Faculty of Biomedical Science

JSS ACADEMY OF HIGHER EDUCATION & RESEARCH
(DEEMED TO BE UNIVERSITY) MYSURU

JSS Academy of Higher Education & Research
(Deemed to be University)
Re-Accredited "A+" Grade by NAAC
Sri Shivarathreeshwara Nagara Mysuru - 570015, Karnataka

Regulation & Syllabus

MEDICAL GENETICS AND GENOMICS
B.Sc HONS MG&G
2022

BSc Honors

REGULATIONS AND CURRICULUM

B.Sc. MEDICAL GENETICS AND GENOMICS

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BSc HONORS PROGRAM (MEDICAL GENETICS AND GENOMICS – BSc MG&G)

About the regulations and Commencement

- The following regulation is made for the **BSc Honors/Honors with Research with an option for the Integrated MSc program (Medical Genetics and Genomics).**
- It intends to identify and foster the unique capability of each student and provide them flexibility in learning, and conceptual understanding of subjects. It emphasizes practical work/research-oriented learning.
- The regulation presented is student-centric and aims to provide holistic and multidisciplinary education suitable for the present 21st generation.
- These regulations will come into force from the Academic year 2022-23

About the program

- The program consists of 4 years of undergraduate with Honors (8 semesters) **& an optional** 1 year (2 semesters) of MSc including a research thesis (9 months) and industry internship (3 months) leading to an integrated master's degree (total of 10 semesters).
- The program integrates conventional BSc and MSc courses into a single curriculum (5 years) providing the students with holistic research-oriented learning.
- It is a credit-based program.

Total credits for the program: 168 credits (For BSc Honors/Honors with research)
208 credits (For the integrated MSc program)

Year of implementation: 2022-2023
Total intake: 20

Overview: The program offered during the first 2 semesters (1 and 2) includes basic and introductory courses in biology including medical subjects such as anatomy, physiology, biochemistry, microbiology, etc. Students will also be trained in computer applications and psychology.
The basic courses taught in the first 2 semesters are meant to train students to develop their understanding and interest in advanced subjects for the next 8 semesters (3-10). This includes Genetics, Developmental and Cell biology, Molecular biology, Cancer genetics, etc. In addition, students will take allied subjects starting from semester 2 and elective subjects from semester 5 onwards. These allied and elective subjects are application-oriented and specifically designed to enhance their skills and in-depth understanding of the subject.
The final year semester (9 and 10) is completely devoted to a master's thesis by research along with an industry internship.

Program vision and mission

- To educate young minds through teaching driven by curiosity and research.
- To impart strong foundational knowledge in genetics and to expose students to the emerging field of genomic medicine.

Program Goal

- To train individuals and nurture their research lab skills in the field of Genetics and genomics and enable them to emerge as skilled laboratory experts or industrial technical experts with research attitude.

- To engage students with genetic counselors and improve their genetics communication skills and enable them to counsel the patients about genetic diseases.

Program outcome: At the end of the program students should be able to

- PO1. Comprehend current concepts in human genetics and genomics, cytogenetics, and epigenetics.
- PO2. Follow the molecular mechanisms underlying the physiological and pathological functioning of cells in the human body.
- PO3. Distinguish and analyze the genetic basis of complex and rare genetic disorders.
- PO4. Establish themselves as Medical Geneticist professionals and apply their knowledge to take up genetic counseling jobs after completing appropriate exams.
- PO5. Research attitude to pursue higher studies (Ph.D.) in life sciences
- PO6. Pursue a career in academia or industry based on the laboratory skills developed during the program.
- PO7. Take up research scientists' jobs at molecular diagnostics, and genetics lab and familiarize with working culture in hospitals.
- PO8. Perform advanced genetics and molecular techniques using high-end equipment.

Pedagogy

- The syllabus is designed to encourage critical thinking and problem-solving ability in students. The classroom lectures include discussions, presentations and encourage self-learning.
- Students are encouraged to develop reasoning abilities and learn through questioning. Faculties are to provide all the necessary fundamentals so that students can develop the art of questioning.
- Learning through experimentation- Most of the core subjects have practical lab work to provide hands-on experience.
- Faculties will be free to follow suitable pedagogy to impart an education that is best suited for the courses. Emphasis is given to learning that suits the Indian context and aligns with our country, context, and culture.
- A combination of an online and in-person mode of teaching is encouraged for evolueffective learning. This Flexibility allows students to listen to lectures/seminars and talks by experts from different geographical locations.

Eligibility for admission:

- Students who have passed the Pre-University Examination conducted by the Pre- University Education Board in Karnataka or any other examination considered equivalent to that shall be eligible for admission to the program. The student should have studied life sciences/ biology as a subject at the qualifying examination (PU).

Medium of instruction:

- Instructions and examinations shall be in English

Definition of Keywords:

- **Academic Year:** Two consecutive semesters (an odd and an even).
- **Semester:** Each semester will consist of over 15-16 weeks of academic work.
- **Program:** A program leading to the award of a Degree, diploma, or Certificate.

- **Credit:** A unit by which the course work is measured. It determines the number of hours of instruction required per week in a semester.
- **Choice-Based Credit System (CBCS):** The CBCS provides options for students to select subjects from the prescribed open elective, discipline elective, ability, and skill enhancement language, soft skill subjects, etc.
- **Course:** is referred to as 'papers' is a component of a program. It includes subjects comprising lectures/ tutorials/laboratory work/ project work/ Internships /viva/ seminars/ term papers /assignments/presentations/self-study or a combination of some of these.
- **Credit-Based Semester System (CBSS):** Under the CBSS, the requirement for awarding a degree /diploma /certificate is prescribed in terms of the number of credits to be earned.
- **Grade Point:** Numerical weight allotted to each letter grade on a 10-point scale.
- **Credit Point:** A product of grade points and the number of credits for a course.
- **Letter Grade:** It is an index of the performance of students in a said course. Grades are denoted by the letters O, A, B, C, D, E and Fail.
- **Semester Grade Point Average (SGPA):** It is a measure of performance of work done in a semester. Defined as the ratio of total credit points secured by a student in various courses registered in a semester and the full course credits taken during that semester. It shall be expressed up to two decimal places.
- **Cumulative Grade Point Average (CGPA):** It measures the overall cumulative performance of a student in all the semesters of the program. The CGPA is the ratio of total credit points secured by a student in various courses in all the semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.
- **Transcript or Grade Card or Marks Card:** Based on the grades earned, a graded transcript shall be issued to all the registered students after every semester. The grade transcript will display the course details (title, number of credits, grade secured).

Research component during the program

- Students must complete one semester of an Honors research project in their 8th semester along with the prescribed courses.
- However, students who wish to continue with an integrated master's degree will continue research in their 9th and 10th semesters (Masters's research) along with the prescribed courses.
- Students will take up 3 months of internship (internal or external) during the 9th and 10th semesters.

Credit awarded for the program

- Each subject taught in the program carries a defined number of credits. The credits are based on the teaching mode i.e. number of contact hours for lectures, tutorials, and laboratory practicals.
- 1 hour of theory/tutorial teaching per week is equal to 1 Credit
- 2 hours of laboratory practicals/laboratory postings per week is equal to 1 Credit.
- Grading calculations – 1 credit is equal to 25 marks in a semester. Therefore, a 4- or 5-credit course will have a maximum of 100 marks, a 2-credit course would cover a maximum of 50 marks. The proportion of marks earned in a course and the credits given to that course is used to calculate the Semester Grade Point Average (SGPA) or Cumulative Grade Point Average (CGPA).

Subjects of study (Table 1)

- Subjects include Discipline specific courses (DSC), discipline-specific elective (DSE) courses, open elective (OE) courses, languages, ability enhancement courses (AEC), skill enhancement courses (SEC), and value-based activity (VBA), laboratory practicals, internships and research project work.

Definitions

- **Discipline Specific Course** (DSC) is a core course, which should be compulsorily studied by a student as a core requirement of the program.
- **Elective Courses** can be chosen from a pool of courses. It may be very specific, specialized, advanced, or supportive to the discipline/subject of study, which provides an extended scope, or enables exposure to some other discipline/subject/domain or nurtures the student's proficiency/skill.
- **Discipline Specific Elective** (DSE) is offered under the main discipline/subject of study.
- **Open Elective** (OE) is chosen from an unrelated discipline/subject to seek exposure beyond discipline/subject.
- **Ability Enhancement Courses** (AEC) may be of two types: Ability Enhancement Compulsory Courses (AECC) and Skill Enhancement Courses (SEC).
    - **AECC** courses are mandatory courses based upon the content that leads to knowledge enhancement viz., Environmental Studies, Indian Constitution, and English/ / Communication skills.
    - **SEC** courses are aimed at providing hands-on training, competencies, skills, etc.
- **Value-Based/Activity Based** (VBA) courses are intended to enhance the employability of the students. The courses will help to bridge the gap between the skill requirements of the employer or industry and the competency of the students.
- **Massive Open Online Courses** (MOOCs) are online courses, which are available on the SWAYAM (Study Web of Active-Learning for Young Aspiring Minds) platform of the Government of India. In case a student selects MOOCs instead of the interdisciplinary course, the credit earned therefrom will be considered for grading and ranking. The credits earned under the SWAYAM platform are also transferable from one institution to another. The student is eligible to take additional courses under MOOCs if he/she opts to earn extra credits, however, these would be considered as additional SWAYAM/ MOOCs and will not be considered either for grading or ranking.

Table 1: Program Design and Subject of Study

SEM	Discipline Core (DSC) (Credits) L+T+P	Discipline-specific elective (DSE) (Credits) L+T+P	Skill enhancement courses (SEC)/Ability enhancement courses (AEC) (Credits) L+T+P	Multidisciplinary (MDC)/ Value-based activity/course (VBA) (Credits) L+T+P	Total Credits
1	Anatomy (DSC-1) 3+1+1 Physiology (DSC-2) 3+1+1 Basic Biochemistry (DSC-3) 3+1+1		Language 1- English (AEC-1) 2+0+0 Language 2- Kannada (AEC-2) 2+0+0	Yoga (VBA-1) 1+0+0	20
2	Pathology including applied aspects (DSC-4) 3+1+1 Microbiology including applied aspects (DSC-5) 3+1+1 Pharmacology (DSC-6) 3+1+1		Health care (AEC-3) 2+0+0 Soft Skills (SEC-1) 1+0+0	Psychology (MDC-1) 2+0+0	20
3	Introduction to Genetics (DSC-7) 3+1+2 Cell & Molecular Biology (DSC-8) 3+1+2 Principles of immunology (DSC-9) 3+1+2		Laboratory posting (SEC)	Computer application (MDC-2) 2+0+0 Environmental Sciences (MDC-3) 2+0+0	22
4	Biophysics & Instrumentation (DSC-10) 3+1+2 Human Evolutionary Genetics (DSC-11) 3+1+2 Developmental Genetics (DSC-12) 3+1+2		Biostatistics & Research Methodology (SEC-2) 2+0+0 Laboratory posting (SEC)	Constitution of India (VBA-2) 2+0+0	22
5	Human Cytogenetics (DSC-13) 3+1+2 Bioinformatics in Genomics (DSC-14) 3+1+2 Human Population genetics (DSC-15) 3+1+2	Recombinant DNA Technology OR Therapeutic genetics (DSE-1) 2+0+0	Laboratory posting (SEC)	Medical Ethics (MDC-4) 2+0+0	22

6	Biochemistry & Metabolic disoders (DSC-16) 3+1+2 Human Molecular Genetics (DSC-17) 3+1+2 Epigenetics in health & disease (DSC-18) 3+1+2	Proteomics OR Principles of Drug Discovery (DSE-2) 2+0+0	Research Methodology (SEC-3) 2+0+0 Laboratory posting (SEC)		22
7	Genetics of rare diseases (DSC-19) 3+1+2 Genetics of complex diseases (DSC-20) 3+1+2 Genetic counselling (DSC-21) 3+1+2	Pharmacogenetics OR Nutrigenomics (DSE-3) 2+0+0	Scientific writing (SEC-4) 2+0+0	IPR (VBA-3) 2+0+0	24
8			**Honors research project 0+0+12**	Summer internship (VBA-4) 0+0+4	16
BSc (Hons) in Medical Genetics & Genomics (168 credits)					
9	Cancer genomics (DSC-22) 3+1+2 Genetic data analysis (DSC-23) 3+1+2	Pharmacovigilance OR Infertility and ART (DSE-4) 2+0+0	**Masters research project** Animal model of human diseases (AEC-4) 2+0+0	Health economics (VBA-5) 2+0+0 BLS (VBA-6)*	18
10			**Masters research project 0+0+18**	Industry internship (VBA-7) 0+0+4	22
Integrated MSc in Medical Genetics & Genomics (208 credits) *BLS (VBA-6) – Basic life support (compulsory on payment basis)					

Tutorials/Seminars/Journal clubs

- Students are expected to actively participate in departmental seminars and journal clubs.
- Seminars for the subjects may be conducted by the subject faculty at his/her convenience.
- A record should be maintained for each student and the list of seminars and papers presented in the journal club by each student should be maintained in the department.

Summer internship for BSc Honors

- Students will undertake a minimum of 2 weeks internship in industries/research institutes (internal or external) during their semester breaks in the 7th or 8th semester.

Industry/Academia internship for integrated MSc

- Students will undergo internship in reputed industries/research institutes (internal or external) for 2 months. Students must maintain the logbook which has to be certified by the concerned authority in the industry on daily basis. At the end of the internship, the student is expected to attain additional competencies and should submit an internship report which will be certified by the industry authorities along with their feedback.

Value-based Activity

- The following extension activities shall be provided for the ability enhancement of the candidates, to provide better health care services. The certificate shall be provided by the offering departments. The Basic Life Support (BLS) and Advanced Cardiac Life Support (ACLS) shall be as per the American Heart Association guidelines and certification.

Research project report/thesis

- Every student is required to carry out work on a selected research project under the guidance of a recognized post-graduate teacher in their respective subjects. The project report (BSc Honors) and thesis (MSc) shall be submitted to the controller of examination of the JSSAHER 15 days before the end of the 8th semester for BSc Honors and 10th semester for MSc to be evaluated by the examiners.
- Every student will be given an introductory course in research methodology, biostatistics, and research techniques before they embark on the research project. He/she will be taught how a research project can be planned and implemented. He/she must also acquire basic knowledge of the statistical methods and their applications.
- The project is aimed to train a postgraduate student in research methods and techniques. It includes identification of a problem, formulation of a hypothesis, search and review of literature, getting acquainted with recent advances, designing of a research study, collection of data, critical analysis, and comparison of results, and drawing conclusions.
- Every student shall submit a synopsis in the prescribed format containing particulars of the proposed project work in the first four weeks of the
    - 7th semester for BSc Honors degree and
    - 9th semester for Integrated MSc respectively
- The synopsis shall be sent through the proper channel. Such synopsis will be reviewed, and the project topic will be registered by the JSS Academy of Higher Education & Research. No change in the research topic or guide shall be made without prior approval of the JSSAHER. A co-guide may be included provided the work requires a substantial contribution from a sister department or another institution recognized for teaching/ training by the JSS Academy of Higher Education & Research.
- The candidates shall report the progress of the research work to the concerned guide periodically and obtain clearance for the continuation of the project work. The **Report/**

Thesis should be written under the following headings

i. Introduction
ii. Aims of Objectives of the study
iii. Review of Literature
iv. Material and Methods
v. Results
vi. Discussion
vii. Conclusion
viii. Summary
ix. References
x. Tables
xi. Annexure

- Four copies of the Report/Thesis thus prepared shall be submitted 15 days before the end of the 8th semester for BSc Honors and 10th semester for MSc or before the dates notified by the JSS Academy of Higher Education & Research.

Attendance

- Candidates should have attended at least 75% of the total number of classes conducted in a semester, from the date of commencement of the term to the last working day, as notified by the Deemed to be University, in each of the subjects prescribed for that semester, separately in theory and practical, to be eligible to appear for the Deemed to be University examinations. Otherwise, the candidate shall not be allowed to appear for the exam.

Maintenance of Logbook and Practical record

- A diary showing each day's work has to be maintained by the candidate, which shall be scrutinized by the Head of the Department every month. A list of the seminars and journal reviews that have been attended and presented by the student must be maintained which should be scrutinized by the Head of the Department.
- A practical record must be maintained by every candidate and duly scrutinized and certified by the Head of the Department and submitted to the external examiner during the end-of-semester examination.

Assessment and Evaluation

The whole purpose of assessment and evaluation is to constantly improve the quality of students. It also acts as an indicator of faculties abilities to teach effectively. Following are the guidelines.

- As far as possible the assessments should provide constructive feedback to the candidates.
- In addition to the regular theory examinations, assessments will involve the active participation of students in seminars, presentations, project participations, and peer-assessments.
- The examination questions may include, open-ended concepts, multiple choices answer to trigger out-of box thinking of students.

Process of evaluation – Theory

- The evaluation will be done based on
    - formative assessment/internal assessment (IA) and
    - summative assessment/end semester examination.
- Total Marks for each course = 100 marks
    - Internal assessment (IA 1) = 40 marks

- Internal assessment (IA 2) = 40 marks
- Semester End Examination = 60 marks.

Process of evaluation – Practicals

- Total Marks for practicals = 150
  - Internal assessment (IA 1) = 50 marks
  - Internal assessment (IA 2) = 50 marks
  - Semester End Examination = 100 marks.

Internal assessment

- The Department will conduct IA tests, each semester. IA shall assess the student's performance on a continuous basis. The tests may include written papers, assignments, seminars, practicals, and viva voce. Marks obtained in each test will be maintained by the Head of the Department and sent to the controller of examination, JSSAHER. The candidates who have failed the end semester examination shall be given an internal assessment improvement test and the best marks shall be submitted to the controller of examination.
- Question paper pattern for internal assessment
  - 5 marks X 3 (out of 5 questions) = 15 marks
  - 3 marks X 5 = 15 marks
  - 2 marks X 5 = 10 marks
- Total **40 marks** for each internal assessment
- Internal assessment IA-1 will be scheduled after completing 50% of the syllabus of the course within the stipulated time. The assessment is for 40 marks.
- Internal assessment IA-2 will be scheduled after completing the remaining 50% of the syllabus of the course within the stipulated time. The assessment is for 40 marks.
- Evaluated papers shall be discussed with the students for their improvement. Average of IA-1 and IA-2 will be taken. Candidates have to secure a minimum of 40% marks in the IA theory (18 marks) and practical (20 marks) separately to become eligible to appear for the JSSAHER examination. IA marks shall be communicated to the controller of examination and shall be put on the notice board. IA marks may be provided separately in the final transcript.

Industry/Academia internship evaluation

- The industry/academia internship report will be submitted to the Head of the Department at JSS Medical College. Based on the logbook, the report and the feedback from the industry marks will be allotted from a maximum mark of 100 (4 credits) for the report.

Research thesis evaluation

- BSc Honors degree (300 marks, 12 credits) - (Minor research project of one-semester duration) - Marks shall be awarded for the project POSTER PRESENTATION and project report submission (50:50 pattern). Two examiners shall be present for the evaluation of posters (**Both may be internal examiners**).
- Integrated master's degree (450 marks, 18 credits) - (Major research thesis of two-semester duration) - Marks shall be awarded for the thesis writing and a project ORAL PRESENTATION (50:50 pattern). Two examiners shall be present for the project presentation (**One internal and One from an external university)**

End semester examination

- The end-of-semester examination shall be conducted by the university during the 20th – 22nd week of the semester. The assessment is for the remaining 60% of the total marks.
- If a student fails to attend take IA-1 and IA-2 on a scheduled date, it shall be deemed that the student has dropped the test. However, in case of genuine reasons such as health emergencies, the student may appeal to the Program Coordinator for a re-test before the commencement of the concerned semester end examinations.
- The examination consists of both theory and practical at the end of every semester as prescribed in the schemes of examination.
- Practical shall be conducted by two examiners (Both internal examiners, nominated by the university)
- The student should submit record books for practical examination signed by the respective faculty for evaluation.

Examination conducted by JSSAHER.

- Theory –2 hours of paper, 60 marks, 4 credits in each course.
- The JSSAHER shall conduct an examination for the core course at the end of each semester. The candidates who satisfy the requirement of attendance and internal assessment, shall be eligible to appear for the JSSAHER examination. The head of the institution shall verify the same before forwarding the applications to the JSSAHER within the stipulated time along with the prescribed fee.

Examination conducted at the Department level.

- Theory – 1.5 hours of paper, 50 marks, 2 credits in each subject. For the scientific writing & presentation course, the student must submit the assignment given to him which will be evaluated for 50 marks.
- Examination for Allied subjects and Elective subjects shall be conducted by the college and the marks obtained shall be submitted to the JSSAHER along with the IA marks of the core subjects at least 15 days before the commencement of the JSSAHER examination. The marks of non-core subjects shall be incorporated into the marks card issued by the JSSAHER.

Criteria for appointment of examiners:

- Examiners shall be appointed by the JSSAHER to conduct the end semester JSSAHER examinations, from the panel of examiners approved by the Board of Studies. For Practical examinations, there shall be two internal examiners. Theory paper shall be valued by both internal examiners. Postgraduate teachers with MD/MS/Ph.D. degrees with 2 years of teaching/research experience shall be appointed as internal examiners.

Examiners for research thesis evaluation

- **BSc Honors degree** – Two examiners shall be present for the evaluation of posters (Both may be internal examiners).
- **Integrated master's degree** – Two examiners shall be present for the project presentation (One internal and One from an external university).

Qualification and experience of examiners

- For question paper setting and external examiner: Postgraduate teachers with MD/MS/ Ph.D. degrees with 2 years of teaching/research experience shall be appointed as examiners.

Scheme of Examination:

- The distribution of subjects, number of teaching hours, credits, and marks distribution for each semester's theory and practical courses and examinations are shown in Table 2.

Table 2: Marks distribution for each semester's theory and practical courses and examinations

Sl. No.	Study Components and Code	Title of the Paper	Teaching hours		Examination			Total Credit
			Hrs/ Week	Total Hours	IA	Theory/ Practical	Max. Marks	
SEMESTER 1								
1	**DSC-1**	Anatomy	4	45	40	60	**100**	**4**
2	**DSC-2**	Physiology	4	45	40	60	**100**	**4**
3	**DSC-3**	Basic Biochemistry	4	45	40	60	**100**	**4**
4	**AEC-1**	Kannada	2	30	--	50	**50**	**2**
5	**AEC-2**	English	2	30	--	50	**50**	**2**
6	**VBA-1**	Yoga	1	15	--	50	**50**	**1**
7	**VBA Practical**	Yoga	1	15				
8	**Practical-1**	Anatomy	2	30	15	35	**50**	**1**
9	**Practical-2**	Physiology	2	30	15	35	**50**	**1**
10	**Practical-3**	Basic Biochemistry	2	30	15	35	**50**	**1**
	Total Marks and Credits						**600**	**20**
SEMESTER 2								
1	**DSC-4**	Pathology including applied aspects	4	60	40	60	**100**	**4**
2	**DSC-5**	Microbiology including applied aspects	4	60	40	60	**100**	**4**
3	**DSC-6**	Pharmacology	4	60	40	60	**100**	**4**
4	**AEC-3**	Health care	2	30	--	50	**50**	**2**
5	**SEC-1**	Soft skills	1	30	--	50	**50**	**1**
6	**MDC-1**	Psychology	2	30	--	50	**50**	**2**
7	**Practical-4**	Pathology including applied aspects	2	30	15	35	**50**	**1**
8	**Practical-5**	Microbiology including applied aspects	2	30	15	35	**50**	**1**
9	**Practical-6**	Pharmacology	2	30	15	35	**50**	**1**
	Total Marks and Credits						**600**	**20**
SEMESTER 3								
1	**DSC-7**	Introduction to Genetics	4	60	40	60	**100**	4

2	**DSC-8**	Cell & Molecular Biology	4	60	40	60	**100**	4
3	**DSC-9**	Principles of immunology	4	60	40	60	**100**	4
4	**MDC-2**	Computer application	2	30	--	50	**50**	**2**
5	**MDC-3**	Environmental Science and health	2	30	--	50	**50**	**2**
6	**SEC**	Laboratory postings	--	60	--	--	**--**	**--**
7	**Practical-7**	Introduction to Genetics Cell & Molecular Biology Principles of immunology	6	180	60	90	**150**	**6**
	Total Marks and Credits						**550**	**22**
SEMESTER 4								
1	**DSC-10**	Biophysics & Instrumentation	4	60	40	60	**100**	**4**
2	**DSC-11**	Human Evolutionary Genetics	4	60	40	60	**100**	**4**
3	**DSC-12**	Developmental Genetics	4	60	40	60	**100**	**4**
4	**SEC-2**	Biostatistics & Research Methodology	2	30	--	50	**50**	**2**
5	**VBA-2**	Constitution of India	2	30	--	50	**50**	**2**
6	**SEC**	Laboratory postings	--	60	--	--	**--**	**--**
7	**Practical-8**	Biophysics & Instrumentation Human Evolutionary Genetics Developmental Genetics	12	180	60	90	**150**	**6**
	Total Marks and Credits						**550**	**22**

SEMESTER 5								
1	**DSC-13**	Human Cytogenetics	4	60	40	60	**100**	**4**
2	**DSC-14**	Bioinformatics in Genomics	4	60	40	60	**100**	**4**
3	**DSC-15**	Human Population Genetics	4	60	40	60	**100**	**4**
4	**DSE-1**	Recombinant DNA Technology OR Therapeutic Genetics	2	30	--	50	**50**	**2**
5	**MDC-4**	Medical ethics	2	30	--	50	**50**	**2**

6	**SEC**	Laboratory postings	--	60	--	--	**--**	**--**
7	**Practical-9**	Human Cytogenetics Bioinformatics in Genomics Human Population Genetics	6	180	60	90	**150**	**6**
	Total Marks and Credits						**550**	**22**
SEMESTER 6								
1	**DSC-16**	Biochemistry & Metabolic disorders	4	60	40	60	**100**	**4**
2	**DSC-17**	Human Molecular Genetics	4	60	40	60	**100**	**4**
3	**DSC-18**	Epigenetics in Health & Disease	4	60	40	60	**100**	**4**
4	**DSE-2**	Proteomics OR Principles of drug Discovery	2	30	--	50	**50**	**2**
5	**SEC-3**	Research Methodology	2	30	--	50	**50**	**2**
6	**SEC**	Laboratory postings	--	60	--	--	**--**	**--**
7	**Practical-10**	Biochemistry & Metabolic disorders Human Molecular Genetics Epigenetics in Health & Disease	6	180	60	90	**150**	**6**
	Total Marks and Credits						**550**	**22**
SEMESTER 7								
1	**DSC-19**	Genetics of Rare Diseases	4	60	40	60	**100**	**4**
2	**DSC-20**	Genetics of Complex Diseases	4	60	40	60	**100**	**4**
3	**DSC-21**	Genetic Counseling	4	60	40	60	**100**	**4**
4	**DSE-3**	Pharmacogenetics OR Nutrigenomics	2	30	--	50	**50**	**2**
5	**SEC-4**	Scientific Writing	2	30	--	50	**50**	**2**
6	**VBA-3**	Intellectual Property Rights	2	30	--	50	**50**	**2**
7	**Practical-11**	Genetics of Rare Diseases Genetics of Complex Diseases Genetic Counseling	6	120	60	90	**150**	**6**
	Total Marks and Credits						**600**	**24**

SEMESTER 8								
1	**VBA-4**	**Summer internship**					**100**	**4**
2	**SEC**	**Honors research project** **Project report & poster evaluation**					**300**	**12**
	Total Marks and Credits						**400**	**16**
SEMESTER 9								
1	**DSC-22**	Cancer Genomics	4	60	40	60	**100**	**4**
2	**DSC-23**	Genetic Data Analysis	4	60	40	60	**100**	**4**
3	**DSE-4**	Infertility and ART OR Pharmacovigilance	2	30	--	50	**50**	**2**
4	**AEC-4**	Animal model of human diseases	2	30	--	50	**50**	**2**
5	**VBA-5**	Health Economics	2	30	--	50	**50**	**2**
6	**VBA-6**	Basic Life Support	--	--	--	--	**--**	**--**
7	**Practical-12**	Cancer Genomics Genetic Data Analysis	4	120	40	60	**100**	**4**
8	**SEC**	**Masters research project** **Literature review and preparation of project synopsis**						
	Total Marks and Credits						**450**	**18**
SEMESTER 10								
1	**VBA-7**	**Industry Internship**					**100**	**4**
2	**SEC**	**Masters research project** **Thesis submission & Oral Presentation**					**450**	**18**
	Total Marks and Credits						**550**	**22**

Question paper pattern for end-of-semester examinations of Discipline Specific Course conducted by JSSAHER – Theory (60 marks) is shown in Table 3

Table 3: Question paper pattern of Discipline-specific course (DSC)

II	Short Essay	(Answer 4 out of 6)	4 x 5 marks	= 20
II	Short Answer	(Answer all 10)	10 x 3 marks	= 30
III	Very short Answer	(Answer all 5)	5 x 2 marks	=10
		Total =		**60 marks**

Question paper pattern for end-of-semester examination of Discipline Specific Elective/Open Elective/Ability Enhancement/Value-based courses conducted at the Department level – Theory (50 marks) is shown in Table 4

Table 4: Question paper pattern of non-Discipline-specific course

II	Short Essay	(Answer 5 out of 7)	5 x 5 marks	= 25
II	Short Answer	(Answer all 5)	5 x 3 marks	= 15
III	Very short Answer	(Answer all 5)	5 x 2 marks	=10
		Total =		50 marks

The minimum requirement for a PASS

- Core Subjects: Students are declared to have passed in a subject if they secure a minimum of 40% of marks in the JSSAHER examination and internal assessment added together. **Theory & practicals shall be considered separately for evaluation**. If a student passes in the practical examination but fails in a theory paper, such a student is exempted from reappearing for practical but shall have to appear in the subsequent examination for the theory paper in which the candidate has failed OR vice versa.
- AEC, SEC, DSE, MDC and VBA: The minimum prescribed marks for a pass shall be 35% of the maximum marks prescribed for a subject.
- Rank allocation- The students who pass all the semester examinations in the first attempts are eligible for ranks provided they secure at least a CGPA of 6.00. Ranks are not allowed for those students who clear their exams in parts.
- The student will be eligible for securing a final degree only upon successful completion of all the subjects in the lower semester's examinations. Otherwise, the result will not be declared for the student.

