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| M.sc.,  human genetics |
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| **SYLLABUS**  **FROM THE ACADEMIC YEAR**  **2023 - 2024** |
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| **TAMILNADU STATE COUNCIL FOR HIGHER EDUCATION, CHENNAI – 600 005** |
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| **PROGRAMME EDUCATIONAL OBJECTIVE (PEOs)** | |
| The M.Sc., Human Genetics and Molecular Biology program describe accomplishments that  graduates are expected to attain within five to seven years after graduation. | |
| **PEO1** | The students can be employed as geneticists in hospitals and Health care sector. |
| **PEO2** | The students can go for higher education in reputed National and International  Institutions. |
| **PEO3** | The candidates would be able to establish a Genetic testing laboratory |
| **PEO4** | Transform the knowledge into design the health care tools/methods for disease  diagnosis. |
| **PEO5** | Delineate and evaluate the clinical data for the diagnosis of diseases of public  health concern. |
| **PEO6** | The graduate can become a teacher in Human Genetics and Molecular Biology  subjects in higher education institute in national and international level. |

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| **PROGRAMME SPECIFIC OUTCOMES (PSOs)** | |
| After the successful completion of M.Sc., Human Genetics and Molecular Biology program,  the students are expected to | |
| **PSO1** | Know the inheritance patterns of human |
| **PSO2** | To explain the role of genetic changes in association with diseases and disorders |
| **PSO3** | Capacity to design a device to identify the genetic changes |
| **PSO4** | Capable of differentiate genetic and non-genetic disorders |
| **PSO5** | Capacity to manipulating the mutated diseased genes |
| **PSO6** | Capable to become a genetic counselor |
| **PSO7** | The confidence to fill their talent gaps in the emerging field in Human Genetics |
| **PSO8** | Practice the learned molecular methods in clinical center, hospitals and laboratories |

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| **PROGRAMME OUTCOMES (POs)** | |
| **On successful completion of the M.Sc., Human Genetics and Molecular Biology**  **program** | |
| **PO1** | Able to know the basics in genetic concepts and organization of genome on  cellular and chromosomal level |
| **PO2** | Able to explain the basic molecular genetics mechanisms in relation to the  structure and function of the cells. |
| **PO3** | Candidatesare able to describe the structure, function and replication of DNA as  the genetic material and its manipulations |
| **PO4** | Understand the impact genetic information in society |
| **PO5** | Acquire the knowledge in the field of Medical, Cyto, Immuno, Molecular,  Cancer, Developmental and Neuro genetics to diagnose diseases and disorders. |
| **PO6** | Capableto explain the various types of molecular biology methods that are used  to study the regulation and function of biomolecules |
| **PO7** | Acquire the ability to use their theoretical knowledge in solving practical issues. |
| **PO8** | Know the bioethics and safety measures to be followed in handling the  biological samples |
| **PO9** | Able to explain the applications and importance of biomarkers, DNA finger  printing and stem cell therapy’s in the field of Biomedical Genetics |
| **PO10** | Can have hands on experience in various genetics techniques and familiar with  practicing of genetic counseling |

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| **TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION** | |
| **Programme** | **M.Sc., Human Genetics** |
| **Programme Code** |  |
| **Duration** | **PG - Two Years** |
| **Programme Outcomes (Pos)** | **PO1: Problem Solving Skill**  Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context.  **PO2: Decision Making Skill**  Foster analytical and critical thinking abilities for data-based decision-making.  **PO3: Ethical Value**  Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities.  **PO4: Communication Skill**  Ability to develop communication, managerial and interpersonal skills.  **PO5: Individual and Team Leadership Skill**  Capability to lead themselves and the team to achieve organizational goals.  **PO6: Employability Skill**  Inculcate contemporary business practices to enhance employability skills in the competitive environment.  **PO7: Entrepreneurial Skill**  Equip with skills and competencies to become an entrepreneur.  **PO8: Contribution to Society**  Succeed in career endeavors and contribute significantly to society.  **PO 9 Multicultural competence**  Possess knowledge of the values and beliefs of multiple cultures and  a global perspective.  **PO 10: Moral and ethical awareness/reasoning**  Ability to embrace moral/ethical values in conducting one’s life. |
| **Programme Specific Outcomes**  **(PSOs)** | **PSO1 – Placement**  To prepare the students who will demonstrate respectful engagement with others’ ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions.  **PSO 2 - Entrepreneur**  To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.  **PSO3 – Research and Development**  Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development.  **PSO4 – Contribution to Business World**  To produce employable, ethical and innovative professionals to sustain in the dynamic business world.  **PSO 5 – Contribution to the Society**  To contribute to the development of the society by collaborating with stakeholders for mutual benefit. |

