DRAFT REGULATION FOR CHOICE BASED CREDIT SYSTEM (CBCS)

FOR MASTER OF SCIENCE (M.Sc.) PROGRAMME UNDER SRI GURU RAM DAS UNIVERSITY OF HEALTH SCIENCES, SRI AMRITSAR

Implemented from

Academic Session 2024-2025

Members of the Core Committee for preparing Draft Regulation for the Choice Based Credit System (CBCS)

Sr No.	Name & Designation	Role
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2.	Dr A.P. Singh, Dean, SGRDUHS	Member
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7.	Dr Prabhjot Kaur Gill, Professor, Department of Genetics, SGRDIMSR	Member Secretary

CONTENT

DRAFT REGULATION FOR MASTER OF SCIENCES CBCS

M.Sc. DEGREE/ P.G. DIPLOMA/ P.G. CERTIFICATE UNDER SRI GURU RAM DAS UNIVERSITY OF HEALTH SCIENCES, SRI AMRITSAR

1. PREAMPLE

The National Education Policy (NEP) 2020, along with the University Grants Commission (UGC) guidelines, aims to bring significant reforms to postgraduate (PG) education in all disciplines, including medical sciences, through the implementation of the Choice Based Credit System (CBCS). This framework seeks to enhance the quality, flexibility, and interdisciplinary nature of M.Sc. programs, aligning them with global standards and promoting a student-centric approach. NEP 2020 proposes varied structures for PG programs, acknowledging the diversity in undergraduate education. The curriculum and credit framework for M.Sc. programs are aligned with the National Higher Education Qualifications Framework (NHEQF). Credits earned will be managed under the National Credit Framework (NCrF), facilitating credit transfer and accumulation. CBCS provides students with the flexibility to choose courses based on their interests and career goals. It encourages interdisciplinary learning, allowing students to select courses from within their discipline and potentially from other disciplines. Students with majors or minors in their UG program may be able to pursue PG studies in either, provided they demonstrate competence.

The framework supports multiple entry and exits options in M.Sc. programs through the Academic Bank of Credits (ABC), allowing students to accumulate credits and resume their studies after a break. The framework encourages the adoption of various learning modes, including offline, online, hybrid, and Open Distance Learning (ODL) methods, providing greater accessibility and flexibility. Emphasis will be on continuous and formative assessment strategies, along with rigorous plagiarism checks. A comprehensive grading system, often a 10-point scale, will be used to evaluate student performance. The Academic Bank of Credits (ABC) facilitates the seamless transfer and accumulation of credit points, supporting both horizontal (across institutions) and vertical (across different levels of education) mobility within the higher education system. Flexibility to choose specialized elective courses within or related to their medical specialization. Implementation of a standardized grading system that aligns with UGC guidelines, facilitating better comparison of academic performance across institutions.

The introduction of CBCS for M.Sc. programs in medical sciences, as per NEP UGC guidelines, holds the potential to modernize medical education, enhance its flexibility, and promote interdisciplinary learning.

2. TITLE AND COMMENCEMENT

These Regulations shall be called the Sri Guru Ram Das University of Health Sciences regulations for Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) for Master of Science Degree Programmes. These Regulations shall be

applicable to all candidates admitted into the full-time M.Sc. programmes run under Sri Guru Ram Das University of Health Sciences, Sri Amritsar from the calendar year 2024.

3. OBJECTIVES:

Introduction of Choice Based Credit System has following objectives:

i. To make the course curriculum learner centric and encourage inter-disciplinary without disturbing the domain centric knowledge
ii. To promote mobility of students and help in optimizing learning
iii. To allow autonomy to the teachers with built in accountability.
iv. Continuous evaluation of students to help in optimizing learning
v. To introduce transparency in the evaluation system and improve employability among students

4. APPLICABILITY OF CBCS AND GRADING SYSTEM

The Regulation herein specified applies to all full-time M.Sc. Programmmes (Medical and Paramedical) under choice Based Credit System by the Sri Guru Ram Das University of Health Sciences herein after referred to as the University.

i. The Institute imparting M.Sc. teaching, hereinafter, shall be referred to as Institute (SGRDIMSR).
ii. The Regulations, herein specified, shall apply to full-time Post- Graduate Programmes offered by the Sri Guru Ram Das University of Health Sciences, hereinafter, referred to as the "University".
iii. The University Department/College/Institute imparting M.Sc. teaching, hereinafter, shall be referred to as the "Department /College/ Institute".

5. DURATION (TIME FRAME)

i. The M.Sc. programme for a regular student shall be for a period of two years to be completed in a maximum of 'Four Years' period from the date of admission/registration of the candidate.
ii. Each academic year shall comprise of two semesters, viz. Odd and Even semesters.
iii. Odd Semesters shall be from August to January and the Even Semester shall be from February to July.

6. CHOOSING PROGRAM STUDY COURSES

i. At the time of admission each student will identify a Degree/ Diploma/ Certificate Programme.
ii. Every programme will have core courses (Foundation, core and elective) as prescribed by the concerned M.Sc. Board of Studies and the Faculty.

7. ELIGIBILITY-FOR ADMISSION

i. The candidate seeking admission in M.Sc. programmes must have obtained at least 50% marks in the subject concerned at the Graduation/equivalent examinations.

ii. The M.Sc. Programme is open to a candidate who has passed Undergraduate degree in Medical Sciences (B.Sc. Medical Stream)/MBBS/BDS/BPT/BAMS or equivalent examination from a Statutory Institution/University.

OR

Any other examination recognized by the Board of Management of this University as an equivalent course/examination thereto, from time to time.

iii. The selection of the candidates shall be purely on Merit/Performance in the Centralised Entrance Test (CET) conducted by SGRDUHS

OR

The National Testing Agency conducted the CUET (PG).

iv. The Centralised Entrance Test shall be a Multiple choice questions examination of 2 hours duration of 50 marks.

v. The syllabus for M.Sc. test includes the syllabus of B.Sc. Medical Sciences as per the chosen specialization.

8. DEFINITIONS:

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

ii. **Academic Calendar**: An Academic Calendar will be prepared by the university to maintain uniformity in the CBCS of all M.Sc. Programmes, semesters and course in the college/institute run under the university.

iii. **Semester**: An academic year comprising 180 working days in the least is divided into two semesters, each semester having at least 90 working days. With six working days in a week this would mean that each semester will have 90 / 6 = 15 teaching/working weeks. Considering that each teaching day has 5 teaching/ working hours, a teaching week would have 5 x 6 = 30 working /teaching hours and each semester will have 30 x 15= 450 teaching hours available for each student. In nut shell, each semester will have 14 — 15 weeks of teaching and the remaining time of the semester will be utilized for examinations, evaluation and publication of the result. Each week will impart 30 hours of teaching spread over 6 days.

iv. The odd semester is scheduled from August to January and the even semester from February to July. Each week has a minimum 30 working hours spread over 6 days.

v. Each semester will include – Admission, Course work, conduct of examinations and declaration of result including semester break.

vi. **Choice Based Credit System (CBCS)**: CBCS provides choice for students to select from the prescribed Programme.

vii. **Programmes**:

   i. Programme: An educational programme leading to award of Master's degree, diploma or certificate.

ii. A Participant of the programme is a student who registered himself/herself with the University for any of the programmes and attend the same as per the schedule followed by the Department/Institute/College.

iii. Full-time programmes are those programmes in which the participants devote their full time in fulfilment of the academic schedule of the programme(s) and are not employed elsewhere.

viii. **Courses**:

a) Course is a structured set of instructions that are imparted to a student on the basis of a syllabus or a framework decided beforehand and has the sanction of the different academic (Board of Studies, Faculty, Academic Council) and executive (Senate/ Executive Council, Finance Committee) bodies of the University extended over a semester

b) Each course is designed variously under instructions given as Lectures, Tutorials, and Practical (laboratory and field exercises). Usually, these components are referred to as L, T, and P components. The credits for each course determine the volume of the course content. where L stands for Lecture session, T stands for Tutorial session consisting participatory discussion/self-study/desk work/ brief seminar presentations by students and such other novel methods that make a student to absorb and assimilate more effectively the contents delivered in the Lecture classes and P stands for Practice session and it consists of Hands-on experience/Laboratory Experiments/OPD-IPD Studies/ Case studies that equip students to acquire the much-required skill component.

c) **Foundation Courses (FC)**: The Foundation Courses may be of two kinds: Compulsory Foundation and Elective foundation. Compulsory Foundation courses are the courses based upon the content that leads to Knowledge enhancement. They are mandatory for all disciplines. Elective Foundation courses are value-based and are aimed at man-making education.

d) **Core Courses (CC)**: There may be Core Courses in every semester. This is the course which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

A Core course may be a Soft Core if there is a choice or an option for the candidate to choose a course from a pool of courses from the main discipline/subject of study or from a related discipline/courses which supports the main discipline/courses. In contrast to the phrase Soft Core, a compulsory core course is called a Hard Core Course.

e) **Elective Course (EC):** This is a course which can be chosen from a pool of courses. It may be: Supportive to the discipline of study, Providing an expanded scope, Enabling an exposure to some other discipline/domain, Nurturing students' proficiency/skill.

Generic Elective course (GE): An elective may be "Generic Elective (GE)" focusing on those courses which add generic proficiency to the students.

Discipline Centric Course (DC): An elective may also be "Discipline Centric (DC)" or may be chosen from an unrelated discipline. It may be called an "Open Elective".

Skill Enhancement Course (SEC/AE): "Skill Enhancement (SE)" is leading to adding to the skill/ability enhancement specific to the programme.

ix. The BOS may add or delete courses in combination of programme.

x. Each PG Degree Programme shall be designed as 80 credits, full-time postgraduate programme delivered in Four (04) Semesters.

xi. **Credit**: The term 'credit' refers to the weightage given to a course, usually in terms of the number of instructional hours per week assigned to it. This explains why usually 'credit' is taken to mean 'credit hours'. The credits also determine the volume of course contents and delivery of programme such as lectures tutorials, practical, assignments etc. Credit: Credit stands for following in the context of CBCS. Term Credit has a connotation of achievement or earning through learning effort.

