1	90	6	60	2	90	6	60	2
	CH2								
Computational Sciences	CS1	60	4	60	2	60	4	60	2
	CS2								
TOTAL		270	18	180	6	270	18	180	6
TOTAL CREDITS		24				24			

Paper	Code	Semester – III				Semester – IV			
Environmental Studies	ES	30	2	-	-	-	-	-	-
Technical Communication skills	TC					30	2		
Biological Sciences (Theory and Practical)	BS3	90	6	60	2	80	6	60	2
	BS4								
Chemical Sciences (Theory and Practical)	CH3	90	6	60	2	80	6	60	2
	CH4								
Computational Sciences (Theory and Practical)	CS3	60	4	60	2	60	4	60	2
	CS4								
TOTAL		270	18	180	6	250	18	180	6
TOTAL CREDITS		24				24			

Paper	Code	Semester – V				Semester – VI			
		Lectures	Credits	Practical	Credits	Lectures	Credits	Practical	Credits
Biological Sciences (Theory and Practical)	BS5	45	3	60	2	45	3	60	2
Chemical Sciences (Theory and Practical)	CH5	90	6	60	2	90	6	60	2
	CH6								
Computational Sciences (Theory and Practical)	CS5	45	3	60	2	45	3	60	2
Entrepreneurship Skills - (Business Economics, Knowledge Management, Innovation, & Principles of Corporate Management)	AC1	60	4	-	-	60	4	-	-
Projects / Assignments / Case Studies	AC2	-	-	60	2	-	-	60	2
TOTAL		240	16	240	8	240	16	240	8
TOTAL CREDITS		24				24			

Note : Biological Sciences – 16+16+10 = 42 credits
 Chemical Sciences – 16+16+16 = 48 credits
 Computational Sciences – 12 + 12+10 = 34 credits
 FC = 04 credits
 Environmental Science = 02 Credits
 Technical Communication Skills = 02 credits
 Entrepreneurship Skill = 08 credits
 Projects/Assignments/Case Studies = 04 credits

Total = 144 credits

Fourth Year / MSc Part I

Paper	Code	Semester – VII				Semester – VIII			
		Lectures	Credits	Practical	Credits	Lectures	Credits	Practical	Credits
Advanced microbiology, molecular biology, Genomics	MMG	60	4	60	2	60	4	60	2
Intellectual Property Rights, Drug act, Quality management	IPR	60	4	60	2	60	4	60	2
Tissue culture (Plant and Animal) and Toxicology	NTC	60	4	60	2	60	4	60	2
Proteomics, Bioinformatics, Pharmacokinetics	PBP	60	4	60	2	60	4	60	2
Seminar/Field visits		15	1	-	-	15	1	-	-
TOTAL		255	17	240	8	255	17	240	8
TOTAL CREDITS		25				25			

Fifth Year / MSc Part II (Specialization – Bioanalysis / Nutraceuticals / Bioinformatics)

BIOANALYSIS

Paper	Code	Semester – IX		Semester – X	
		Industrial training project	Lectures Credits	Practical Credits	
Different Medicinal Systems, Pharmacognosy, Standardization of ASU	ASU		120 8	120 4	
Application of GMP, GCP, GLP, Method Validation, BA/BE, Metabolite isolation and identification, Thermal analysis, Tracer techniques	GMP		120 8	120 4	
Industrial Training	INT	12			
Project / Report writing / Industrial visits	PRV	12			
Seminar	SEM	01	Seminar	01	
TOTAL CREDITS		25	25		

NUTRACEUTICALS

Paper	Code	Semester – IX	Semester – X			
		Industrial training/project	Lectures	Credits	Practical	Credits
Nutraceuticals and functional foods, food as remedy in human nutrition and nutritional genomics	NFF		120	8	120	4
Nutraceuticals; Evaluation, instrumentation, product development, label claims, marketing and future prospects	NPD		120	8	120	4
Industrial Training	INT	12				
Project / Report writing / Industrial visits	PRV	12				
Seminar	SEM	01	Seminar		01	
TOTAL CREDITS		25	25			

BIOINFORMATICS

Paper	Code	Semester – IX	Semester – X			
		Industrial training / project	Lectures	Credits	Practical	Credits
Concepts in computing	BCC		120	8	120	4
Bioinformatics	BNF		120	8	120	4
Industrial Training	INT	12				
Project / Report writing / Industrial visits	PRV	12				
Seminar	SEM	01	Seminar		01	
TOTAL CREDITS		25	25			

R. 81118 MINIMUM INFRASTRUCTURE REQUIRED FOR RUNNING THE COURSE

Sr. No.	Item
a.	Laboratory Space & Furniture – of ~ 900 sq ft carpet area with about 6 sq ft table space /student (Batch of 20 students)
b.	Air-conditioned Instrumentation Room for Analytical Equipments
c.	Library Facilities
d.	Computational Facilities
e.	Animal / poly House
f.	Water & Electricity
g.	Instrumental Support

R. 8149 RECOMMENDED EQUIPMENT AND ACCESSORIES

FOR UNDERGRADUATE:

- Well equipped Wet Laboratory for Chemistry and Biochemistry.
- Well equipped Laboratory for Biology.(zoology, Botany and Microbiology, Molecular biology)
- Standard Laboratory equipment for Undergraduate Science class.
- Well equipped Computation Laboratory with Internet Access.