Grading of performances

- Based on the performances, each student shall be awarded a letter grade for each course. The letter grades and their corresponding grade points are given in Table 5.

Table 5: Grade description

Percentage of Marks obtained	Letter Grade	Grade Point	Result/grade description
90.00 – 100	O	10	Outstanding
80.00 – 89.99	A	9	Excellent
70.00 – 79.99	B	8	Good
60.00 – 69.99	C	7	Fair
50.00 – 59.99	D	6	Satisfactory
40.00 – 49.99	E	5	Average
Less than 40	F	Below 4	Fail
Absent	AB	0	Fail

Illustration of SGPA and CGPA (Tables 6 and 7)

The Semester Grade Point Average (SGPA)

The performance of a student in a semester is indicated by a number called Semester Grade Point Average (SGPA). The SGPA is the weighted average of the grade points obtained in all the courses by the student during the semester. The Credit Points (CP) shall then be calculated as the product of the grade points earned and the credits for the course. For example, if a student takes five courses (Theory/Practical) in a semester with credits C1, C2, C3, C4, and C5, and the student's grade points in these courses are G1, G2, G3, G4, and G5, respectively and then students' SGPA is equal to:

$$SGPA = \frac{C1G1 + C2G2 + C3G3 + C4G4 + C5G5}{C1 + C2 + C3 + C4 + C5}$$

The SGPA is calculated to two decimal points. It should be noted that the SGPA for any semester shall take into consideration the F and ABS grade awarded in that semester. For example, if a learner has an F or ABS grade in course 4, the SGPA shall then be computed as:

$$SGPA = \frac{C1G1 + C2G2 + C3G3 + C4 * ZERO + C5G5}{C1 + C2 + C3 + C4 + C5}$$

Cumulative Grade Point Average (CGPA)

The CGPA is calculated with the SGPA of all the 8 semesters for BSc Honors and 10 semesters for integrated MSc. CGPA is calculated up to two decimal points and is indicated in the final grade report card/final transcript showing the grades of all semesters and their courses. The CGPA shall reflect the failed status in case of F grade(s), till the course(s) is/are passed. When the course(s) is/are passed by obtaining a pass grade on subsequent examination(s) the CGPA shall only reflect the new grade and not the fail grades earned earlier. The CGPA is calculated as:

$$\text{CGPA} = \frac{C1S1 + C2S2 + C3S3 + C4S4 + C5S5 + C6S6 + C7S7 + C8S8 + C9S9 + C10S10}{C1 + C2 + C3 + C4 + C5 + C6 + C7 + C8 + C9 + C10}$$

where C1, C2, C3,…. is the total number of credits for semesters 1, 2, 3,…. and S1, S2, S3,….is the SGPA of semesters 1, 2, 3,…. .

Table 6: An Illustration of Calculation of Semester Grade Point Average (SGPA): Semester 7 (Typical)

Courses/Papers	DSC	DSC	DSC	DSE	SEC	VBA	Practicals	Total
Maximum Marks	100	100	100	50	50	50	150	600
Marks Obtained	77	74	62	38	39	36	134	460
% Marks Obtained	77	74	62	76	78	72	89	-
Grade Points Earned (G)	8	8	7	8	8	8	9	-
Credits for the Course (C)	4	4	4	2	2	2	6	24
Credit Points CP (G x C)	32	32	28	16	16	16	54	194

Semester Aggregate Marks: 460/ 600 = **76.6%**
SGPA = Total CP / Total Credits = 194/24 = **8.08**

Table 7: Calculation of Cumulative Grade Point Average (CGPA) for the Integrated Master's Degree: Illustration

Semester	1	2	3	4	5	6	7	8	9	10	Total
Maximum Marks	600	600	550	550	550	550	600	400	450	550	5,400
Marks Obtained	398	480	464	484	490	499	507	306	381	425	4,434
Semester GPA	7	9	9	9	9	10	9	8	9	8	87
Semester Credits (C)	20	20	22	22	22	22	24	16	18	22	208
Semester Credit Points (CP) (SGPA x C)	140	180	198	198	198	220	216	128	162	176	1816

Aggregate Percentage of Marks = 4434/5400 = **82.1%**
Cumulative Grade Point Average (CGPA) = Total of Semester CP / Total Credits for the program = 1816/208 = **8.73**
Program Alpha Sign Grade: **A**
Classification of Result: **First Class with Distinction**

Declaration of class

The class shall be awarded based on CGPA as follows:

- First Class with Distinction = CGPA of 7.50 and above
- First Class = CGPA of 6.00 to 7.49
- Second Class = CGPA of 5.00 to 5.99
- Pass Class = CGPA of 4.00 to 4.99

Carryover system

- A student can move on to the higher semester even if he/she fails the lower semester examinations. However, at the end of the final semester, the candidate should clear all the exams including lower semester examinations to be awarded a result/degree.

Award of Ranks/Medals

- Ranks and Medals shall be awarded on the basis of final CGPA. However, candidates who fail in one or more subject during the course shall not be eligible for award of ranks.

Award of Degree

- A candidate who has passed in all the subjects of all the semesters and has successfully completed the research project/internship shall be eligible for the award of the degree.

Revaluation and Re-totaling of answer papers

- There is no provision for revaluation of the answer papers in any examination. However, the candidates can apply for re-totalling by paying prescribed fee.

Maximum duration for completion of course

- A candidate shall complete BSc Honors within six years from the date of admission, and in case of integrated MSc within seven years from the date of admission failing which candidate shall re-register for the course.

Semester 1
DSC-1 Anatomy
(45 hrs, LTP – 3+1+1)

Course Outcome:
At the end of the course, students should be able to

- CO1: Demonstrate the acquisition of comprehensive knowledge of basic tissues of the body.
- CO2: Demonstrate the acquisition of comprehensive knowledge of gross anatomy of muscles, joints and organ system of human body
- CO3: Demonstrate the acquisition of analysing the applied aspects concerned to human body.
- CO4: Demonstrate the skill of identification of viscera of organ systems of human body
- CO5: Demonstrate the skill of identification of microscopic structure of basic tissues and organs and correlate with their functions
- CO6: Demonstrate the acquisition of comprehensive knowledge regarding the general embryology with congenital anomalies

Unit I **03hrs**

Organization of the human body
Introduction to the human body
Definition and subdivisions of anatomy
Anatomical position and terminology
Cell – Definition of a cell, shapes and sizes of cells Parts of a cell-cell membrane, cytoplasm, cell organelles
Cell division – definition and main events in different stages of mitosis and meiosis
Tissues – Tissues of the body
Characteristics, functions and locations of different types of tissues
Epithelial tissue – definition, classification with examples
Glands – classification with examples
Connective tissue and Nervous tissue

Unit II **06hrs**

Locomotion and support
Cartilage – structure, types with examples
Skeletal system
Classification, structure, functions and ossification
Name, location and features of bones of the body.
Joints – Definition, types of joints with examples
Name, location, type, bones forming, movements possible in the synovial joints of the body.
Muscular system
Muscular tissue – skeletal muscle - gross anatomy and histology
Cardiac and smooth muscle – histology
Muscles of upper limb, lower limb, thorax, abdomen and head and neck

Unit III
Maintenance of the Human Body **12hrs**
1.Cardio-vascular system
Types and structure of blood vessels, capillaries
Heart – location, coverings, external and internal features of heart,Blood supply of heart
Systemic arteries and veins – major arteries and veins of the body

Lymphatic system

Lymphoid organs – structure and functions

1. Respiratory system

   Organs of respiration, location, features of nasal cavity, pharynx, larynx, trachea, bronchi, lungs and pleura

2. Digestive system

   Organs of digestive system, location, features of oral cavity, Tongue, pharynx, oesophagus, stomach, intestine and accessory organs of digestion – salivary glands, liver and pancreas.

Unit IV

1. **Excretory system and reproductive system**
   Organs of urinary system, location and features of kidneys, ureter, urinary bladder and urethra Male and female reproductive organs. Location, features of scrotum, testis, epididymis, vas deferens, seminal vesicle, ejaculatory ducts, prostate gland, penis and spermatic cord Location and features of uterus, its supports, uterine tube, ovary and mammary gland
2. **Embryology I - IV week** – gametogenesis, structure of sperm, growth of the ovarian follicles, events of 1st, 2nd and 3rd weeks of development, folding of embryo, derivatives of germ layers, placenta

Unit V

Control Systems of the Body **12hrs**

1.Nervous system

Introduction, coverings and blood supply of brain and spinal cord

Spinal cord – location, external features and internal structure of spinal cord

Brain – subdivisions, location, external features and internal structure of medulla oblongata, pons and midbrain, cerebellum and cerebrum.

Thalamus and hypothalamus

Basal ganglia

Ventricles – location, formation and circulation of CSF

Cranial nerves

2.Sense organs

Location and features of olfaction, eye, ear and skin

3.Endocrine system

Name of the endocrine glands, location and features, histology of pituitary gland, thyroid gland, parathyroid, suprarenal gland, pancreas, testis and ovary. Hormones secreted by each gland.

Practical : **30hrs**

1. Demonstration of parts of microscope and its uses
2. Demonstration of skeleton and joint
3. Demonstration of deltoid and gluteus maximus, Cubital fossa
4. Demonstration of heart and its blood supply, demonstration of major arteries ofupper limb and lower limb, histology of cardiac muscle and histology of vessels
5. Demonstration of location and parts of lungs, histology of trachea and lungs
6. Demonstration of location of stomach, small and large intestines. Location andfeatures of pancreas, liver and gall bladder
7. Demonstration of location and features of kidney, ureter, urinary bladder and urethra. Histology of urinary system except urethra
8. Demonstration of location of male and female reproductive organs

9. Demonstration of brain and spinal cord
10. Histology of cornea and retina

Practical Examination Pattern **35 Marks**

1. Gross Anatomy- Discussion of any one specimen
2. Disscusion of specimens of Cardiovascular system, Respiratory System,Gastrointestinal system, Urinary system, Reproductive system
3. Spotters - Cardiovascular system, Respiratory System, Gastrointestinal system, Urinary system, Reproductive system
4. Histology discussion of any one demonstrated slide

Recommended Books Recent Editions:

1. Ross and Wilson: Anatomy and Physiology in Health and illness
2. Understanding Human Anatomy and Physiology, William Davis (p) MC Graw Hill
3. Essentials of Human Embryology. Bhatnagar, Orient Blackswan Pvt. Ltd.
4. Anatomy for B.Sc Nursing by Renu Chauhan. Arichal publishing company 2012
5. Hand book of Anatomy BD Chaurasia
6. Basics in Human Anatomy for B.Sc. Paramedical Courses 1st edition 2008 Jaypee Publishers

Reference books:

1. B D Chaurasia: Regional Anatomy. Vol I, II, III 6th edition

Semester 1

DSC-2 Physiology

(45 hrs, LTP – 3+1+1)

Course Outcome:

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

- CO1: Demonstrate the acquisition of comprehensive knowledge in the basic physiological concepts of general physiology.
- CO2: Demonstrate the acquisition of comprehensive knowledge of circulation in human body.
- CO3. Demonstrate the acquisition of comprehensive knowledge of all organ system of the body
- CO4. Perform and analyse the investigation of blood.

Unit -I

General physiology and Blood

General Physiology **(2 Hrs)**

- Homeostasis with body fluid compartments
- Cell membrane, types of transport across cell membrane Membrane potential-RMP & AP

Blood **(7 Hrs)**

- Composition and function of blood:Haemopoiesis
- Haemoglobin : types & functions:RBC structure & function ,destruction. Anaemia & Jaundice
- WBC: types & functions. Immunity: definition & classification
- Platelets: structure & function. Haemostasis :steps in brief ,anticoagulant eg
- Blood groups: types, incompatibility, blood transfusion.
- Lymph: composition and functions

Unit -II

Digestive system & Respiratory system

Digestive System **(3Hrs)**

- Organization and functions of digestive system
- Saliva: composition & functions
- Mastication and deglutition
- Functions of stomach
- Gastric juice: composition & functions
- Types of gastric motility
- Liver: functions, bile juices: composition & function, functions of gall bladder
- Pancreatic juice: composition & functions
- Small intestine: succus entericus, types of motilities
- Large intestine: functions

Respiratory system **(4 Hrs)**

- Functions of respiratory system. Mechanism of breathing {inspiration and expiration}

- Surfactant: composition and function. Lung volumes and capacities
- Pulmonary ventilation, alveolar ventilation, dead space
- Transport of oxygen and carbon di oxide {only difference}
- Hypoxia: definition, types, dyspnea, apnea, hyperventilation

Unit -III
Cardiovascular and Endocrine system
Cardiovascular system **(4Hrs)**

- List the properties of cardiac muscle
- Origin spread of cardiac impulse
- ECG: Definition, normal ECG, diagram in lead II
- Cardiac cycle: definition, normal duration, phases
- Heart sounds types, normal characteristics
- Blood pressure: Definition, components, normal values, factors affecting it Name different regional circulation, effect of exercise on CVS (brief)

Endocrine System **(7 Hrs)**

Name the different endocrine glands, hormones secreted by them
HORMONE: Structure, Function, name the disorders involved with that hormone {hypo and hyper secretion}

Unit -IV
Excretory system and Reproductive system
Excretory System **(4Hrs)**

- Types of nephrons and its differences, JG Apparatus
- GFR: definition , normal values , factors affecting
- Tubular functions: absorption and secretion in different segment
- Micturition process
- Skin and body temperature

Reproductive system **(3Hrs)**

- Puberty in male and female
- Spermatogenesis, semen composition& analysis
- Functions of Testosterone
- Functions of Estrogen
- Functions of Progesterone.
- Menstrual cycle: uterine and ovarian cycle (brief only)
- Contraception both in men and women: types

Unit -V
Muscle nerve physiology, Nervous system and Special senses
Muscle nerve physiology **(2Hrs)**

- Classification of neurons and nerve fiber. List of properties of nerve fibers
- Neuroglia: types
- Types of muscle, steps of neuromuscular transmission ,E-C coupling ,muscle contraction

Nervous system **(5Hrs)**

- Synapse: types, list properties, list functions

- Receptor: structure, type, sensation carried by it , list the properties
- Reflex: reflex arc, classification, functions
- Ascending tract: list them and its function
- Descending tract: list them and its function
- Cerebral cortex: different lobes and its functions
- functions of basal ganglia, thalamus, hypothalamus
- functions of cerebellum
- CSF: composition and function

Special senses **(4Hrs)**

- Olfaction: tract, types of smell, odorant, receptor, name the applied aspect
- Gustation: pathway, types of tastes, taste buds, name the applied aspect
- Vision: rods, cones, differences, dark & light adaptation, visual pathway & name the applied aspect, errors of refraction & its correction, colour blindness, cataract
- Audition: functions of external ear, middle ear & inner ear, content of middle ear & inner ear, Organ of Corti, hearing pathway, name the applied aspect

Practicals **(30 Hrs)**

1. Haemoglobinometry.
2. Haemocytometry
3. Total leucocyte count.
4. Total Red blood cell count.
5. Determination of blood groups.
6. Differential WBC count.
7. Determination of clotting time, bleeding time.
8. Erythrocyte sedimentation rate (ESR). Determination of packed cell Volume,Calculation of Blood indices: CI, MCH, MCV, MCHC.
9. Blood pressure recording.
10. Spirometery,Artificial Respiration

Practical Examination: 35 Marks

1. Estimation of Hemoglobin.
2. Determination of Blood Groups.
3. Determination of Bleeding and Clotting time.
4. Spotters-Haemocytometer, (Identification of cells) Differential Count,Sphygmomanometer, Spirometer . - 15 marks

Recommended Books Recent Editions

1. A.K.Jain, Human Physiology and Biochemistry for Physical Therapy and Occupational Therapy, 1st Ed. Arya Publication.
2. Dr. Venkatesh.D and Dr. Sudhakar H.S. Basic of Medical Physiology, 3rd Ed.,Wolter-Kluwer Publication.
3. Chaudhari (Sujith K) Concise Medical Physiology 6th Ed. New Central Book.

Reference Books

1. A.K.Jain, Text book of Physiology for Medical Students, 8th Ed. AryaPubliction.

2. Guyton (Arthur) Text Book of Physiology.13rd Ed. Prism Publishers.
3. Ganong (William F) Review of Medical Physiology. 27th Ed. Appleton.

Semester 1

DSC 3 – Basic Biochemistry

(45 hrs, LTP – 3+1+1)

Course outcome

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

- CO1: Demonstrate acquisition of comprehensive knowledge of cellular structure with its functions
- CO 2: Demonstrate acquisition of comprehensive knowledge and skills related to Biomedical importance of macromolecules and micromolecules
- CO 3: Demonstrate acquisition of comprehensive knowledge of the enzymes
- CO 4: Demonstrate acquisition of comprehensive knowledge and skills related to biochemical components of blood, urine and body fluids.
- CO 5: Demonstrate acquisition of comprehensive knowledge of biochemical importance of nutrition

Unit I **12hrs**

Chemistry of Cell & Chemistry of Carbohydrates, Proteins, Lipids & Nucleotides-

Cell- Structure & Function of Cell Membrane, Subcellular Organelles, and their Functions.
Carbohydrates- Definition, Classification & Biological importance of carbohydrates, Derivatives of Monosaccharides.
Proteins- Definition & Classification of amino acids. Definition & Classification of Proteins based composition, conformation, and function. Functions Plasma proteins, Biologically important peptides and their functions, and Immunoglobulins -structure and functions
Lipids- Definition, Classification, Biological importance, and Functions of Lipids. Structure and functions of Cholesterol, types and functions of Lipoproteins. Fatty acids -definition and Classification
Nucleotides- Structure and Functions of DNA & RNA. Biologically important nucleotides and their functions.

Unit II **06 hrs**

Enzymes & Acid base balance

Enzymes- Definition and Classification. Factors affecting enzyme activity. Coenzymes and Cofactors. Enzyme inhibition – types and their importance.
Acids, Bases & Body Buffers-Definition with examples, regulation of pH in brief.

Unit III **12hrs**

Vitamins & Minerals

Vitamins-Classification, Sources, RDA, Functions (in brief), deficiency manifestationsand hypervitaminosis of fat-soluble vitamins A, D, E and K.
Sources, RDA, Functions (in brief), deficiency manifestations of water-soluble vitamins – Thiamine. Riboflavin, Niacin, Pyridoxine, Biotin, Pantothenic acid, Folic acid , cobalamin and Ascorbic acid.
Minerals-Classification.
Calcium, Phosphorus, Iron , copper Iodine, zinc, calcium, phosphorous, sodium, potassium & chloride -Sources, RDA, Functions (in Brief), deficiency manifestations.

Unit IV **05hrs**

Nutrition, Blood chemistry & Urine Chemistry

Nutrition- Nutrients, Calorific value of food, BMR and factors affecting BMR, respiratory quotient and its applications, biological value of proteins,nitrogen balance, Protein energy

malnutrition.
Blood chemistry- Biochemical components & their reference ranges in normal & diseased states- glucose, urea ,creatinine , electrolytes, total proteins and albumin.

Unit V **10hrs**

Clinical Biochemistry

Specimen Collection - Blood, Urine and Body fluids.Preanalytical, analytical and postanalytical errors Clinical Biochemistry- Parameters to diagnose Diabetes & Cardiovascular diseases. Diagnostic enzymology,Assessment of arterial Blood gas status and electrolyte balance,Point of Care Testing. Renal Function tests(in brief), Liver function tests(in brief), Biomedical Waste Management.

Practicals

1. General Reactions of Carbohydrates.
2. Identification of carbohydrates
3. Color reactions of Proteins.
4. Reactions of Non-Protein nitrogenous substances.
5. Demonstration of pH meter, Colorimeter, and spectrophotometer.
6. Demonstration of Chromatography and Electrophoresis.

Practical Examination (35marks)

1. Identification carbohydrates or NPN substances - 10 Marks
2. Color reactions of Proteins - 15 Marks
3. Spotters - 10 Marks

Recommended books Recent edition.

1. Textbook of Biochemistry - D.M.Vasudevan
2. Biochemistry - Pankaja Naik
3. Clinical Biochemistry - Principles and Practice - Praful. B. Godkar
4. Textbook of Biochemistry - Chatterjea and Shinde
5. Textbook of Clinical Chemistry - Norbert W Teitz

Reference Books Recent Edition

1. Harpers Biochemistry
2. Clinical Biochemistry-Michael L. Bishop
3. Textbook of Biochemistry-Rafi M.D
4. Lippincott's Illustrated review of Biochemistry
5. Practical Clinical Biochemistry-Harold Varley

Semester 1

Language 1 – English

(30 hrs, LTP – 2+0+0)

Unit I Introduction

a) Study Techniques - Reading Comprehension
Exercises on reading passages and answering questions based on the passage.

b) Organization of Effective Note-Taking
Why good note-taking is important
Effective note-taking is an important practice to master at university. You have alot of new knowledge and you need to develop reliable mechanisms for recordingand retrieving it when necessary. But note-taking is also a learning process in itself, helping you to process and understand the information you receive.

c) Use of the Dictionary

Tips on how to use the dictionary

1. Choose the right dictionary.
2. Read the introduction.
3. Learn the abbreviations.
4. Learn the guide to pronunciation.
5. Looking Up a Word
   a) Find the section of the dictionary with first letter of your word.
   b) Read the guide words.
   c) Scan down the page for your word.
   d) Read the definition.
6. Online dictionaries
7. Research various facts.
8. Thesaurus

It is a dictionary of synonyms and antonyms, such as the online Thesaurus.com.Enlargement of Vocabulary

Roots : A to G Effective Diction

Foreign Expressions - meaning and pronunciation

Unit II

Applied Grammar

a) Correct Usage

The Eight Parts of Speech

1. Noun
2. Pronoun
3. Adjective
4. Verb
5. Adverb
6. Preposition
7. Conjunction
8. Interjection

b) The Structure of SentencesWhat is a sentence?

What are clauses? What are phrases? Types of sentences:

1. Simple sentences
2. Compound sentences
3. Complex sentences

c) The Structure of Paragraphs

1. What is a Paragraph?
   Paragraphs are comprised of sentences, but not random sentences. A paragraph is a

group of sentences organized around a central topic.

2. The Secrets to Good Paragraph Writing:Four Essential Elements
   The four elements essential to good paragraph writing are: unity, order, coherence,and completeness.
3. Paragraph Structure

A paragraph consists of 3 main structures :

1. Claim
2. Evidence
3. Analysis

d) Enlargements of VocabularyRoots: H to M

Unit III

Written Composition

a) Precise writing and Summarizing

1. Definition of precise:
   A precise or summary is an encapsulation of someone's writing or ideas. Technically it should be one - third the length of the actual passage given.
2. Definition of summary:
   Summaries may not always follow a direct line through what they're summarizing - ifyou want to summarize someone else's ideas in a few sentences, it might make moresense if you begin with their conclusion, and work back to the arguments they use todevelop that conclusion.

Guidelines to follow while writing a summary are:

1. Divide…and conquer.
2. Read.
3. Reread.
4. One sentence at a time.
5. Write a thesis statement.
6. Check for accuracy.
7. Revise.

b) Writing of a Bibliography

I. What is a bibliography?
   A bibliography is an alphabetical list of all materials consulted in the preparation of your assignment.

II. What is an annotated bibliography?
   An annotated bibliography is an alphabetical list of books or articles for whichyou have added explanatory or critical notes.

III. Why you must do a bibliography?

   a) To acknowledge and give credit to sources of words, ideas, diagrams, illustrations and quotations borrowed, or any materials summarized or paraphrased.

   b) To show that you are respectfully borrowing other people's ideas, not stealing them, i.e. to prove that you are not plagiarizing.

IV. What must be included in a bibliography?

- Author
- Title
- Place of publication
- Publisher
- Date of publication
- Page number(s) (for articles from magazines, journals, periodicals, newspapers,

encyclopedias, or in anthologies)

V. Writing a bibliography in MLA style

1. Standard Format for a Book:
   Author. Title: Subtitle. City or Town: Publisher, Year of Publication.
   If a book has no author or editor stated, begin with the title. If the city or town is not commonly known, add the abbreviation for the State or Province.
2. Standard Format for a Magazine, Periodical, Journal, or Newspaper Article: Author. "Title: Subtitle of Article." Title of Magazine, Journal, or Newspaper Day, Month, Year of Publication: Page Number(s).

- Enlargement of VocabularyRoots - N to S

Unit IV

Reading and Comprehension

a) Review of selected materials and express oneself in one's words Seminar for students on powerpoint presentation and book review.
b) Enlargement of VocabularyRoots - T to Z

Unit V

The study of Varioius forms of Composition

a) Paragraph
   Exercises for students on short paragraph topics.
b) Essay
   How to Write an Essay
   The writing of an essay has three stages :

1. Essay writing
2. Close reading
3. Research

c) Letter
   Mechanics of writing formal and business letters. Exercises on writing letters for students.
d) Summary
   Writing reports: project report, magazine article and reporting in newspaperson sporting events.
e) Practice In Writing
   Exercises and assignments on report writing for students

Unit VI

Verbal Communication

- Discussions And Summarization Tips on taking minutes of a meetingWhy Meeting Minutes Matter Meeting minutes are important. They capture the essential information of a meeting - decisions and assigned actions. The following instructions will help you take useful and concise meeting minutes.