Credit: A unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit shall mean one hour of teaching (lecture or tutorial) or two hours of laboratory /practical work per week in a semester of 16-18 weeks.

9. EVALUATION OF STUDENTS

i. Continued Internal Assessment has to be followed by giving at least four examinations, unannounced quiz, assignment, field work etc.

ii. Postgraduate Programme: Purely internal evaluation for courses and external evaluation for thesis/dissertation/project work.

10. EXAMINATION SCHEDULE

i. At least four examinations shall be held–First hourly examination (weightage 10%), Mid-term examination (weightage 25%), Second hourly examination (weightage 10%) and end semester examination (weightage not less than 50%) and 5% attendance weightage. The weightage for Continued Internal Assessment and the End Semester Examination will be equal

ii. The teacher may decide to give an assignment or a class seminar in lieu of the first or second hourly examination with intimation to Head of the Department.

iii. All postgraduate examinations will be held in the regular class and conducted by the class teacher under supervision of Head of the Department.

iv. All the teachers offering courses shall submit a midterm report to COE in a prescribed format within one week of holding the midterm examination.

v. All the examinations will be held during the week earmarked by the Registrar in the academic calendar.

11. ELIGIBILITY FOR APPEARING IN END SEMESTER EXAMINATION

i. 50% aggregate marks in First Hourly, Second Hourly and Mid Term Examination.

ii. 75% attendance in class lectures and practical classes.

iii. List of students detained in different courses to be displayed by the concerned Head of the Department well in advance of filling examination forms.

12. THESIS SUBMISSION GUIDELINES

i. After the allotment of Supervisor and Co-Supervisor in the first semester by the Competent Authority of the Institution (Director Principal, Registrar, Dean). Every candidate shall submit a thesis plan (synopsis) to the University within second semester from the date of admission.

ii. Every candidate shall carry out work on an approved research project under the guidance of a recognized PG Teacher (First preference given to Professor only or I. Teachers holding Ph.D. qualification having at least 3 years teaching experience after Ph.D. may be appointed as supervisor, II. After MD/MS 10 years of teaching and research experience). The teachers mentioned at [I and II] should also have at least 5 research papers in indexed National and International Journals.

iii. Thesis shall be submitted to the University before the commencement of the fourth semester Theory Examinations i.e. by March of the preceding year for July/August examinations.

iv. The Vice-Chancellor may allow a candidate to submit the thesis within one month after the date fixed for the purpose with the prescribed late fee.

v. The thesis shall embody the results of the candidate's own research and/or experience and shall contain precise reference to the publications quoted, and 'must attain a good standard and shall be satisfactory in literary presentation and in other respects and should end with a summary embodying conclusion arrived at by the candidate. The original thesis as well as the photocopies should be prepared on a high quality white paper of A4 size. All pages must have at least 4 cm margin on the left 1.5 cm on right and 2.5 cm on the top and bottom. The general text of the manuscript should be typed in 1.5 line space in Arial font, size 12 with one side printing of the paper. The text of the manuscript should be justified.

vi. After completion of all prescribed requirements of the programme, five hard bound copies of thesis using high quality Rexene (The colour of Rexene to be used for binding will be Navy Blue) with printing in golden letters on the front cover as well as on the spine shall be submitted for stamping by the Registrar. A soft copy of thesis on a CD will be submitted.

vii. The thesis shall be examined by a minimum of two examiners. One internal and one external examiner. Ordinarily, this examiner will not be appointed the External Examiner for theory and Clinical/Practical examination. The candidates who have submitted the thesis in University will be allowed to appear in the final examination. However, the result shall be declared only on receipt of the thesis acceptance from both the examiners.

viii. The internal examiner shall send only report to the University after evaluation of thesis and the evaluated copy will be deposited in the CoEs office. The external examiner shall also send copy of the thesis along with the report to the University. The University shall keep two copies of thesis in the University Library for reference of the students.

13. ACADEMIC QUALIFICATIONS AND APPOINTMENT OF EXTERNAL/INTERNAL EXAMINERS

i. M.D/Ph.D. as per specialization (Anatomy/Biochemistry/Microbiology /Pathology/Physiology/Genetics) with minimum one year of teaching/professional experience after Postgraduation in a teaching institution. OR

ii. M.Sc. Medical with minimum five years of teaching/professional experience of which at least 2 years after the post-graduate qualification in a teaching Institution.

iii. There shall be two examiners out of which one shall be external examiner recommended by Board of Studies and approved by Academic Council. The Board of Studies shall supply the panel of examiners to university for appointment of internal/external examiners by the Vice Chancellor.

14. EXAMINATIONS AND EVALUATION OF STUDENTS

i. In case a student could not appear in any component of the Continuous Internal Assessment of a course due to medical reasons or under other exceptional circumstances (supported by documentary evidence), a separate examination in that component will be arranged by the concerned teacher with the approval of respective HOD before the beginning of End Semester Examination.

ii. A student will be permitted to appear in the End-Semester Examination as per the Conduct of Examinations Rules after filling up the prescribed examination form, payment of the prescribed examination fee, satisfying the attendance requirement and fulfilling other eligibility criteria.

iii. The question paper pattern of the End Semester Examination will be prescribed by the concerned Board of Studies and at least two sets of question papers for these examinations will be submitted to COEs in the beginning of the semester, one of these sets will be passed on to the concerned HOD one hour before the Examination. It will be compulsory to pass the End Semester Examination for successful completion of the course.

iv. Unless prescribed in the Regulations and the Scheme of Examination of a particular programme, a candidate will be deemed to have completed his/her course successfully if he/she obtains minimum 50% marks/Grade point of 5.00/ as per the 10-point scale.

v. If a student fails in the End Semester Examination, a supplementary examination within six weeks of declaration of result will be arranged for such students by the respective department with the help of COEs. The marks for all other components as applicable will however, be carried forward in such cases. The students will be required to deposit the examination form along with prescribed fee for all such examinations.

vi. The marks obtained in the Continued Internal Assessment and all the examinations will be shown to the students. The evaluation scheme will also be explained to students.

vii. At the end of semester, the result for each course is compiled by the concerned teacher, discussed with the head of department and compiled result submitted by HOD to COE.

15. **SUPPLEMENTARY EXAMINATIONS**

i. If a student fails in the End Semester Examinations, a supplementary examination will be conducted with next semester examinations. The marks for all other components as applicable will however, be carried forward in such cases. Whereas shortfall in attendance will be covered by assignments or lecture attendance.
ii. Supplementary examination can be given for maximum of three courses (including practicals) or 50% courses (core & foundation courses).
iii. After declaration of result the Principal concerned shall display the list of students eligible to take supplementary examinations.
iv. The eligible students shall apply for the examination within three days of display of this list after paying the fee and filling the prescribed application form.
v. The students who fail to get pass marks shall have to register the course again and no more chance to appear in the supplementary examination shall be permitted until or unless some serious circumstances.

16. **RE-EVALUATION**

i. The re-evaluation is applicable only for final theory examinations conducted under External Examination System. If the student is eligible for supplementary examination, he/she can either opt for re-evaluation of the final paper or request for supplementary examination.
ii. Only one of these two options shall be considered by the Controller of Examinations. Once the student appears in the supplementary examination then only, the paper of supplementary examination can be considered for re-evaluation if desired by the student.
iii. The number of courses for re-evaluation in a semester can be availed up to 50% of the number of courses registered or three, whichever is less, even if a candidate has passed the course in the final examination while considering eligibility for re-evaluation, based on 50% of registered courses, the fraction of 0.5 and above will be rounded off upwards.
iv. The student may apply for re-evaluation with prescribed fee within fifteen working days of declaration of the result in a prescribed performa. The re-evaluation will be done by an examiner other than the one who has earlier marked the answer book. The re-evaluation result will be submitted to the Controller of Examinations through the teacher concerned for revision of the result, if need be.

17. **GRADING SYSTEM:**

A. Award of Grades and Credit points

i. Adopted the UGC recommended 10-point grading system of awarding grades and CGPA under ChoiceBased Credit Semester System.
ii. Grading of Performance Based on the performance, each student shall be awarded a final grade at the end of the semester for each course. Absolute grading is used by converting the marks to grade, based on predetermined class intervals.
iii. UGC 10 point grading system is used with pass grade modified.

Table 1: CBCS Grading System and Marks Equivalence

Percentage Marks	**Letter Grade**	**Grade Points**
>90 to ≤100	O (Outstanding)	**9.1-10**
>80 to 90	A+ (Excellent)	**8.1-9.0**
>70 to ≤80	A (Very Good)	**7.1-8.0**
>60 to ≤70	B+ (Good)	**6.1-7.0**
>50 to ≤60	B (Above Average)	**5.1-6.0**
>40 to ≤50	C (Average)	**4.1-5.0**
≥35 to ≤40	F (Fail)	**3.5-4.0**
Below 40	F (Fail)	**0**
Absent (Ab)	F (Fail)	**0**

For Medical/Paramedical Programme – Pass is at C Grade (5.0 grade point) 50% and above

Computation of Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA). SPGA is the weighted average of the grade points obtained in all courses by the student during the semester.

i. A student obtaining Grade F shall be considered failed and will be required to reappear in the examination. Registrations of such students for the respective courses shall be treated as cancelled and the candidate has to re-register and repeat the course when it is offered next time.
ii. For non-credit courses 'Satisfactory' or 'Unsatisfactory' shall be indicated instead of the letter grade and this will not be counted for the computation of SGPA/CGPA.