**Template for P.G., Programmes**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Semester–I** | **Credit** | **Hours** | **Semester-II** | **Credit** | **Hours** | **Semester-III** | **Credit** | **Hours** | **Semester–IV** | **Credit** | **Hours** |
| 1.1. Core-I | 5 | 7 | 2.1. Core-IV | 5 | 6 | 3.1. Core-VII | 5 | 6 | 4.1. Core-XI | 5 | 6 |
| 1.2 Core-II | 5 | 7 | 2.2 Core-V | 5 | 6 | 3.2 Core-VII | 5 | 6 | 4.2 Core-XII | 5 | 6 |
| 1.3 Core – III | 4 | 6 | 2.3 Core – VI | 4 | 6 | 3.3 Core – IX | 5 | 6 | 4.3 Project with viva voce | 7 | 10 |
| 1.4 Discipline Centric  Elective -I | 3 | 5 | 2.4 Discipline Centric  Elective – III | 3 | 4 | 3.4 Core – X | 4 | 6 | 4.4Elective - VI (Industry / Entrepreneurship)  20% Theory  80% Practical | 3 | 4 |
| 1.5 Generic Elective-II: | 3 | 5 | 2.5 Generic Elective -IV: | 3 | 4 | 3.5 Discipline Centric Elective - V | 3 | 3 | 4.5 Skill Enhancement course / Professional Competency Skill | 2 | 4 |
|  |  |  | 2.6 NME I | 2 | 4 | 3.6 NME II | 2 | 3 | 4.6 Extension Activity | 1 |  |
|  |  |  |  |  |  | 3.7 Internship/ Industrial Activity | 2 | - |  |  |  |
|  | **20** | **30** |  | **22** | **30** |  | **26** | **30** |  | **23** | **30** |
| **Total Credit Points -91** | | | | | | | | | | | |

**Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF) Guideline Based Credits and Hours Distribution System**

**for all Post – Graduate Courses including Lab Hours**

**First Year – Semester – I**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credits** | **No. of Hours** |
|  | Core – I | 5 | 7 |
| Core – II | 5 | 7 |
| Core – III | 4 | 6 |
| Elective – I | 3 | 5 |
| Elective – II | 3 | 5 |
|  |  | **20** | **30** |

**Semester-II**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credits** | **No. of Hours** |
|  | Core – IV | 5 | 6 |
| Core – V | 5 | 6 |
| Core – VI | 4 | 6 |
| Elective – III | 3 | 4 |
| Elective – IV | 3 | 4 |
| Skill Enhancement Course [SEC] - I | 2 | 4 |
|  |  | **22** | **30** |

**Second Year – Semester – III**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credits** | **No. of Hours** |
|  | Core – VII | 5 | 6 |
| Core – VIII | 5 | 6 |
| Core – IX | 5 | 6 |
| Core (Industry Module) – X | 4 | 6 |
| Elective – V | 3 | 3 |
| Skill Enhancement Course - II | 2 | 3 |
|  | Internship / Industrial Activity [Credits] | 2 | - |
|  |  | **26** | **30** |

**Semester-IV**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credits** | **No. of Hours** |
|  | Core – XI | 5 | 6 |
| Core – XII | 5 | 6 |
| Project with VIVA VOCE | 7 | 10 |
| Elective – VI (Industry Entrepreneurship) | 3 | 4 |
| Skill Enhancement Course – III / Professional Competency Skill | 2 | 4 |
| Extension Activity | 1 | - |
|  |  | **23** | **30** |

**Total 91 Credits for PG Courses**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **METHODS OF EVALUATION** | | | | |
| **Internal Evaluation** | Continuous Internal Assessment Test | | **25 Marks** | |
| Assignments / Snap Test / Quiz | |
| Seminars | |
| Attendance and Class Participation | |
| **External Evaluation** | End Semester Examination | | **75 Marks** | |
| **Total** | | | **100 Marks** | |
| **METHODS OF ASSESSMENT** | | | |
| **Remembering (K1)** | | * The lowest level of questions require students to recall information from the course content * Knowledge questions usually require students to identify information in the text book. | |
| **Understanding (K2)** | | * Understanding of facts and ideas by comprehending organizing, comparing, translating, interpolating and interpreting in their own words. * The questions go beyond simple recall and require students to combine data together | |
| **Application (K3)** | | * Students have to solve problems by using / applying a concept learned in the classroom. * Students must use their knowledge to determine a exact response. | |
| **Analyze (K4)** | | * Analyzing the question is one that asks the students to break down something into its component parts. * Analyzing requires students to identify reasons causes or motives and reach conclusions or generalizations. | |
| **Evaluate (K5)** | | * Evaluation requires an individual to make judgment on something. * Questions to be asked to judge the value of an idea, a character, a work of art, or a solution to a problem. * Students are engaged in decision-making and problem – solving. * Evaluation questions do not have single right answers. | |
| **Create (K6)** | | * The questions of this category challenge students to get engaged in creative and original thinking. * Developing original ideas and problem solving skills | |

M.Sc., HUMAN GENETICSAND MOLECULAR BIOLOGY

# Curriculum (University Department)

*(For the students admitted during the academic year 2021–2022 batch and onwards)*