Before the Meeting

If you are recording the minutes, make sure you aren't a major participant in the meeting. You can't perform both tasks well.

Create a template for recording your meeting minutes and make sure you leave someblank space to record your notes.

Decide how you want to record your notes. If you aren't comfortable relying on yourpen and notepad, try using a tape recorder or, if you're a fast typist, take a laptop to themeeting.

During the Meeting
As people enter the room, check off their names on your attendee list. Ask the meeting lead to introduce you to meeting attendees you aren't familiar with. This willbe helpful later when you are recording assigned tasks or decisions.

After the Meeting
Review the notes and add additional comments, or clarify what you didn't understandright after the meeting.
a) Debates
Group Discussions:
1. Do's in a group discussion:
- Be confident. Introduce yourself with warm smile and get into topic soon
- Have eye contact with all group members
- Learn to listen
- Be polite
- Be a good team player. Move with all group members and help them when needed.

2. Don'ts in a group discussion:
- Don't be harsh when you are interrupted
- Don't interrupt the other person
- Don't try to push your ideas on others
- Don't argue. Everyone is free to express their idea

3. Do's in a group discussion:
- Be confident. Introduce yourself with warm smile and get into topic soon
- Have eye contact with all group members
- Learn to listen
- Be polite
- Be a good team player. Move with all group members and help them when needed.

4. Don'ts in a group discussion:
- Don't be harsh when you are interrupted
- Don't interrupt the other person
- Don't try to push your ideas on others
- Don't argue. Everyone is free to express their ideas.

c) Oral Reports
An oral report is a presentation, usually done for a student's teacher andclassmates, though it can also be done for a larger segment of the school community, for parents, or for a more open group, depending on the circumstances. For example, at a science fair, a student might present a report onhis or her project periodically for the class, for other visitors who pass by, and forjudges.

d) Use in Teaching Writing of dialogues
Originating from dialogues, the Greek word for conversation, the term dialogue refers to a verbal conversation between two or more people.
When writing dialogues, it is important to adhere to specific grammar rules. Thefollowing points

need to be remembered while writing dialogues for role play.

1. Quotation Marks
2. Periods
3. Question Marks
4. Commas
5. Capitalization and Paragraphs
6. How Dialogue Enhances Writing

Dialogue reveals information about the speaker(s) within a written work. Dialoguealso enhances the story line and plot.

a) Exposes Character Traits
   Through indirect characterization, dialogue reveals details about a character bywhat they say, how they say it, and perhaps what they choose not to say.
b) Unveils Mood/Emotions
   A character's word choice, description of tone, and choice of language reveal the inner state of the character without directly "telling" the audience. Showinginstead of telling creates a deeper understanding of the character through the eyes of the reader or audience.
c) Reveals Motivation/Influences
   Dialogue can illuminate a character's internal motivation or desires.
d) Establishes Relationships
   Seeing how a character addresses and responds to other characters shows the typeof relationships that they form and where their relationships currently stand. Dialogue can demonstrate how relationships change throughout the course of thestory. It can show how a character changes or responds to various situations.

Exercises for students on preparing a dialogue exchange between two people

1. On the street (with a vegetable vendor)
2. At college with a lecturer (regarding admissions)
3. In a bank with the manager (for opening a bank account)
4. Telephone conversation with a hotel receptionist (make room reservations)
5. Telephone conversation (taking an appointment with the dentist/doctor)

I Semester

Language 2- Kannada

ಕನ್ನಡ : ಒಂದು

ಪಠ್ಯಕ್ರಮದ ರೂಪರೇಖೆ

ಸ್ಥಾನ : ಬಿ.ಎಸ್.ಸಿ. (ಅಲೈಡ್ ಹೆಲ್ತ್ ಸೈನ್ಸ್‌ಕೋರ್ಸ್) ಮೊದಲವರ್ಷ
ಸಮಯ : 30 ಘಂಟೆಗಳು (ಮೂವತ್ತು ಘಂಟೆಗಳು)
ಪಠ್ಯಕ್ರಮದ ವಿವರಣೆ : ವಿದ್ಯಾರ್ಥಿ/ ವಿದ್ಯಾರ್ಥಿನಿಯರು ದಿನನಿತ್ಯ ಸಂಪರ್ಕಿಸಬಹುದಾದ ಜನಸಾಮಾನ್ಯರೊಡನೆ ಶುಶ್ರೂಷೆಗೆ ಸಂಬಂಧಿಸಿದಂತೆ ಕನ್ನಡದಲ್ಲಿ ಸಂಭಾಷಣೆ ಮಾಡಲು ಹಾಗೂ ತಿಳುವಳಿಕೆ ನೀಡಲು ಸಹಕಾರವಾಗುವಂತೆ ಪಠ್ಯಕ್ರಮದ ಮಾದರಿಯನ್ನು ಅಳವಡಿಸುವುದು.
ಉದ್ದೇಶ : ದಿನಬಳಕೆಯ ವ್ಯವಹಾರದಲ್ಲಿ ಶುಶ್ರೂಷಣೆಗೆ ಸಂಬಂಧಪಟ್ಟಂತೆ ಕನ್ನಡ ಭಾಷೆಗೆ ಅಳವಡಿಕೆ.
ಕನ್ನಡೇತರರಿಗೆ ಕನ್ನಡ ಭಾಷೆಯ ಪರಿಚಯ ಮಾಡಿಕೊಡುವುದು.

ಪಠ್ಯಕ್ರಮದ ವಿವರಣೆ
ಘಟಕಒಂದು (ಆರು ಘಂಟೆಗಳು) : ಅಕ್ಷರಮಾಲೆ, ಸ್ವರಗಳು, ವ್ಯಂಜನಗಳು,, ಕಾಗುಣಿತ, ಬರವಣಿಗೆ, ಅಭ್ಯಾಸ.
ಚಟುವಟಿಕೆ : 1. ಕನ್ನಡ ವರ್ಣಮಾಲೆಯ ಅಕ್ಷರಗಳನ್ನು ಬರೆಯಿರಿ.
ಘಟಕಎರಡು (ಆರು ಘಂಟೆಗಳು) : ಪದಪರಿಚಯ, ಪದಪುಂಜ, ದಿನಬಳಕೆಯ ಪದಗಳು, ಸಂಬಂಧಗಳು, ನಾಮಪದ, ಸರ್ವನಾಮ, ಅಂಕಿಗಳ ಪರಿಚಯ, ಪ್ರಶ್ನಾರ್ಥಕ ಪದಗಳು.
ಚಟುವಟಿಕೆ : 1. ನಿಮಗೆ ತಿಳಿದಿರುವ ವಿವಿಧ ರೋಗಗಳ ಹೆಸರುಗಳನ್ನು ಪಟ್ಟಿಮಾಡಿ.
2. ನಿಮಗೆ ತಿಳಿದಿರುವ ತಿಂಡಿ – ತಿನಿಸುಗಳ ಹೆಸರುಗಳನ್ನು ಪಟ್ಟಿಮಾಡಿ.
ಘಟಕಮೂರು (ಆರು ಘಂಟೆಗಳು) : ಲಿಂಗ, ವಚನ, ಅವ್ಯಯ, ತಿಂಡಿ – ತಿನಿಸುಗಳ ಪರಿಚಯ, ದೇಹದ ಅಂಗಗಳ ಪರಿಚಯ, ವಿವಿಧ ಬಗೆಯ ರೋಗಗಳ ಪರಿಚಯ.
ಚಟುವಟಿಕೆ : ರೋಗಿಯ ವಿವರ ತಿಳಿಯಲು ಆಸ್ಪತ್ರೆಯಲ್ಲಿ ಬಳಸಲಾಗುವ ನಮೂನೆಯ ಮಾದರಿಯನ್ನು ರಚಿಸಿ.
ಘಟಕ ನಾಲ್ಕು (ಆರು ಘಂಟೆಗಳು) : ಶುಶ್ರೂಷಣಾ ಪದಗಳು, ಆಸ್ಪತ್ರೆಯಲ್ಲಿ ಬಳಸುವ ವಿವಿಧ ನಮೂನೆಗಳ ಪರಿಚಯ, ನಮೂನೆಗಳ ರಚನೆ.
ಚಟುವಟಿಕೆ : ಶುಶ್ರೂಕರು ಮತ್ತು ರೋಗಿಯ ನಡುವಿನ ಸಂಭಾಷಣೆಯ ಮಾದರಿಯನ್ನು ತಯಾರಿಸಿ.
ಘಟಕ ಐದು (ಆರು ಘಂಟೆಗಳು) : ಶುಶ್ರೂಕರ ಹಾಗೂ ರೋಗಿಗಳ ನಡುವೆ ನಡೆಯುವ ಸಂಭಾಷಣೆಗೆ ಬೇಕಾದ ವಾಕ್ಯಗಳ ಪರಿಚಯ.

ಅಧ್ಯಯನಕ್ಕೆ ಶಿಫಾರಸ್ಸು ಮಾಡಲಾಗಿರುವ ಗ್ರಂಥಗಳು
1. ಕನ್ನಡ ವ್ಯಾಕರಣ (8,9 ಮತ್ತು 10ನೇ ತರಗತಿಗಳಿಗೆ ಕರ್ನಾಟಕ ಸರ್ಕಾರ, ಪಠ್ಯಪುಸ್ತಕಗಳ ಇಲಾಖೆ)
2. ವ್ಯವಹಾರಿಕಕನ್ನಡ : ಎಚ್ಚೆಸ್ಕೆ
3. ಪತ್ರಲೇಖನ : ಕನ್ನಡಸಾಹಿತ್ಯಪರಿಷತ್ತು
4. ಲೇಖನಕಲೆ : ಎನ್‌ಪ್ರಹ್ಲಾದರಾವ್
5. ಆರೋಗ್ಯ ಮತ್ತು ಇತರೆ ಪ್ರಬಂಧಗಳು : ಡಾ॥ ಪಿ.ಎಸ್ ಶಂಕರ್
6. ವೈದ್ಯ ಪದಗಳ ಹುಟ್ಟುರಚನೆ : ಡಾ॥ ಡಿ.ಎಸ್.ಶಿವಪ್ಪ

ಕನ್ನಡ: ಎರಡು
ಪಠ್ಯಕ್ರಮದರೂಪರೇಖೆ
ಸ್ಥಾನ : ಬಿ.ಎಸ್ಸಿ(ಅಲೈಡ್ ಹೆಲ್ತ್ ಸೈನ್ಸ್‌ಕೋರ್ಸ್) ಮೊದಲ ವರ್ಷ
ಸಮಯ : 30 ಘಂಟೆಗಳು (ಮೂವತ್ತು ಘಂಟೆಗಳು)
ಉದ್ದೇಶ : ಜನರ ಆರೋಗ್ಯದ ಬಗ್ಗೆ ಸಮುದಾಯಕ್ಕೆ ತಿಳುವಳಿಕೆ ಕೊಡುವುದು.

Semester 1

VBA-1 Yoga

Learning Objectives

- To define Yoga and understand the history of yoga
- To understand general concept and practice of yoga.

Yoga theory- 15 hours

Unit I: History & Origin of Yoga **(2 hours)**

- Introduction to Yoga
- Introduction to Yoga education & its importance.
- Evolution of Yoga- Concept about yoga origin, Pre-vedic & Vedic period
- Modern view about yoga.

Unit: II General Perspective of Yoga **(3 hours)**

- Definitions of Yoga, Objectives of Yoga, Importance of yoga and Misconceptions about Yoga,
- Principles of Yoga,
- Brief Introduction of schools of Yoga.
- Yogic Lifestyle.

Unit: III Introduction to Yoga practises **(10 hours)**

- Standing & Sitting Series of Asanas
- Supine & Prone Series of Asanas.
- Relaxation technique & its importance.
- Pranayama & its importance

REFERENCE:

1. Lal Basant Kumar: Contemporary Indian Philosophy, Motilal Banarsidas Publishers
2. Pvt. Ltd, Delhi, 2013
3. Dasgupta S. N: History of Indian Philosophy, Motilal Banarsidas, Delhi, 2012
4. Singh S. P: History of Yoga, PHISPC, Centre for Studies in Civilization Ist, 2010
5. Singh S. P & Yogi Mukesh: Foundation of Yoga, Standard Publication, New Delhi, 2010
6. G.C pande, Histroy of science, philosophy, and culture of Indian Civilization Vol.VII part 10 Centre for Studies in Civilisations.
7. Asana, Pranayama, Bandha, Mudra by Swami Satyananda Saraswati Bihar School of Yoga.

Yoga practical **15 hours**

All Yogic sessions will be started with brief theory of technique of yogic practices, name of the practice, precautionary measures to be taken before, during and after practice of yoga & its benefits. This will enhance the students to learn different techniques of yoga.

Unit I: Breathing Practices & Sukshma Vyayama (Loosening exercise)

- Hands stretch breathing , Hand In & out breathing.
- Sukshma Vyayama*: All Joints Rotation*: Fingers, Wrist, Elbows, Shoulder rotation, Neck Flexion/ Extension, Neck rotation, knee movements & ankle joint movements
- Hip rotation, extension and all possible movements.
- Stretching: Forward, Backward & Sideward bending & Situps.

Unit II: Asanas, Pranayama & Relaxation technique.

- Suryanamaskara (12 Series of asansa)
- **Standing Series:** Ardha Chakräsana , Ardhakati Chakräsana, Trikonasana, Vrikshansana, Tadasana;
- **Sitting Series:** Vajräsana, paschimotasnasana Ustrasana, Vakrāsana,; **Prone Series:** Bhujangasana, Shalabasana ;**Supine series:** Uttitapadasana & setubhandasana,
- **Pranayama & Relaxation technique:** Suryabedana, Chandrabedana, Anuloma Viloma; Relaxation technique- Quick relaxation technique.

Reference:

1. Asana by Swami Kuvalyananda Kaivalyadhama, Lonavla.
2. Asana, Pranayama, Bandha, Mudra by Swami Satyananda Saraswati Bihar School of Yoga.
3. Light on Yoga, by B.K.S Iyengar,Harper Collins Publishers.
4. Surya Namaskar by Saraswati, Swami Satyananda, Bihar School of Yoga.

Semester 2
DSC 4 – General Pathology
(45 hrs, LTP – 3+1+1)

Course outcome:

At the end of the course student should be able to

CO1: Demonstrate the acquisition of comprehensive knowledge of cell pathology and repair

CO2: Demonstrate the acquisition of comprehensive knowledge of pathogenesis, morphology and complications of hematological diseases of the body.

CO3: Perform and analyse basic hematology techniques.

CO4: Acquisition of Knowledge of workflow and to perform basic investigations in Transfusion medicine and clinical pathology.

CO5: Demonstrate the acquisition of comprehensive knowledge of handling, storage and quality assurance of cytology lab.

Unit I **10 hrs**

General pathology-Introduction- & scope of pathology

1. Cell injury and Cellular adaptations- Normal cell, Cell injury- types, etiology, morphology, Cell death-autolysis, necrosis, apoptosis, Cellular adaptations- atrophy, hypertrophy, hyperplasia, metaplasia.
2. Inflammation-Introduction, acute inflammation-vascular events, cellular events, chemical mediators, chronic inflammation- general features, granulomatous inflammation, tuberculosis.
3. Healing and repair- Definition, different phases of healing, factors influencing wound healing, fracture healing.
4. Haemodynamic disorders- Edema, hyperemia, congestion, hemorrhage, embolism, thrombosis, infarction.
5. Neoplasia- defintion, nomenclature, features of benign and malignant tumors, spread of tumors, dysplasia, carcinoma in situ, precancerous lesions.
6. Environmental and nutritional pathology-smoking, obesity and vitamin deficiencies.

Unit- II **10 hrs**

Hematological Disorders **5 hrs.**

1. Introduction and hematopoiesis
2. Anemia-introduction and classification (morphological and etiological).
3. Iron deficiency anemia: distribution of body iron, iron absorption, causes of iron deficiency, lab findings, megaloblastic anemia: causes, lab findings.
4. Hemolytic anemias: definition. Causes, classification, and lab findings.
5. WBC disorders- quantitative disorders, leukemia-introduction, Pancytopenia.
6. Bleeding disorders- Introduction, Classification, causes of inherited and acquired bleeding disorders, thrombocytopenia, DIC, laboratory findings.

Basic Hematological Techniques **5 hrs**

1. Characteristics of good technician, Blood collection- methods (capillary blood, venipuncture, arterial puncture) complications, patient after care.
2. Anticoagulants, transport of the specimen, preservation, effects of storage, separation of serum and plasma, universal precautions.
3. Complete hemogram- CBC, peripheral smear, BT, CT, PT, APTT, ESR, PCV

4. Automation in hematology-principles of autoanalyzer -3 part, 5 part and six part analysers and coagulometer-interpretation of autoanalyzer results.
5. Disposal of the waste in the laboratory.

Unit- III **5 hrs**

Transfusion Medicine

1. Selection of donor, blood grouping, Rh typing, cross matching, and storage.
2. Transfusion transmitted diseases, transfusion reactions, components- types, indications.

Clinical Pathology

1. Examination of cerebrospinal fluid-physical examination, chemical examination, microscopic examination.
2. Examination of body fluids (pleural, pericardial and peritoneal), physical examination, chemical examination, microscopic examination.
3. Sputum examination.

Unit- IV **10 hrs**

1. Blood collection- methods (capillary blood, venipuncture, arterial puncture) complications, patient after care.
2. Handling and storage of samples in hematology
3. Interpretation of autoanalyzer results- complete blood count and erythrocyte Indices- MCV, MCH, MCHC.
4. Reticulocyte staining and counting.
5. Staining of peripheral smear and Differential leucocyte count
6. Quality assurance in hematology.
7. Introduction and basics of histopathology –Handling, storage, and processing of specimens.

Unit- V **10 hrs**

1. Introduction to clinical pathology and Urinalysis- collection. Preservatives, physical, chemical examination and microscopy
2. Physical examination; volume, color, odor, appearance, specific gravity and ph,
3. Chemical examination; strip method- protein- heat and acetic acid test, sulfosalicylic acid method, reducing sugar- benedicts test, ketone bodies- rotheras test, bile pigments- fouchet method, bile salt- hays method, blood- benzidine test, urobilinogen and porphobilinogen- ehrlich aldehyde and schwartz test, bence jones protein, microscopy.
4. Handling and storage of samples in cytology and clinical pathology.
5. Quality assurance in cytology and clinical pathology

Practicals: **30 hrs**

1. Laboratory organization- Reception of specimen, dispatch of reports, records keeping. Laboratory safety guidelines.
2. SI units and conventional units in hospital laboratory.
3. Basic requirements for hematology laboratory, glasswares for hematology, pipettes and equipments for haematology lab and anticoagulant vials.
4. Blood collection- methods (capillary blood, venipuncture, arterial puncture) complications, patient after care.
5. Determination of haemoglobin.
6. Determination of ESR and PCV.
7. RBC count and TLC by hemocytometer.
8. Differential leukocyte count and Absolute eosinophil count
9. Interpretation of autoanalyser results- complete blood count and erythrocyte Indices- MCV,

MCH, MCHC.

10. Reticulocyte staining and count.
11. Introduction to clinical pathology and Urinalysis- collection. Preservatives, physical, chemical examination and microscopy- semiautomated and automated methods Physical examination; volume, color, odor, appearance, specific gravity and pH, Chemical examination; strip method- protein- heat and acetic acid test, sulfosalicylic acid method, reducing sugar- benedicts test, ketone bodies- Rothera's test, bile pigments- fouchet method, bile salt- hays method, blood- benzidine test, urobilinogen and porphobilinogen- Ehrlich aldehyde and Schwartz test, Bence jones protein, microscopy.
12. Charts.

Practical Examination- 35 marks.

1. Spotters
2. Hemoglobin estimation and blood grouping
3. Charts
4. Urinalysis

Recommended Books Recent Editions.

1. Basic Pathology Robbins Saunders, an imprint of Elsevier Inc., Philadelphia,USA.
2. Text book of Pathology Harsha Mmohan Jaypee Brothers, New Delhi.
3. Practical Pathology P. Chakraborthy, Gargi Chakarborty New Central bookagency, Kolkata.
4. Text book of Haematology Dr Tejinder Singh Arya Publications, Sirmour (H P)
5. Text book of Medical Laboratory Technology Praful Godkar Bhalani Publications house, Mumbai.
6. Textbook of Medical Laboratory Technology Ramanik Sood.
7. Practical Haematology Sir John Dacie Churchill Livingstone, London.
8. Todd and Sanford, Clinical Diagnosis and Management by Laboratory
9. Methods John Bernard Henry, All India Traveller Bookseller.
10. Histopathology Techniques, Culling.
11. Histopathology Techniques Bancroft.
12. Diagnostic Cytopathology Koss.
13. Diagnostic Cytopathology Winfred Grey.
14. Hand book of Medical Laboratory Technology, CMC Vellore.
15. Basic Haematological Techniques Manipal.

Semester 2

DSC 5 – Microbiology

(45 hrs, LTP – 3+1+1)

Course outcome:

At the end of the course student should be able to

CO1: Demonstrate the acquisition of knowledge of morphology of bacteria, viruses, parasites and fungal pathogens causing human infections

CO2: Demonstrate capability to practice appropriate staining technique, sterilization and disinfection techniques used in microbiology

CO3: Demonstrate the acquisition of knowledge of immunity, immunization schedule and role of Immunoprophylaxis.

CO4: Demonstrate the acquisition of knowledge about infection control and practices in laboratory.

CO5: Demonstrate capability to explain the concepts and principles of compound microscope and its applications

Unit - I **09 hours**

General Microbiology

- Introduction to Medical microbiology and Classification of microorganisms
- Morphology and Physiology of bacteria
- Sterilization and Disinfection practices followed in a tertiary care centre including CSSD and recent advances.
- Culture methods
- Infection
- Specimen collection and laboratory diagnosis of infectious diseases

Immunology

- Antigen
- Antibodies
- Immunity
- Vaccines and immunization schedule, Immunoprophylaxis

Unit – II **09 hours**

Systemic bacteriology

- Staphylococcus, Streptococcus pyogenes and Pneumococcus
- Overview of Clostridia and C. tetani
- M. tuberculosis
- Enterobacteriaceae - Klebsiella, E. coli, Proteus
- Non-fermenters - Pseudomonas and Acinetobacter

Unit – III **09 hours**

Parasitology

- Introduction to parasitology and lab diagnosis of parasitic infections
- Protozoa - *Entamoeba histolytica*, Giardia, trichomonas, Malaria, Hook worm and Round

worm

Unit – IV **09 hours**

Mycology

- Introduction to mycology and lab diagnosis of fungal infections
- Yeasts - Candida and Cryptococcus
- Moulds – Aspergillus, Zygomycetes

Virology

- General properties of viruses and laboratory diagnosis of viral infections
- Blood borne viral infections - Hepatitis B and C viruses, HIV

Unit – V **09 hours**

Applied microbiology

- Hospital acquired infections - Causative agents, transmission methods, investigation, prevention and control of hospital Acquired infections.
- SSI, VAP, CAUTI, CLABSI
- Overview of opportunistic infections – Definition, predisposing factors and etiological agents
- Standard and universal precautions
- Biomedical waste management

Practicals **30 hours**

1. Compound microscope and demonstration of the parts.
2. Demonstration of sterilization equipment's - hot air oven, autoclave- principle, mechanism of action, preparation of the materials and quality control
3. Disinfection practices in a tertiary care centre - Disinfection of OT, Wards, OPD, dialysis units and laboratories
4. Testing of water, air and environmental surveillance
5. Demonstration of commonly used culture media with and without growth- Nutrient agar, blood agar, chocolate agar, Mac Conkey medium, Lowenstein-Jensen media, AST plate and Robertson cooked meat broth
6. Classification of Stains and Procedure and interpretation of Grams staining

Practical examination : 35 marks

Spotters, Culture media, Equipments, Slides
Discussion:
1.Gram stain
2.Ziehl- Neelsen stain

Reference Books

1. Ananthanarayan & Panikar's Textbook of Microbiology – Latest Edition University Press.
2. Parasitology (protozoology and helminthology Parasitology) by K D Chatterjee
3. Text book of Practical Microbiology for MLT by C P Baveja, Arya publications
4. Text book for laboratory technicians by RamnikSood. Jaypee publishers
5. Textbook of parasitology by Paniker. 7th edition

Semester 2

DSC 6 – Pharmacology

(45 hrs, LTP – 3+1+1)

Course outcome

At the end of the course student should be able to

- CO1: Demonstrate the acquisition of comprehensive knowledge of basics of pharmacology
- CO2: Demonstrate the acquisition of comprehensive knowledge about the pharmacokinetics and pharmacodynamics of drugs
- CO3: Demonstrate the capability of enlisting the drugs used on various organ system of the body including hormones and chemotherapy
- CO4: Demonstrate the capability of enlisting the drugs used on emergency conditions
- CO5: Demonstrate the capability of enlisting the uses of various devices and instruments used in hospital setting.
- C06: Demonstrate the skills of identifying the devices, instruments, drugs and dosage forms

UNIT I- General Pharmacology, ANS, PNS **9 Hrs**

Sources of Drugs, Route of drug administration, Pharmacokinetics (Absorption, Metabolism, Distribution, Excretion), Pharmacodynamics (Mechanisms of action),
Adverse drug reactions
ANS : Adrenergic drugs -Adrenaline,
Anti adrenergic-alpha and beta blockers
Cholinergic drugs-Acetyl choline
Anti cholinergic agents-Atropine

Unit II- PNS, CVS, Renal system **9 hrs**

Skeletal muscle relaxants-
Local anaesthetics-lignocaine, LA + vasoconstrictor
CVS-ionotropic agents -Digoxin,
Antianginal drugs-GTN,
Antihypertensives-
Management of different types of shock and Plasma expanders
Renal system-Diuretics Antidiuretics-Vasopressin

Unit III- CNS, Blood **9 hrs**

CNS-general Anaesthetics
Sedative hypnotics-
Antiepileptics
Opioid analgesics-
NSAIDS-
Respiratory system-treatment of cough And Bronchial asthma
Blood-Hematinics, Anticoagulants -Warfarin, Heparin
Thrombolytics & Antiplatelet drugs-streptokinase,/ aspirin,

Unit IV- GIT,Chemotherapy **9 hrs**

GIT-drugs used in peptic ulcer-
Antiemetics -Metaclopromide, Domperidone, Ondensetron
Purgatives & Laxatives
Drugs used in Diarrhoea- ORS, Super ORS, Antimotility drugs (loperamide, diphenoxylate)
Chemotherapy-general considerations MOA, Resistance, Prophylaxis

Unit V- Chemotherapy, Hormones **9 hrs**

Anti-bacterial, anti-fungal, anti-viral, anti-protozoal, anti-helminthic
Cancer chemotherapy (names, common Adverse effects, general principles in the treatment of cancer)
Hormones-Thyroid and antithyroid drugs, Insulin, glucagon, antidiabetic drugs, corticosteroids, oestrogen, progesterone, oxytocin

Practicals Syllabus **30 hrs**

Dosage forms,
Solid Dosage forms
Liquid Dosage forms
Gaseous Dosage forms
Oral route
Parentral routes
Novel routes
Fixed dose combination-Amoxycillin+clavulinic acid-cotrimoxazole, Lignocaine+ Adrenaline
Drug stations-Adrenaline, dopamine, Dobutamine)
Drug stations-Corticosteroids(hydrocortisone, prednisalone, inhaltional steroids) Drug stations-common antibiotics (Amoxycillin, Ciprofloxacin, Azithromycin, Metronidazole, Cephalosporins)
Drug stations-Insulin preparations

Instrument & devices(Nasogastric tube, laryngoscope, Different Cathetors, Nebulizers, Inhalers, Rotahalers)

Practical examination **35 marks**

1. Dosage Forms
   Capsules, Tablets, Syrup, Iv, Im, Sc, Ia , Intra Articular -
   Advantages (1 Mark), Disadvantages (1 Mark) Examples (1 Mark)
2. Mention the name of the Device/Instruments and uses : Inhalers, Rota halers, Space halers, Drip sets, Vaso fix, Ryle's tube, Urinary catheter, Endotracheal tube, Hand gloves
3. 10 Spotters

Recommended Books

1. K.D. Tripathi, Essentials of Medical Pharmacology, V. Edition, M/s. Jaypee Brothers, Post Box, 7193, G-16, Emca House, 23/23, Bansari Road, Daryaganj, New Delhi.
2. Padmaja Udaykumar -Pharmacology for Allied Sciences
3. R. S. Satoskar, S.D. Bhandarkar, S. S. Ainapure, Pharmacology and Pharmacotherapeutics, 18th Edition, Single Volume, M/s Popular Prakashan, 350, Madan Mohan Marg, Tardeo, Bombay - 400 034.