B. SGPA Computation

Course Number	Credits	Letter grade	Grade point	Credit point (Credit × grade)
1	3 (C1)	A	8 (G1)	3 × 8 = 24
2	4(C2)	B+	7(G2)	4 × 7 = 28
3	3(C3)	B	6(G3)	3 × 6 = 18

SGPA=	C1G1+C2G2+C3G3	70	=7
	C1+C2+C3	10	

Table 2. Illustration of Computation of SGPA and CGPA

Course	**Credit**	**GradeLetter**	**Grade Point**	**Credit Point (Credit x Grade)**
Course 1	3	A	8	3 X 8 = 24
Course 2	4	B+	7	4 X 7 = 28
Course 3	3	B	6	3 X 6 = 18
Course 4	3	O	10	3 X 10 = 30
Course 5	3	C	5	3 X 5 = 15
Course 6	4	B	6	4 X 6 = 24
	20			139
Illustration for SGPA **Thus, SGPA = 139/20 = 6.95**				

Table 3: Total SGPA

Semester 1	**Semester 2**	**Semester 3**	**Semester 4**
Credit : 20 SGPA : 6.9	Credit : 22 SGPA : 6.8	Credit : 25 SGPA : 6.6	Credit : 26 SGPA : 6.0
Semester 5	**Semester 6**		
Credit : 26 SGPA : 6.3	Credit : 25 SGPA : 8.0		
Illustration for CGPA			

Thus,

CGPA =20 x 6.9 + 22 x 6.8 + 25 x 6.6 + 26 x 6.0 + 26 x 6.3 + 25 x 8.0/144

= 6.75/B+

C. Transcript:

Based on the above recommendations on Letter grades, grade points and SGPA and CGPA, the transcript for each semester and a consolidated transcript indicating the performance in all semesters may be issued.

D. Re-Entry after Break of Study:

i. The University regulations for readmission are applicable for a candidate seeking re-entry to a program.
ii. Students admitted the program and absenting for more than 3 months must seek readmission into the appropriate semester as per university norms.
iii. The student shall follow the syllabus in vogue (currently approved/is beingfollowed) for the program.
iv. All re-admissions of students are course to the approval of the Vice-Chancellor.
v. All dropped students with CGPA of less than 5.0 in PG programmes, have right to petition for readmission to first year class against vacant seats.
vi. The student shall apply to the Registrar within seven days of his/her dropping from the university.
vii. The case will be reviewed by a petition committee.
viii. Readmission shall be permitted only once.

E. Ranking

i. The first two ranks of the programme will be decided on the basis of grades of CGPA in the courses.
ii. In case of a tie, marks % of core courses only will be taken into account.

F. Normal, Maximum and Minimum Credit Load in a Semester

i. In a programme, the normal full-time programme of work in a semester shall be 24 credit hours.
ii. A maximum of 30 and a minimum of 18 credit hours may be taken by a student.
iii. The PG students on 'Good Standing' may be allowed to register a maximum of 34 credit hours (4 extra credit hours) during their semesters by the Dean, provided these courses registered have been offered on regular basis.

18. **PROGRAMME CONTINUATION / DISCONTINUATION**:

The continuation/discontinuation and Exit with Degree shall be governed as follows:

i. A candidate shall be allowed to continue the programme provided he/she maintains a CGPA of 5.0 both in all theory and lab courses at the end of the even semesters (e.g. 2^{nd}, 4^{th} for the academic programmes). Otherwise, the candidate shall remain in the same year till he/she maintains the required CGPA as 5.0.

ii. Further, if a student who has been detained due to shortage of attendance in more than 50% course in a semester and due to that he/she is not able to maintain minimum criteria of required CGPA 5.0, then such student will be detained in entire semester and shall have to attend regular classes of all courses in next academic year of said semester.

iii. A candidate shall have to re-appear in semester examinations of the courses with Fail/Absent grade (as per Grade Assignment Table), as and when the same course is offered during regular course of study. Such students shall retain their internal/sessional marks.

iv. Attendance requirement for appearing in End Semester Examination of each of the semesters shall be 75%.

v. A student who has been detained due to shortage of attendance shall not be allowed to be promoted to next semester and he/she will be required to repeat only those courses where the student could not make up required 75% attendance in a semester. That is, attendance of a student shall be considered course-wise and if any student fails to maintain minimum criteria of 75% attendance in a course, then he/she will be detained in that particular course only and all such students will have to reappear for that course(s) and also attend the class of that particular course with the next batch of students of said semester.

vi. Maximum three attempts including main exam (main exam + two backlogs) shall be provided to all students to clear his/her backlogs/arrear in order to get promoted in next year/semester. That is, maximum two academic years are permissible for a student for the completion of the academic programme/course. In no situation a student will be allowed to take more than two academic years, for any reason whatsoever, including for the reasons of detention for shortage of attendance or deficiency of CGPA during the whole term of completion of the course/programme.

vii. A student who has already availed two additional academic years to clear his/her backlogs/arrears in order to be eligible for the Degree in stipulated time period, will not get any further chance and therefore admission of such student(s) would be automatically stand cancelled.

19. CORRECTION OF ERRORS

In case of any error is detected in the marks recorded on the award list, the examiner(s) concerned shall make a request to correct the mistake to the Principal through the Head of the department, and shall attach relevant documentary evidence. A committee consisting of the following members shall take suitable remedial measures depending upon the merit of the case.

a) Dean/Principal (Chairman)
b) Head of the department.
c) Two Faculty Member nominated by the Dean

20. QUESTION PATTERN AND PAPER SETTING

i. At least two sets of question papers for the examinations will be submitted to COE in the beginning of the semester, one of these sets will be passed on to the concerned in-

charge one hour before the Examination. It will be compulsory to pass the End Semester Examination for successful completion of the course.

ii. Question Paper Pattern for End Term Examinations (100 Marks for 3 hours) includes- (a). Filling in the blanks 10 marks, (b) Multiple choice questions 10 marks., (c). Short notes 10x3=30 marks and (d). Essay type questions 10x5=50 marks

iii. Question Paper Pattern for End Term Examinations (50 Marks for 2 hours) includes- (a). Filling in the blanks 5 marks, (b). Multiple choice questions 5 marks, (c). Short notes 5x2=20 marks and (d). Essay type questions 3x10=30 marks.

iv. Similar pattern for first hourly, second hourly and Midterm/sendup examinations should be followed.

21. LIST OF ELECTIVES COURSES

Course code	Title	Credits
HVE.501	Human Values & Ethics (Value added course)	**03**
RMB.501	Research Methodology and Biostatistics	**03**
IPR.550	Bioethics & Intellectual Property Rights	**03**
BMW.575	Biomedical waste management	03
ACA.575	Advances in Cancer Biology	**03**
PGC.575	Principles of Medical Genetics	**03**
GEP.575	Genomics and Proteomics	**03**
RDT.575	Recombinant DNA Technology and Genetic Engineering	**03**

COURSE CODES			
Sr. No.	**Programme**	**Course code**	**Number code**
1.	MSc Human Anatomy	M.Sc.-ANT	5.1
2.	MSc Human Physiology	M.Sc.-PHY	5.2
3.	MSc Medical Biochemistry	M.Sc.-BIC	5.3
4.	MSc Medical Microbiology	M.Sc.-MIC	5.4
5.	MSc MLT Biochemistry	M.Sc.MLT-BIC	5.5
6.	MSc MLT Microbiology	M.Sc.MLT-MIC	5.6
7.	MSc MLT Histopathology	M.Sc.MLT-HIS	5.7

Postgraduate Level	Human Physiology	PHY.501 onwards PHY.601 onwards
	Human Anatomy	ANT. 501 onwards ANT. 601 onwards
	Biochemistry MLT Biochemistry	BIC.501 onwards MLTB.501 onwards
	Genetics	MGC.501 onwards
	Microbiology MLT Microbiology	MIC.501 onwards MLTM.501 onwards
	Histopathology	MLTHP.501 onwards
	Research Methodology and Biostatistics	RMB.501 RMB.601
	Seminar in respective discipline	599
	Masters Research in respective discipline	600
Advanced level Certified courses	Seminar in respective discipline	699
	Research in respective discipline	700

Sri Guru Ram Das University of Health Sciences, Amritsar
Course Structure for the M.Sc. MLT Biochemistry

Course code	Course Title	Course Type	L+T+P	Total Credits	Marks
Semester-I					
MLTB.501	Biomolecules Chemistry	Core Course	3+0+0	3	100
MLTB.502	Enzymology	Core course	2+1+0	3	100
MLTB.503	Nutrition & Electrolytes	Core Course	3+0+0	3	100
HVE.501	Human Values & ethics	Value added course	3+0+0	3	NC**
MLTB.599	Seminar-I/Journal Club	Core course	2+0+0	2	50
MLTB.525	Practical in Medical Biochemistry-I	Core course	0+0+3	3	50
MLTB.550	Clinical Lab Rotation-I	Core course	0+0+5	5	-
		Total Credits	**13+0+9**	**22**	**400**
Semester-II					
MLTB. 504	Carbohydrates, Lipid & Heme Metabolism	Core Course	3+0+0	3	100
MLTB.505	Immunology	Core Course	3+0+0	3	100
MLTB.506	Laboratory Management	Core Course	3+0+0	3	100
MLTB.507	Analytical Biochemistry	Core Course	3+0+0	3	100
MLTB.526	Practical in Medical Biochemistry-II	Core Course	0+0+2	2	50
MLTB.550	Clinical Lab Rotation-II	Core Course	0+0+5	5	-
MLTB.600	Thesis Plan/Synopsis writing	Core course	2+0+0	2	-
		Total Credits	**14+0+7**	**21**	**450**
Semester-III					
MLTB.508	Protein & Nucleic acid Metabolism	Core course	3+0+0	3	100
MLTB.509	Endocrinology & Organ function test	Core course	3+0+0	3	100
RMB.501	Research Methodology and Biostatistics	Elective course	3+1+0	4	100
IPR.550	Bioethics & Intellectual Property Rights	Elective Course	2+0+0	2	50
MLTB.599	Seminar-II/Journal Club/ Assignments	Core Course	2+0+0	2	50
MLTB.527	Practical in Medical Biochemistry-III	Core Course	0+0+2	2	50
MLTB.550	Clinical Lab Rotation-III	Core Course	0+0+5	5	-
		Total Credits	**13+1+7**	**21**	**450**
Semester-IV					
MLTB.600	Thesis /Dissertation Work	Core course	0+0+15	15	100
MLTB.550	Clinical Lab Rotation	Core course	0+0+10	10	50
.575	Elective course	Elective course	3+0+00	03	50
		Total Credits	**3+0+25**	**28**	**200**
		Grand Total Credits	**43+1+48**	**92**	**1500**
*** Choose any one**					
BMW.575	Biomedical waste management	Elective course	3+0+0	3	50
ACA.575	Advances in Cancer Biology	Elective course	3+0+0	3	50
PGC.575	Principles of Medical Genetics	Elective course	3+0+0	3	50
GEP.575	Genomics and Proteomics	Elective course	3+0+0	3	50
RDT.575	Recombinant DNA Technology and Genetic Engineering	Elective course	3+0+0	3	50
Thesis/Dissertation work: Thesis/Dissertation work will begin in third semester. The proposal for Thesis/Dissertation work shall be finalized in second semester.					