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course Code** | **Title of the Course** | | **Credits** | **Hours/Week** | | **Maximum Marks** | | |
| **Theory** | **Practical** | **CIA** | **ESE** | **Total** |
| **FIRST SEMESTER** | | | | | | | | |
| Core-I | | Medical Biochemistry | 5 | 7 | - | 25 | 75 | 100 |
| Core-II | | Cell Biology and Cell Signaling | 5 | 7 | - | 25 | 75 | 100 |
| Core-III | | Principles of Human Genetics | 4 | 6 | - | 25 | 75 | 100 |
| Discipline Centric Elective-I | | - Molecular Genetics  Practical -I (Medical Biochemistry, Cell Biology and Cell Signaling, Principles of Human Genetics, Molecular Genetics) | 3 | 5 | - | 25 | 75 | 100 |
|  | |
| Generic Elective-Ii | | Genomics and Proteomics / r*–* DNA Technology / Medical  Physiology | 3 | 5 | - | 25 | 75 | 100 |
|  | | Supportive I -  Genetics and Society |  |  | - | 25 | 25 | 50 |
| **Total** | | | **20** | **30** | **-** |  |  |  |

**SECOND SEMESTER**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Core-IV | Human Cytogenetics | 5 | 6 | - | 25 | 75 | 100 |
| Core-V | Medical Genetics | 5 | 6 | - | 25 | 75 | 100 |
| Core-VI | Developmental and  Behavioral Genetics | 4 | 6 | - | 25 | 75 | 100 |
| Discipline Centric  Elective II | Biostatistics  Practical -II (Human Cytogenetics, Medical Genetics, Developmental and Behavioral Genetics,  Biostatistics) | 3 | 4 |  | 25 | 75 | 100 |
| Generic Elective -IV | Bio Instrumentation / Nanobiology /  Pharmacogenomics and  Cheminformatics | 3 | 4 | - | 25 | 75 | 100 |
| NME | Supportive II -  Principles of Genetics | 2 | 4 | - | 25 | 25 | 50 |
| **Total** | | **22** | **30** | **-** |  |  |  |

**Second year : SEMESTER-iii**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Core-VII | Immunogenetics | 5 | 6 | - | 25 | 75 | 100 |
| Core-VIII | Cancer Genetics | 5 | 6 | - | 25 | 75 | 100 |
| Core – IX | Neurogenetics and  Epigenetics | 5 | 6 | - | 25 | 75 | 100 |
| Core – X | Bioethics and Biosafety | 4 | 6 | - | 25 | 75 | 100 |
| Discipline Centric Elective - V | Practical -III (Immunogenetics, Cancer Genetics, Epigenetics,  Bioethics and Biosafety) | 3 | 3 | 6 | 25 | 75 | 100 |
| NME II | Stress and Biomarkers / Stem  Cell Biology / | 2 | 3 | - | 25 | 75 | 100 |
| Internship/ Industrial Activity |  | 2 |  |  |  |  |  |
|  | **Total** | **26** | **30** |  |  |  |  |

**SEMESTER-IV**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Core-XI | Genetic  Counseling | 5 | 6 | - | 25 | 75 | 100 |
| Core-XII | Genetic toxicology | 5 | 6 |  | 25 | 75 | 100 |
|  | Project and Viva | 7 | 10 |  | 25 | 75 | 100 |
| Elective - VI (Industry / Entrepreneurship)  20% Theory  80% Practical | Forensic Biology | 3 | 4  - | - |  |  |  |
| Research papers / Oral or Poster presentation as presenting author or Training / work shop attended more than  3 days in relevant to Genetics**\***  Industrial Visit OR Hospital Visits\* |
| Skill Enhancement course / Professional Competency Skill | | 2 | 4 | - |  |  |  |
| Extension Activity: Industrial Visit OR Hospital Visits\* | | **1** |  |  |  |  |  |
| **Total** | | **23** | **30** |  |  |  |  |
| **Grand Total** | | **91** |  |  |  |  |  |

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| **CO-SCHOLASTIC COURSES** | | | | | | | |
| **ONLINE COURSES** | | | | | | | |
|  | SWAYAM - MOOC - Online  Course\*\* | 2 | - | - | - | - | 50 |
| Non-scholastic with Credits | | | | | |
| **VALUE ADDED COURSES** | | | | | | | |
|  | Value Added Course – I\*\*\* | 2 | 30 | - | 50 | - | 50 |
|  | Value Added Course - II\*\*\* | 2 | 30 | - | 50 |  | 50 |
| **JOB ORIENTED COURSES** | | | | | | | |
|  | Certificate Course - I\*\*\* | 4 | 30-40 | - | 100 | - | 100 |
|  | Certificate Course – II\*\*\*\* | 4 | 30-40 | - | 100 | - | 100 |
| The scholastic courses are only counted for the final grading and ranking. However, for the award of the  degree, the completion of co-scholastic courses is also mandatory. | | | | | | | |

\*Report to be submitted along with project work.