Semester 2

AEC 3 – Health Care

(30 hrs, LTP – 2+0+0)

Learning Objectives

1. To define Health and understand various concepts of Health
2. To understand concept of disease and its causation.
3. To know the Health care delivery system in India
4. To understand epidemiology of common infectious diseases of India.
5. To know various National Health Programmes of India
6. To have overview of First Aid and Bio-Medical Waste management Principles and guidelines

Unit I

1a. Concepts of Health

Definition of health; evolution in concepts of public health; public health events-sanitary awakening, germ theory of disease, rise of public health in various countries, changing concepts of health- biomedical concept, ecological concept, psycho-social concept and holistic concept.

1b. Dimensions of Health

Physical dimension, mental dimension, Social dimension etc;

1c. Determinants of Health

The factors which determine human health like social, economic, cultural, nutritional factors, etc. will be discussed. Common health problems in India - Communicable diseases, Non communicable diseases, MCH problems, Nutritional problems, Environmental sanitation, Glance over National Health profile.

Unit II

2a. Concept of disease and causation.

Germ theory of disease, Epidemiological triad, Natural History of disease, concept of prevention. Definition of Epidemiology.

2b. Epidemiology of common infectious diseases

Brief epidemiology of Tuberculosis, Malaria, Dengue, HIV, Leprosy

Unit III

3a. Evolution of health care delivery systems

History of health care delivery services; Genesis of primary health care; National health policy; SDGs.

3b. Levels of health care

Primary health care, secondary health care, tertiary health care.
Primary health care-principles of primary health care, elements of primary health care.

Unit IV

4a. Primary health care: Delivery of services

Introduction; Structure of health care delivery system; Delivery of primary health care services at village level; Village health guide, ASHA, ICDS: Subcentre: Primary health centre.
Primary Health care- current status in India- Status of health care infrastructure; Health team

concept.

4b.Secondary and tertiary health care: Delivery of services

Community Health centre; First referral unit; District hospital.

Unit V

5a. National Health Programmes- Communicable diseases

Introduction; National Vector Borne Disease Control Programme; National Leprosy Eradication Programme; National Tuberculosis Elimination Programme; National AIDS Control Programme; Universal Immunization Programme; National Rural Heath Mission.

5b. National Health Programmes- Non-communicable diseases

National Programme for Control of Blindness; National Programme for control of Diabetes, Cardiovascular diseases, Cancer and Stroke (NPCDCS); National Mental Health Programme. Nutritional programmes.

5c. National Health Programmes – Maternal and Child Health

Reproductive and Child Health Programme; Integrated Management of Neonatal and Childhood Illnesses; National Nutritional Anemia Prophylaxis Programme

UNIT VI

6a. First aid

Basic terminologies; general guidelines; first aid in specific situations; Wound, bleeding, fracture, choking, burns, epistaxis, strains and sprain, animal bites (classification, causes and first aid), Cardio-pulmonary resuscitation

6b. Biomedical Waste (BMW) Management

Sources of Bio-medical waste, principles of bio-medical waste management, step in management of BMW**.**

Recommended Books Recent Editions.

1. Park K. Park's Textbook of Preventive and Social Medicine. 26th ed. Jabalpur: Banarsidas Bhanot Publishers, 2015. p.135-141
2. Suryakantha. Textbook of Community Medicine with recent advances. 6th edition
3. Bhalwar R editor. Textbook of Public Health and Community Medicine. 2nd Pune, Department of Community medicine AFMC; 2012
4. Essentials of Community Medicine for Allied Health Sciences, JSS University Publications, 2015

Semester 2

MDC 1 – Psychology

(30 hrs, LTP – 2+0+0)

Description

This course is designed to enable the students to develop understanding about basic concepts of psychology and its application in personal and professional life. It further provides students opportunity to recognize the significance and application of counselling skills.

Objectives

On completion of the course, the students will be able to

1. Identify the importance of psychology in individual and professional life.
2. Understand biological basis of human behaviour
3. Understand mental health and hygiene
4. Understand personality and gain experience in personality assessment
5. Understand stress and learn coping strategies
6. Learn suicide prevention and counselling skills

Unit -I

- Meaning of Psychology
- Scope of Psychology- Scope, branches and methods of psychology
- Relationship with other subjects
- Applied psychology to solve everyday issues

Unit -II

- Personality Introduction: Meaning, definition, Classification, measurement and evaluation of personality

Unit -III

Biological basis of behavior –Introduction

- Body mind relationship
- Genetics and behaviour
- Inheritance of behaviour
- Brain and behaviour.
- Psychology and sensation – sensory process normal and abnormal.

Unit-IV

Mental health and mental hygiene

- Concept of mental health and mental hygiene
- Characteristic of mentally healthy person
- Warning signs of poor mental health
- Promotive and preventive mental health strategies and services
- Defense mechanism and its implication
- Frustration and conflict – types of conflicts and measurements to **overcome**

Unit-V

- **Intelligence –** Meaning of intelligence – Effect of heredity and environment in intelligence, classification, Introduction to measurement of intelligence tests – Mental deficiencies
- **Learning –** Definition of learning, types of learning, Factors influencing learning – Learning process, Habit formation
- **Memory** – meaning and nature of memory, factors influencing memory, methods to improve memory, forgetting

Unit VI
Stress

- Hans Selye Model of stress. Lazarus and Folkman model of stress.
- Sources of stress. Stress, disease and health.
- Coping strategies and styles- emotion focused and problem focused
- Relaxation techniques

Unit VII
Counselling

- Counselling-meaning and definition.
- Micro skills of counselling
- Psychotherapy- meaning and definition.
- Relaxation-types.
- Suicide and suicide prevention

Recommended Books Recent Editions.

1. C.P. Khokhar (2003) Text book of Stress Coping and Management Shalab Publishing House.
2. S.M.Kosslyn and R.S.Rosenberg (2006) Psychology in Context. Pearson Education Inc.
3. C.R. Carson, J.N. Bitcher, S.Mineka and J.M. Hooley (2007), Abnormal Psychology13th, Pearson Education, Inc.
4. D.A. Barlow and V.M. Durand (2004) Abnormal Psychology Wadsworth, Thompson Learning, 3rd edition USA.
5. R.J . Gerrig & P.G. Zimbardo (2006) Psychology and life, Pearson Education, Inc.
6. Pestonjee, D.M. (1999). Stress & Coping, The Indian Experience 2nd edn. New Delhi, Sage India Publications.

Semester 2

SEC 1 – Soft Skills

(30 hrs, LTP – 2+0+0)

Learning objectives

- To give each student a realistic perspective of work and work expectations
- To help formulate problem solving skills, to guide students in making appropriate and responsible decisions
- To create a desire to fulfill individual goals, and to educate students about unproductive thinking, self-defeating emotional impulses, and self- defeating behaviors

Unit I

Definition of soft skills, Soft skills and Hard Skills, Advantage of Soft Skills, Real life scenarios, Measurement of soft skills.
Self Discovery, Definition of Self, Identification of Strengths and weakness of self, Setting goals, Personal beliefs, values and ethics.

Unit II

Mindsets: Types of Mindsets, Developing a learning and Growth mindset, Developing a positive outlook towards life, Increasing emotional and Spiritual intelligence.
People skills, Types of people - passive, assertive and aggressive people, Developing assertive personality, dealing with aggressive and submissive people.

Unit III

Communication Skills: Definition of Communication, Verbal and Nonverbal communication, Telephone and internet communication, Common mistakes in communication.
Interpersonal skills: Listening skills, Understanding body language, polite communication and people friendly attitude.

Unit IV

Time management: Importance of punctuality, Efficient time handling, Avoiding leakage of time and procrastination
Stress Management: Definition of Stress, Positive and negative stress. Handling major projects through effective delegation.

Unit V

Organizational behavior: Definition of an organization, Understanding the rules and egulations of an organization, Creating an ideal working Environment.
Professional attitude-Definition and developing an effective professional attitude.
Leadership Skills: Developing a positive attitude, Presentation and public speaking skills,

effective handling of the team and sub ordinates. Recognizing and encouraging talents in Sub ordinates.

Recommended books

1. Barun Mitra (2016), Personality Development and Soft Skills, 2nd edition, Oxford University Press
2. Alex K (2014), Soft Skills Paperback, S Chand & Company
3. Peggy Klaus (2008) The Hard Truth About Soft Skills: Workplace Lessons Smart People Wish They'd Learned Sooner 1st edition, HarperBusiness.
4. Sanjay Kumar, Pushp Lata (2018) Communication Skills Paperback 1st edition, Oxford University Press
5. John Hayes (1994), Interpersonal Skills: Goal Directed Behavior at Work, Routledge.
6. Gurdeep Singh Gujral (2013) Leadership Qualities for Effective Leaders, VIJ Books (India) Pty Ltd.

Semester 3

DSC 7 – Introduction To Genetics

(60 hours, LTP – 3+1+1)

Course Outcome

Students will be able to

CO1. Conceptualize basic concepts in genetics and basic features of cellular reproduction.
CO2. Comprehend classical Mendelian genetics and understand the exceptions.
CO3. Maintain and handle Drosophila lines
CO4. Perform genetic crosses with Drosophila

Unit 1

The Science of Genetics **4 hrs**

The personal genome, three great milestones in genetics, DNA as the genetic material, genetics and evolution, levels of genetic analysis, genetics in the world: applications of genetics to human endeavours.

Cellular reproduction **3 hrs**

Cells and chromosomes, the cell cycle, cell division, mitosis, meiosis.

Basic principles of inheritance **5 hrs**

Mendel's study of heredity, applications of Mendel's principles, testing genetic hypotheses, mendelian principles in human genetics.

Unit 2

Extensions of Mendelism **5 hrs**

Allelic variation and gene function, incomplete dominance and codominance, multiple alleles, allelic series, testing gene mutations for allelism, variation among the effects of mutations, genes function to produce polypeptides, why are some mutations dominant and others recessive?

Gene action: from genotype to phenotype **4 hrs**

Influence of the environment, environmental effects on the expression of human genes, penetrance and expressivity, gene interactions, epistasis, pleiotropy.

Inbreeding: another look at pedigrees **3 hrs**

The effects of inbreeding, genetic analysis of inbreeding, measuring genetic relationships.

Unit 3

The Chromosomal Basis of Mendelism **4 hrs**

Sex, chromosomes, and genes, chromosome number, sex chromosomes, the chromosome theory of heredity, experimental evidence linking the inheritance of genes to chromosomes, nondisjunction as proof of the chromosome theory, the chromosomal basis of Mendel's principles of segregation and independent assortment.

Sex-Linked Genes in Humans **3 hrs**

Hemophilia, an X-linked blood-clotting disorder, color blindness, an X-linked vision disorder, genes on the human y chromosome, genes on both the X and Y chromosomes.

Sex Chromosomes and Sex Determination **3 hrs**

Sex determination in drosophila, sex determination in other animals, dosage compensation

of X-linked genes, hyperactivation of X-linked genes in male drosophila, inactivation of X-linked genes in female mammals.

Pedigree analysis **3 hrs**
Penetrance and Expressivity, Family Tree, Dominant Inheritance, Recessive Inheritance, Sex-Linked Inheritance.

Unit 4
Linkage, Crossing Over, and Chromosome Mapping in Eukaryotes **4 hrs**
Early evidence for linkage and recombination, crossing over as the physical basis of recombination, evidence that crossing over causes recombination, chiasmata, and the time of crossing over.

Chromosome Mapping **4 hrs**
Crossing over as a measure of genetic distance, recombination mapping with a two-point testcross, recombination mapping with a three-point testcross, interference and the coefficient of coincidence, recombination frequency, and genetic map distance.

Cytogenetic Mapping **4 hrs**
Localizing genes using deletions and duplications, genetic distance and physical distance, linkage analysis in humans, and detecting linkage with molecular markers.

Recombination and Evolution **2 hrs**
Evolutionary significance of recombination, suppression of recombination by inversions.

Student seminars **7 hrs**

Practical classes
- Rearing and handling of Drosophila
- Genetic crosses with Drosophila melanogaster to understand Mendelian Inheritance
- Study of mitotic chromosomes of Drosophila melanogaster OR from cells of the onion root tip
- Examples of Monohybrid cross, Dihybrid cross, and test cross and back cross for understanding the Mendelian principles
- Examples of Dihybrid crosses for understanding inter-allelic Epistatic interactions
- Principles of Pedigree drawing
- Risk calculation through information provided in a given Pedigree and determination of inheritance pattern

Recommended books Recent edition
1. Principles of genetics, D. Peter Snustad, Michael J. Simmons.
2. Principles of Genetics, Tamarin.
3. Introduction to Genetic Analysis, Anthony J. F. Griffiths, John Doebley, Catherine Peichel, David A. Wassarman

Semester 3

DSC 8 – Cell and Molecular Biology

(60 hours, LTP – 3+1+2)

Course Outcome:

Students should be able to

- CO1. Conceptualize the fundamentals of cell structure, function of different organelles, fundamentals of molecular biology covering the central dogma of molecular biology and techniques used in molecular biology
- CO2. Comprehend cell-cell interaction mechanisms underlying various cellular functions
- CO3. Students should be able to perform experiments which are routinely used in research and diagnostic labs.

Unit 1: Fundamentals of cell biology **(10hr)**

The cell theory- fundamental units of life, Eukaryotic and prokaryotic cells, structure and function of cell components- cell membrane and fluid mosaic model, cell wall, golgi apparatus, endoplasmic reticulum, nucleus, lysosomes, mitochondria **(4hr)**. Fluidity of membranes- membrane proteins, permeability of lipid bilayer protein-protein transport- passive diffusion, active transport, ATP driven pumps in transport, ABC transport system and sorting, pinocytosis, phagocytosis, receptor mediated endocytosis, Electron transport chain and proton pump **(6hr)**

Unit 2: Cell- cell communications **(20hr)**

Signalling, paracrine, juxtacrine and endocrine factors, tight and Gap junctions, cadherins and cell adhesion, integrins and cell adhesion, morphogen gradients in development, cell surface receptors and internal receptors, signal transduction **(6hr)**

Cell Signalling – G protein coupled cell surface receptors, enzyme couple cell surface receptors, signalling pathways dependent on latent gene regulatory proteins (Hedgehog and Wnt signalling) **(6hr)**

Cytoskeletal filaments - microtubes and filament, centrosomes and centrioles, actin cytoskeleton, molecular motors. Eukaryotic cell cycle – overview of cell cycle, different phases, mitosis and meiosis and cell cycle regulation and apoptosis **(8hr)**

Unit 3: Fundamentals of molecular biology **(20hr)**

Structure and function of genetic materials, DNA, RNA, Chromosome and its packaging as chromatin, organization and regulation of chromatin, Prokaryotic and Eukaryotic DNA replication, Conservative and semi-conservative DNA replication, DNA repair and recombination- Types of DNA repair- Mismatch repair, base excision repair, nucleotide excision repair, homologous and site specific recombination **(6hr)** Mitochondrial DNA and associated disorders. Central dogma of molecular biology- DNA to protein, transcription, post transcriptional modification, translation, post-translational modification, Differential gene expression – anatomy of gene- exons, introns, promoters, activation and repressor mechanisms of gene expression, generation of transgenic cell lines and organisms (**14hr)**

Unit 4: Techniques in molecular biology **(10hr)**

Nucleic acids isolation, protein isolation and analysis, gene expression studies- PCR analysis, Basic principles of gene cloning- Vectors and bacteriophages introduction of DNA to living cells, cloning vectors for eukaryotes, application of gene cloning in medicine.

Practicals

1. Mammalian cell culturing (Thawing, passaging, trypsinization, cell counting and replating and freezing)
2. Transfection using lipofectamine in mammalian cells
3. Wound healing assays using cancerous cell lines
4. Cell cycle analysis using PI staining by flow cytometry
5. Immunofluorescence staining in mammalian fixed cells
6. MTT assay for cell proliferation studies
7. RNA isolation, cDNA preparation and PCR to analyse gene expression
8. Preparation of cell lysates from cancer cell line; estimation of total protein (Lowry/Bradford); analysis of protein of interest by western blotting.
9. Restriction digestion analysis of DNA using enzymes

Recommending reading:

1. Molecular Biology of the Cell: B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts and P. Walter (2007) 5 edition, Garland Science
2. Campbell Biology: Jane B. Reece, Lisa A. Urry et al, Tenth edition
3. Molecular Biology of the Gene: J.D. Watson, T.A. Baker, S.P. Bell, A.A.F. Gann, M. Levine and R.M. Losick (2007) 7 edition, Benjamin Cummings

Semester 3

DSC 9 – PRINCIPLES OF IMMUNOLOGY

(60 hours, LTP – 3+1+2)

Course outcome

Student should be able to

- CO1. Comprehend how human immune system combats foreign bodies
- CO2. Understand how cells and molecules of immune system work
- CO3. Understanding of the diseases of immune origin, working of vaccines and immunetherapies
- C04. Should be able to perfrom immuno assays, serological tests and perfrom flow cytometric analysis

Unit 1: **8hrs**

Cells, Organs, and Microenvironments of the Immune System **3Hrs**

Hematopoiesis and Cells of the Immune System: Red and White Blood Cells**,** Myeloid and Lymphoid Blood Cell Lineages, Primary Lymphoid Organs: The Bone Marrow and The Thymus, Secondary Lymphoid Organs: The Spleen, The Lymph Node and Mucosa Associated Lymphoid Tissue**.**

Recognition and Response **5Hrs**

General Properties of Immune Receptor-Ligand Interactions, Immune Antigen Receptor Systems., Cytokines and Their Receptors, A Conceptual Framework for Understanding Cell Signaling, Immune Responses: The Outcomes of Immune System Recognition.

Unit 2: **14Hrs**

Innate Immunity **4Hrs**

Anatomical Barriers to Infection, Cellular Innate Response Receptors and Signaling, Induced Innate Immunity Effector Mechanisms, Innate Lymphoid Cells, Regulation and Evasion of Innate and Inflammatory Responses, Interactions between the Innate and Adaptive Immune Systems, Ubiquity of Innate Immunity.

The Complement System **4Hrs**

The Major Pathways of Complement Activation-Classical Pathway ,The Lectin Pathway, The Alternative Pathway, Generation of the MAC, The Diverse Functions of Complement, The Regulation of Complement Activity, Complement Deficiencies, Microbial Complement Evasion Strategies, The Evolutionary Origins of the Complement System.

The Organization and Expression of Lymphocyte Receptor Genes **3Hrs**

Immunoglobulin Gene Structure, Multigene Organization of Immunoglobulin Genes, The Mechanism of V(D)J Recombination, B-Cell Receptor Expression, T-Cell Receptor Genes and Their Expression.

The Major Histocompatibility Complex and Antigen Presentation **3Hrs**

The Structure and Function of MHC Class I and II Molecules, The Organization and Inheritance of MHC Genes, The Role and Expression Pattern of MHC Molecules, The Endogenous Pathway of Antigen Processing and Presentation, The Exogenous Pathway of Antigen Processing and Presentation, Unconventional Antigen Processing and Presentation, Presentation of Non peptide Antigens.

Unit 3 **13Hrs**

T-Cell Development **2Hrs**

Early Thymocyte Development, Positive and Negative Selection, Lineage Commitment, Exit from the Thymus and Final Maturation, Other Mechanisms That Maintain Self-Tolerance.

B-Cell Development **2Hrs**

B-Cell Development in the Bone Marrow, Completion of B-Cell Development in the Spleen, The Properties and Development of B-1 and Marginal Zone B Cells, Comparison of B- and T-Cell Development.

T-Cell Activation, Helper Subset Differentiation, and Memory **3Hrs**

T-Cell Activation and the Two-Signal Hypothesis, Helper CD4 T-Cell Differentiation, T-Cell Memory.

B-Cell Activation, Differentiation, and Memory Generation **3Hrs**

T-Dependent B-Cell Responses: Activation, Differentiation and Memory Generation; T-Independent B-Cell Responses; Negative Regulation of B Cells.

Effector Responses: Antibody- and Cell-Mediated Immunity **3Hrs**

Antibody-Mediated Effector Functions and Cell-Mediated Effector Responses.

Unit 4 **25Hrs**

Barrier Immunity: The Immunology of Mucosa and Skin **3Hrs**

Common Themes in Barrier Immune Systems, Intestinal Immunity, Maintaining Immune Homeostasis in the Intestine, Intestinal Immune System Response to Invasion, Dysbiosis, Inflammatory Bowel Disease, and Celiac Disease, Other Barrier Immune Systems.

The Adaptive Immune Response in Space and Time **3Hrs**

Immune Cells in Healthy Tissue: Homeostasis, Immune Cell Response to Antigen: The Innate Immune Response, First Contact between Antigen and Lymphocytes, The Effector and Memory Cell Response.

Allergy, Hypersensitivities, and Chronic Inflammation **4Hrs**

Allergies: Type I Hypersensitivity, Antibody-Mediated (Type II) Hypersensitivity, Immune Complex–Mediated (Type III) Hypersensitivity, Delayed-Type (Type IV) Hypersensitivity, Chronic Inflammation.

Tolerance, Autoimmunity, and Transplantation **4Hrs**

Establishment and Maintenance of Tolerance, Autoimmunity, Transplantation Immunology.

Infectious Diseases and Vaccines **4Hrs**

The Importance of Barriers and Vectors in Infectious Disease, The Link between Location and Immune Effector Mechanism, Viral Infections, Bacterial Infections, Parasitic Infections, Fungal Infections, Emerging and Re-emerging Infectious Diseases and Vaccines.

Immunodeficiency Diseases **3Hrs**

Primary Immunodeficiencies, Secondary Immunodeficiencies

Cancer and the Immune System **4Hrs**

Terminology and the Formation of Cancer, Tumor Antigens, The Immune Response to Cancer, Anticancer Immunotherapies

Practicals

1. To identify different types of cells in blood smear using leishmann's stain
2. Identification of blood groups - To demonstrate antigen-antibody reaction by Hemeagglutination reaction.
3. WIDAL TEST - Serological tests
4. ELISA sandwich assay with cell culture supernatants/serum
5. To separate T & B lymphocytes from peripheral blood by E-rosette technique.
6. Flow cytometric analysis with blood cells/lymphocytes

Recommended books

- Kuby Immunology
- Clinical Immunology: Principles and Practice. Robert R. Rich, Thomas A. Fleisher, Benjamin D. Schwartz, William T. Shearer, Warren Strober

Semester 3

MDC 2 – Computer Application

(30 hrs, LTP – 2+0+0)

Learning Objectives

1. To know various aspects of basic components of computer
2. To learn the modes of application of basic utility of the computer

Introduction to Computer & Operating System: **Introduction to computers** – Definition, Characteristics, Generation, Applications, Classifications, Hardware, Software, Computer Arithmetic & Number System, Decimal, Binary, Octal & Hexadecimal System.
Arithmetic Operations on Binary Numbers. ASCII, EBCDIC, BCD codes, Fixed point & floating point representation of numbers.
Computer Organization & Architecture – Memory hierarchy, Primary Memory - memory unit, SRAM, DRAM, SDRAM, RDRAM, Flash memory. Secondary storage devices include Magnetic Disk, Floppy Disks, Optical Disks, Magnetic Drum
Input Devices, Output Devices.
Softwares – Introductory ideas of System Software, Application Software, Operating Systems, Translators, Interpreters, Compilers, Assemblers, and Generation of Languages.
Operating System : Definition, Introductory ideas of single user and multi-uer operating system, Time sharing, multitasking, multiprogramming, Batch Processing, on-line processing, spooling.
Introduction to Windows – Windows basics, Windows Accessories, Miscellaneous Windows features, Web Features & Browsers.
Networks: Different types of networks and their application
Internet and Intranet: Similarities in Internet and Intranet, Differences in Internet and Intranet, Effective Internet use.
Computer Viruses: Types of computer viruses, Use of Antivirus software
Application of Computer: General and Health industry
Software: Different types based on applications. Download open-source softwares. Convert one file format into another (Pdf to Word, Word to pdf, etc.). Ways to protect the documents

MS Office: (Theory & Practicals)

Word Processing:

- Introduction to Microsoft Word
- Font options in Microsoft Word
- Paragraph Formatting in Microsoft Word
- Heading Styles in Microsoft Word
- Editing Options in the Home Tab
- Clipboard & Format Painter Options in Microsoft Word
- Page Insert Options in Microsoft Word
- Inserting Tables in Microsoft Word
- Insert Pictures in Microsoft Word
- Shapes, Icons & 3d Models in Microsoft Word
- SmartArt Options in Microsoft Word
- Inserting Charts in Microsoft Word
- Text Box & Drop Cap Options in Microsoft Word

- Hyperlink in Microsoft Word
- Header, Footer & Page Number Options in Microsoft Word
- Equations & Symbols in Microsoft Word
- Water Mark, Page Color & Page Border Options in Microsoft Word
- Page Setup Options in Microsoft Word -
- Table of Contents & Table of Figures in Microsoft Word
- Endnote & Footnote Options in Microsoft Word
- Mailings Tab Options in Microsoft Word

Microsoft PowerPoint

- Introduction to Microsoft PowerPoint Interface
- Font & Slide Options in Microsoft PowerPoint
- Paragraph Formatting in Microsoft PowerPoint
- Drawing Tools in Microsoft PowerPoint
- Editing Options in the Home Tab
- Inserting Tables in Microsoft PowerPoint -
- Inserting Pictures in Microsoft PowerPoint
- Screenshot Option in Microsoft PowerPoint
- Inserting Photo Albums in Microsoft PowerPoint
- Inserting Icons in Microsoft PowerPoint
- Inserting 3D Models in Microsoft PowerPoint
- Inserting Smart Arts in Microsoft PowerPoint
- Inserting Charts in Microsoft PowerPoint
- Inserting Videos in Microsoft PowerPoint
- Design Tab Options in Microsoft PowerPoint
- Transitions Tab Options in Microsoft PowerPoint
- Animations Tab Options in Microsoft PowerPoint
- Slide Show Tab Options in Microsoft PowerPoint
- View Tab Options in Microsoft PowerPoint
- Built-in Presentation Templates in Microsoft PowerPoint

Microsoft Excel

- Introduction to Microsoft Excel Interface
- Basic Math Functions
- AutoSum Functions
- Sum IF Function & Remove Duplicates Option
- Sum IF & Sum IFs, Count IF & Count IFs Functions
- Sub Total Function
- Arrays & Sum Product Functions
- Other Math Functions
- Absolute & Relative References
- Formatting Techniques in Excel
- Excel Data Types
- Go to & Replace Options

- Auto Fill Options
- Copy, Paste & Paste Special Options
- Conditional Formatting
- Sort & Filter
- Excel Operators
- Equations Solving in Excel
- Errors in Excel Sheet
- Logical Function IF
- Logical Function IF Error
- Logical Function (IF, Nested IF, OR)
- Logical Function AND
- VLOOKUP Function
- VLOOKUP with Data Validation
- Nested VLOOKUP
- HLOOKUP Function
- Selecting the Chart
- Charts in Excel
- Tables in Excel
- Inserting Comments
- Inserting Hyperlink
- Text Functions
- Date, Time & Reference Functions
- Text to Columns Tool
- Data Consolidation
- Goal Seek Option
- Data Table Option

III Semester

MDC 3 – Environment Science and Health

(30 hrs, LTP – 2+0+0)

Learning Objectives

1. To know various Environmental factors which affect Health
2. To learn the modes of disease transmission and various control measures

Unit I

1. a. Introduction to Environment and Health and Water

Ecological definition of Health, Population perspective of relations, Health & environment perspective of relations, Environmental factors, Environmental Sanitation, Need to study environmental health, Predominant reasons for ill-health in India

1.b. Water

Safe and wholesome water, requirements, uses, sources; sanitary well; Hand pump; water Pollution; Purification of water; large scale & small scale; slow sand filters; rapid sand filters; Purification of Water on a small scale; Household purification, Disinfection of wells; water quality criteria & standards.