SYLLABUS OF M.Sc. MLT BIOCHEMISTRY

Name of the Course	**BIOMOLECULES CHEMISTRY**
Course Code	**MLTB.501**
Credit hours	**03**
Teaching Objective	1. To provide fundamental knowledge of the chemical nature, classification, and properties of biomolecules. 2. To understand the structure and metabolism of carbohydrates, proteins, nucleic acids, and lipids.
Learning Outcomes	By the end of the course, students will be able to: 1. Classify and describe the structure, properties, and functions of biomolecules. 2. Explain digestion, absorption, and metabolism of carbohydrates, proteins, lipids, and nucleic acids.

Unit No.	Content	Lectures
1.	**Biomolecules:** Definition**,** Characteristics and properties.	**5**
	Carbohydrates chemistry: Classification, Digestion & Absorption, Chemistry and properties Glycoproteins, isomerism, mucopolysaccharides	**5**
2.	**Proteins chemistry:** Classification, Digestion & Absorption, properties and chemistry of amino acids and proteins, peptides, structure of proteins and classification.	10
3.	**Amino acid chemistry:** Classification, Functions, physical & chemical properties, structure.	7
4.	**Nucleic acid chemistry:** Properties, Purine, pyrimidines, nucleosides, nucleotides, structure of DNA & RNA, Nucleoprotein, Genes & Chromosomes.	10
5.	**Lipids:** Classification, Digestion & Absorption, Chemistry and properties & metabolism, Cholesterol structure and Metabolism, Prostaglandins.	8
	Total	**45**

SEMESTER-I		
Name of the Programme	**M.Sc. MLT BIOCHEMSITRY**	
Name of the Course	**ENZYMOLOGY**	
Course Code	**MLTB.502**	
Credit hours	**03**	
Teaching Objective	1. To provide in-depth knowledge about enzyme structure, function, and kinetics. 2. To explain mechanisms of enzyme regulation and diagnostic importance of enzymes.	
Learning Outcomes	Students will be able to: 1. Classify enzymes based on IUB system and explain their kinetics. 2. Perform and interpret enzyme assays for clinical and diagnostic purposes. 3. Evaluate the role of enzymes in metabolic regulation and disease diagnosis.	
Unit No.	**Content**	**Lectures**
1.	IUB system of classification and nomenclature, Enzyme units , Active site, Enzyme Kinetics-Activation energy, Derivation of Michaelis Menten equation, Factors affecting enzyme activity, Enzyme assay, Coenzymes, Isoenzymes and mutlienzyme complex, Mechanism and regulation of enzyme action- Allosteric and feedback regulation.	10
2.	Princi**ples of Diagnostic enzymology** – Laboratory investigation of serum and urinary enzymes, Intracellular localization of enzymes, Diagnostic and Prognostic importance of plasma and non plasma specific enzymes. Cytosolic enzymes – SGPT,ALP and Myocardial isoenzymes LDH, CPK – their source, properties, function, normal value, diagnostic importance. Significance of enzymes in bone disorder and muscle wasting	15
3.	**Clinical significance of Enzymes** -Transaminases, Creatine Kinase, Lactate Dehydrogenase, Alkaline phosphatase, Acid phosphatase, Aldolases, Amylases, Elastase, Gamma glutamyl Transferase, 5' - Nucleotidase, Choline Esterases, Hexokinase, Lipoprotein Lipase.	10
4.	**Enzymes in Inborn error of metabolism** – Phenylketonuria, Alkaptonuria, Tyrosinosis, Albinism, Hartnup's disease ,Galactoemia, Taysacch's disease, Niemann Pick's disease, Hunter Syndrome, Lesh Nyhan Syndrome.	10
	Total	**45**

SEMESTER-I		
Name of the Course	**NUTRITION & ELECTROLYTES**	
Course Code	**MLTB.503**	
Credit hours	**03**	
Teaching Objective	1. To introduce concepts of human nutrition, energy requirements, and dietary balance. 2. To explain the role of functional foods, nutraceuticals, and supplements in health and disease.	
Learning Outcomes	1. Explain energy metabolism, BMR, and factors influencing nutritional needs. 2. Describe roles of functional foods, nutraceuticals, and dietary supplements in disease prevention. 3. Evaluate the role of electrolytes in acid-base balance and homeostasis.	

Unit No.	Content	Lectures
1.	Composition of human body. Energy content of foods. Measurement of energy expenditure: direct & indirect calorimetry. Basal metabolic rate (BMR) and specific dynamic action (SDA) and factors affecting BMR. Thermogenic effects of foods. Energy requirements of man and woman and factors affecting energy requirements.	**10**
2.	Nutritional disorders and management – Malnutrition, Kwashiorkor, Marasmus and nitrogen imbalance.	5
3.	Obesity and secondary causes of obesity, appetite and eating disorders. Physicochemical properties and physiological functions of dietary fibres.	5
4.	Functional Foods and Nutraceuticals - Introduction - Defining the concept – Cereals and pulses and functional food.	5
5.	General Teleology – a) Carotenoids b) Conjugated linolenic acid c) Flavonoids d) Sulphur containing Amino Acid Derivatives e) Omega 3 fatty acids f) PUFA g) Terpenoids.	8
6.	Dietary Supplements – role of nutraceuticals in the management of Inborn errors of metabolism, obesity, neurological disorder, diabetes mellitus, hypertension, Cardiac vascular disease, vitamin A Deficiency.	7
7.	**Electrolytes**: Acid Base Balance Introduction and Terminology	5
	Total	**45**

Name of the Course	HUMAN VALUES AND ETHICS
Course Code	HVE.501
Credit hours	03
Teaching Objective	**1.** To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings. 2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way. 3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature. Thus, this course is intended to provide a much needed orientational input in value education to the young enquiring minds.
Learning Outcomes	By the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind. They would have better critical ability. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

Unit No.	Content	Credits
Module 1	Introduction to Value Education (6 lectures and 3 tutorials for practice session) Lecture 1: Understanding Value Education Lecture 2: Self-exploration as the Process for Value Education Tutorial 1: Practice Session PS1 Sharing about Oneself Lecture 3: Continuous Happiness and Prosperity – the Basic Human Aspirations Lecture 4: Right Understanding, Relationship and Physical Facility Tutorial 2: Practice Session PS2 Exploring Human Consciousness Lecture 5: Happiness and Prosperity – Current Scenario Lecture 6: Method to Fulfill the Basic Human Aspirations Tutorial 3: Practice Session PS3 Exploring Natural Acceptance	5+4
Module 2	Harmony in the Human Being Lecture 7: Understanding Human being as the Co-existence of the Self and the Body Lecture 8: Distinguishing between the Needs of the Self and the Body Tutorial 4: Practice Session PS4 Exploring the difference of Needs of Self and Body Lecture 9: The Body as an Instrument of the Self Lecture 10: Understanding Harmony in the Self Tutorial 5: Practice Session PS5 Exploring Sources of Imagination in the Self Lecture 11: Harmony of the Self with the Body Lecture 12: Programme to ensure self-regulation and Health	7+3

	Tutorial 6: Practice Session PS6 Exploring Harmony of Self with the Body	
Module 3	Harmony in the Family and Society (6 lectures and 3 tutorials for practice session) Lecture 13: Harmony in the Family – the Basic Unit of Human Interaction Lecture 14: Values in Human-to-Human Relationship Lecture 15: 'Trust' – the Foundational Value in Relationship Tutorial 7: Practice Session PS7 Exploring the Feeling of Trust Lecture 16: 'Respect' – as the Right Evaluation Tutorial 8: Practice Session PS8 Exploring the Feeling of Respect Lecture 17: Understanding Harmony in the Society Lecture 18: Vision for the Universal Human Order Tutorial 9: Practice Session PS9 Exploring Systems to fulfil Human Goal	6+3
Module 4	Harmony in the Nature/Existence (4 lectures and 2 tutorials for practice session) Lecture 19: Understanding Harmony in the Nature Lecture 20: Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature Tutorial 10: Practice Session PS10 Exploring the Four Orders of Nature Lecture 21: Realizing Existence as Co-existence at All Levels Lecture 22: The Holistic Perception of Harmony in Existence Tutorial 11: Practice Session PS11 Exploring Co-existence in Existence	4+2
Module 5	Implications of the Holistic Understanding – a Look at Professional Ethics (6 lectures and 3 tutorials for practice session) Lecture 23: Natural Acceptance of Human Values Lecture 24: Definitiveness of (Ethical) Human Conduct Tutorial 12: Practice Session PS12 Exploring Ethical Human Conduct Lecture 25: A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order Lecture 26: Competence in Professional Ethics Tutorial 13: Practice Session PS13 Exploring Humanistic Models in Education Lecture 27: Holistic Technologies, Production Systems and Management Models Typical Case Studies Lecture 28: Strategies for Transition towards Value-based Life and Profession Tutorial 14: Practice Session PS14 Exploring Steps of Transition towards Universal Human Orde	6+3
	Suggested Readings:	
	Text Book and Teachers Manual a. The Textbook A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1 b. **b.** The Teacher's Manual Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2	
	Reference Books 1. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999. 2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004. 3. The Story of Stuff (Book). 4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi	

	5. Small is Beautiful - E. F Schumacher. 6. Slow is Beautiful - Cecile Andrews 7. Economy of Permanence - J C Kumarappa 8. Bharat Mein Angreji Raj – Pandit Sunderlal 9. Rediscovering India - by Dharampal	

Name of the Course	TECHNIQUES IN BIOCHEMISTRY-I
Course Code	MLTB.525
Credit hours	03
Teaching Objective	1. To train students in fundamental biochemical laboratory techniques. 2. To ensure safe handling of biological specimens and reagents.
Learning Outcomes	Students will be able to: 1. Collect, handle, and process biological specimens safely. 2. Perform qualitative and quantitative analysis of blood and urine parameters. 3. Interpret results with reference to clinical ranges and laboratory standards.