\*\*SWAYAM - MOOC - online course shall be of duration at least 4 weeks with at least 2 credits. The course shall be mandatory and shall be completed within third semester (i.e., before the beginning of fourth semester).

\*\*\*Students need to complete one Value Added Course before completion of M.Sc.,Degree.

\*\*\*\*Students need to complete one Job Oriented Course before completion of M.Sc., Degree.

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| **Course code** | | **13A** | **MEDICAL BIOCHEMISTRY** | **L** | | **T** | **P** | | **C** |
| **CORE-I** | | | **4** | | **-** | **-** | | **4** |
| **Pre-requisite** | | | **Basic understanding about**  **macromolecules** | **Syllabus**  **Version** | | | | **2021-22** | |
| **Course Objectives:** | | | | | | | | | |
| The main objectives of this course are to:   1. Understand the basis of biochemical and physiological changes that are underlined in various genetic defects 2. Ffamiliarize with topics such as synthesis, classification, structure and properties of carbohydrates, lipids, proteins and enzymes. 3. Introduce the learner with basics of the genes that are responsible in various biochemical   pathways with the chemical nature and properties of biomolecules | | | | | | | | | |
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| **Expected Course Outcomes:** | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | |
| 1 | Get clear understanding about basic structure and function of biological  macromolecules | | | | | | | K2 | |
| 2 | Distinguish the various advanced molecular and physiological mechanisms in  human being. | | | | | | | K2 | |
| 3 | Distinguish the different processing mechanism of macromolecules in our system  and how energy generation and transformations occurs. | | | | | | | K2 | |
| 4 | Apply the knowledge of the acid-bases role, electrolyte balances, and osmolality  regulation in our system and its associated diseases diagnosis. | | | | | | | K3 | |
| 5 | Distinguish different enzymes types its clinical significance and advancements. | | | | | | | K2 | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create | | | | | | | | | |
|  | | | | | | | | | |
| **Unit:1** | | **STRUCTURE AND FUNCTION OF**  **BIOMOLECULES** | | | **18 hours** | | | | |
| Carbohydrates – Structure, Classification, Function and Their clinical significance; Amino acids  – Structure and properties; Proteins: Structure and classification, Role of proteins in various  biological functions; Lipids - Structure and classification, Storage lipids and structural lipids in membranes, Lipids with specific biological activities | | | | | | | | | |
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| **Unit:2** | | **METABOLISM** | | | **12 hours** | | | | |
| Oxygen transport, Enzymes and coenzymes, Bioenergetics, Glycolysis, TCA cycle, Glycogen breakdown and synthesis, Gluconeogenesis, Oxidative phosphorylation. Biosynthesis of  triglycerides and cholesterol. Oxidation of fatty acids | | | | | | | | | |
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| **Unit:3** | | **HORMONAL AND GENETIC REGULATIONS**  **OF METABOLISM** | **10 hours** |
| Hormones: Functions and classification, Hormonal regulation of fuel metabolism. Genes and  chromosomes in metabolism. Molecular mechanism of signal transduction. DNA–as a new weapon in forensic sciences. | | | |
|  | | | |
| **Unit:4** | | **HOMEOSTATIC MECHANISMS IN THE**  **BODY** | **16 hours** |
| Acid base balance: Hydrogen ion homeostasis and related disorders; Blood gas parameters and clinical applications. Fluid and electrolyte balance; Regulation of osmolality and maintenance of  fluids in the various body compartments and related disorders | | | |
|  | | | |
| **Unit:5** | | **CLINICAL ENZYMOLOGY** | **14 hours** |
| Enzymes: Introduction, Classification and regulation. Clinical enzymology: Clinical importance of serum enzymes – Aspartate transaminase, Alanine transaminase, Alkaline, phosphatase, Acid phosphatase, amylase, Lactate dehydrogenase, Creatine phosphokinase and Gamma- glutamyltransferase. Clinical significance of enzymology. Recent advancements in enzymatic  approach | | | |
|  | | | |
| **Unit:6** | | **CONTEMPORARY ISSUES** | **2 hours** |
| Expert lectures, online seminars – webinars | | | |
|  | | | |
|  | | **Total Lecture hours** | **72 hours** |
| **Text Book(s)** | | | |
| 1 | Textbook of Medical Biochemistry Chatterjea M. N. Jaypee Brothers Medical Publishers | | |
|  | | | |
| **Reference Books** | | | |
| 1 | Principles of Biochemistry (4th edition) by Albert L. Lehninger, 2004. CBS Publishers and  Distributors, New Delhi. | | |
| 2 | Biochemistry (8th edition) by LubertStryer, 2015. Co-written by Jeremy Berg, John L.  Tymoczko and Gregory J. GattoJr and published by Palgrave Macmillan. | | |
| 3 | Biochemistry (4th edition) by D. Voet and J.G. Voet, 2010. John Wiley and Sons, USA  Biochemistry, by R.H. Garrett and C.M. Grisham, Saunders College Publishers | | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
| 1 | <https://swayam.gov.in/nd2_cec20_bt12/preview> | | |
| 2 | <https://swayam.gov.in/nd2_cec19_bt02/preview> | | |
| 3 | <https://nptel.ac.in/courses/102/105/102105034/> | | |
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| **Mapping with Programme Outcomes** | | | | | | | | | | |
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **M** | **M** | **M** | **L** | **S** | **S** | **M** | **L** | **S** | **M** |
| **CO2** | **S** | **S** | **S** | **M** | **S** | **S** | **M** | **L** | **S** | **M** |
| **CO3** | **M** | **M** | **S** | **M** | **S** | **S** | **M** | **M** | **S** | **M** |
| **CO4** | **L** | **M** | **L** | **L** | **S** | **S** | **S** | **L** | **S** | **S** |
| **CO5** | **L** | **M** | **M** | **L** | **S** | **M** | **L** | **L** | **L** | **L** |