Unit II

Air, Light, Noise, Radiation

2 a. Air

Composition, Indices of Thermal Comfort, Air pollutants, Air Pollution - Health Effects, Environmental Effects, Green-house effect, Social & Economic Effects, Monitoring, Prevention & Control.

2. b. Light, Noise, Radiation

Natural and Artificial light; Properties, sources, noise pollution and its control, types, sources, biological effects and protection.

Unit III

Waste and Excreta Disposal

3 a. Disposal of Wastes

Solid Wastes, Health hazards, Methods of Disposal; Dumping, Controlled tipping/ sanitary landfill, Incineration, Composting.

3 b. Excreta Disposal

Public health importance, Health hazards, sanitation barrier, Methods of excreta disposal, unsewered areas and sewered areas, sewage, Modern Sewage Treatment.

Unit IV

Housing and Health and Medical Entomology

4 a. Housing and Health

Human Settlement, Social goals of housing, Criteria for Healthful Housing by Expert Committee of the WHO, Housing standards- Environmental Hygiene Committee, Rural Housing Standards, Overcrowding, Indicators of Housing.

4 b. Medical Entomology

Classification of Arthropods, Routes of Disease transmission, Control measures.

Unit V
Insecticides and Rodents
5 a. Insecticides

Types, mechanism of action, dosage and application for control of insects.

5 b. Rodents

Rodents and its importance in disease, along with anti-rodent measures.

Reference Books (latest edition)

1. Park K. Park's Textbook of Preventive and Social Medicine. 26th ed. Jabalpur: Banarsidas Bhanot Publishers; 2015. p.135-141
2. Suryakantha. Textbook of Community Medicine with recent advances. 4th edition.
3. Bhalwar R. Textbook of Public Health and Community Medicine. 2nd edition. Pune: Department of Community Medicine AFMC, 2012
4. Essentials of Community Medicine for Allied Health Sciences, JSS University Publications, 2015.

Semester 4

DSC 10 – Biophysics & Instrumentation

(60 hours, LTP – 3+1+2)

Course outcome

Student should be able to -

- CO1. Perfrom biochemical experiements using various techniques
- CO2. Understand properties of biomolecules with the help of bioanalytical techniques.
- CO3. Follow the principles and importance of various techniques.

Unit I – General Biophysical Methods **(10 hrs)**

Laboratory Basics **(2 hrs)**

Units of Measurement; safety procedures in the laboratory

Concept of pH **(3 hrs)**

Definition of pH; Electrolytes (acids and bases) and buffers; Measurement of pH using pH meter; calibration of pH meter

Radioactivity **(3 hrs)**

Basics on radioactivity – units, detection, radioisotopes, radioactive decay; radioactive labeling and counting; scintillation counters; applications of radioactivity

Immunological Techniques **(3 hrs)**

Ligand binding assays; Radio-immuno assays (RIA) – principle, types and applications; ELISA – principle, types and applications; Biosensors; Lateral flow devices; FACS; Immunohistochemistry; immunomicroscopy; immunoaffinity chromatography

UNIT II – Separation Techniques **(20 hrs)**

Cell fractionation techniques **(1 hr)**

Cell lysis; homogenization; extraction; salting in; salting out; dialysis and ultra-filtration

Centrifugation **(4 hrs)**

Basic principles of sedimentation; factors affecting sedimentation velocity, standard sedimentation coefficient; Centrifugation; types and applications of centrifugation – preparative centrifugation (differential centrifugation, density gradient centrifugation, rate-zonal centrifugation, sedimentation equilibrium centrifugation), and analytical centrifugation; types of rotors; safety measures and operation of centrifuges; ultracentrifugation – principle, instrumentation, types and applications.

Electrophoresis **(5 hrs)**

General principles; types of electrophoresis methods based on different support media (paper, cellulose acetate, starch gel, agar gel, agarose gel, polyacrylamide gel); electrophoresis of nucleic acids; electrophoresis of proteins (isoelectric focusing, 2D-PAGE); Detection, estimation and recovery of nucleic acids and proteins in gels; capillary electrophoresis; microchip electrophoresis

Chromatography **(10 hrs)**

Principles of chromatography – partition coefficient, analyte development and elution; thin-layer paper chromatography (TLC), principle and types of adsorption chromatography; principle and types of partition chromatography (normal-phase, liquid-phase, ion-pair reversed-phase and chiral chromatography); ion exchange chromatography; molecular size-exclusion chromatography; principle and types of affinity chromatography; column chromatography – principles, types and their instrumentation (HPLC and GC) and applications

UNIT III – Microscopy **(18 hrs)**

Light Microscopy **(4 hrs)**

Principles, types, instrumentation and applications (bright- and dark-field, fluorescence and phase-contrast microscopy)

Electron Microscopy **(6 hrs)**

Principles, types, instrumentation and applications (TEM and SEM); sample preparation for electron microscopy; artefacts and methods to minimize artefacts in electron microscopy; determination of molecular structure using Electron Microscope; basics of elemental analysis – generation of X-rays, X-ray spectrometer and its application in X-ray microanalysis in Electron Microscope (EDXS and WDXS, qualitative X-ray mapping and quantitative analysis); image processing and interpretation of electron micrographs

Autoradiography **(2 hrs)**

High Resolution Autoradiography; principles, types and applications; sample preparation

X-Ray crystallography **(6 hrs)**

Crystallography – definition of crystals; concept of unit cell and lattice parameters; point lattice and different types – Bravais lattice and different crystal systems, and reciprocal lattice; crystal structures – covalent, metallic, and ionic; crystallographic coordinate system; concept of origin, coordinate system, directions and planes in crystals; Miller indices; Fundamental properties of X-rays; types of X-ray interactions with matter and materials; Principle of wave interference and X-ray diffraction (XRD); Bragg equation and its applications; instrumentation for XRD; determination of crystal structure by XRD

Unit IV – Photometry and Spectroscopy **(22 hrs)**

Spectrophotometry **(2 hrs)**

Electromagnetic radiations; Lasers; UV and visible light spectroscopy – absorbance, Beer-Lambert's Law, chromophores and factors affecting their absorption properties; instrumentation for measuring the absorbance of visible light – calorimeter and UV/V spectrophotometer; Fluorescence spectroscopy – principle, instrumentation and applications (quenching, FRET, BRET, FRAP); Luminometry – principle, instrumentation and applications

Mass Spectrometry **(3 hrs)**

Principle; instrumentation; types of ionization system in mass spectrometer; mass analyzers and types of mass spectrometry; interpretation of mass spectrometry results; applications

Absorption Spectroscopy **(4 hrs)**

Concept of Light scattering and its types; Absorption Spectroscopy - Principle, types, instrumentation and applications; Absorption spectroscopy of electronic states; Extinction co-efficient; Spectral properties of a simple molecule (Formaldehyde); Peptide group domination

of far UV absorption for proteins; Aromatic amino acid domination of near UV absorption for proteins; estimation of protein concentration from UV absorbance; nucleic acid absorption dominated by bases

Infrared Spectroscopy **(5 hrs)**

Infrared Spectroscopy – Principles and theory of IR spectroscopy; bond order and bond strength; vibrational spectra of biopolymers; Fourier transform-Infrared (FTIR) spectroscopy – instrumentation, factors influencing the IR-spectra of biomolecules (Vibronic coupling, H-bond, electronic factors, bond angles, etc.); applications of IR-spectroscopy

Raman Spectroscopy **(3 hrs)**

Raman Spectroscopy – What is Raman effect, Quantum mechanical reason of Raman effect, Molecular Polarizability, Polarizability ellipsoid, Experimental technique of Raman effect, Basic concept of Pure Rotational & Vibrational, Raman spectra of simple molecule (linear molecule); applications of Raman spectroscopy

NMR Spectroscopy **(5 hrs)**

NMR Spectroscopy – Basic principle and types of NMR spectroscopy; concepts of chemical shift, hyperfine splitting, and relaxation process; instrumentation; interpretation of NMR spectra; applications of NMR spectroscopy

Practicals **(60 hrs)**

1. Microscopy – Light microscopy: principles, parts & function, Operation
2. Sterilization techniques: principles & operations – Autoclave, Hot Air Oven, Filtration, Laminar Air Flow
3. Principles & operations of water bath, Incubators & Shakers
4. Principle & operation of Centrifuge
5. Principle & operation of pH meter
6. Principle & operation of Colorimeter
7. Principle & operation of Spectrophotometer
8. Electrophoresis techniques
9. Chromatography techniques

Recommended books:

1. Cantor & Schimmel: Biophysical Chemistry (Part I, II & III)
2. Keith Wilson and John Walker (2010) Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, 7th Ed.
3. Alan H. Gowenlock, Varley's Practical Clinical Biochemistry, CBS Publishers & Distributors, 6th Ed.
4. J Mendham, R C Denney, J D Barnes, M Thomas, and B Sivasankar (2009) Vogel's Textbook of Quantitative Chemical Analysis, Pearson Education Ltd., 6th Ed.
5. Boyer, R. F. (2012) Biochemistry Laboratory: Modern Theory and Techniques, Boston, Mass: Prentice Hall, 6th Ed.
6. Plummer, D. T. (1998) An Introduction to Practical Biochemistry, Tata McGraw Hill Education Pvt. Ltd., 3rd Ed.
7. Relevant research and review articles

Semester 4

DSC-11 Human Evolutionary Genetics

(60 hours, LTP – 3+1+2)

Course Outcome

Students should be able to

- CO1. Understand the different sources of genomic variation, and the methods for assaying diversity experimentally.
- CO2. Understand the evolutionary concepts and analytical tools that are used to interpret this diversity.
- CO3. Understand the chronological course through the aspects of our current state of knowledge about human origins.
- CO4. Demonstrate the wider applications of an evolutionary approach for our understanding of phenotypic variation, the genetics of diseases both simple and complex, and the identification of individuals.

Unit 1

An Introduction to Human Evolutionary Genetics **3 hrs**

Understanding evolutionary history to understand human biology, an understanding of evolutionary history that shapes our expectations about the future, and understanding the chronology of events from different scientific approaches. The ethics of studying human populations.

Human Genome Variations **6 hrs**

Single Nucleotide Polymorphisms (SNPs) in the Nuclear Genome, Sequence Variation in Mitochondrial DNA**,** Variation in Tandemly Repeated DNA Sequences, Transposable Element Insertions, Structural Variation in The Genome, The Effects of Age and Sex on Mutation Rate, The Effects of Recombination on Genome Variation

Unit 2

Finding and Assaying Genome Diversity **6 hrs**

Find your DNA, The Polymerase Chain Reaction (PCR), Sanger Sequencing, the Human Reference Sequence, and SNP Discovery, Next-Generation Sequencing, SNP Typing: Low -, Medium-, and High -Throughput Methods for Assaying Variation, Databases of Sequence Variation, Discovering and Assaying Variation at Microsatellites, Discovering and Assaying Structural Variation on Different Scales, methods to determine haplotypes from genotypes, Studying Genetic Variation in Ancient Samples.

Making Inferences from Diversity **7 hrs**

Measuring Genetic Distance, Phylogenetics, Coalescent Approaches to Reconstructing Population History, Dating Evolutionary Events Using Genetic Data

Unit 3

What Genetic Changes Have Made Us Human **5 hrs**

Morphological and Behavioral Changes En Route to Homo Sapiens, Genetic Uniqueness of Humans and Hominins, Genetic Basis of Phenotypic Differences Between Apes and Humans

Origin of Modern Humans **5 hrs**

Evidence from Fossils and Morphology, Evidence from Archaeology and Linguistics hypotheses to Explain The Origin of Modern Humans, Evidence from the Genetics of Present-Day

Populations, Evidence from Ancient DNA.

What Happens When Populations Meet **4 hrs**

What is Genetic Admixture? The Impact of Admixture, Detecting Admixture, Local Admixture, and Linkage Disequilibrium, Sex-Biased Admixture, Transnational Isolates

Unit 4

Understanding the Past, Present, and Future of Phenotypic Variation **6 hrs**

Normal and Pathogenic Variation in an Evolutionary Context, Known Variation in Human Phenotypes, Skin Pigmentation as an Adaptation to Ultraviolet Light, Life at High Altitude and Adaptation to Hypoxia, Variation in the Sense of Taste, Adapting to a Changing Diet by Digesting Milk and Starch, The Future of Human Evolution

Evolutionary Insights into Simple Genetics Diseases **6 hrs**

Genetic Disease and Mutation–Selection Balance, Genetic Drift, Founder Effects, and Consanguinity, Evolutionary Causes of Genomic Disorders, Genetic Diseases and Selection by Malaria

Evolution and Complex Diseases **5 hrs**

Defining Complex Disease, The Global Distribution of Complex Diseases, Identifying Alleles Involved in Complex Disease, What Complex Disease Alleles do we Expect to Find in the Population? Genetic Influence on Variable Response to Drugs

Identity and Identification **3 hrs**

Individual Identification, What DNA Can Tell Us About John or Jane Doe, Deducing Family and Genealogical Relationships, The Personal Genomics Revolution

Haplogroup Nomenclature **4 hrs**

The Mitochondrial Genome, The Y Chromosome

Practical classes

- Construct a Phylogenetic tree for the given specimens according to their evolutionary pattern.
- Perform the Clustal W analysis and comment on the divergence pattern.
- Essential bioinformatic tool to study the rate of human evolution.
- Analyze and interpret results from different studies in the evolution.

Recommended books Recent edition

1. Human Evolutionary Genetics by Mark Jobling, Edward Hollox, Toomas Kivisild, Chris Tyler-Smith.
2. Human Gene Evolution by David N. Cooper.
3. Theoretical Evolutionary Genetics by Joseph Felsenstein.
4. Human Evolutionary Genetics by Isaac Jenkins.

Semester 4

DSC 12 – Developmental Genetics

(60hrs, LTP – 3+1+2)

Course Outcome

Students should be able to

- CO1. Comprehend early developmental theories and fundamental concepts in animal development.
- CO2.mAppreciate use of Model organisms including drosophila and C-elegans, mammalian system will be used to explain early and late embryonic developmental mechanisms.
- CO3. The subject also aims to explain medical conditions associated with developmental defects and underling mechanism and possible therapeutic interventions.
- CO4. Perform experiments with Drosophila to study developmental stages
- CO5. Perform experiments with Drosophila to assess phenotypic changes such as negative geotaxis assays

Unit 1: Principles and concepts in developmental biology (15hr)

Introduction to anatomical, experimental and Genetic approaches to study developmental biology, Generalized life cycle of the Frog – Introduction to fertilization, cleavage, blastula formation, Gastrulation, organogenesis and metamorphosis using frog as a model system **(2hr),** Introduction to comparative embryology – Theory of epigenesis and preformation, primary germ layers, developmental principles of Karl Ernst von Baer, concept of embryonic homology and analogy, cell fate mapping with vital dyes, introduction to medical embryology and disruption and teratogens **(6hr)**

Cell- cell communication in development – thermodynamic model of cell interactions, concept of induction and competence, Role of cadherins in cell adhesion, epithelial mesenchymal interactions- Genetic and Regional specificity of induction, Brief introduction to signalling pathways in development with examples– RTK pathway, SMAD pathway, Jak-stat pathway, Wnt pathway, the hedgehog pathway, cell death pathway, and Notch signalling, mechanisms of cell specification – autonomous, conditional, syncytial **(7hr)**

Unit 2: Early embryonic development in Drosophila and Mammals (20hr)

Early embryonic development in drosophila– drosophila life cycle, syncytial development, gastrulation, Morphogens and Protein gradient, Role of maternal effect gene in drosophila development. Bicoid, hunchback, nanos and caudal protein gradient formation. Formation of nurse cells and oocyte in drosophila, Body Plan -Anterior-posterior polarity, Dorso-ventral polarity, pattern formation, Role of Gap genes, pair rule genes, segmentation and homeotic genes in drosophila development, metamorphosis in drosophila. (**8hr)**

Early embryonic development in mammals – development from cleavage to gastrulation in mammals. Signaling pathways and genes involved in mammalian gastrulation. Anterior-posterior axis formation in mammals, dorsal- ventral axis formation in mammals. Hox code hypothesis in mammalian development, Role of organiser in development **(8hr)**

Determination of primordial germ cells, germ cell determination in drosophila and mammals, Germ cell migration, Meiosis, spermatogenesis and oogenesis, introduction to evolutionary developmental biology **(4hr)**

Unit 3: Late embryonic development, Organogenesis in Drosophila and mammals- (15hr)

Development of nervous system – primary and secondary neurulation, differentiation of neural tube and axis formation **(4hr)**

Development of eye, sequential and additive induction of lens, Epidermis and formation of

cutaneous structures, formation of somites **(3hr)**
Skeletal Muscle Development – Development of dermamyotome and myotome, role of myogenic proteins, signalling pathways in muscle differentiation and fusion, **(2hr)**
Development of kidney and signalling pathways involved and development of gonads, Development of trachea and lungs - signalling pathways and morphogens involved in lung development, **(3hr)**
The concept of programmed cell death, senescence and aging **(3hr)**

Unit 4: Medical aspects of developmental biology and developmental therapies (10hr)
Genetic errors in human development, retinoic acid and alcohol as teratogen **(2hr)** cancer in development **(2hr)**, Concept of stem cells- pluripotency, embryonic stems, adult stem cells and stem cell therapies in regenerative medicine **(2hr)** Techniques used to study development – generation of transgenic flies and mouse, GAL4-UAS system in drosophila, mouse CRE-LOX system and genome editing tools – CRISPR- CAS9 technology **(4hr)**

Practicals
Drosophila embryo development
1. Rearing and handling of drosophila
2. Collection of embryos & Developmental observation
3. Analysis of drosophila larval stage
4. Study of adult morphology
5. Dissection of salivary glands and polytene chromosome preparation
6. Analysis of drosophila eye pigments by thin layer chromatography
7. Dissection and Gene expression study in imaginal disc of drosophila
8. Genetic crosses to understand inheritance
9. Study of quantitative traits in drosophila (Sternoplural bristles)
10. Techniques to study phenoytypes: Locomotory assay, Gustatory assay

Recommended books:

1. Developmental Biology: S.F. Gilbert (2006) 9th edition, Sinauer
2. Associates
3. Principles of Development: L. Wolpert, R. Beddington, T. Jessell, P.
4. Lawrence, E. Meyerowitz and J. Smith (2008) Oxford University Press.
5. Experiments with Drosophila for biology courses, SC Lakhotia and HA Ranganath, Indian Academy of Sciences

Semester 3

SEC 2 – Biostatistics and Research Methodology

(30 hrs, LTP – 2+0+0)

Learning Objectives

1. To have a basic knowledge of Biostatistics and its applications in medicine
2. To know various types of data presentation and data summarization in medical field
3. To have overview of data analysis and sampling techniques
4. To understand various study designs in medical field
5. To know applications of various study designs in Medical Research

Biostatistics

Unit I

Introduction and Presentation of data

Meaning , Branches of Statistics, Uses of statistics in medicine, Basic concepts, Scales of measurement, Collection of data, Presentation of data; Tabulation, Frequency Distribution, Diagrammatic and Graphical Representation of Data.

Unit II

Measures of central tendency and Measures of variation

Arithmetic Mean (Mean), Median, Mode, Partition values, Range, Interquartile range , Mean Deviation, Standard Deviation, Coefficient of Variation.

Unit III

Probability and standard distributions

Definition of some terms commonly encountered in probability, Probability distributions, Binomial distribution, Normal distribution, Divergence from normality; Skewness and kurtosis

U**nit IV**

Census and Sampling Methods

Census and sample survey, Common terms used in sampling theory, Non-probability (Non-random) Sampling Methods; Convenience sampling, Quota sampling, Snowball sampling, Judgmental sampling or Purposive sampling, Volunteer sampling, Probability (Random) Sampling methods; Simple random sampling, Systematic Sampling, Stratified Sampling, Cluster sampling, Multi-stage sampling, Sampling error, Non-sampling error.

Unit V

Inferential Statistics

Parameter and statistic, Estimation of parameters; Point estimation, Interval Estimation, Testing of hypothesis; Null and alternative hypotheses, Type-I and Type-II Errors.

Research Methodology

Unit I

Introduction to research methodology

Types of research; Quantitative vs. Qualitative, Conceptual vs. Empirical

Unit II

Study Designs-Observational Studies

Epidemiological study designs; Uses of Epidemiology, Observational studies, Descriptive

studies; Case reports, Case series, Analytical studies; Case control studies, Cohort studies, Cross sectional

Unit III

Experimental Studies

Experimental studies (Interventional studies); Randomized control Trials (Clinical trials), Field trials, Community trials and Randomized Trials, Application of study Designs in Medical Research

Recommended Books Recent Editions.

1. K.R.Sundaram, S.N.Dwivedi and V Sreenivas (2010), Medical Statistics, Principles and Methods, BI Publications Pvt Ltd, New Delhi
2. NSN Rao and NS Murthy (2008), Applied Statistics in Health Sciences, Second Edition, Jaypee Brothers Medical Publishers (P) Ltd.
3. J.V.Dixit and L.B.Suryavanshi (1996), Principles and practice of Biostatistics, First Edition, M/S Banarsidas Bhanot Publishers.
4. Getu Degu and Fasil Tessema (2005), Biostatistics, Ethiopia Public Health Training Initiative.
5. Essentials of Community Medicine for Allied Health Sciences, JSS University Publications, 20.
6. Park K. Park's Textbook of Preventive and Social Medicine. 26th ed. Jabalpur: Banarsidas Bhanot Publishers, 2015. p.135-141.
7. Suryakantha. Textbook of Community Medicine with recent Advances. 4th edition.

Semester 4

VBA 2 – Constitution of India

(30 hrs, LTP – 2+0+0)

Learning Objective:

1. To know about the fundamental rights and duties of the Constitution.
2. To know about the sustainable development and special rights of the backward class and tribes.

Unit – I Meaning of the term 'Constitution'. Making of the Indian Constitution 1946-1950.

Unit – II The democratic institutions created by the constitution, Bicameral system of Legislature at the Centre and in the States.

Unit – III Fundamental rights and duties their content and significance.

Unit – IV Directive principles of States, policies the need to balance fundamental rights with directive principles.

Unit – V Special rights created in the Constitution for dalits, backwards, women and children and the religious and linguistic minorities.

Unit – VI Doctrine of Separation of Powers, legislative, executive and judicial and their functioning in India.

Unit – VII The Election Commission and State Public Service commissions.

Unit – VIII Method of amending the Constitution.

Unit – IX Enforcing rights through writs.

Unit – X Constitution and sustainable development in India.

Recommended Books Recent Editions.

1. J.C. Johari. The Constitution of India. A Politico-Legal Study. Sterling Publication, Pvt. Ltd. New Delhi.
2. J.N . Pandey. Constitution Law of India, Allahbad, Central Law Agency, 1998. Granville Austin. The Indian Constitution. Corner Stone of a Nation-Oxford, New Delhi, 200

Semester 5

DSC 13 – Human Cytogenetics

(60 hours, LTP – 3+1+2)

Course Outcome

Student should be able to

- CO1. Understand the structure and number of chromosomes using microscopy
- CO2. Analyze various chromosomal aberrations and chromosomal mapping
- CO3. Understand how cytogenetics can be used to study cell division, karyotyping, chromosomal recombinations, etc.
- CO4. Perfrom Karyotype and analyse chromosomal abnormalities in genetic disorders.

Unit I – Introduction to Cytogenetics **(15 Hrs)**

History of human cytogenetics, confirmation of human chromosome number, morphology of human chromosomes, non-banding techniques, classification of human chromosomes into different groups (A-G), Modal number, international system for human cytogenetic nomenclature (ISCN), Karyotyping.

Banding techniques: Chromosome Nomenclature, Conventional banding patterns of chromosomes; specialized banding techniques – Q- banding, G- banding, C banding, silver staining for nucleolus organizer region (NOR), R-banding, sister chromatid exchange (SCE), chromosome analysis, chromosome band nomenclature, Identification and definition of chromosome landmarks, regions, bands and sub-bands, high resolution banding (HRB)

Chromosomal abnormalities: General principles, Chromosome abnormalities [Numerical and structural (markers, isochromosomes, ring chromosomes, deletion, duplication, insertions, translocations (Reciprocal and robertsonian) and inversions) abnormalities; sex chromosome abnormalities, autosomal abnormalities], uniparental disomy, Chromosome breakage Studies (chromatid and chromosome breaks) and their Applications.

Unit II – Clinical Cyotogenetics **(5 Hr)**

- Nomenclature: General principles, specification of breakpoints, designating structural chromosome aberrations by breakpoints and band composition.
- Short system for designating structural chromosome aberrations, two break, three break, four break rearrangements and complex rearrangements, additional symbols, derivative chromosomes, recombinant chromosomes, uncertain breakpoint and interpretations.
- Variations in heterochromatic segments, satellite and Stalks, fragile sites, inversions as normal variations.
- Interpretation and Reporting of normal and abnormal reports using International System for Human Cytogenetic Nomenclature (ISCN) for FISH and Karyotype.
- Autosomal Aneuploidy, Sex Chromosomes and associated disorders, Chromosome Instability, Chromosome Infertility, Prenatal Cytogenetics

Unit III – Cancer Cytogenetics **(15 Hrs)**

- Inytroduction to cancer Genetics, Application of Cytogenetics in cancer diagnosis (karyotyping and FISH), analysis and interpretation of results.
- Clone:Definition of a clone, clone size, Clonal evolution, mainline, stemline, sideline, composite karyotype, unrelated clones, Non-clonal aberrations.
- Constitutional karyotype, chromosome markers found in different Lymphomas and

leukemias (CML, AML, APML,ALL, CLL, MPN, Multiple myeloma, Myelodysplastic syndromes etc.,) and solid tumors (Sarcomas and carcinomas).

Adjunct Technologies: Fluorescence in situ Hybridization (FISH): Principles, procedure, labelling of DNA (Direct and Indirect methods), antibodies used to detect the probe signals, probe amplification, advantages of FISH, various tissue samples used for FISH study, clinical Applications.
FISH probes: Alpha satellite, telomeric, NOR specific, chromosome specific paint probes, unique sequence specific, repetitive sequence etc., and their applications in clinical diagnosis of various syndromes giving examples of normal and abnormal results.

Unit IV – Advanced Molecular clinical cytogenetic Techniques (10 Hrs)
Principles and procedures involved and their applications in clinical diagnosis of genetic abnormalities (including complex chromosomal translocations – CCRs etc.,) – Primed in situ labeling (PRINS), comparative genomic hybridization (CGH), Spectral karyotyping (SKY), multicolor FISH (mFISH) and multicolor banding (mBAND), Fiber FISH.

Molecular Cytogenetics: History of molecular cytogenetics, various molecular techniques applied in clinical cytogenetics – Microarray-Based Cytogenetics and NGS, advantages and applications in clinical cytogenetics using appropriate examples.