Unit No.	Content	Lectures+ Practicals
1.	Managing the Laboratory: collection, handling and storage of specimens, quality management and risk management, utilization and maintenance of general lab equipment including minor repairs	10
2.	Safety in the laboratory: control of chemical and biological hazardous to health and environment, risk management, handling of histological chemicals	10
3.	Molality, Molarity and Normality, normal and molar solution.	5
4.	Qualitative estimation of Normal and abnormal urine components	3
5.	Colorimetry & Spectrophotometry	2
6.	Quantitative estimation of Blood & Urinary Sugar	3
7.	Quantitative estimation of serum & urinary Urea	2
8.	Quantitative estimation of serum & urinary creatinine	3
9.	Quantitative estimation of Uric acid	3
10.	Reference range of all routine parameters	4
	Total	45

SEMESTER-II	
Name of the Course	**CARBOHYDRATES, LIPID & HEME METABOLISM**
Course Code	**MLTB.504**
Credit hours	**03**
Teaching Objective	• To provide detailed knowledge of carbohydrate, lipid, and heme metabolism. • To understand regulatory mechanisms and clinical implications of metabolic pathways.
Learning Outcomes	By the end of the course, students will be able to: • Describe pathways of carbohydrate, lipid, and heme metabolism. • Explain regulation of glucose, lipid, and heme metabolism under normal and diseased states.

Unit No.	Content	Lectures
1.	**Carbohydrate Metabolism:** Glycolysis, Gluconeogenesis, Uronic acid pathway, TCA cycle, I-IMP pathway, Glycogen metabolism, Galactose metabolism, Fructose metabolism, Regulation of blood glucose, Inb0N1 errors of metabolism.	15
2.	**Lipid metabolism:** Fatty acid synthesis, fatty acid oxidation, ketogenesis, Metabolism of triglycerides and cholesterol. Lipoprotein metabolism, obesity, fatty liver, lipotropic factors, atherosclerosis and coronary heart disease and Inborn errors of metabolism.	15
3.	**Heme Metabolism:** Function of heme, the detailed steps of heme synthesis (including the role of key enzymes like ALA synthase), the degradation pathway leading to bilirubin production, the regulation of heme synthesis, the clinical implications of heme metabolism disorders (porphyrias), and the role of heme in different proteins like hemoglobin and cytochromes	15
	Total	**45**

SEMESTER-II	
Name of the Course	**IMMUNOLOGY**
Course Code	**MLTB.505**
Credit hours	**03**
Teaching Objective	• To provide comprehensive knowledge of the immune system, its components, and mechanisms. • To understand immune responses, antigen–antibody interactions, and immunological disorders.
Learning Outcomes	Students will be able to: • Describe structure and function of immune cells, organs, antigens, and immunoglobulins. • Explain T-cell and B-cell activation, differentiation, and immune regulation. • Analyze immune responses in hypersensitivity, autoimmune diseases, and immunodeficiencies.

Unit No.	Content	Lectures
1.	Overview of the immune system: Non – specific and specific components of immunity. Cells, primary and secondary organs of immune system. Hematopoiesis. Antigens – Immunogenicity, haptens, adjuvants, epitopes - T cell and B cell epitopes. Immunoglobulins- Structure, classes, biological activities, antigenic determinants, Ig superfamily.	15
2.	T cell and B cell receptors, Interaction of T cells and B cells. T cell and B cell maturation, activation, differentiation and proliferation. Effector mechanism- Macrophage activation, cytokine mediated immunity. Clonal selection theory, Immunoglobulin rearrangements, Class switching. Complement system and regulation. Cytokines and Cell – mediated effector responses.	15
3.	Organization and functions of MHC, structure of MHC molecules, Antigen processing and presentation. Classes of MHC molecules. Hypersensitive reactions [all types]. Immune response to infectious diseases. Transplantation types, MHC antigens in transplantation, Mechanism of graft rejection and Immunosuppressive therapy. Autoimmunity and Immuno-deficiency diseases; types, mechanism of HIV organization and pathogenesis.	15
	Total	**45**

Suggested Books:

Sr. No.	Authors/ Name of Books/Publisher
1.	Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.
2.	Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.
3.	Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999.
4.	Paul, Fundamental of Immunology, 4th edition, Lippencott Raven, 1999.
5.	Goding, Monoclonal antibodies, Academic Press. 1985.

SEMESTER-II	
Name of the Course	**LABORATORY MANAGEMENT**
Course Code	**MLTB.506**
Credit hours	**03**
Teaching Objective	To develop Problem solving skills to overcome errors through statistical analysis occurring in clinical laboratories Manage an organization's policies, procedures and processes to promote continual improvement To Ensure importance of quality Control, Customer satisfaction, Satisfy

	regulatory requirement, and create more efficient processes.	
Learning Outcomes	To Conduct Internal Audits To ensure Good laboratory clinical practices (GLCP). To face the External Audits. To understand statistics to ensure the precision and accuracy of Quality control materials and EQAS. To Prepare Standard operating procedures (SOP).	
Unit No.	**Content**	**Lectures**
1.	Overview of the quality management system: Facilities and safety overview: Equipment management	5
2.	Purchasing and Inventory: Sample management: Process Control Quality control for quantitative tests.	5
3.	Quality control for qualitative and semi – quantitative procedures: Assessment: External quality assessment (EQA): Norms and Accreditation	5
4.	Personnel management: Customer service: Occurrence management: Process Improvement. Documents and Records: Information management & Statistical Analysis	5
5.	Biosafety Management – Scenario — Equipment Failure Scenario — Purchasing and Inventory Sample Management Calculation of Mean and Standard Deviation, Levey- Jennings Charts QC Procedures and QC for serology Scenario—Organizing an Internal Audit EQA and Processing Proficiency Testing Samples	10
6.	Scenario — Preparations Needed for a Laboratory Accreditation Scenario — Overview of Personnel Restoring Customer Confidence and Planning a Customer Satisfaction Survey	5
7.	Laboratory errors Scenario — Improving Laboratory Processes Differentiating Documents from Records and The Quality Manual Assessing the Relevancy of a Computerized Laboratory Information System and Developing a System for Assigning Understanding Planning, Implementation, and Monitoring Processes; Understanding Managerial and Staff Responsibilities	10
	TOTAL	**45**

SEMESTER-II		
Name of the Programme	**M.Sc. MLT Biochemistry**	
Name of the Course	**ANALYTICAL BIOCHEMISTRY**	
Course Code	**MLTB.507**	
Credit hours	**03**	
Teaching Objective	• To provide knowledge of analytical tools and techniques used in biochemistry. • To study principles, instrumentation, and applications of chromatography, electrophoresis, and spectroscopy.	
Learning Outcomes	By the end of the course, students will be able to: • Explain principles and applications of chromatography, electrophoresis, and spectroscopy. • Select and apply suitable bioanalytical techniques for laboratory investigations. • Interpret analytical data for clinical and research purposes.	
Unit No.	**Content**	**Lectures**
1.	**pH scale**: buffer solution, pH electrode, Clarke's Oxygen electrode and their applications.	5
2.	**Microscopy**: Principles and applications of light, phase contrast, fluorescence, scanning and transmission electron microscopy.	5
3.	**Chromatography**: Principles, Instrumentation and applications of paper chromatography, exclusion chromatography, column chromatography, Chromato focussing affinity chromatography and adsorption chromatography: Gel preparation, principle and application ion–exchange chromatography–Types of resins, apparatus preparation and applications. Liquid chromatography: Principle, Instrumentation and applications of GLC, LC, LPLC and HPLC.	10
4.	**Electrophoresis**: Principles, Instrumentation and applications of paper electrophoresis, agar gel, starch gel, PAGE, Capillary electrophoresis PFGE, high and low voltage electrophoresis, Isoelectric focussing, Tachophoresis,	5
5.	**Centrifugation**: Principles, laws of sedimentation. Preparative and Analytical Centrifugation – Differential centrifugation and Density gradient centrifugation. Analytical Ultracentrifuges. – Instrumentation and application; Sedimentation equilibrium methods. Analysis of sub cellular fractions. Criteria of purity of macromolecules.	10
6.	**Spectroscopy**: Basic laws of light absorption, optical rotatory dispersion. Basic principles, instrumentation and applications Circular dichroism and X-ray diffraction. Basic principles, instrumentation and applications of UV and visible light spectrophotometry, spectro fluorimetry, Atomic Flame Photometry, Plasma Emission Spectroscopy, Infra–red spectrophotometry, Mass spectrometry, Tandem mass spectroscopy, ESR, NMR. Semi and Auto analysers- Principal and applications	10
	Total	**45**
Suggested Books		

1. Principles and techniques of practical Biochemistry, Keith Wilson and John Walker, 1995.Cambridge University Press.
2. An Introduction to Spectroscopy for Biochemist, Brown. SB Academic Press.
3. Introduction to Centrifugation, Ford T.C and Graham J.N., Bioscientific Publishers Ltd, Oxford.
4. Biophysical chemistry Principles and Techniques- Avinash Upadhyaye and Nirmalendhe Nath , 2001. Himalaya Publishers.
5. A Biologist Guide to Principles and Techniques of Biochemistry, Keith Wilson and Kenneth Goulding, Edward Arnold publishers.