\*S-Strong; M-Medium; L-Low

|  |  |  |  |  |  |  |  |  |  |  |
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| **Course code** | | **13B** | **CELL BIOLOGY AND CELL SIGNALLING** | **L** | | **T** | | | **P** | **C** |
| **CORE – II** | | | **4** | | **-** | | | **-** | **4** |
| **Pre-requisite** | | | **Basic understanding about cell and signaling**  **mechanism** | **Syllabus**  **Version** | | | | **2021-**  **2022** | | |
| **Course Objectives:** | | | | | | | | | | |
| The main objectives of this course are to:   1. Cell Biology gives a detailed understanding of the fundamental processes of cellular function is critical to all specialties within biology. 2. This course detail properties of cell-cell and cell-substrate interactions and elaborates on the fundamentals of intracellular signal transduction during these interactions. 3. Topics will include the function and regulation of signaling modules and membrane component   in the context of cellular interactions with other cells and with the extracellular matrix. | | | | | | | | | | |
|  | | | | | | | | | | |
| **Expected Course Outcomes:** | | | | | | | | | | |
| On the successful completion of the course, students will be able to: | | | | | | | | | | |
| 1 | The students will be having a clear idea of the structural arrangements of the  components of the cell, a functional unit of living system. | | | | | | K1 & K2 | | | |
| 2 | Acquire knowledge basics of mechanism of membrane transport system. | | | | | | K1 & K2 | | | |
| 3 | The students will be exposed to the basics of the nucleus. | | | | | | K1 & K2 | | | |
| 4 | The cell communication is a crucial part of living systems and their  functioning. Being a life science student, this must be learnt from them clearly. This course deals with the same. | | | | | | K1 & K2 | | | |
| 5 | The molecular mechanisms of the cell and cell signaling pathways are basics  of the cell research, this has also been dealt in this course. | | | | | | K1, K2 &  K4 | | | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create | | | | | | | | | | |
|  | | | | | | | | | | |
| **Unit: 1** | | **CELLULAR ORGANIZATION** | | | | | **14 hours** | | | |
| Structure of cell organelles, an overview, cell wall and membrane structure*.* Membrane  constituents: phospholipids, glycolipids, cholesterol, membrane proteins*,* receptors and phospholipases*,* phospholipid bilayer, fluid mosaic model. | | | | | | | | | | |
|  | | | | | | | | | | |
| **Unit: 2** | | **MEMBRANE TRANSPORT** | | | | | **14 hours** | | | |
| Membrane transport of small molecules and the ionic basis of membrane excitability. Principles of membrane transport*,* carrier proteins, passive movements of solutes and active membrane transport*,* ion channels and electrical properties of membranes. Cell junctions and cell adhesion  molecules*,* basement membrane*,* extracellular matrix. | | | | | | | | | | |
|  | | | | | | | | | | |
| **Unit: 3** | | **THE NUCLEUS** | | | **14 hours** | | | | | |
| Structure of nuclear envelope, the nuclear pore complex. Selective transport of proteins to and fro | | | | | | | | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| from nucleus. Regulation of nuclear protein import, transport of RNA’s. Internal organization of  nucleus. Chromosomes. | | | |
|  | | | |
| **Unit: 4** | | **CELLULAR COMMUNICATION** | **14 hours** |
| General principles of cell signaling*,* types and mechanisms. Cell surface receptors, GPCR Molecular structure and functions*,* enzyme linked receptors*,* Activated tyrosine kinase and MAP kinase pathways. Cell Division: Overview of cell cycle*,* mitosis and meiosis. cell cycle control in  mammalian cells. Regulation of cell cycle and its mechanisms. Checkpoint in cell cycle regulation. | | | |
|  | | | |
| **Unit: 5** | | **AGING PROCESS** | **14 hours** |
| Cell biology of cell aging process and its significance. Molecular mechanism of cell death: Cell necrosis and apoptosis. CASPASE types and molecular mechanisms*,* proapoptotic regulators, inhibitors of apoptosis. Molecular biology of Survivin and Bcl2 family members. Computer aided  tools for studying cell signaling. | | | |
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| **Unit:6** | | **CONTEMPORARY ISSUES** | **2 hours** |
| Expert lectures, online seminars – webinars on the cell biology and cell signaling | | | |
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|  | | **Total Lecture hours** | **72 hours** |
| **Book(s) for study** | | | |
| 1 | Cell Biology Orgnelle Structure and Function by Davide E. Sadava. Published by Panima  India Edition. | | |
| 2 | Molecular Biology by Lodish, Berk, Kaiser, Krieper, Scot, Bretscher, Ploegh, Matsundania.  Published by NH Freeman and Company. | | |
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| **Book (s) for reference** | | | |
| 1 | The Cell (7th edition) by Gerald Karp. Published by Wiley. | | |
| 2 | Molecular Cell Biology (6th edition) by Alberts. Published by Garland Science. | | |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
| 1 | <https://swayam.gov.in/nd2_cec19_bt12/preview> | | |
| 2 | <http://ugcmoocs.inflibnet.ac.in/ugcmoocs/view_module_ug.php/152> | | |
| 3 | <http://ugcmoocs.inflibnet.ac.in/ugcmoocs/view_module_ug.php/41> | | |
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| Mapping with Programme Outcomes | | | | | | | | | | |
| **Cos** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | S | S | M | M | L | M | M | L | L | L |
| **CO2** | S | S | M | M | L | M | M | L | L | L |
| **CO3** | S | S | S | S | S | S | M | M | L | S |
| **CO4** | S | S | S | S | S | M | M | M | L | M |
| **CO5** | S | S | S | S | S | M | M | M | L | M |