Unit V –Prenatal Diagnosis and confirming micro deletion syndromes (15 Hrs)
FISH (Prenatal): Principles and procedure involved, alpha satellite and unique sequence FISH probes used in prenatal diagnosis of genetic abnormalities on cultured and uncultured cells using appropriate examples.Prenatal diagnosis of trisomies that could lead to live birth.
FISH (Postnatal): Diagnosis of micro deletion syndromes (Prader-Willi, Angelman, Williams, DiGeorge etc.,) using FISH probes, confirmation of cryptic translocations by FISH using appropriate examples.
Application of FISH in Cancer Diagnosis: Principles and procedure, details of FISH probes used in detecting various markers [(BCR/ABL, t(15;17), t(8;21) etc.,] found in Hematologic Neoplasms Leukemia and solid tumors(HER-2/neu, C-myc, p53 etc.,), use of single fusion, dual fusion, break apart and multipanel probes used in cancer detection, confirmation of probe amplifications seen in breast cancer and solid tumors, section in situ hybridization used to study probe amplifications on tissue sections, RNA in situ hybridization on tissue sections using appropriate examples.

Practicals - Human Cytogenetics

1. **Basics of Microscopy –** Principle and types of microscopes, Handling and mounting
2. **GTG banding –** culturing, harvesting and chromosome preparation using peripheral blood lymphocytes (PBL)
3. **Karyotyping using karyotype workstation**–Identification of chromosomes under the microscope, use of software in capturing G-banded metaphases, chromosome analysis and karyotyping.
4. **Fluorescent insitu hybridization (FISH)**: Tissue/cell preparation, Probe Hybridization, Post hybridization and Analysis.
5. **Sister chromatid exchange (SCE)** – Culturing PBL with BrdU, Harvesting, slide preparation, staining and analysis.
6. **Quality Assurance**: Interpretation and Reporting of normal and abnormal reports using International System for Human Cytogenetic Nomenclature (ISCN 2020) for karyotyping and FISH.

Recommended books

1. S Gersen and MB Keagel (2013) The Principles of Clinical Cytogenetics, Springer Science
2. S Heim, F Mitelman (2015) Cancer Cytogenetics: Chromosomal and Molecular Genetic Aberrations of Tumor Cells, Fourth edition, John Willey and Sons Publications
3. Hollander A (Editor) 1971-76 Chemical mutagens: Principles and Methods of their detection. Vols. 1-3, Plenum Press New York.
4. Verma R. S. (Editor) 1988. Heterochromatin: Molecular and Structural aspects. Cambridge University Press. Cambridge.
5. International System for Human Cytogenetic Nomenclature (ISCN) 2020, Karger Publications
6. Marilyn S. Arsham (2017) The AGT Cytogenetics Laboratory Manual, Wiley-Blackwell

Semester 5

DSC-14 BIOINFORMATICS IN GENOMICS

(60 hours, LTP – 3+1+2)

Course Outcome

Students will be able to

- CO1. Acquire advanced knowledge on topics, algorithms, tools and methods employed in the field of Bioinformatics for analysis of biological data.
- CO2. Describe the contents and properties of the most important Bioinformatics databases, and perform text- and sequence-based searches.
- CO3. Use bioinformatics tools and advanced methods relevant to the execution of sequence alignment and genome analysis using both manual methods as well as dynamic programming.
- CO4. Analyze and predict the secondary and tertiary structures of proteins using information available in protein databases.

Unit I – Basics in Bioinformatics **(15 hrs)**

Introduction to Bioinformatics **(2 hrs)**

Definition, history and application of Bioinformatics; Genomic research: Genome projects, an overview of activities in bioinformatics with emphasis on the types of information in modern biology and the need for (computational biology and bioinformatics) databases and software; Contribution of Bioinformatics in Genomics.

Basics of programming in Bioinformatics **(13 hrs)**

commonly used computer programming languages in Bioinformatics; Linux operating system; introduction to basic Linux commands and programming concepts.

Unit II – Databases used in Bioinformatics **(10 hrs)**

Commonly used Databases **(5 hrs)**

General concepts and organization of biological databases; an overview of database types; common databases and their utilities (NCBI, EBI, ExPasy, Entrez, ENSEMBL, SRS system, Genecards); Sequence databases (NCBI: Gene, Nucleotide, Genbank, dbEST, STS, UniGene); using DNA sequence databases for PCR primer designing and restriction site analysis NEBcutter, Primer3plus, Primer Blast); Primary Protein structure databases (SwissProt/ Uniprot, EMBL, PIR, PDB, HPRD, KEGG, etc.); Secondary (Derived) Protein Databases (Prosite, Pfam, SCOP, CATH, DSSP, FSSP, RNAbase); Information resources – Pubmed, OMIM; Significance of data analysis at various levels: genome vs. exome vs transcriptome and proteome.

Unit III – Similarity and Sequence Alignment **(10 hrs)**

Similarity Searching and Sequence Alignment **(10 hrs)**

common methods used in sequence analysis and alignment; basic concepts of sequence similarity (similarity, identity, homology, definitions of homologues, orthologues and paralogs, scoring, Gap cost, Linear and affine Gap Penalty); basics of scoring system and matrices (PAM, BIOSUM, GONNET, ClustalW and ClustalX); pair-wise sequence alignment: Brute Force method, Dot matrix method; Global Alignment (Needleman- Wunsch); Local Alignment (Smith-Waterman) using Dynamic programming; BLAST and its variants, PSI-BLAST, MSA, comparison of operation and applications of BLAST and MSA, and interpretation of results.

Unit IV – Sequence Analysis **(23 hrs)**

Basic concepts **(3 hrs)**

importance of sequence analysis; sequence file formats: fasta, genbank, embl, Swiss-prot, pdb, nbrf, pir and multiple sequences formats (Aln, Mega, Pileup, Phylip etc.); common databases used to retrieve gene, mRNA and protein sequences; concepts in sequence pattern and profiles (DNA and RNA motif analysis, relevant databases and softwares).

Human genome analysis **(5 hrs)**

genetic variations - types and their significance; understanding the relationship between mutations, SNPs, insertions or deletions (indels), copy number variations (CNVs) and alleles; SNP and other variant databases and analysis of reference and sample sequences using databases (dbSNP, Clinvar, dbVar, and Cosmic); methods for detection of genetic variations: PCR-RFLP, Sanger Sequencing, Genome wide association studies (GWAS), Next-Generation Sequencing (NGS) approaches; genome versus exome analysis; concept of metagenomics: types of metagenomics approaches and their relative significances; significance of microbiomes to human health; case studies.

Transcriptome analysis **(5 hrs)**

databases used for obtaining transcriptomic data; microarray technology - introduction, principle, applications, microarray databases and data analysis; discussions on RNA-seq analysis; miRNA analysis; ChIP-seq technology and related data analysis; DNA motif analysis.

Bioinformatics for Proteins **(5 hrs)**

review of protein structures and domains; techniques and databases for protein-structures, gene ontologies, protein-interactions and pathways; domain analysis; significance of interaction analysis and systems biology; concepts in Structural Bioinformatics – protein structure visualization tools (RasMol, Pymol), homology modelling, drug discovery, docking and drug design.

Computational Methods for Phylogenetic analysis **(5 hrs)**

phylogenetic analysis with reference to nucleic acids and proteins, and its significance; Phylogenetics prediction methods: Basics, molecular clock, Substitution Models of evolution, Tree reconstruction methods (Distance based, character based method, statistical), Bootstrapping; software and Programmes for comparative genome analysis (sequence comparison); phylogenetic analysis software; molecular structure drawing tool.

Unit V – Applications of Bioinformatics **(2 hrs)**

Applications **(2 hrs)**

applications of Computational Biology/Bioinformatics in Biotechnology, Molecular Biology, human health, Neurobiology, drug designing, Environment Sciences, Agricultural and Veterinary Sciences

Practical:

1. Tools used for Literature survey
2. Databases and its types (NCBI, UCSC, Uniprot, PDB)
3. Retrieval of nucleotide and protein sequences from suitable databanks
4. Online tools for similarity search between nucleotide and protein sequences
5. Online tools for PCR primer designing

6. Online tool for designing RFLP study protocol
7. Tools for finding conserved sequences
8. ORF finding using bioinformatics tools
9. Tools for visualization of genomic sequences
10. Tools for visualization of protein and nucleic acid structure

Recommended books:

1. N. Gautham (2006) Bioinformatics: Databases and Algorithms; Alpha Science.
2. J. Bedell, I. Korf and M. Yandell (2003) BLAST; O'Reilly Press.
3. J. M. Keith (2008) Bioinformatics Vol. 1, Data, sequence analysis & evolution; Humana Press.
4. R. Durbin (1998) Biological sequence analysis; Cambridge University Press.
5. David, W Mount (2004) Bioinformatics: Sequence and genome analysis, Cold Spring Harbour Press.
6. R. M. Holmes (2007) A cell biologists' guide to modelling and bioinformatics; Wiley Interscience.
7. Bryan Bergeron, Bioinformatics Computing, Publisher: Prentice Hall PTR.
8. A D Baxevanis and B.F. Francis Ouellette (2002) Bioinformatics a practical guide to analysis of genes and protein, Wiley Interscience.
9. Primrose SB, Twyman RM, (2002) Principles of Genome analysis and genomics, Blackwell Science.
10. M.R. Barnes, I.C. Gray (2002) Bioinformatics for Geneticists, John Wiley & Sons, New York
11. Rastogi SC, Mendiratta N, Rastogi P (2016) Bioinformatics Concepts Skills and Application 2nd Ed., CBS Publishers and Distributors, New Delhi
12. Dov Stekel (2003) Microarray Bioinformatics, Cambridge University Press
13. Knudsen S. (2004) Analysis of DNA Microarray data, 2nd Ed., John Wiley & Sons, New York
14. Baldi P. and Brunak S. Bioinformatics (2001) The Machine Learning Approach, The MIT Press, USA
15. Des Higgins and Willie Taylor, Bioinformatics: Sequence, structure and databanks, Oxford University Press

Databases:

1. NCBI Genome Browser and databases: http://www.ncbi.nlm.nih.gov/
2. UCSC Genome Browser: http://genome.ucsc.edu/
3. Ensemble Genome Browser: http://www.ncbi.nlm.nih.gov/
4. Protein Catalogue ExPASy: http://www.expasy.org/
5. Protein Catalogue Uniprot: http://www.uniprot.org/; RCSB PDB: https://www.rcsb.org/
6. Online course: ExPASy: http://www.expasy.org/
7. Web portal of multiple sources: wws.startbioinfo.com

Semester 5

DSC-15 HUMAN POPULATION GENETICS

(60 hours, LTP – 3+1+2)

Course Outcome

Students should be able to

- CO1. Appreciate the intersection of mathematics, biology, and anthropology.
- CO2. Understand the mathematical basis of evolutionary theory by describing changes in the frequency of genetic variants from one generation to the next.
- CO3. Understand the genetic diversities in the human population through specific case studies.
- CO4. Applying bioinformatics tools to analyse genetic drift.

Unit 1

Genetic, mathematical, and anthropological background **5 hrs**

The scope of population genetics, Genetics background, Mendel's laws, Alleles, genotypes and phenotypes, how do we assess human genetic diversity? Principles of probability, simple rules of probability, genetics and probability, the anthropological connection, what is a population? Anthropology and population genetics, a short history of population genetics.

Hardy–Weinberg equilibrium **10 hrs**

Genotype and allele frequencies, computing genotype frequencies, computing allele frequencies, what is Hardy–Weinberg equilibrium, The mathematics of Hardy–Weinberg equilibrium, what does equilibrium mean? Assumptions of Hardy-Weinberg equilibrium, using Hardy–Weinberg equilibrium, detecting deviations from Hardy-Weinberg equilibrium, Hardy–Weinberg equilibrium and dominant alleles, extensions of Hardy–Weinberg equilibrium, Linkage disequilibrium, more than two alleles, X-linked genes, Hardy–Weinberg equilibrium and evolution

Unit 2

Inbreeding **5 hrs**

Quantifying inbreeding, genealogies and inbreeding, types of inbreeding, the inbreeding coefficient, mean inbreeding, Population genetics and inbreeding, the impact of inbreeding on genotype frequencies, why inbreeding does not change allele frequencies, the medical impact of inbreeding, inbreeding in human populations, rates of inbreeding in human population, examples of inbreeding studies using genealogical data, surname analysis, potential-mates analysis.

Mutation **5 hrs**

The nature & types of mutations, evolutionary impact of mutation, rates of mutation, Models of mutation, simple mutation model, reverse mutation, number of new mutations in a generation, fate of mutant alleles, Mutational history and anthropological questions, mutation and haplogroup trees.

Genetic drift **5 hrs**

What is genetic drift? Genetic sampling, simulation of genetic drift, outcome of genetic drift, Genetic drift and population size, how does population size affect genetic drift, effective population size, Effects on genetic variation, measuring genetic variation, decay of genetic variation over time, Mutation and genetic drift, fate of a mutant allele, equilibrium between mutation and genetic drift, Coalescent theory, average time to coalescence, coalescent theory and demographic history,

Unit 3

Models of natural selection **10 hrs**

How does natural selection work? Absolute and relative fitness, simulation of natural selection, A general model of natural selection, Types of natural selection, selection against the recessive homozygote, selection against dominant alleles, selection with codominant alleles, selection against heterozygote, selection for the heterozygote, other aspects of selection, selection and mutation, selection and genetic drift, selection and inbreeding, natural selection and quantitative traits.

Natural selection in human populations **5 hrs**

Case studies of natural selection in human populations, Hemoglobin S and malaria, Duffy blood group and malaria, CCR5-Δ32 allele and disease resistance, lactase persistence and the evolution of human diet, genetic adaptation to high-altitude population, evolution of human skin color, are humans still evolving? How do we detect recent selection, the future.

Unit 4

Gene flow **5 hrs**

The evolutionary impact of gene flow, introducing new alleles, reducing genetic differences between population, Models of gene flow, the island model, Two-way gene flow, Kin-structured migration, Gene flow and genetic drift, measuring genetic variation between populations, equilibrium between gene flow and genetic drift, isolation by distance, migration matrix analysis, Estimating admixture in human populations, a simple admixture model, assumptions of admixture estimation, extensions of admixture analysis.

Human population structure and history **5 hrs**

Case studies of human population structure, Gainj and Kalam of New Guinea, the Aland Islands, Altitude and population structure in Jujay Argentina, The origin of modern humans, genetic consequences of an African origin, fate of the Neandertals, Case studies of population origins, peopling of the new World, Genetics and the spread of agriculture, colonization of Polynesia, origin of the irish travelers, admixture in African-Americans.

Student seminar **5 hrs**

Practical's

- Calculate the allele frequencies from the observed population genotype numbers.
- Calculate the genotype frequencies from the observed genotype numbers.
- Apply the Hardy-Weinberg principle to calculate the expected genotype frequencies from the allele frequencies in the population.
- Use Chi-Square test to determine if the observed and expected genotype frequencies are significantly different from each other or not.
- Problems with models of mutation – calculating the expected frequencies of any allele in generation *t.*
- To study the influence of genetic drift in a population using a Bioinformatics tool **(PopG)**

Recommended books Recent edition

1. Human Population Genetics John H. Relethford John Wiley & Sons, Inc., Publication.
2. The Genetics of Human Populations by Luigi Luca Cavalli-Sforza, Walter Fred Bodmer.
3. Principles of Population Genetics (Daniel L. Hartl, Andrew G. Clark)
4. Population Genetics (Matthew Hamilton)

Semester 5

DSE-1a Recombinant DNA Technology

(30Hrs, LTP – 2+0+0)

Learning objectives

- The topics covered provides overview and importance of DNA recombinant technology
- To understand the basics of plasmids and expression vectors
- To learn how to use molecular tools to perform gene cloning and understand its applications

Unit 1 **10 Hrs**

Structure of gene, Introduction to gene cloning and PCR, essential components of gene cloning, conjugative and non-conjugative plasmids, cosmids, Yeast artificial chromosomes, bacterial artificial chromosomes, phagemid vectors, and vectors for higher organisms. Structure. function and characterization of plasmids, types and replication of plasmids

Unit 2 **10Hrs**

Enzymes in Genetic engineering – DNA polymerases, reverse transcriptases,Terminal deoxynuclotidyl transferases, RNA polymerases, Addition and removal of phosphate group, Ligases, function and type of Restriction endonucleases, Nick translaiton

Unit 3 **10Hrs**

Introduction to cloning, Interpretation of plasmid map, Preparation of competent cells, transformation and transfection, Transformation of double stranded DNA, Recombinant selection and screening, molecular tools required for cloning. Applications of recombinant DNA technology- Site directed mutagenesis, applications in diagnostics, forensics, Gene therapy

Recommended books

- Recombinant DNA technology and Genetic engineering by K Rajagopal 2012 Tata McGraw Hill
- Genomes 2nd edition TA Brown, Oxford: Wiley-Liss; 2002.

Semester 5

DSE-1b Therapeutic Genetics

(30 hours, LTP – 2+0+0)

Learning objectives:

- The student will be able to understand the basic principles of genetic manipulation
- To understand the differences between somatic and germline gene therapy and some of the problems involved in these potential treatments
- To understand how genetics may be used in the design of drugs.

Unit I

Stem cells **(6 Hrs)**

Embryonic stem cells, Multipotent adult stem cells (Cardiac stem cell, Neuronal stem cell, Hematopoietic Stem cell, Liver Stem Cell), transgenic stem cells. Regeneration Therapy. ii) Stem cell therapy: Current stem cell therapies – iPS cells, use of stem cells cure genetic diseases, Correlation between stem cells and cancer. Clinical applications of hematopoietic stem cells from cord blood (Ex. first successful transplantation of cord blood in a child with Fanconi‟s anemia). Treatment of diseases - Parkinson's disease, Huntington‟s disease, Alzheimer's disease, and Muscular diseases, Repair of damaged organs such as the liver and pancreas.

Unit II

RNAi Therapeutics **(6 Hrs)**

Expression of dsRNA in animals and plants, and its applications: RNAi vectors and generation of transgenic animals and plants, Analysis of expression of dsRNA and gene silencing; The use of RNAi in the prevention of diseases in animal models and crop improvement; RNAi therapy; Future prospects of RNAi in biology, medicine and agriculture.

Unit III

Gene Therapy **(4 Hrs)**

Introduction, Somatic and germ line gene therapy, Gene replacement and gene addition. In vivo, ex vivo and in vitro gene therapy, Transgenic animal models.

Unit IV

Viral Vectors **(6 Hrs)**

History of Gene Transfer, Nonviral Gene Transfer, Gene Therapy Strategies, Molecular Biology and Virology Basics, Safety and Compliance. Vectors: Retroviruses, Adenoviruses, Adenoviruses and Adeno-associated Viruses (AAV), Herpes Viruses, Pox Viruses, Rabies Viruses.iii) Techniques in Gene Therapy: CAR and editing, Immunotherapy in cancer, DNA vaccination, RNAi in gene therapy, Antisense Oligonucleotides. iv) Gene Therapy for Cancer: Cancer gene therapy, RNA-DNA chimera, Gene therapies for Criglar Najjar syndrome I, Viral Vaccines. v) Gene Therapy in Genetic Diseases: Liver diseases, Eye diseases, Cystic fibrosis, Duchnne muscular dystrophy, Bleeding disorders, Tyrosinemia, Severe combined immunodeficiency syndrome (SCID), Gene therapy of nonheritable disorders,

Unit V

Personalized Medicine **(8 Hrs)**

Molecular Diagnostics: New insights into the structure of the human genome and different types of genetic and non-genetic variation that occur, Genetic screening and diagnosis for Mendelian and complex diseases, Whole Genome/Exome (NGS) sequence analysis, identification and annotation of genetic variations, candidate gene screening, identification of

gene targets, genomic and personalized map, clinical and molecular diagnostics, blood based gene expression profiles in cancer diagnosis and prognosis. The use of next-generation sequencing for solving diagnostic dilemmas, Methods used in patient populations to uncover associations between genome variation and common diseases, Predictive tests for common, complex diseases, Pharmacogenomic testing for drug selection, dosing and predicting adverse effects of commonly prescribed drugs.

Recommended books

1. K.K. Jain (1998) Textbook of Gene Therapy Hogrefe & Huber Pub
2. Doaa Hashad (2015) Gene therapy – Principles and Challenges IntechOpen Limited
3. Peter J. Quesenberry (1998) Stem Cell Biology and Gene Therapy Wiley online library

Semester 5

MDC 4 – Medical Ethics

(30 hrs, LTP – 2+0+0)

Learning objectives:

1. To know about the basics and importance of ethics in the profession

Content

General Considerations of Medical Ethics

1. Medical Ethics - Introduction
2. Three Cor Contents in Medical Ethics - Best Interest, Autonomy Unrights
3. Doctors, Patient & Profession

Special Considerations of Medical Ethics

1. Consent
2. Confidentiality
3. Genetics
4. Reproductive Medicine
5. Mental Health
6. End of life and Organ Transporentation
7. Research & Clinical Trials

Recommended Books Recent Editions.

- Medical Ethics & Law, The Cor Curriculum
- Author - Tony Hope Atla
- Reference book No. 16715 Center Library

Semester 6

DSC 16 – Biochemistry & Metabolic Disorders

(60 hours LTP – 3 + 1 + 2)

Learning Objectives:

- CO1: To understand the role of High energy compounds and synthesis of ATP.
- CO2: To understand the metabolic pathways and regulatory mechanisms
- CO3: To understand the basic concepts of metabolic disorders
- CO4: To perform experiments to estimate and analyse biochemical compounds

Unit 1

Biological Oxidation and Electron Transport **4 hrs**

Primary, secondary and tertiary metabolism, Redox potential, Biological oxidation, Enzymes of biological oxidation, High energy compounds, Organization of electron transport chain, NADH shuttle, Malate aspartate shuttle, Flow of electrons, Oxidative phosphorylation, Chemi-osmotic theory, ATP synthase, Inhibitors of ATP synthesis, Uncouplers of oxidative phosphorylation.

Carbohydrate metabolism **12 hrs**

Stages of metabolism, types of metabolic pathways, Digestion and absorption of carbohydrates and their clinical applications, glucose transporters. Embden-Meyerhof pathway- glycolysis, Cori's cycle, BPG shunt, Fate of pyruvate. Gluconeogenesis, Glucose-alanine cycle, Glycogenolysis, Glycogen synthesis, Glycogen storage diseases. Hexose monophosphate shunt pathway, Glucose-6-phosphate dehydrogenase deficiency, Glucuronic acid pathway, Essential pentosuria, Polyol pathway, Fructose metabolism, Hereditary fructose intolerance, Fructosuria, Galactose metabolism, Galactosemia, Metabolism of alcohol, Amino sugars, Glycoproteins, Mucopolysaccharidoses, Inborn errors associated with carbohydrate metabolism- genetic defects and lab diagnosis, Regulation of blood sugar

Unit 2

Amino Acid Metabolism **12 hrs**

Digestion of proteins and Absorption of amino acids and their clinical applications, Meister cycle, Intracellular protein degradation, Cathepsins, Ubiquitin pathway, Proteasomes, Inter-organ transport of amino acids, Glucose Alanine cycle; Formation of ammonia- Transamination, Oxidative deamination, Nonoxidative deamination, Detoxification of ammonia, Urea cycle, Disorders of urea cycle, Hepatic coma, Blood urea. Metabolism of Simple, Hydroxy and Sulfur Containing Amino Acid - Glycine, Serine, Methionine, Cysteine and their clinical significance, Metabolism of Acidic, Basic and Branched Chain Amino Acids -Glutamic Acids, Aspartic Acid, Lysine, Arginine, Nitric Oxide, Histidine, Valine, Leucine, Isoleucine and their clinical significance. Metabolism of Aromatic Amino Acids and Amino Acidurias- Phenylalanine, Tyrosine, Tryptophan, Proline and their clinical significance. Citric Acid Cycle - Citric acid cycle reactions, significance, Amphibolic role, Regulation. Inborn errors associated with amino acid metabolism- genetic defects and lab diagnosis.

Plasma Proteins **2 hr**

Serum electrophoretic pattern in normal and abnormal states, Albumin- functions and clinical significance, Hypergammaglobulins, Transport proteins, Polymorphism, Acute phase proteins- Ceruloplasmin, Alpha-1-anti-trypsin, Alpha-2- macroglobulin, Negative acute phase proteins, Clotting factors, Anticoagulants, abnormalities in coagulation.

Unit 3

Lipid metabolism **10 hrs**

Digestion and absorption of lipids and their clinical applications, β-oxidation of fatty acids- even and odd-numbered saturated and unsaturated fatty acids, oxidation of odd chain fatty acid, Alpha oxidation, Omega oxidation, Organic acidurias. De novo synthesis of fatty acids, Synthesis of triglycerides, Metabolism of adipose tissue, Liver adipose tissue axis, Fatty liver, Lipotropic factors, Ketone bodies, Ketogenesis, Ketolysis, Ketosis, Structure and function of cholesterol, Biosynthesis of cholesterol, Plasma lipids- classification of lipoproteins, apolipoproteins, Chylomicrons- metabolism and functions, VLDL, LDL, HDL, Lp(a), Free fatty acid, Non-esterified fatty acids, Bile salts, Steroid hormones- metabolism. Polyunsaturated fatty acids, Desaturation of fatty acids, Essential fatty acids, Eicosanoids-Prostanoids & Leukotrienes, Very long chain fatty acids, Synthesis of Compound Lipids, Phosphatidylcholine, Sphingomyelin, Lipid storage diseases. Inborn errors associated with lipid metabolism- genetic defects and lab diagnosis

Electrolyte and Water Balance **2 hr**

Body water compartments, Donnan membrane equilibrium, Osmolality, Electrolyte concentration of body fluid compartments. Regulation of sodium and water balance, Renin-angiotensin system, Assessment, Disturbances, Isotonic contraction, Hypotonic contraction, Hypertonic contraction, Isotonic expansion, Hypotonic expansion, Hypertonic expansion. Clinical applications- Hypernatremia, Hyponatremia, Hypokalemia, Hyperkalemia, Hyperchloremia, Hypochloremia.

Unit 4

Nucleotides Metabolism **6 Hrs**

Composition of nucleotides: Purine bases, Pyrimidine bases, Nucleosides, Nucleotides. Biosynthesis of purine nucleotides- Denovo and Salvage pathway, Regulation of synthesis, Degradation of purines, Uric acid, Gout, Secondary hyperuricemia, Lesch-Nyhan syndrome. Synthesis of pyrimidine nucleotide, Regulation, Orotic aciduria, Deoxyribonucleotide formation, Degradation of pyrimidine. Inborn errors associated with nucleotide metabolism- genetic defects and lab diagnosis

Heme Synthesis and Breakdown **5 hrs**

Structure of heme, Biosynthesis of heme, disorders of heme synthesis, Catabolism of heme, Hyperbilirubinemias- Congenital hyperbilirubinemia, Hemolytic jaundice, Hepatocellular jaundice, Obstructive jaundice genetic defects and lab diagnosis

Hemoglobin **5 hrs**

Structure of hemoglobin, Transport of gases, Oxygen dissociation curve, Hemoglobin interaction, Effect of 2,3-BPG, Isohydric transport of carbon dioxide, Chloride shift, Fetal hemoglobin, Hemoglobin derivatives, Carboxy hemoglobin, Met-hemoglobin, Hemoglobin variants- haemoglobinopathies: Sickle cell hemoglobin (HbS), HbE, HbC, HbD, Thalassemias- Beta and alpha thalassemia, Myoglobin, Anemias. Genetic defects and lab diagnosis of disorders

Free Radicals and Anti-Oxidants **2 hr**

Free radicals, Reactive oxygen species- Generation, Damage, Free radical scavenger systems, Inflammation, Respiratory diseases, Retrolental fibroplasia, Reperfusion injury, Atherosclerosis, Skin diseases, Age-related diseases, Lipid peroxidation- Initiation, propagation and termination phases. Preventive anti-oxidants, Chain breaking anti-oxidants.