Name of the Course	**TECHNIQUES IN MLT BIOCHEMISTRY-II**
Course Code	**MLTB.525**
Credit hours	**03**
Teaching Objective	• To provide hands-on training in advanced biochemical experiments. • To develop accuracy in preparation of standard curves and biochemical estimations.
Learning Outcomes	Students will be able to: • Prepare and interpret standard curves for glucose, urea, and creatinine. • Perform electrophoresis techniques for protein and nucleic acid separation. • Apply laboratory findings in clinical correlation and diagnosis.

Unit No.	**Content**	**Lectures & practicals**
1.	Isolation, purification, and kinetics of ALP and ACP from samples	5
2.	Standard curve of blood glucose	3
3.	Standard curve of serum urea	2
4.	Standard curve of serum creatinine	2
5.	**Electrophoresis**: SDS-PAGE, paper, cellulose acetate, starch gel, Agarose gel electrophoresis	11
6.	All quantitative estimation by semi autoanalyser 1. Enumeration of RBC and WBC 2. Differential count 3. Estimation of Haemoglobin a) Colorimetric method b) Sahli's method 4. Determination of Bleeding Time and Clotting time 5. ESR, Haematocrit and PCV **II Blood/ Serum Analysis** 1. Estimation of total blood sugar, OGTT, GlyHb & DIPSI 2. Estimation of Total protein by Lowry's method 3. Determination of A:G ratio by Biuret method	22

	4. Estimation of Creatine and Creatinine- Alkaline picrate method 5. Estimation of Cholesterol, TG, HDL,LDL and VLDL 6. Estimation of Bilirubin [TB, DB & IB] 7. Estimation of Vitamin A and C 8. Determination of LDH and CPK activity 9. Determination of AST & ALT activity 10. Estimation of Cu and Fe **III Urine Analysis** 1. Estimation of Urea, Uric acid, Creatine and Creatinine 2. Estimation of Titrable acidity 3. Estimation of Phosphate 4. Estimation of Na & K, Ca **IV Agglutination** 1. Blood Grouping and Rh Typing 2. RA test 3. CRP test 4. Pregnancy Test	
	Total	45

SEMESTER-III	
Name of the Course	**PROTEIN & NUCLEIC ACID METABOLISM**
Course Code	**MLTB.508**
Credit hours	**03**
Teaching Objective	• To explain the metabolism of proteins and nucleic acids in detail. • To describe digestion, absorption, synthesis, and degradation of proteins.
Learning Outcomes	By the end of the course, students will be able to: • Describe protein digestion, absorption, and metabolism. • Analyze catabolic and anabolic pathways of amino acids and proteins. • Evaluate clinical implications of protein/nucleic acid metabolism disorders.

Unit No.	Content	Lectures
1.	**Introduction to Protein Metabolism**: • Definition of protein metabolism and its significance in the body • Structure of amino acids and peptide bonds • Levels of protein structure (primary, secondary, tertiary, quaternary)	4
2.	**Protein Digestion and Absorption**: • Digestive enzymes involved in protein breakdown (pepsin, trypsin, chymotrypsin) • Mechanisms of protein digestion in the stomach and small intestine • Transport of amino acids across the intestinal wall	8
3.	**Protein Synthesis (Anabolism)**: • Central dogma of molecular biology (DNA to RNA to protein) • Transcription process: DNA to mRNA • Translation process: mRNA to polypeptide chain • Role of ribosomes and tRNA Post-translational modifications (glycosylation, phosphorylation)	8
4.	**Amino Acid Metabolism**: • Classification of amino acids (essential vs. non-essential) • Transamination and deamination reactions • Carbon skeletons of amino acids and their entry points into the citric acid cycle Biosynthesis of non-essential amino acids	5
5.	**Urea Cycle**: • Importance of the urea cycle in nitrogen excretion • Steps of the urea cycle and the enzymes involved	5
6.	**Protein Catabolism**: • Mechanisms of protein degradation (ubiquitin-proteasome pathway, lysosomal degradation) • Regulation of protein turnover Amino acid catabolism for energy production during starvation	5
7.	**Liver Function in Protein Metabolism**: • Role of the liver in protein synthesis (albumin, clotting factors) • Deamination and transamination reactions primarily occurring in the liver • Regulation of plasma amino acid levels by the liver	5

8.	**Clinical Applications:** • Protein deficiency and malnutrition • Genetic disorders affecting protein metabolism (phenylketonuria, maple syrup urine disease) Liver diseases and their impact on protein metabolism	5
	Total	45

Name of the Course	ENDOCRINOLOGY & ORGAN FUNCTION TEST
Course Code	MLTB.509
Credit hours	03
Teaching Objective	• To provide knowledge of hormones, their classification, and mechanisms of action. • To study diagnostic laboratory tests related to endocrine disorders.
Learning Outcomes	Students will be able to: • Classify hormones and explain their mechanisms of action. • Evaluate hormonal imbalances and their pathophysiology. • Perform and interpret laboratory tests for endocrine and organ functions.

Unit No.	Content	Lectures
1.	Hormones - Introduction, classification, hormonal effects and regulation – basic concepts Chemical properties of hormones: Peptide hormones, Steroid hormone, Neurohormone. Concept of Receptors – Cell surface and intracellular (cytoplasmic and nuclear) receptors, G protein coupled receptors, Pharmacological receptors – Neurotransmitter receptors. Second messenger system – Ca2+ cAMP, cGMP, DAG, and IP3.	10
2.	Chemical nature and mechanism of action of steroid hormones and glycoprotein hormones on target tissues. Hypothalamus, Pituitary-Posterior and Anterior, Thyroid, parathyroid, Adrenal and Pineal glands: Secretions, Structure, physiology and Mechanism of action.	10
3.	Secretions, Structure, physiological function and Mechanism of action of Pancreatic hormones – Insulin, glucagon, Gastrointestinal hormones – Gastrin, secretin and somatostatin, Sex hormones - testosterone, progesterone and oestrogen.	5
4.	Secretions, Structure, physiological function, Mechanism of action, Dysfunction and pathophysiology of hypothalamus – Posterior and anterior hypophyseal complex. Dysfunction and pathophysiology of thyroid, parathyroid, pancreas, adrenals, gonads and gastrointestinal hormones.	8
5.	Endocrine system: Laboratory diagnosis and investigations related to the disorders of Hypothalamus- Hypophyseal complex. ELISA, [All types] PCR Techniques with reference to hormones estimation in biological sample: Insulin, T3 and T4. TSH. FSH, LH GH, EGN, PGN.	7
6.	Liver function tests, Renal function tests, Thyroid function tests, Lipid profile tests.	5
	Total	**45**

Suggested Books:

Sr. No.	Authors/ Name of Books/Publisher
1.	Endocrinology, Mac E. Hadley, 2006, 4TH . Edition. Prentice Hall International Inc.
2.	Textbook of Medical Physiology, Guyton and Hall, 2000. 10th Edition, Saunders Publishing Co.
3.	Principles of Biochemistry, Emil Smith, Handler Abraham, 1983.7 th Edn., White, Mcgraw Hill International book company.

4.	Williams textbook of Endocrinology, P.Reed Larson, HenryM. Korenberg, Shlom Melmed and Kenneth S. Polonsky, 2003, 10th Edition, Saunder Philadelphia, USA.
5.	Harpers Biochemistry, Murray *et al.*, 2003. 2nd Edition, Mc Graw Hill Publications, USA

Name of the Course	**RESEARCH METHODOLOGY AND BIOSTATISTICS**
Course Code	**RMB.501**
Credit hours	**04**
Teaching Objective	To equipping learners with the knowledge and skills to design, conduct, and interpret research, understand statistical concepts, and apply them in their respective fields. This involves developing abilities in formulating research questions, selecting appropriate research designs, collecting and analyzing data, and reporting findings ethically includes defining research, its purpose, scope, and various types (e.g., qualitative, quantitative, experimental, observational).
Learning Outcomes	Students get an idea about collection, interpretation and presentation of statistical data.

Unit No.	**Content**	**Lectures**
1.	Definitions-Scope of Biostatistics- Variables in biology, collection, classification and tabulation of data- Graphical and diagrammatic representation. Measures of central tendency – Arithmetic mean, median and mode. Measures of dispersionRange, standard deviation, Coefficient of variation	15
2.	Correlation – Meaning and definition - Scatter diagram –Karl pearson's correlation coefficient. Rank correlation. Regression: Regression in two variables – Regression coefficient problems – uses of regression	12
3.	Test of significance: Tests based on Means only-Both Large sample and Small sample tests - Chi square test - goodness of fit. Analysis of variance – one way and two way classification. CRD, RBD Designs	15
4.	Research: Scope and significance – Types of Research – Research Process – Characteristics of good research – Problems in Research – Identifying research problems. Research Designs – Features of good designs	12
5.	Sampling Design: Meaning – Concepts – Steps in sampling – Criteria for good sample design. Scaling measurements – Techniques – Types of scale.	10
	Total	**64**

Suggested Books

Sr. No.	**Authors/ Name of Books/Publisher**
1.	Deepak Chawla, Neena Sondhi, Research Methodology Concepts and Cases, Vikas books publishers, 2th edition, 2016
2.	Donald H. McBurney -Theresa L. White "Research Methods" (Cengage learning India Pvt. Ltd), 5th edition, 2006
3.	B. K. Mahajan, Methods in Biostatistics: for medical students and Research workers. Kothari Book Depot, Mumbai, 7th edition

Name of the Course	**BIOETHICS AND INTELLECTUAL PROPERTY RIGHT**
Course Code	**IPR.550**
Credit hours	**03**
Teaching Objective	Students will gain a comprehensive understanding of foundational ethical principles and their application to medicine and healthcare. They will learn to analyze and resolve complex ethical dilemmas in clinical and research settings, considering topics from patient rights and end-of-life care to emerging biomedical technologies. Additionally, students will develop a solid grasp of intellectual property rights (IPR), particularly patents in biotechnology, and learn to critically evaluate the ethical and legal conflicts surrounding IPR, such as access to medicine and biopiracy.
Learning Outcomes	By the end of this course, students will be able to: i. Apply ethical theories like utilitarianism and deontology to real-world healthcare scenarios. ii. Critically evaluate the four core principles of bioethics: autonomy, beneficence, non-maleficence, and justice. iii. Demonstrate a systematic approach to ethical decision-making in both clinical practice and medical research. iv. Analyze and navigate the legal and ethical landscape of intellectual property, including patenting biological materials and managing patent applications. v. Debate and articulate informed positions on major controversies at the intersection of bioethics and IPR, such as compulsory licensing and the protection of traditional knowledge.