\*S-Strong; M-Medium; L-Low

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| **Course code** | | **13C** | **PRINCIPLES OF HUMAN GENETICS** | **L** | **T** | | **P** | **C** |
| **CORE-III** | | | **4** | **-** | | **-** | **4** |
| **Pre-requisite** | | | **Basic understanding about principles of**  **human genetics and genetic disorder Ve** | **Syllabus**  **rsion** | | **2021-2022** | | |
| **Course Objectives** | | | | | | | | |
| The main objectives of this course are to:   1. To provide the knowledge about the genetic influence and history of human genetics and Mendelian laws to the students for their curriculum development and knowledge enrichment. 2. To understand the principles and mechanisms of the inheritance from one generation to the next. 3. To understand the mechanism of inheritance by scientific experimentation. 4. To get updated with the knowledge on genetic diseases and its research approach. 5. To understand the genetic disorders and its complications | | | | | | | | |
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| **Expected Course Outcomes** | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | |
| 1 | Gain knowledge on fundamentals of genetics and its impact. | | | | | | K1 &K2 | |
| 2 | Identify the genetic disease and the pattern of inheritance. | | | | | | K2 &K3 | |
| 3 | The course would be helpful for the students to obtain job opportunities in public and  private sectors related to biology and medicine. | | | | | | K3, K5&  K6 | |
| 4 | This aims to gain knowledge on futuristic aspects of genetics diseases and treatment  and preventive options. | | | | | | K4, K5,  &K6 | |
| 5 | Helps the students to avail opportunities in research in different areas of genetics  both Nationally and internationally. | | | | | | K2, K4  & K5 | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create | | | | | | | | |
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| **Unit:1** | | **HISTORY OF GENETICS** | | **14 hours** | | | | |
| History and development of human genetics; Mendelian Laws (law of segregation*,* law of independent  assortment*,* law of segregation and independent assortment); ABO blood grouping. | | | | | | | | |
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| **Unit:2** | | **INTERNATIONAL SYSTEM OF HUMAN**  **CHROMOSOME NOMENCLATURE** | | **14 hours** | | | | |
| International system of Human Chromosome Nomenclature, Nomenclature of aberrant karyotypes, common syndromes due to numerical chromosomal changes, Structural alterations (translocations, duplications, deletions, microdeletions, fragile sites), Chromosomal basis and non-chromosomal basis  of sex-determination, consanguinity and its effects. | | | | | | | | |
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| **Unit:3** | | **GENETICS OF HUMAN TRAITS** | | **14 hours** | | | | |
| Monogenic traits, autosomal inheritance, Sex*–*linked inheritance, mitochondrial inheritance, MIM | | | | | | | | |