Practical classes

1. Demonstration of colorimeter
2. Estimation of blood glucose by glucose oxidase method (Single standard)
3. Estimation of serum total protein by biuret method (Single standard)
4. Estimation of blood glucose using glucometer
5. Estimation of reducing sugar, protein using dipstick method
6. Interpretation of ABG
7. Interpretation of HPLC pattern for haemoglobinopathies
8. Interpretation of electrophoretic pattern of serum protein
9. Interpretation of IFE
10. Interpretation of chromatograms- carbohydrate and proteins

Recommended books Recent edition

1. Textbook of Biochemistry – D.M.Vasudevan
2. Biochemistry – Pankaja Naik
3. Textbook of Biochemistry – Rafi M.D
4. Clinical Biochemistry – Principles and Practice - Praful. B. Godkar
5. Textbook of Biochemistry – Chatterjea and Shinde

Reference Books Recent Edition

1. Harpers Biochemistry
2. Lippincott's Illustrated review of Biochemistry
3. Clinical Biochemistry – Michael L. Bishop
4. Practical Clinical Biochemistry – Harold Varley

Semester 6

DSC 17 – Human Molecular Genetics

(60 hours, LTP – 3+1+2)

Course outcome

Students should be able to

- CO1. Comprehend fundamental concepts to analyse human genome and genetic manipulation
- CO2. Perform handle equipment's and perform experiments used for genome analysis
- CO3. To design primers, handle PCR machine efficiently and perform various types of PCR to detect genetic variations

Unit-1: Basic principles of nucleic acid and gene expression and analysis (10 hours)

Introduction to central dogma of molecular biology **(1 hour)**

The process of human genome sequencing- generation of genomic DNA library, strategies for genome sequencing- whole-genome shotgun and hierarchical shotgun sequencing, RFLP, microsatellite DNA polymorphism, high and low density DNA markers for genome mapping, mapping with somatic cell hybrid panels, construction of clone contigs by STS content mapping, DNA cloning using YAC and BAC, the basic method of gene expression analysis-RT-PCR, sequence assembly in complex genomes, high-throughput gene expression analyses-microarrays, profiling global protein expression using mass spectrometry, protein separation and annotation, Single-cell genomics- natural DNA variation in single-cell, cell lineage tracing, cell identity, DNA-based sequencing assays in single cells- isolating single cells, whole transcriptome analysis **(8 hours)**

Unit-2: Principles of genetic manipulation of mammalian cells (15 hours)

Construction of immortalized cell lines and immortalized euploid cell lines, the concept of genome editing using homologous recombination, site-specific recombination, role of site-specific endonucleases-Zinc finger nucleases, TALENs (transcription activator-like effector nucleases)and its role in gene therapy, CRISPR-Cas system, gene silencing using RNAi, RISC, RITS, siRNA and methods of inducing RNAi into animal cells, RNAi therapy for treating genetic disorders. Transgenesis-nonviral method of transfection, lipofection, transduction using retroviral vectors and non-retroviral vectors, principles of transgene expression in mammalian cells-tetracyclin-regulated expression, tamoxifen-regulated expression, transgenic animals- pronuclear microinjection method of germ-line transgenesis.

Unit-3: Genome architecture (15 hours)

Characteristics of human nuclear and mitochondrial genome, replication and transmission of mtDNA, limited autonomy of mitochondrial DNA, variant mitochondrial genetic code, transfer of mtDNA sequences into nuclear genome, human nuclear genome and heterochromatic DNA, mtDNA disorders and its prevention by mitochondrial replacement therapy, the concept of short and long noncoding RNA, heterochromatin DNA transcription, the concept of retrotransposons and its types- LINEs, SINEs, LTR, SVA repeats, Alu repeats, the concept of transposon repeats. Different origins of duplicated genes in the human genome- whole genome duplication, tandem repeats duplication, duplicative transposition by recombination, RNA-directed duplicative transposition, segmental duplication,

Unit-4: Mapping and identifying genes for monogenic disorders (20 hours)

Method of positional cloning by mapping to identify disease genes- recombinants identification by genotyping parents, recognizing recombinants in human pedigrees, mapping human

disease using genetic markers, LOD-score calculation and analysis, haplotype sharing and autozygosity- autozygosity mapping using SNP arrays, Whole-exome and whole-genome sequencing to identify the cause of the monogenic condition, strategies for exome-based disease gene identification, identifying the mutated gene in Miller-syndrome, Schinzel-Giedion, Kabuki syndrome.

Practicals:

1. Isolation and Estimation of DNA: Isolation of DNA from human cells; DNA quantification and agarose gel electrophoresis.
2. Primer design: Guidelines for primer designing; tools for designing primers- NCBI primer BLAST and MFEprimer; Primer design for genes to be used for PCR and sequencing.
3. Polymerase chain reaction (PCR): Amplification of DNA sequences from genomic DNA/ plasmid DNA/cDNA; optimization of conditions, eg. MgCl2 concentration and annealing temperature.
4. Types of PCRs and its multiple applications; Gradient PCR, Multiplex PCR, ARMS PCR, DNA gel electrophoresis of PCR amplified products
5. Purification of PCR amplified products.
6. Sanger sequencing of gene exons for mutation detection.
7. Molecular cloning: Preparation of competent cells, transformation of E coli DH5α, preparation of plasmid DNA; restriction enzyme digestion, analysis of products through agarose gel electrophoresis; gel elution of restriction enzyme digested fragments; ligation, transformation and analysis of clones.

Recommended books:

1. Human Molecular Genetics by Tom Strachan, Andrew Read, 5th edition.
2. Brown T. A. 2007, Genomes 3. Garland Science Publishing, New York.
3. Dunham, I., 2003. Genome Mapping and sequencing. Horizon Scientific

Semester 6

DSC 18 – Epigenetics in Health and Disease

(60 hours, LTP – 3+1+0)

Course outcome

Students should be able to

1. CO1. Understand the fundamentals of epigenetic mechansims
2. CO2. Comprehend transcriptional regulation of genes by epigenetic factors
3. CO3. To know how deregulation of epigenetic mechanisms is involved in diseases
4. CO4. Perform techniques used to detect epigenetic marks.

Unit 1: Basic concepts in epigenetics (8hr)

Definition and importance, brief introduction to transcription, transcription initiation, gene structure (promoters and enhancers) – heterochromatin and euchromatin, Nucleosome structure and chromatin architecture, chromatin remodelling and role of SWI/SNF complex, Epigenetic modifications of DNA– DNA methylation- CpG islands, activity of DNA methyltransferases, DNA hydroxymethylation (5hmc), concept of epigenetic memory

Unit 2: Post-translational modification of histones (10hr)

Post-translational modification of histone tails, acetylation and methylation of histone residues, Histone modifying enzymes – methyltransferases (SET domain family members), acetyltransferases, and demethylases and deacetylases. Sumoylation and ubiquitination of histones and enzymes involved. Functioning of Polycomb and trithrox family proteins, functioning of bromodomain family proteins, histone variants

Unit 3: Epigenetic regulation of transcription (15hr)

Epigenetic control of transcription- in myogenesis and β-globin, Hox genes, Non coding RNAs and microRNA in transcriptional regulation. Epigenetic control in cellular differentiation, development, concept of bivalent domains in stem cells Epigenomic reprogramming during somatic nuclear transfer technology and induced pluripotency Epigenetic mechanisms in stem cell plasticity. Techniques used to study DNA methylation – bisulphite conversion and methylation specific PCR. Understanding DNA methylation through restriction digestion analysis. Chormatin immunoprecipitation (ChIP) and ChIP sequencing.

Unit 4: Medical epigenetics (17hr)

X chromosome inactivation and Genomic imprinting with e.g. imprinting of IGF2 and role of CTCF insulator proteins, Establishment of methylation patterns during development.Genome imprinting disorders Prader–Willi and Angelman syndromes, concept of epigenetic drift in aging, diet induced epigenetic changes introduction to cancer epigenetics – mechanisms of suppression of tumor suppressor genes, DNA hyptermethylation in cancers. E.g. of epigenetic changes in cancers such as leukemia, Epigenetics in Diabetes, Potential role of Epigenetic inhibitors (small molecule inhibitors)- Brd4 inhibitors, HDAC inhibitors, methyltransfereaes inhibitors in treating diseases including cancer

Practicals

- Identification of CpG islands using computational analysis
- Introduction to EWAS data hub
- Identification of promoter sequences of genes using NCBI
- PCR analysis for epigenetic markers such as DNMTs, Tet enzymes

- Estimation of DNMT level in serum by ELISA method
- DNA isolation and bisulfite conversion of DNA for methylation studies
- DNA methylation analysis using MSP PCR
- DNA methylation analysis using restriction digestion
- Chromatin immunoprecipitation assays
- Isolation of histones and western blot for histone, global methylation and acetylation status of histones in mammalian cells
- Dot blot analysis for 5mc and 5hmc on DNA

Recommended reading

1. Epigenetics by Lyle Armstrong, 2014 by Garland Science, Taylor & Francis Group, LLC
2. Bradley E. Bernstein Alexander MeissnerEric S. Lander Cell 128, 669–681, February 23, 2007

Semester 6

DSE 2a – Proteomics

(30 hours, LTP – 2+0+0)

Learning objectives

- The student will be able to understand the basic concept of proteomics
- The student will be able to describe the technique used to study proteomics
- The student will be able to understand the applications of proteomics in diagnosis and therapy

Unit I **(7 hours)**

Public protein databases and interfaces, Protein structural and functional databases Uniprot, Swiss Prot and String Bioinformatics and proteomic technologies, Placing proteins in pathways using Reactome, Ab initio protein structure prediction:

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Unit II **(8 hours)**

Proteomic technologies Protein Microarrays, Construction, applications. Advantages and limitations. Transcriptomes and analysis; SAGE, DNA Microarray technology; Next Generation Sequencing. Analytical proteomics tools (1-D & 2-D gel electrophoresis); Mass spectrometry and analysis (ESI, MALDI and Hybrid), LC/MS-MS; Applications of mass spectrometry (PMF and PTMs)

Unit III **(8 hours)**

Computational methods, Structure prediction from sequence, Deriving function from sequence, Application of structural proteomics, Merits and demerits of structural proteomics techniques. Comparison of various technologies used in structural proteomics.

Unit IV **(7 hours)**

Interactomes and Proteomic interactions (Y2H approaches, Co-IP); Proteome- wide interaction maps; Protein structure determinations and Structural proteomics tools (experimental and computational); Concepts of protein engineering.

Recommended books

1. Twyman, R.M. (2004) Principles of Proteomics. Bios Scientific Publisher, Oxford.
2. Kraj, A. & Silberring J. (2008) Introduction to Proteomics. Ed. Wiley, UK.
3. Lovrik, J. (2011) Introducing Proteomics: From concepts to sample separation, mass spectroetry and data analysis. Ed. Wiley-Blackwell, UK.
4. D.C. Liebler, (2002) Introduction to Proteomics: Tools for the New Biology, Humana Press.
5. R.M. Twyman, (2004) Principles of Proteomics, Bios Scientific Pub.
6. Timothy D. Veenstra, John R.Yates III (2006)Proteomics for Biological Discovery, John-Wiley & Sons, Hoboken, New Jersey, USA.
7. R. Hubert, (2006) Protein Biochemistry and Proteomics (The Experimenter Series), Academic Press.
8. Reiner Westermeier, Tom Naven, Hans□Rudolf Höpker (2008) Proteomics in Practice: A Guide to Successful Experimental Design, Wiley-Blackwell.
9. N Saraswathy, P Ramalingam (2011) Concepts and Techniques in Genomics and Proteomics. E Book
10. Naveen Mistra (2010)Introduction to proteomics E Book

Semester 6

DSE-2b Principles of Drug Discovery

(30 hours, LTP – 2+0+0)

Learning Objectives

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

- Explain the various stages of drug discovery.
- Appreciate the importance of the role of genomics, proteomics and bioinformatics in drug discovery.
- Explain various targets for drug discovery.
- Explain various lead seeking method and lead optimization.
- Appreciate the importance of the role of computer aided drug design in drug discovery.

Unit 01 **12 Hours**

Introduction

An overview of modern drug discovery process: Target identification, target validation, lead identification and lead Optimization. Economics of drug discovery, Target Discovery and validation-Role of Genomics, Proteomics and Bioinformatics, Role of Nucleic acid microarrays, Protein microarrays, Antisense technologies, siRNAs, antisense oligonucleotides, Zinc finger proteins, Role of transgenic animals in target validation.

Unit 02 **12 Hours**

Lead Identification- combinatorial chemistry & high throughput screening, in silico lead discovery techniques, Assay development for hit identification, Protein structure, Levels of protein structure, Domains, motifs, and folds in protein structure, Computational prediction of protein structure: Threading and homology modeling methods, Application of NMR and X-ray crystallography in protein structure prediction

Unit 03 **12 Hours**

Rational Drug Design

Traditional vs rational drug design, Methods followed in traditional drug design, High throughput screening, Concepts of Rational Drug Design, Rational Drug Design Methods: Structure and Pharmacophore based approaches

Virtual Screening Technique

Drug likeness screening, Concept of pharmacophore mapping and pharmacophore based screening

Unit 04 **12 Hours**

Molecular Docking

Rigid docking, flexible docking, manual docking; Docking based screening, De novo drug design, Quantitative analysis of Structure Activity Relationship, History and development of QSAR, SAR versus QSAR, Physicochemical parameters, Hansch analysis, Fee Wilson analysis and relationship between them

Unit 05 **12 Hours**

QSAR Statistical methods – regression analysis, partial least square analysis (PLS) and other multivariate statistical methods, 3D-QSAR approaches like COMFA and COMSIA, Prodrug design-Basic concept, Pro-drugs to improve patient acceptability, Drug solubility, Drug absorption and distribution, site specific drug delivery and sustained drug action, Rationale of

pro-drug design and practical consideration of pro-drug design

Recommended books

- Basic Principles of Drug Discovery and Development, Benjamin Blass, Elsevier

Semester 6

SEC-3 Research Methodology

(30 hours, LTP – 2+0+0)

Learning objectives

1. The subject covers key points to be considered while designing and executing a research project.
2. The topics helps students to frame result oriented objectives and aims in their research.
3. To conduct research with ethics and organization of research data.

Unit 1

Foundations of Research: Meaning, Objectives, Motivation, Utility. Understanding the language of research – Concept, Construct, Definition, Variable. Research Process. Problem Identification & Formulation – Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis – Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance

Unit 2

Selection of topic for research, literature search, research question and framing aims and objectives of the study, Study design.

Synopsis and manuscript writing – introduction, sample size estimation, statistical analysis, methodology, tools for data analysis and discussion, reference citations (zotero/mendeley), Plagiarism Ethics – Ethical concerns in medical research, translational research

Unit 3

Student class workshops – Research article presentation, Research topic selection and framing questions and Synopsis writing

Recommended books

1. David E Gray (2017) Doing Research in the Real World 2nd Edition, SAGE publications Ltd
2. Donald H. McBurney, Theresa L. White (2009) Research Methods 7th Edition, Wadsworth/ Cengage Learning

Semester 7

DSC 19 – GENETICS OF RARE DISEASES

(60 hours, LTP – 3+1+2)

Course outcome

Students should be able to

- CO1. To understand the socio-economic burden of rare disorders
- CO2. To understand the inheritance pattern and genetic defect in different rare disorders
- CO3. To understand the diagnosis and treatment options for rare disorders
- CO4. To perfrom screening tests for rare disease identificaiton

Unit 1 **(15 hrs)**

Definition of rare disease, Incidence and prevalence of rare diseases globally and in India, Indian scenario of rare disease, socio-medical issues regarding diagnosis and treatment.

List of rare disorders based on carbohydrate, amino acid, lipid, and nucleotide metabolism. Peroxisomal. Lysosomal and mitochondrial disorders, single gene disorders and disorders of coagulation and bleeding.

Introduction to Inborn Errors of Metabolism- definition, types, lab investigations and diagnosis Peroxisomal Disorders: X-linked adrenoleukodystrophy, Zellweger spectrum syndrome, neonatal adrenoleukodystrophy, infantile Refsum disease incidence, prevalence, inheritance pattern, biochemical & pathological basis, different types, genetic defect, gene mutation, function of the gene, lab diagnosis and treatment options available

Mitochondrial disorders: MELAS, Leigh syndrome and Mitochondrial myopathies- incidence, prevalence, inheritance pattern, biochemical & pathological basis, different types, genetic defect, gene mutation, function of the gene, lab diagnosis and treatment options available

Unit 2 **15 hrs**

Mucopolysaccharidosis (Lysosomal Storage Disorders) - incidence, prevalence, inheritance pattern, biochemical & pathological basis, different types, genetic defect, gene mutation, function of the gene, lab diagnosis and treatment options available

Organic-Acid Disorders: maple syrup urine disease methylmalonic aciduria, propionic aciduria and isovaleric aciduria - incidence, prevalence, inheritance pattern, biochemical & pathological basis, different types, genetic defect, gene mutation, function of the gene, lab diagnosis and treatment options available

Unit 3 **15 hrs**

Mucolipidosis (Lysosomal Storage Disorders) - incidence, prevalence, inheritance pattern, biochemical & pathological basis, different types, genetic defect, gene mutation, function of the gene, lab diagnosis and treatment options available

Disorders of Copper Metabolism- Wilson *disease*, Menkes *disease* : incidence, prevalence, inheritance pattern, biochemical & pathological basis, different types, genetic defect, gene mutation, function of the gene, lab diagnosis and treatment options available

Unit 4 **15 hrs**

Disorders of coagulation and bleeding**:** Factor VIII, Factor IX, Afibrinogenemia, Other disorders of coagulation, Wiskott Aldrich syndrome and others - incidence, prevalence, inheritance pattern, biochemical & pathological basis, different types, genetic defect, gene mutation, function of the gene, lab diagnosis and treatment options available

Single-Gene Disorders**:** Huntington Disease, Myotonic Dystrophy, Hereditary Motor and Sensory Neuropathy, Neurofibromatosis, Marfan Syndrome, Cystic Fibrosis, Inherited Cardiac

Arrhythmias and Cardiomyopathies, Spinal Muscular Atrophy, Duchenne Muscular Dystrophy, Hemophilia, Collagen disorders: Osteogenesis imperfects and Ehlers Danlos syndrome- incidence, prevalence, inheritance pattern, biochemical & pathological basis, different types, genetic defect, gene mutation, function of the gene, lab diagnosis and treatment options available

Practicals:

1. Screening tests for Inborn errors of metabolism
   i. Ferric Chloride Test
   ii. Cyanide Nitroprusside test
   iii. Murexide test for Galactosemia
2. LCMS to detect altered metabolites in dried blood samples
3. Thin layer Chromatography for carbohydrates and amino acids
4. New Born Screening

References:

1. https://ordindia.in/about-rd/rare-disease-in-india/
2. https://rarediseases.org/for-patients-and-families/information-resources/rare-disease-information/
3. Rare Diseases and Orphan Drugs: Keys to Understanding and Treating the Common Diseases by Jules J Berman.
4. Genomics of Rare Diseases: Understanding Disease Genetics Using Genomic Approaches 1st Edition - June 12, 2021 Editors: Claudia Gonzaga-Jauregui, James R. Lupski

Semester 7

DSC 20 – Genetics of Complex Diseases

(60 hours, LTP – 3+1+1)

Course outcome

Student should be able to

- CO1. To compare complex diseases with Mendelian and chromosomal diseases.
- CO2. To understand various plans and strategies to investigate complex diseases.
- CO3. To understand the statistical analysis in complex diseases.
- CO4. To perfrom biochemical analysis to identifiy complex diseases

Unit 1

Defining Complex Disease **8 hrs**

Chromosomal Diseases, Mendelian Diseases, Variation in The Mitochondrial Genome and Associated Diseases, *De Novo* Mutations and Human Diseases, Three Different Types of Complex Disease, Alzheimer's Disease a Monogenic Complex Disease, HSCR – An Oligogenic Complex Disease, Crohn's Disease is Mostly a Polygenic Complex Disease, Applying Disease Models to Populations.

How to Investigate Complex Disease Genetics **7 hrs**

Planning Stage 1: Gathering the Basic Knowledge, Planning Stage 2: Choosing a Strategy, Good and Bad Practice, New Technologies and the Future.

Unit 2

Why Investigate Complex Disease Genetics? **6 hrs**

Disease Diagnosis, Patient Treatment/Management and Care, Disease Pathogenesis of ankylosing spondylitis, Rheumatoid arthritis, Bipolar disease, coronary artery disease.

Statistical Analysis in Complex Disease: Study Planning and Data Handling **9 hrs**

Linkage Analysis, The Basic Statistical Concepts of Association Analysis and their Application in Study Design, Statistical Error, Power, and *P* Values, The Basic Statistical Considerations for Analysis of Case Control Association Studies and their Application to Data Collection and Analysis, How to Interpret a GWAS

Unit 3

The Major Histocompatibility Complex **8 hrs**

Histocompatibility, The Extended Human MHC MAP, Immune Function of HLA Class I and Class II, HLA Class I and Disease, HLA Class II and Disease, Comparing the Hla Associations of the Three Liver Diseases, Non-HLA MHC Genes and Disease, A Single Gene or a Risk Portfolio, How to Compare and Critically Evaluate Contrasting Studies.

Cancer as a Complex Disease: Genetic Factors Affecting Cancer Susceptibility and Cancer Treatment **7 hrs**

Defining Cancer, Cancer as a Complex Disease, Genetic Risk Factors for Particular Cancers Detected by GWAS, General Cancer Risk Loci Detected by GWAS, Previously Established Cancer Risk Factors Confirmed by GWAS, Individualizing Drug Treatment Based on Tumor Genotype.

Unit 4

Genetic Studies on Susceptibility to Diabetes **7 hrs**

Diabetes Mellitus, Genetics of T1D, Early Genetic Studies in T1D, GWAS Studies in T1D, Early Genetics of T2D, GWAS Studies in Type T2D, The Future of Genetics in T2D, Genetics of Monogenic Diabetes.

Sequencing Technology and the Future of Complex Disease Genetics 8 hrs
DNA Sequencing: The Past, Present, and Future, The Future of NGS in Clinical Practice and Research, Whole-Genome Versus Exome Sequencing, The Next Generations of Genome/ Exome-Wide Association Studies, Epigenetics: A Complimentary Strategy in Complex Disease Studies, Metagenomics and the Bacterial Genome, Major Ongoing International Genome Projects, Systems Biology

Practical's

- Isolation and Estimation of DNA: Isolation of DNA from human cells; DNA quantification and agarose gel electrophoresis.
- Primer design: Guidelines for primer designing; tools for designing primers- NCBI primer BLAST and MFEprimer; Primer design for genes to be used for PCR and sequencing.
- Biochemical investigations for complex diseases – Lipid profile, liver function test, renal function test, hormones and tumor markers.
- Identifying the Molecular basis of complex disorders using real-time PCR and next generation sequencing.

Recommended books Recent edition

1. Genetics of complex disease/Peter Donaldson, Ann Daly, Luca Ermini, Debra Bevitt.
2. Current topics in human genetics: studies in complex diseases, co-editors-in-chief, Hong-Wen Deng and Hui Shen; associate editors, Yong-Jun Liu, Hai Hu.
3. Genes and Common Diseases, Alan Wright & Nicholas Hastie.
4. Genetic Analysis of Complex Disease, Jonathan L. Haine.

Semester 7

DSC-21 Genetic Counseling

(60 hours, LTP – 3+1+0)

Course Objectives

Students should be able to

- CO1. To know what a referral to a medical genetics service entails and to understand the importance of genetic investigations when such a diagnosis is suspected.
- CO2. Co-ordinate with clinical geneticists or genetic counsellors.
- CO3. To comprehend genetic basis of diseases
- CO4. To provide a basic level of genetic information and appropriate emotional support to the patients and to patients' families.

Unit 1

General aspects of Genetic Counselling **5 hrs**

Introduction, Genetic Counselling in Mendelian Disorders, Common Disorders and Genetic Counselling, Chromosome Abnormalities, Molecular Genetics and Genetic Counselling, Dysmorphology and Genetic Syndromes, Carrier Testing and Genetic Prediction, Prenatal Diagnosis and Reproductive Aspects of Medical Genetics, Special Issues in Genetic Counselling, The Genetic Counselling Clinic.

Unit 2

Genetic Counselling: Specific organ systems Part 1 **25 hrs**

Pedigree, inheritance pattern and molecular basis of Neuromuscular Disorders – Eg: Muscular dystrophies, Congenital myopathies, Metabolic myopathies, Myotonic dystrophy, Myasthenia gravis, Spinal muscular atrophies, Motor neurone disease, Charcot–Marie–Tooth disease.

Pedigree, inheritance pattern and molecular basis of Central Nervous System Disorders – Eg: Huntington's disease, Parkinson's disease, Multiple sclerosis, Neurofibromatosis, Von Hippel–Lindau syndrome, Tuberous sclerosis, Epilepsy, Cerebral aneurysms and stroke, Migraine, Cerebral palsy, Neural tube defects, Hydrocephalus.

Pedigree, inheritance pattern and molecular basis of Disorders of Mental Function – Eg: The dementias, Mental retardation, Behavioural disorders.

Pedigree, inheritance pattern and molecular basis of Disorders of Bone and Connective Tissue – Primary bone dysplasias, Osteopetrosis, Limb defects, Connective tissue disorders, Arthritis and arthropathies.

Pedigree, inheritance pattern and molecular basis of Oral and Craniofacial Disorders – The teeth, Cleft lip and palate.

Pedigree, inheritance pattern and molecular basis of The Eye – Choroidoretinal degenerations, Nystagmus, Colour vision, Leber's optic atrophy, Corneal dystrophies, Retinal detachment, Retinoblastoma, Cataract, Glaucoma, Refractive errors, Heterochromia of the iris.

Pedigree, inheritance pattern and molecular basis of Deafness – Severe congenital sensorineural deafness, The external ear, Ménière's disease.

Unit 3

Genetic Counselling: Specific organ systems Part 2 **25 hrs**

Pedigree, inheritance pattern and molecular basis of Cardiovascular and Respiratory Disorders – Congenital heart disease, Cardiomyopathies, Coronary heart disease, Aneurysms.
Cystic fibrosis, Asthma and atopy, Emphysema and chronic obstructive pulmonary disease, Sarcoidosis.

Pedigree, inheritance pattern and molecular basis of The Gastrointestinal Tract – Oesophageal atresia, Diaphragmatic hernia, Infantile pyloric stenosis, Omphalocele, Inflammatory bowel disease, Familial adenomatous polyposis and colon cancer, Hirschsprung's disease, Anal atresia.

Pedigree, inheritance pattern and molecular basis of Inborn Errors of Metabolism – Amino acid disorders, Galactosaemia, Sphingolipidoses, Glycogen storage diseases, Hyperlipidaemias, The porphyrias, Fatty acid metabolic defects and sudden infant death.

Pedigree, inheritance pattern and molecular basis of Disorders of Blood and Immune Function – Disorders of haemoglobin structure and synthesis, Immune deficiency disease, Genetic aspects of infectious disease, Haemophilia.

Unit 4

Genetic Counselling in Context: The broader picture **5 hrs**

Communication in genetic counselling, Population aspects of genetic counselling and genetic screening, Genetics, society and the future.

Practicals

- Genetic counselling clinic postings

Recommended books

1. Harper's Practical Genetic Counselling, Eighth Edition.
2. Genetic Counseling Research A Practical Guide (Ian MacFarlane)

Semester 7

DSE 3a – Pharmacogenetics

(30 hours, LTP – 2+0+0)

Learning objectives

- To understand the basic principles of pharmacogenetics including factors relevant to drug disposition and the role of pharmacodynamics.
- To have an overview of pharmacogenetics in many important therapeutic areas.
- To know the ethical and related issues in implementing pharmacogenetics into clinical practice.