Unit No.	Content	Lectures
1.	**Introduction to ethics**: Exploration of fundamental ethical concepts, theories (like utilitarianism and deontology), and their application to medicine and healthcare. **Core principles of bioethics**: In-depth analysis of the four central principles: autonomy (respect for the patient's right to choose), beneficence (the duty to do good), non-maleficence (the duty to do no harm), and justice (the fair distribution of benefits and burdens). **Historical context**: Study of significant historical events that shaped modern bioethics, such as the Nuremberg Code and the Tuskegee syphilis study. **Ethical decision-making**: Training in systematic approaches for resolving ethical dilemmas in clinical and research settings.	8
2.	**Ethical issues in clinical practice:** **Patient rights**: Understanding patient rights, informed consent, truth-telling, and confidentiality. **Beginning-of-life issues**: Discussion of ethical considerations related to reproductive technologies, abortion, contraception, and genetic screening. **End-of-life care**: Moral and legal issues surrounding euthanasia, physician-assisted suicide, advance directives, and organ transplantation. **Doctor-patient relationships**: Exploration of the power dynamics, trust, and communication necessary for therapeutic relationships.	7
3.	**Ethical issues in medical research** **Human experimentation**: Ethical guidelines for clinical trials, research involving vulnerable populations (e.g., children, prisoners), and the use of placebos.	5

	Biomedical technology: Ethical analysis of emerging technologies such as stem cell research, genetic engineering, cloning, and artificial intelligence in medicine. **Animal rights**: Debate surrounding the ethical use of animals in research and testing. **Biobanking**: Ethical issues involved in the collection, storage, and use of human biological samples for research.	
4.	**Introduction to IPR** **Fundamentals of IPR**: Definition and rationale behind intellectual property, including its role in incentivizing innovation in the healthcare industry. **Types of IP**: Overview of the main forms of IPR, including patents, copyrights, trademarks, and geographical indications, with relevance to the life sciences. **International framework**: Study of international agreements like the World Intellectual Property Organization (WIPO) and the TRIPS Agreement (Trade-Related Aspects of Intellectual Property Rights). Indian Position on WTO Regime. General Agreement on Trade and Tariff (GATT).	10
5.	**Patents in biotechnology and medicine** **Patentability criteria**: Detailed examination of the requirements for patenting biotechnological inventions, including novelty, inventive step (non-obviousness), and industrial applicability. **Patenting biological materials**: Analysis of patenting issues related to genes, microorganisms, and other life forms, referencing landmark court cases such as *Diamond v. Chakrabarty*. **Indian patent law**: Indian Patent Act 1970 (Patent Amendment Acts-1999, 2002 and 2005) **Patent process**: Practical guidance on drafting and filing patent applications and managing a patent portfolio.	5
6.	**Ethical and legal controversies in IPR** **Biopiracy and traditional knowledge**: Investigation of the appropriation of traditional knowledge and biological resources by pharmaceutical companies, Patent Case study: Basmati Case, Neem Controversy, Turmeric Case **Access to medicine**: Examination of the ethical conflict between a company's patent rights and the public's need for affordable medicines. This includes discussions on compulsory licensing. **Data and privacy**: IPR issues related to medical data, digital technologies, and the protection of patient information. **Case studies**: Use of real-world cases to explore conflicts between patent protection, patient welfare, and global health priorities.	10
	Total	**45**

Suggested Books:

Important Links
http://www.w3.org/IPR/ http://www.wipo.int/portal/index.html.en http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html www.patentoffice.nic.in www.iprlawindia.org/ - 31k - Cached - Similar page http://www.cbd.int/biosafety/background.shtml http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html Bioethics - by Ellen Frankel Paul , Fred D. Miller, Jeffrey Paul , Fred Dycus Miller http://www.accessexcellence.org/RC/AB/IE/#Anchor-Bioethics-6296 www.bioethics.net Bioethics & Science http://www.americanprogress.org/issues/domestic/science?_kk=bioethics&_kt=21a1e10d-48e4-44bc-8b39-21c695383746 **The Stem cell debate** http://www.billmuehlenberg.com/2005/09/02/the-stem-cell-debate/

Name of the Course	TECHNIQUES IN BIOCHEMISTRY-III
Course Code	MLTB.525
Credit hours	02
Teaching Objective	• To provide practical exposure to advanced biochemical techniques. • To train students in chromatography, electrophoresis, and automation in laboratories.
Learning Outcomes	Students will be able to: • Perform chromatography and electrophoresis for biomolecule separation. • Analyze biochemical parameters of blood, urine, and serum. • Record, interpret, and report experimental data accurately.

No.	Content	Lectures and Practical
1	Chromatography: define, types (TLC, Absorption, ion exchange & Partition, Paper, HPLC, GC)	10
2	Analysers, Semi auto-analysers, Auto analysers Automation in clinical biochemistry lab.	5
3	Separation of amino acids and sugars by paper chromatography (Ascending, Descending, and Circular)	5
5.	Separation of Protein Hb, Cytochrome C by Molecular sieve chromatography Separation of amino acids by Paper Electrophoresis	5
6.	Separation of Serum Protein by SDS PAGE	5
7.	Separation of DNA by AGE	5
	Total	**35**

Name of the Course	THESIS WORK-IV
Course Code	MLTB.600
Credit hours	15
Teaching Objective	i. To train students in independent biomedical research. ii. To provide experience in experimental design, data collection, and analysis.
Learning Outcomes	Students will be able to: i. Design and execute an independent, hypothesis-driven research project in a relevant area of clinical or laboratory medical biochemistry. ii. Apply appropriate statistical and bioinformatic methods to analyze and critically interpret complex experimental data. iii. Produce a comprehensive scientific thesis that adheres to established academic conventions for structure, citation, and ethical reporting.

Sr. No.	Content
1.	Review of literature search
2.	Laboratory base research work
3.	Compilation of data

4.	Analysis of data
5.	Thesis writing & presentation

Elective courses

SEMESTER-IV		
Name of the Course	**BIOMEDICAL WASTE MANAGEMENT**	
Course Code	**BWM.575**	
Credit hours	**03**	
Teaching Objective	The objective of the paper is to · Teach how to manage biomedical waste · Provide Knowledge about various biomedical management and handling rules · Learn the treatment and disposable techniques used for biomedical management · Teach biomedical waste management rules.	
Learning Outcomes	Understand how to manage biomedical waste Know various biomedical management and handling rules Learn the treatment and disposable techniques of biomedical management. Know various biomedical waste management rules.	
Unit No.	Content	Lectures
1.	Waste disposal management, Hospital waste management, Biosafety-regulatory framework for GMOs, bioethics and its socio economic impact, Hazards associated with poor health care waste management	10
2.	Characterization of medical waste- Bio-medical wastes (Management and Handling) Rules, 1998, Amendments and guidelines, segregation, packaging, storage, transport of infectious waste. Techniques of Biomedical waste management. Health and safety rules. Protocols, issues, and challenges in transportation of Biomedical waste.	10
3.	Treatment method- Autoclave, Hydroclave, Microwave, Chemical Disinfection, Solidification and stabilization, Bioremediation, Thermal Conversion Technologies, accumulation and storage of hazardous waste, land disposal of hazardous waste, other treatment and disposal method. Common Hazardous Waste Treatment Facilities (TSDF)	11
4.	Biomedical waste management rule: Biomedical wastes categories and their segregation, collection, treatment, processing, and disposal options, Standards For Treatment and Disposal Of Bio-Medical wastes, Standards for autoclaving of bio-medical waste, standards of microwaving, standards for deep burial, standards for the efficacy of chemical disinfection, standards for dry heat sterilization, standards for liquid waste	14

Suggested Readings

Sr. No.	**Authors/ Name of Books/Publisher**
1.	Biomedical Waste Management: R. Radharisham
2.	Hospital Waste Management's-A guide for self-assessment and review: ShishirBasarkar
3.	Biomedical Waste Disposal: Anantpreet Singh and Sukhjit Kaur
4.	Medical Waste Management and Disposal: V. J. Landrum

SEMESTER-IV	
Name of the Course	**Principles of Medical Genetics**

Course Code	PGC.575
Credit hours	03
Teaching Objective	• To provide understanding of Mendelian and non-Mendelian inheritance patterns. • To explain molecular basis of genetic diseases and their diagnosis.
Learning Outcomes	Students will be able to: • Explain inheritance patterns and genetic variability. • Interpret chromosomal abnormalities and their clinical significance.