FOR Post-GRADUATE:

Sr. No	Equipment
1.	Agarose and PAG Electrophoresis systems
2.	Analytical Balance
3.	Autoclave
4.	Capillary Electrophoresis (with PDA & UV detectors)
5.	Computers
6.	Refrigerated Centrifuge
7.	Counter Current Chromatograph
8.	Deep Freezer
9.	Dissolution Test Apparatus
10.	DNA Sequencer
11.	Flame Photometer
12.	Fourier Transform Infrared Spectrometer
13.	Gas Chromatograph
14.	Gel Documentation
15.	HPLC with various detectors (UVNIS, E.C.D, PDA) & software
16.	HPTLC Densitometer with CATS 3.0software
17.	HPTLC Spotter
18.	LC/MS/MS
19.	Low Volume Evaporator
20.	Melting Point Apparatus
21.	pH - meter
22.	Refrigerators
23.	Solid Phase Extractor
24.	Top pan balance
25.	Ultrasonic bath with Temperature control
26.	UV-Vis Scanning Spectrophotometer
27.	Vacuum Concentrator
28.	Water Distillation Apparatus
29.	Water Purification System

R. 8150 LIST OF REFERENCE BOOKS

- Basic Books on Chemistry, Statistics, Zoology, Botany, Microbiology and Biochemistry for Undergraduate class are mandatory.
- List of Specialized books are listed below;

CHEMICAL SCIENCES :

1. Douglas A. Skoog ,Principles of Instrumental Analysis, Saunders College Publishing
2. Allen J.Bard, Electroanalytical Chemistry, A series of Advances Volume -5, Marcel Dekker, Inc; New York
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12. Garry D.Christian , Analytical Chemistry 5th ed ,John Wiley and Sons Inc
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24. B.Ravindranath ,Principles and Practice of Chromatography , Ellis Horwood Ltd
25. G.Subramanian ,Preparative and Process Scale Liquid Chromatography ,Ellis Horwood
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32. Yoichiro Ito ,Welter D. Conway ,High Speed Countercurrent Chromatography ,John Wiley and Sons
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34. Raymond P.W.Scott ,Chromatographic Detectors Design Function Function and Operation ,Marcel Dekker Inc
35. Larry T.Taylor ,Supercritical Fluid Extraction ,John Wiley and Sons
36. John A.Adam ,Chromatographic Analysis of Pharmaceuticals 2nd ed ,Marcel Dekker Inc
37. W.M.A.Niessen ,Liquid Chromatography Mass Spectrometry 2nd ed ,Marcel Dekker Inc
38. P.D.Sethi ,Dilip Charegaokar ,Identification of Drugs in Pharmaceutical Formulations by Thin Layer Chromatography, CBS Publishers and Distributors
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130. Dr.C.R.Karnick, Pharmacopoeial Standards Of Herbal Plants Vol II, Sri Satguru Publisher
131. Dr.V.Rajpal, Standardization of Botanicals Vol I, Eastern Publishers
132. Regional Research Lab & IDMA, Indian Herbal Pharmacopoeia Vol II, Regional Research Lab
133. World Trade Centre, Export Potential of Herbal and Ayurvedic Drugs, Quest Publications
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145. Lloyd R.Snyder, Joseph L.Glajch, Joseph J.Krikland, Practical HPLC Method Development

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147. William S.Hancock, High Performance Liquid Chromatography in Biotechnology, John Wiley and Sons
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151. J.B.Pattison, A Programmed Introduction to Gas Liquid Chromatography, Heyden & Sons
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153. H.M.McNair, Basic Gas Chromatography, John W.Dolan, Lloyd R.Snyder, Troubleshooting LC Systems, Human Press
154. Fulton G.Kitson, Barbara S.Larsen, Gas Chromatography and Mass Spectrometry A Practical Guide, Academic Press
155. George Lunn, HPLC Methods for Pharmaceutical Analysis Vol 2 (A-D), John Wiley and Sons
156. George Lunn, HPLC Methods for Pharmaceutical Analysis Vol 3 (E-O), John Wiley & Sons
157. George Lunn, HPLC Methods for Pharmaceutical Analysis Vol 4 (P-Z)
158. Eric Reid, Ian D.Wilson, Analysis for Drugs and Metabolites, Royal Society of Chemistry
159. Malcolm R.Smyth, Chemical Analysis in Complex Matrices, Ellis Horwood Ltd
160. J.P.Hart, Electroanalysis of Biologically Important Compounds, Ellis Horwood
161. Quanyun A.Xu, Lawrence A.Trissel, Stability - Indicating HPLC Methods for Drug Analysis, Pharmaceutical Press
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166. Richard Anderson, Sample Pretreatment and Separation, John Wiley & Sons
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