Unit 1: Pharmacogenetics: Relationship To Pharmacokinetics And Pharmacodynamics

Pharmacogenetics in Drug Metabolism: Role of Phase I Enzymes, Pharmacogenetics of Phase II Drug Metabolizing Enzymes, Pharmacogenetics of Drug Transporters, Pharmacogenetics of Drug Targets.

Unit 2: Pharmacogenetics: Therapeutic Areas

Cardiovascular Pharmacogenetics, Pharmacogenetics in Psychiatry, Pharmacogenetics in Cancer, Pharmacogenetics of Asthma and COPD, Pharmacogenetics of Adverse Drug Reactions, Pharmacogenomics of Inflammatory Bowel Diseases, Pharmacogenetics of Pain Medication.

Unit 3: Pharmacogenetics: Implementation in Clinical Practice

Ethical and Social Issues in Pharmacogenomics Testing, High-Throughput Genotyping Technologies for Pharmacogenetics, Developments in Analyses in Pharmacogenetic Datasets.

Unit 4: Pharmacogenetics: industry and regulatory affairs

Applications of Pharmacogenetics in Pharmaceutical Research and Development, Role of Pharmacogenetics in Registration Processes, Pharmacogenetics: Possibilities and Pitfalls.

Recommended books

- Pharmacogenetics and individualized therapy / edited by Anke-Hilse Mailand-van der Zee, Ann K. Daly.
- Pharmacogenomics: The Search for Individualized Therapies. Edited by J. Licinio and M.-L. Wong.

Semester 7

DSE 3b – Nutrigenomics

(30 hours, LTP – 2+0+0)

Learning objectives

- The subject discusses how diet, food, nutrients affects our genome.
- It describes chages in epigenome due to availability of metabolites.
- The chapter describes how human body is susceptible to disease due to changes in nutrition.

Unit 1 **10hrs**

Nutrition and common diseases – An introduction **5Hrs**

Introduction to nutrition and its importance, Impact of exercise, Nutrition and obesity, Nutrition and diabetes, Nutrition and cancer, Nutrition and cardiovascular diseases

Molecular genetic basis **5Hrs**

Nutrient sensing mechanisms via nuclorecoptors, Function and action of PPARs, Circadian control of metabolic process. Adaptation of human genome to dietary change, Vitamin D and skin color association, Integrative personal omics profiling.

Unit 2 **10Hrs**

Nutritional signaling and epigenetics

Metabolism and epigenetic signaling, One carbon metabolism and DNA methylation Nutritional triggered epigenomic changes in mice and humans. Function of sirtuins in Aging, Age associated Nutrient sensing pathways, AMPK signalin and calorie restriction in drosophila and mice

Unit 3 **10Hrs**

The link between diseases and Nutrition

Haromonal regulation in Obesity, Genetics of obesity, Diabetes – Insulin signaling pathway, glucose homeostasis, genetics of Diabetes, central role of FOXO transcription factors, thrifty gene hypothesis. Metabolic syndromes- genetic and epigenetic basis of metabolic syndromes. Mechanisms of hypertension and atherosclerosis.

Recommended books

- Nutrigenomics, Carsten Carlberg, Stine Marie Ulven, Ferdinand Molnar, Springer

Semester 7

SEC 4 – Scientific Writing

(30 hours, LTP – 2+0+0)

Learning objectives:

This course is aimed at teaching the fundamentals of effective scientific writing. The primary focus is to introduce the students to the format of scientific writing, the peer review process, and ethical issues in publication. Additionally, fundamental professional skills in writing CV/ Resume and presentation will also be addressed. The course will be presented in two segments: Part (1) lectures- 20 hours; and Part (2) presentations by the students- 10 hours.

Unit I - Basics of effective writing **(3 Hrs)**

Introduction to the characteristics of good writing, crafting the ideas and themes, the right choice of words, voice, grammar and style, formation of better sentences and paragraphs, organization and streamlining the writing process.

Unit II – Professional Skills **(5 Hrs)**

Effective oral presentation, professional email and what's app etiquette, use of social media as a professional tool, writing an effective CV/ resume, applying for internship or approaching for research opportunities.

Unit III– Structure of scientific articles **(8 Hrs)**

Different types of scientific writing, differences in structure between reviews and research articles; literature review, composition of an abstract, title, introduction, methods, results and discussion, preparing figures and figure legends, bibliography, process involved in publishing scientific articles, issues in scientific writing (plagiarism, authorship, ghost writing), peer review process.

Unit IV – Science Careers **(4 Hrs)**

Different career options in science, communicating science to layman, Pursuing PhD- international and national opportunities.

Recommended books

- How to write and publish a scientific paper by Robert A. Day and Barbara Gastel.
- The craft of scientific writing by Michael Alley.
- The scientists guide to writing by Stephen B. Heard.
- The elements of style by William Struck and White.
- An utterly correct guide to clarity and style by Benjamin Dreyer.

Semester 7

VBA 3 – Intellectual Property Rights

(30 hours, LTP – 2+0+0)

Learning objectives

- The student will be able to understand the fundamental aspects of Intellectual property Rights
- The students will be introduced to all aspects of the IPR Acts and will be familiarized with the remedies and licensing regime associated with each kind of intellectual property

Sl No.	Chapters
I	**Introduction to Intellectual Property Rights**
II	**Fundamentals of Patent Law** Criteria of Patentability, Invention, Novelty, Utility, Inventive step/ Non-obviousness, Non-patentable Inventions and Drafting of patent specification: patent specification, provisional specification, complete specification and Patent procedure in India, Patent infringement
III	**Concept of Trademark** What is a trademark?; Rights of trademark?; What kind of signs can be used as trademarks?; types of trademark function does a trademark perform; How is a trademark protected?; How is a trademark registered?; How long is a registered trademark protected for?; How extensive is trademark protection?
IV	**Geographical Indications and industrial Design**: What is a geographical indication? How is a geographical indication protected? Why protect geographical indications? Industrial Designs: What is an industrial design? How can industrial designs be protected? What kind of protection is provided by industrial designs? How long does the protection last?; Why protect industrial designs?
V	**Copy right law:** Definition, Rights of the Copyright Owner, Term of Copyright, Assignment and Licensing of Copyright, Rights of the Performers and Broadcasting Organisations, and ***Overview of Biotechnology and Intellectual Property***

Recommended books

1. T. M Murray and M.J. Mehlman, (2000) Encyclopedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons
2. P.N. Cheremisinoff, R.P. Ouellette and R.M.Bartholomew, (1985) Biotechnology Applications and Research, Technomic Publishing Co., Inc. USA,
3. D.Balasubramaniam, C.F.A.Bryce,K. Dharmalingam, J. Green and K. Jayaraman, (2002) Concepts in Biotechnology, University Press (Orient Longman Ltd.)
4. Bourgagaize, Jewell and Buiser, (2000) Biotechnology: Demystifying the Concepts, Wesley Longman, USA.
5. Ajit Parulekar and Sarita D' Souza, (2006) Indian Patents Law – Legal & Business Implications; Macmillan India ltd.
6. B.L.Wadehra; (2000) Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd., India

7. P. Narayanan;(2010) Law of Copyright and Industrial Designs; Eastern law House, Delhi.
8. Dr. Kalyan C. Kankanala, Arun Narasani and Vinita Radhakrishnan, Indian Patent Law and Practice, OUP Publications, ISBN: 0-19-806774-7 978-0-19-8066740.
9. P. Narayanan, Patent Law, Eastern Law House, 4th edition, 2006, ISBN: 81-7177-1785.
10. Thomas G. Field, Introduction to Intellectual Property, California Academic Press, 2003 edition, ISBN: 0-089089-236-9
11. Basudurga das, the Constitutional Law of India, (8th edition. Vol.3, 2008) Lexis Nexis Butter Worths Wadhwa, Nagpur.
12. Constitutional Law of India , Dr. J. N.Pandey
13. B.L Wadhera- Intellectual Property
14. WIPO - Reading Material on Intellectual Property Law
15. Brainbridge, David – Cases and Materials in Intellectual Property Law
16. Cornish W.R - Cases and Materials in Intellectual Property Law
17. Dr.S.K Singh- Intellectual Property Rights Laws

Semester 8
Honors research project
(12 credits)
VBA 4 – Summer internship
(4 credits)

Semester 9

DSC 22 – Cancer Genomics

(60 hours, LTP – 3+1+2)

Course Outcome

Student should be able to

- CO1. Understand basics of Cancer, types and associated hallmarks.
- CO2. To comprehend underlying molecular (genetic as well as epigenetic) biology of cancer.
- CO3. Understand emerging technologies to detect and treat various cancers
- CO4. Perform molecular techniques to estimate tumor markers and stain/quantify tumor markers in the tumor tissue samples.

Unit I – Basics about Cancer

Characteristics of Cancer **(2 hrs)**

Defining cancer; origin of cancer; epidemiology (incidence, deaths, global patterns); causes or etiology of cancer – lifestyle factors, physical and chemical agents, infectious agents, radiation, magnetic fields, heredity, and; hallmarks of cancer.

Viral causes of cancer **(2 hrs)**

History of discovery; Rous sarcoma virus; examples of DNA viruses and RNA viruses that cause cancer and their underpinning mechanism of action in cancer pathogenesis.

Tumour and Tumour microenvironment **(6 hrs)**

Definition of tumour, types of tumours (tumour classification hierarchy); the benign-malignant boundary; composition of the tumour microenvironment (TME); stages and molecular mechanisms of malignancy (different steps and cellular state transitions in metastases); organ specific metastases; tumour grading.

Unit II – Epigenetics of Cancer

Epigenetic mechanisms underpinning Cancer **(6 hrs)**

Loss of heterozygosity; Role of Telomeres and Telomerase in Cancer biology; Post-transcriptional regulation; Mechanisms of Gene Silencing (Antisense RNA, RNA_i (Transitive RNA_i, Micro-RNAs (miRNAs), small temporal RNA, short hairpin RNA); Epigenetic alterations and Chromothripsis role of the Polycomb group (PcG) and Trithorax (Trx) proteins in carcinogenesis.

Oncogenes **(6 hrs)**

Historical perspectives; Proto-oncogenes; Oncogenes – definition, oncogene families and functional classes, mechanisms of activation and action, characteristics and functions of different oncogenes (*ras*, *myc*, *src*, *jun* and *fos*, *bcr-abl*, *myb*, *NF-*κB*/rel*, *erbB-2* (*Her-2/neu*); growth factor or growth factor receptor oncogenes (*kit*, *met*); cellular *onc* gene expression during normal embryonic development.

Tumour Supressor Genes **(4 hrs)**

Definition; different functions of tumour suppressor genes; Characteristics and mechanism of action of individual tumour supressor genes (*rb*, *p53*, *apc*, *dcc*, *nf-1*, *nf-2*, *BRCA1* and *BRCA2*); Knudsen's two hit hypothesis.

Unit III – Molecular Mechanisms Involved in Cancer

Signalling pathways in normal cells and cancer cells **(12 hrs)**

Molecular players and mechanisms involved in the regulation of normal tissue homeostasis: regulation of cell-cycle and proliferation (MYC, CDKs, CDK inhibitors, Cyclins, Cell-cycle checkpoints, therapeutic perspectives), growth (Insulin-like growth factors, Nerve growth factor, Epidermal growth factor, Fibroblast growth factor, Platelet-derived growth factor, Transforming growth factors, Hematopoietic growth factors and others), differentiation, and apoptosis (Caspases, Bcl-2 family, role of mitochondria, anoikis, potential for therapeutics); Cancer and cell senescence; Cellular responses during tumour development; signalling pathways commonly affected in cancers and systems biology.

Metabolic reprogramming in cancer **(1 hr)**

Warburg effect – definition and its mechanistic role in cancer

Tumour Immunology **(7 hrs)**

Historical perspectives; Mechanisms of the immune responses to cancer - the adaptive and innate immune responses, immunological synapse; role of immune system in warding off various types of cancer; cancer cells' evasion from immune detection and their resistance to immune responses; how do tumour cells act against immune cells

Unit IV – Cancer Diagnostics and Therapeutics

Cancer Diagnosis **(6 hrs)**

Clinical diagnosis; Tumour biomarkers; human genome sequencing and cancer; role molecular tools in cancer diagnosis and assessment of one's predisposition to cancer (role of various genetics and genomics approaches like GWAS and genomic partitioning, epigenetic approaches, and studies related to proteomics and metabolomics as cancer diagnostic/ prognostic tools); role of study models in understanding the role of genetic/epigenetic alterations in the development of cancer.

Therapeutics against Cancer **(4 hrs)**

Rationale behind different cancer therapeutic approaches and their mechanism of action - Anti-cancer drugs and chemotherapy, targeting angiogenesis for cancer therapy, efficacy of chemotherapy (therapeutic resistance and non-specific effects), occurrence of a relapse; Current developments in cancer therapeutics (therapeutics driven by the sequencing revolution or Gene therapy, different immunotherapeutic strategies against cancers, drug development and personalized medicine).

Practicals

- Demonstration of H&E staining and immunohistochemistry
- Principle of Chemiluminescence and estimation of tumor markers
- Fluorescent in-situ hybridization for HER2Neu, BCR-ABL
- Quantification of BCR-ABL using real-time PCR
- Quantification of EGFR using real-time PCR

Recommended books

1. Raymond W. Ruddon (2007) Cancer Biology 4th ed., Oxford University Press
2. Robert A. Weinberg (2012) The Biology of Cancer, Garland Science, Taylor and Francis Group Publication, 2nd Edition
3. B Alberts, A Johnson, J Lewis, M Raff, K Roberts and P Walter (2008) Molecular Biology of

Cell, Taylor and Francis group Publication, 5th Edition

4. V T DeVita, TS Lawrence and SA Rosenberg (2015) Cancer: Principles & Practice of Oncology, Wolters Kluwer Publication, 10th Edition
5. Robin Hesketh (2012) Introduction to Cancer Biology: A Concise Journey from Epidemiology through Cell and Molecular Biology To Treatment and Prospects, Cambridge University Press.
6. Margaret A. Knowles and Peter J. Selby (2005) Introduction to the Cellular and Molecular Biology of Cancer (4th Ed.), Oxford University Press
7. Arthur B. Pardee and Gary S. Stein (2008) The Biology and Treatment of Cancer: Understanding Cancer, Wiley Online Library
8. Relevant research articles, reviews and online resources

Semester 9

DSC 23 – GENETIC DATA ANALYSIS

(60 hours, LTP – 3+1+2)

Course outcome

Students should be able to

- CO1. To understand monogenic, polygenic and omnigenic effects and polygenic scores.
- CO2. To outline the basics and assumptions of statistical models used in genetic research.
- CO3. To prepare flowchart of working with polygenic scores and comprehend the main principles of constructing it.
- C04. To manage genotyping and sequencing data and sequencing technologies. Comprehend linkage disequilibrium and imputation in relation to genomic data.

Unit 1

Fundamental Concepts and the Human Genome **6 hrs**

DNA, the genome, chromosome, Mendel's law, sexual reproduction, genetic recombination, Genetic polymorphisms, Alleles, single-nucleotide polymorphism (SNP), minor allele frequency (MAF), monogenic, polygenic and omnigenic effects, from genes to proteins, the central dogma of molecular biology, Homozygous and heterozygous alleles, dominant and recessive traits

Heritability **3 hrs**

Defining heritability, broad- and narrow-sense heritability, common misconceptions about heritability, twin, SNP and GWAS heritability, missing and hidden heritability.

Statistical primer for genetic data analysis **6 hrs**

Introduction, basic statistical concepts, mean, standard deviation and variance, covariance and the variance-covariance matrix, Statistical model, regression models, the null and alternative hypothesis and significance thresholds, correlation, causation and multivariate causal models, correlation versus causation, multivariate causal model. Fixed-effect models, random-effect models, and mixed models, replication of results and overfitting.

Unit 2

Introduction to polygenic scores and genetic architecture **4 hrs**

Introduction, what is polygenic score? The origin of polygenic scores, construction of polygenic scores, large sample sizes required in GWAS discovery, selection of SNPs to include.

Validation and prediction of polygenic scores **6 hrs**

Independent target sample, similar ancestry in target sample, relatedness, population stratification, and differential bias, variance explained by common genetic markers missing rare variants. Missing and hidden heritability in prediction of phenotypes from genetic markers, Trade-off between prediction and understanding biological mechanisms.

Shared genetic architecture of phenotypes **5 hrs**

Predicting other phenotypes, phenotypic and genetic correlation, pleiotropy, multitrait analysis, causal modelling with polygenic scores, genetic confounding, Mendelian randomization, controlling for confounders, gene-environment interaction and heterogeneity.

Unit 3

Gene-environment interplay **6 hrs**

Introduction, what is gene-environment (GXE) interplay, Defining the environment in GXE research, nature and scope of E: multilevel, multidomain and multitemporal, Interdependence of environmental risk factors, brief history of GXE research, classic approaches, candidate gene cGXE approaches, Genome-wide polygenic score GXE approaches.

Conceptual GXE models **5 hrs**

Diathesis-stress, vulnerability or contextual triggering model, bioecological or social compensation model, differential susceptibility model, social control or social push model, research designs to study GXE.

Gene-environmental correlation **4 hrs**

Passive gene-environmental correlation (rGE), evocative (or reactive) rGE, active rGE, what are models of rGE important? Research designs to study rGE, Why haven't many GXEs been identified, future directions.

Unit 4

Working with Genetic Data **6 hrs**

Introduction, genotyping and sequencing array, genotyping and sequencing technologies, linkage disequilibrium and imputation, limitations of genotyping arrays and next generation sequencing, drop in costs per genome, overview of human genetic data analysis, prominently used genetic data, sources that archive and distribute data, obtaining GWAS summary statistics.

Different formats in genomic data **5 hrs**

Genomic data is big data, PLINK software and genotype formats, PLINK binary files, Genetic formats for imputed data, PLINK 2.0, Oxford file formats, the variant call format (VCF).

Data transfer, storage, size and computing power **4 hrs**

Data storage, data sharing, transfer across borders and cloud storage, size of data and computational power.

Practical classes

- Data management, descriptive statistics and quality control – 4 hrs
- Association analysis, population stratification and genetic relatedness – 4 hrs
- Creating and validating polygenic scores – 4 hrs
- Polygenic score and gene-environment interaction – 3 hrs
- Genome-wide association results – 3 hrs
- Mendelian randomization and instrumental variables – 2 hrs

Recommended books Recent edition

1. An introduction to statistical genetic data analysis, Milinda C. Mills, Nicola Barban, Felix C. Tropf
2. Introduction to genetic analysis, Anthony J. F. Griffiths, John Doebley, Catherine Peichel, David A. Wassarman

Semester 9

DSE-4b Pharmacovigilance

(30 hours, LTP – 2+0+0)

Learning objectives

- The student will be able to understand regarding basic terminologies used in Pharmacovigilance, Adverse drug reactions, ADR form filling, Causality assessment, SOPs, Pharmacovigilance methods, Drug dictionaries and coding in Pharmacovigilance, Tools used in Pharmacovigilance
- The student will gain knowledge about Basic terminologies detection, assessment, understanding & prevention, SOPs, Coding and Tools used in Pharmacovigilance, Patient safety, Job placement in industries.

Unit 1 **10 hours**

Introduction to Pharmacovigilance, History and development of Pharmacovigilance, Importance of safety monitoring / Why Pharmacovigilance?

National and international scenario, Pharmacovigilance in India, Pharmacovigilance - global perspective, WHO international drug monitoring programme.

Basic terminologies used in Pharmacovigilance, Terminologies of adverse medication related events, Regulatory terminologies

Introduction to adverse drug reactions, Definition and classification of adverse drug reactions, Detection and reporting of adverse drug reactions, Management of adverse drug reactions.

Causality assessment, Severity and seriousness assessment, Predictability and preventability assessment, PSUR

Unit 2 **10 hours**

Information resources in Pharmacovigilance, Basic drug information resources, Specialised resources for adverse drug reactions, Critical evaluation of medication safety literature

Establishing Pharmacovigilance program, Establishment of Pharmacovigilance centre in a hospital, Establishment & operation of drug safety department in industry, Establishing a national Pharmacovigilance programme.

SOPs – Types, designing, maintenance and training, Roles and responsibilities in Pharmacovigilance.

Licence Partners, Contract Research Organisations (CROs) and Market Authorisation Holders (MAH)

Pharmacovigilance methods, Passive surveillance – Spontaneous reports and case series, Intensified reporting, Active surveillance – Targeted reporting, cohort event monitoring and electronic health record mining, Comparative observational studies – Cross sectional study, case control study and cohort study.

Adverse drug reaction reporting, Introduction to reporting systems, Spontaneous reporting system, reporting to regulatory authorities, Guidelines for reporting adverse drug reaction.

Unit 3 **10 hours**

Drug and disease classification, international classification of diseases, Anatomical, therapeutic and chemical classification of drugs.

Defined Daily dose, International Non-proprietary Names for drugs

Drug dictionaries and coding in Pharmacovigilance, WHO adverse reaction terminologies, MedDRA and Standardised MedDRA queries.

WHO drug dictionary, Eudravigilance medicinal product dictionary.

Effective communication in Pharmacovigilance, Communication in Drug Safety Crisis

management.
Tools used in Pharmacovigilance, Introduction to Argus, Introduction to Aris G Pharmacovigilance and safety

Recommended Books

1. Textbook of Pharmacovigilance by SK Gupta, Mann's Pharmacovigilance- A comprehensive textbook

Semester 9

DSE 4a – Infertility & Assisted Reproductive Technology

(30 hours, LTP – 2+0+0)

Learning Objectives

- The student will be able to identify the causes of female and male infertility and describe appropriate workup, testing and treatment.
- The student should be able to discuss assisted reproductive technologies, including IVF and embryo transfer, intracytoplasmic sperm injection, sperm preparation techniques, and embryo cryopreservation, as well as indications and protocols for these procedures.
- Identify patients at increased risk of genetic disorders, and common indications and techniques for genetic screening, testing and counseling.

Unit 1

Oogenesis and Folliculogeneis: Oocyte retrieval and selection. Preparation and evaluation of oocytes for ICSI. Hyaluronic acid binding-mediated sperm selection for ICSI.
Spermatogenesis and Andrology: Evaluation of sperm. Sperm preparation techniques. Sperm chromatin assessment.
Fertilization and Embryos in assisted reproduction technology (ART): Embryology, In Vitro Fertilization (IVF), Analysis of Fertilization, Morphological Assessment of Embryos and Oocytes, Embryo Transfer Techniques, Cryopreservation and Vitrification, Time Lapse Videos.

Unit 2

Endometrial Receptivity and Female Factor Sterility: Window of implantation, endometrial cycle, Assessment of Receptivity, Impact of Ovarian Stimulation.
Male Infertility: Etiology and Pathophysiology, Clinical and Endocrinal Evaluation.
Genetics of Infertility: Cytogenetic Abnormalities, Genetics of y chromosome-Derived Infertility, Molecular Genetic Testing.
Female Factor Infertility: Uterine, Cervical, Tubal and Fallopian tube factors, Infertility and Molecular Genetics in Females.

Unit 3

Advances and Dilemmas in Assisted Reproductive Technologies, Preimplantation Genetic Screening of Embryos, Preimplantation Genetic Diagnosis, Preimplantation Genetic Diagnosis and HLA typing, OMICS in Infertility.

Recommended books

1. Dhastagir Sultan Sheriff (2018) Infertility, Assisted Methods of Reproduction and Hormonal Assays, IntechOpen publisher
2. National Research Council. (2002). Scientific and Medical Aspects of Human Reproductive Cloning. Washington, DC: The National Academies
3. Gey Becker (2000) The Elusive Embryo: How Women and Men Approach New Reproductive Technologies. University of California Press. Berkeley, CA. Publication

Semester 9

AEC-4 Animal Models of Human Diseases

(30 hours, LTP – 2+0+0)

Learning objectives:

- The student will be able to understand and explain the use and value of model organisms such as Planaria, Drosophila, C. elegans, and Zebrafish in the analysis and elucidation of biological principles and describe the hierarchy of testing models.
- Basic Master culturing, genetic manipulation, and phenotypic analysis techniques in handling genetic model organisms. This course is aimed at an interactive learning experience for the students and will consist of seminars and discussions led by invited speakers who use model organisms in their research. Students will also make presentations and write essays defending a particular choice of a model organism.

Unit I – Introduction **(2 hours)**

Use of model organisms to study human diseases, History, Characteristic of ideal model organism, different Applications of model organisms in the research field, comparison of different genomes (Planaria, C. elegans, Drosophila melanogaster, Zebrafish, laboratory mouse), Advantages, disadvantages & Limitations of model organisms in the research field.

Unit 2 – C. elegans as model organism **(5 hours)**

Introduction to C. elegans – Background, Overview of C. elegans - Anatomy, Life cycle, Nematode handling and husbandry - ease of performing cellular and genetic studies, Advantages & Limitations; Modelling C. elegans as a system to study human diseases – Conservation in cellular pathways, cellular differentiation studies, and RNA interference studies.

Unit 4 – Drosophila as a model organism **(10 hours)**

Introduction to Drosophila – Background, Overview of Drosophila – Anatomy, Life cycle, Drosophila husbandry - ease of performing cellular and genetic studies, Advantages & Limitations; Generation of Transgenic Drosophila – Conservation of cellular pathways, UAS-GAL4 Germ-line transformation, P-element based vectors; Drosophila model to study Human genetic disorders and drug screening.

Unit 5 – Zebrafish as a model organism **(4 hours)**

Introduction to Zebrafish – Background, Overview of Zebrafish - Anatomy, Life cycle, Aquaculture – ease of performing cellular and genetic studies, Advantages & Limitations; Genetic mosaic techniques – FLP-FRT and Cre-Lox recombination based transgenic models; Modelling using vertebrate orthologous genetic mutants to study Human disorders and drug screening.

Unit 6 –Laboratory mouse as a model organism **(9 hours)**

Introduction – Background, Overview of Mouse model - Anatomy, Life cycle, animal husbandry guidelines and ethics concerning the use of mice and primates. – Goals of CPCSEA, IAEC and IBSC/ IBC committees, 3R principles; advantages, disadvantages & Limitations; Construction of a transgene, introduction of a foreign gene into the animal model – pronuclear microinjection methods, embryonic stem cell transformation; RNA interference-based screening of gene function & mechanism, knock-in & knockout models, CRISPR/CAS-9 techniques; use as models to study diseases that affect cellular pathways and cellular mechanisms, metabolic disorders – ob/ob mice (the role of the protein Leptin in controlling obesity) and db/db mice for type 2 diabetes, modeling cancers (C5BL/6), genetic disorders, and neuromuscular disorders – laboratory rodents; uses in drug testing.

Study references:

1. Developmental Biology by Gilbert S., F. Sinauer

Semester 9

VBA 5 – Health economics

(30 hours, LTP – 2+0+0)

Learning objectives

- The student will be able to demonstrate advanced knowledge of how medical knowledge, individual and organizational competence and the resources of healthcare and society can best be utilized for improving people's health
- Demonstrate advanced knowledge about structure and governance as well as developments within medical and social care work
- Demonstrate advanced knowledge and understanding of how health systems function and health policy is created and implemented

Theory **30 hrs**

Unit I

Introduction to Health Economics, The economic way of thinking about health, Health measurement, determinants and long run trends, economic evaluation of healthcare

Unit II

Economic Models of Health, Health and Socioeconomic Status, cost containment measures in genetics

Unit III

Health Insurance, Indian scenario and social security, third party administrators

Unit IV

National health programs and screening programs, planning and designing of genetic laboratories, equipment management in genetic laboratory, legal and statutary compliances in Medical genetics.

Unit V

Medical audit, clinical audit

Recommended books

1. Sherman Folland, Allen C. Goodman, and Miron Stano (2017) The Economics of Health and Health Care, 8th ed. New York, NY: Routledge.
2. Jay Bhattacharya, Timothy Hyde, Peter Tu (2013) Health Economics, Palgrave Macmillan

Semester 10
Master's research project
(18 credits)
VBA 7 – Industry internship
(4 credits)