Unit No.	Content	Lectures
1.	**Mendelian Genetics:** Introduction to human genetics; background and history; types of genetic diseases; role of genetics in medicine. Human pedigrees; patterns of single gene inheritance-autosomal recessive; autosomal dominant; X linked inheritance. Complicating factors-incomplete penetrance; variable expression; multiple alleles; co dominance; sex influenced expression; hemoglobinopathies-genetic disorders of hemoglobin and their diseases.	4
2.	**Non Mendelian inheritance patterns:** Mitochondrial inheritance; genomic imprinting; Lyon hypothesis; isodisomy. Complex inheritance– genetic and environmental variation; Heritability; twin studies; behavioral traits; analysis of quantitative and qualitative traits.	4
3.	**Cytogenetics:** Cell division and errors in cell division; Non disjunction; Structural and numerical chromosomal abnormalities–deletion; duplication; translocation; sex determination; Role of Y chromosome. Genetic recombination; disorders of sex chromosomes and autosomes. Molecular cytogenetics–Fluorescence In Situ Hybridization (FISH); Comparative Genomic Hybridization (CGH).	7
4.	**Developmental genetics:** Genes in early development; maternal effect genes; pattern formation genes; homeotic genes; and signaling and adhesion molecules.	5
5.	**Immunogenetics:** Major histocompatibility complex; immunoglobulin genes-tissue antigen and organ transplantation. Single gene disorders of immune system.	5
6.	**Genetic variation:** Mutations; kinds of mutation; agents of mutation; genome polymorphism; uses of polymorphism.	5
7.	**Gene maping and human genome project:** Physical mapping; linkage and association.	5
8.	**Population genetics and evolution:** Phenotype; genotype; gene frequency; Hardy-Weinberg law; factors distrubing Hardy-Weinberg equilibrium; mutation selection; migration; gene flow; genetic drift. human genetic diversity; origin of major human groups.	5
	Total	**45**

Suggested Books:

Sr. No.	Authors/ Name of Books/Publisher
1.	S.R. Maloy, J.E. Cronan, D. Friefelder, Microbial Genetics, 2nd Edition, Jones and Bartlett Publishers, 1994.
2.	Strachan T and Read A P, Human molecular genetics, 3rd Edition Wiley Bios, 2006.
3.	Mange E J and Mange A. P., Human genetics, 2nd Edition, Sinauer Associates publications, 1999.
4.	Hartl L D and Jones B, Analysis of genes and genomes, 3rd Edition, Jones and Bartlett Publishers, 1994.

Name of the Course	Recombinant DNA Technology and Genetic Engineering	
Course Code	**RDT.575**	
Credit hours	**03**	
Teaching Objective	• To introduce principles of recombinant DNA technology. • To study cloning vectors, gene expression systems, and sequencing methods.	
Learning Outcomes	Students will be able to: • Demonstrate knowledge of cloning, PCR, and sequencing techniques. • Apply recombinant DNA methods for molecular diagnostics and therapy. • Discuss ethical issues related to recombinant DNA technology.	
Unit No.	**Content**	**Lectures**
1.	**Basics Concepts:** DNA Structure and properties; restriction enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; cohesive and blunt end ligation; linkers; adaptors; homopolymeric tailing; labeling of DNA: nick translation, random priming, radioactive and non-radioactive probes. Hybridization techniques: Northern, Southern and Colony hybridization, fluorescence in situ hybridization; chromatin immunoprecipitation; DNA-Protein interactions-electromobility shift assay; DNaseI footprinting; methyl interference assay	10
2.	**Cloning Vectors:** Plasmids; bacteriophages; M13 mp vectors; PUC19 and bluescript vectors, phagemids; lambda vectors; insertion and replacement vectors; EMBL; cosmids; artificial chromosome vectors (YACs; BACs); animal virus derived vectors-SV-40; vaccinia/bacculo & retroviral vectors; expression vectors; pMal; GST; pET based vectors. Protein purification: His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; baculovirus and pichia vectors system, plant based vectors, ti and ri as vectors, yeast vectors, shuttle vectors.	9
3.	**Cloning Methodologies:** Insertion of foreign DNA into host cells; transformation; construction of libraries; isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; jumping and hopping libraries; Southwestern and Far-western cloning; protein-protein interactive cloning and yeast two hybrid system; phage display; principles in maximizing gene expression	8
4.	**PCR and its Applications:** Primer design; fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; T vectors; proof reading enzymes; PCR in gene recombination; deletion; addition; overlap extension; and SOEing; site specific mutagenesis; PCR in molecular diagnostics; viral and bacterial detection; PCR based mutagenesis, mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test)	10
5.	**Sequencing methods**; Enzymatic DNA sequencing; chemical sequencing of DNA; automated DNA sequencing; RNA sequencing; chemical Synthesis of oligonucleotides; introduction of DNA into mammalian cells;	8

	Transfection techniques; Gene silencing techniques; introduction to siRNA; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; gene knockouts and gene therapy; creation of knock out mice; disease model; somatic and germ-line therapy- in vivo and ex-vivo; suicide gene therapy; gene replacement; gene targeting; transgenics; cDNA and intragenic arrays; differential gene expression and protein array.	
	Total	**45**

Suggested Books

Sr. No.	Authors/ Name of Books/Publisher
1.	S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2.	J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3.	Brown TA, Genomes, 3rd ed. Garland Science 2006
4.	Selected papers from scientific journals and Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.

Name of the Course	**Genomics and Proteomics**	
Course Code	**GEP.575**	
Credit hours	**03**	
Teaching Objective	• To provide knowledge of genome organization, sequencing, and comparative genomics. • To introduce DNA microarray and proteomic technologies.	
Learning Outcomes	Students will be able to: • Analyze genomic data and apply computational tools for sequence analysis. • Describe DNA sequencing projects and comparative genomics. • Evaluate the role of genomics and proteomics in disease diagnosis and therapeutics.	
Unit No.	**Content**	**Lectures**
1.	**Introduction to Genomics:** Structure and organization of prokaryotic and eukaryotic genomes - nuclear, mitochondrial and chloroplast genomes; Computational analysis of sequences- finding genes and regulatory regions; gene annotation; similarity searches; pairwise and multiple alignments; alignment statistics; prediction of gene function using homology, context, structures, networks; genetic variation-polymorphism, deleterious mutation; phylogenetics; tools for genome analysis– PCR, RFLP, DNA fingerprinting, RAPD, automated DNA sequencing; linkage and pedigree analysis; construction of genetic maps; physical maps, FISH to identify chromosome landmarks.	10
2.	**Genome sequencing:** Human genome project-landmarks on chromosomes generated by various mapping methods; BAC libraries and shotgun libraries preparation; Physical map-cytogenetic map, contig map, restriction map, DNA sequence; DNA sequencing and sequence assembly; Model organisms and other genome projects; comparative genomics of relevant organisms such as pathogens and non-pathogens; evolution of a pathogen e.g. Hepatitis C virus or a bacterial pathogen; taxonomic classification of organisms using molecular markers- 16S rRNA typing/sequencing;	9

3.	**DNA Microarray technology:** Basic principles and design: cDNA and oligonucleotide arrays; Applications: Global gene expression analysis, Comparative transcriptomics, differential gene expression; genotyping/SNP detection; detection technology; computational analysis of microarray data.	6
4.	**Proteomics:** Overview of protein structure-primary, secondary, tertiary and quarternary structure; Relationship between protein structure and function; outline of a typical proteomics experiment; identification and analysis of proteins by 2D analysis; spot visualization and picking; tryptic digestion of protein and peptide fingerprinting; mass spectrometry : ion source (MALDI, spray sources); analyzer (ToF, quadrupole, quadrupole ion trap) and detector; clinical proteomics and disease biomarkers; Prions; proteins in disease; protein-protein interactions: Solid phase ELISA, pull-down assays (using GST-tagged protein), far western analysis, by surface plasmon resonance technique, yeast two hybrid system, phage display; Protein interaction maps; Protein arrays-definition, applications- diagnostics, expression profiling.	10
5.	**Human disease genes**; DNA polymorphism including those involved in disease; hemoglobin and the anemias; phenylketonuria (monogenic) and diabetes (multigenic) genetic disorders; 'disease' gene vs. 'susceptibility' gene; SNP detection: hybridization based assays (allele specific probes); polymerization based assays (allele specific nucleotide incorporation, allele-specific PCR); ligation based assays (allele specific oligonucleotide ligation); polymorphism detection without sequence information: SSCP; proteomics and drug discovery; high throughput screening for drug discovery; identification of drug targets; pharmacogenomics and pharamacogenetics and drug development; toxicogenomics; metagenomics.	10
	Total	**45**

Suggested Books:

Sr. No.	Authors/ Name of Books/Publisher
1.	Brown TA, Genomes, 3rd Edition, Garland Science, 2006.
2.	Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and
3.	Bioinformatics, 2nd Edition, Benjamin Cummings, 2007.
4.	Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.
5.	Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998.
6.	Ed. C. Cantor and C.L. Smith, Genomics: The Science and Technology behind the Human Genome Project, Wiley-Interscience, 2000.
7.	G. Gibson, S. V. muse, A Primer of Genome Science, Sinauer Associates Inc. Publishers, 2002.
8.	H. Rehm, Protein Biochemistry and Proteomics, 4th Edition, Academic Press, 2006.
9.	E. de Hoffman and V. Stroobant, Mass Spectrometry, 2nd Edition, Wiley. 2002.

Name of the Course	**Advances in Cancer Biology**
Course Code	**ACA.575**
Credit hours	**03**
Teaching Objective	• To introduce molecular and cellular mechanisms underlying cancer. • To provide knowledge of cancer diagnostic techniques and biomarkers.
Learning Outcomes	Students will be able to: • Describe genetic, molecular, and environmental

	causes of cancer. • Explain oncogenes, tumor suppressor genes, and mechanisms of carcinogenesis. • Correlate cancer biology with prevention, diagnosis, and treatment strategies.

Unit No.	Content	Lectures
1.	Cancer Epidemiology, Geographic, Environmental and age factors: Genetic basis of cancer, autosonal dominant/ recessive inherited cancer, DNA damage. Familial cancer, Non-Genetic basic of cancer. Chronic inflammation, precancerous condition, oxidative stress.	5
2.	Molecular basis of cancer, introduction, essential alteration for malignant transformation, proto-oncogenes, oncogenes, oncoproteins. Growth factors and their receptors, signal transducing proteins, insensitivity to growth inhibition & escape from senescence, role of tumor suppressors genes, genomic instability, dysregulation of cancer associated genes.	10
3.	Carcinogenic agents & their cellular interactions, radiation (Ionizing and Non Ionizing), microbial (Oncogenic RNA & DNA viruses).	5
4.	Stem cells, history and axis of research, what makes stem cell a stem cell, stem cell therapies. Future regeneration medicine	10
5.	Bioinformatics and cancer	5
6	Biologically important techniques in cancer research, laboratory diagnosis of cancer, histological & cytological. Immuno histro chemistry, flow cytometery, molecular diagnosis (Polymerase chain reaction, fluorescent in-situ hybridization). Cytogenetic Techniques (Karyotyping), DNA Microarray, comparative genomic hybridization, snp chips, gene sequencing, tumor markers.	10
	Total Credits	45