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| number, Complex traits*,* approaches to analysis of complex traits, monozygotic and dizygotic twins,  linkage, crossingover*.* | | | |
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| **Unit:4** | | **PEDIGREE AND ITS COMPLICATIONS** | **14 hours** |
| Pedigree analysis: family history, pedigree symbols, construction of pedigrees, presentation of molecular genetic data in pedigrees, Complications to the basic pedigree patterns*,* mosaicism and chimerism, male lethality, X*–*inactivation. Artificial Intelligence – Introduction – Genetic influence-  Genetic disorder diagnosis. | | | |
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| **Unit:5** | | **GENETIC DISORDERS** | **14 hours** |
| Phenylketonuria, neurogenetic disorders: Alzheimer’s disease, Duchenne Muscular Dystrophy*,*  Sickle cell anemia*,* Diabetes mellitus*;* Management of genetic disorders. | | | |
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| **Unit:6** | | **CONTEMPORARY ISSUES** | **2 hours** |
| Expert lectures, online seminars – webinars | | | |
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|  | | **Total Lecture hours** | **72 hours** |
| **Text Book(s)** | | | |
| 1 | Concepts Of Genetics 10th Edition by Michael A Palladino and Michael K Cummings and  William S Klug, Pearson | | |
| 2 | Brooker, R. J. 2014. Genetics: Analysis and Principles. 5th edition. McGraw Hill. | | |
| 3 | Cummings, M. R. 2014. Human Heredity: Principles and Issues. West Publishing Company. | | |
| 4 | Principles Of Genetics 8th Edition by Gardner | | |
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| **Reference Books** | | | |
| 1 | Alberts*et al.,* Molecular Biology of the Cell 2nd Edition, Garland2007. | | |
| 2 | Snustad and Simmons, Principles of Genetics, 4th Edition, Wiley'2005. | | |
| 3 | Lewin, Genes IX, 9th Edition Jons and Bartlett2007. | | |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
| 1 | https://dmhuk8np1ucwy.cloudfront.net/wp-content/uploads/2015/08/CH25-lm.pdf | | |
| 2 | https://nptel.ac.in/courses/102/104/102104052/ | | |
| 3 | [https://www.coursera.org/learn/geneticsevolution?ranMID=40328&ranEAID=7bhGe75fAQ8&ra](https://www.coursera.org/learn/geneticsevolution?ranMID=40328&ranEAID=7bhGe75fAQ8&ranSiteID=7bhGe75fAQ8-GHJVooGTS0D2rg9M08o2uA&siteID=7bhGe75fAQ8%20GHJVooGTS0D%202rg9M08o2uA&utm_content=15&utm_medium=partners&utm_source=linkshare&utm_campaign=7bhGe75fAQ8) [nSiteID=7bhGe75fAQ8-GHJVooGTS0D2rg9M08o2uA&siteID=7bhGe75fAQ8 GHJVooGTS0D](https://www.coursera.org/learn/geneticsevolution?ranMID=40328&ranEAID=7bhGe75fAQ8&ranSiteID=7bhGe75fAQ8-GHJVooGTS0D2rg9M08o2uA&siteID=7bhGe75fAQ8%20GHJVooGTS0D%202rg9M08o2uA&utm_content=15&utm_medium=partners&utm_source=linkshare&utm_campaign=7bhGe75fAQ8) [2rg9M08o2uA&utm\_content=15&utm\_medium=partners&utm\_source=linkshare&utm\_campaig](https://www.coursera.org/learn/geneticsevolution?ranMID=40328&ranEAID=7bhGe75fAQ8&ranSiteID=7bhGe75fAQ8-GHJVooGTS0D2rg9M08o2uA&siteID=7bhGe75fAQ8%20GHJVooGTS0D%202rg9M08o2uA&utm_content=15&utm_medium=partners&utm_source=linkshare&utm_campaign=7bhGe75fAQ8)  [n=7bhGe75fAQ8](https://www.coursera.org/learn/geneticsevolution?ranMID=40328&ranEAID=7bhGe75fAQ8&ranSiteID=7bhGe75fAQ8-GHJVooGTS0D2rg9M08o2uA&siteID=7bhGe75fAQ8%20GHJVooGTS0D%202rg9M08o2uA&utm_content=15&utm_medium=partners&utm_source=linkshare&utm_campaign=7bhGe75fAQ8) | | |
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| **Mapping with Programme Outcomes** | | | | | | | | | | |
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **S** | **S** | **S** | **M** | **S** | **M** | **S** | **M** | **M** | **S** |
| **CO3** | **S** | **S** | **M** | **S** | **S** | **S** | **M** | **S** | **S** | **M** |
| **CO3** | **M** | **M** | **M** | **S** | **M** | **M** | **S** | **M** | **M** | **M** |
| **CO4** | **S** | **S** | **S** | **M** | **M** | **S** | **M** | **M** | **M** | **S** |
| **CO5** | **M** | **S** | **M** | **M** | **M** | **M** | **M** | **S** | **S** | **S** |

\*S-Strong; M-Medium; L-Low

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| **Course code** | | **13D** | **MOLECULAR GENETICS** | **L** | **T** | **P** | | | **C** |
| **CORE – IV** | | | **4** | **-** | **-** | | | 4 |
| **Pre-requisite** | | | **Fundamentals in genetics** | **Syllabus**  **Version** | | | **2021-22** | | |
| **Course Objectives:** | | | | | | | | | |
| The main objectives of this course are to:   1. To understand the fundamentals of genetic material in living system 2. To enable them with better understanding about the defects in genetic material and to modify them for the proper functioning 3. To have an overview of all kinds of diagnostic techniques for such molecular mechanisms. | | | | | | | | | |
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| **Expected Course Outcomes:** | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | |
| 1 | Understanding the fundamentals of hereditary materials and their role in  functioning of human system. | | | | | | | K1&K2 | |
| 2 | Able to identify the damage in hereditary material and malfunctioning of genes  to help in eradicating the disease. | | | | | | | K3&K4 | |
| 3 | Capable of understanding the Gene editing techniques | | | | | | | K3 | |
| 4 | Able to understand the human Genome and features | | | | | | | K2&K4 | |
| 5 | With the wide technical knowledge, the students able to modify the genes and  restore the functions of the hereditary material. | | | | | | | K5&K6 | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create | | | | | | | | | |
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| **UNIT:1** | | **GENES AND CHROMOSOMES** | | | | | | **14 hours** | |
| General concept of a gene, gene families, C-value paradox non– coding genes, repetitive DNA, replication, transcription (“rho” dependent and “rho” independent termination), splicing, translation and post translational changes in Prokaryotes and Eukaryotes. Regulation of Gene  Expression at different levels Inducible operons – Galactose Repressible operon – Tryptophan. | | | | | | | | | |
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| **UNIT:2** | | **FUNDAMENTALS OF DNA CLONING AND MOLECULAR**  **HYBRIDIZATION** | | | | | | **14 hours** | |
| Cell based DNA cloning, vector based cloning; nucleic acid hybridizations, PCR based DNA cloning and DNA analyses. Types of mutations and nomenclature, mutagenesis. DNA damage and DNA repair: Types of DNA damage, Endogenous and Exogenous origins of DNA damage. DNA  repair pathways: Error– prone, Mismatch, photo activation, excision and SOS. | | | | | | | | | |
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| **Unit:3** | | **RECOMBINATION** | | | | | | **14 hours** | |

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| Models and molecular mechanisms, Site Specific recombination: Molecular mechanism. Transposons and transposition mechanisms. Gene editing techniques: using CRISPR-Cas9, ZFNs  and TALENs. | | | |
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| **Unit:4** | | **FEATURES OF THE HUMAN GENOME** | **14 hours** |
| Organization and expression of the human genome, human multigene families. Human genome  project: Mapping of the human genome: Physical mapping and Genetic mapping. Footprints of evolution, human DNA instability. Chromosome walking. | | | |
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| **Unit:5** | | **DISSECTING AND MANIPULATING GENES** | **14 hours** |
| Studying human gene structure and function and creating animal models of disease, gene theory and other molecular genetics based therapeutic approaches | | | |
| **Unit:6** | | **CONTEMPORARY ISSUES** | **2 hours** |
| Expert lectures, online seminars – webinars | | | |
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|  | | **Total Lecture hours** | **72 hours** |
| **Text Book(s)** | | | |
| 1 | Principles of Genetics Gardner, Simmons, Snustad8th Edition 2006. | | |
| **Reference Books** | | | |
| 1 | TomStrachan and Andrew. P.Read, Human Molecular Genetics, Bios‟ Scientific Pub UK.  (1996). | | |
| 2 | Watson, J.D., Hopkins, N.H., Roberts, J.W., Steitz, J. and Weinter, A.M., Molecular Biology  of Genes (4th edition) 1987. The Benjamin/Cummings publishing Company Inc., Joky. | | |
| 3 | Lewin, B. GenesVI (1997). Oxford University Press, Oxford, New York, Tokyo. | | |
| 4 | Darvell, J.et.al., Molecular Cell Biology (7th edition) 2002. Garland Publishing Iwc., New  York | | |
| 5 | Molecular Biology by Glick and Pasternack, 2003. | | |
| 6 | Lewin, GenesIX, 9th Edition Jones and Bartlett 2007 | | |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
| 1 | <https://swayam.gov.in/nd1_noc20_bt06/preview> | | |
| 2 | <https://brighterion.com/artificial-intelligence-101-genetic-algorithms/> | | |
| 3 | <https://www.ncbi.nlm.nih.gov/books/NBK21571/> | | |
| 4 | <https://www.cell.com/trends/biotechnology/pdf/0167-7799(92)90173-S.pdf> | | |
| 5 | <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2628815/> | | |
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| **Mapping with Programme Outcomes** | | | | | | | | | | |
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **S** | **S** | **S** | **S** | **M** | **L** | **L** | **L** | **M** | **S** |
| **CO2** | **M** | **M** | **S** | **S** | **S** | **M** | **M** | **M** | **S** | **M** |
| **CO3** | **L** | **M** | **S** | **S** | **S** | **M** | **L** | **M** | **S** | **S** |
| **CO4** | **S** | **S** | **S** | **M** | **M** | **S** | **L** | **L** | **S** | **M** |
| **CO5** | **S** | **S** | **S** | **M** | **M** | **S** | **L** | **M** | **S** | **S** |

\*S-Strong; M-Medium; L-Low

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| **Course code** | | **13P** | **MEDICAL BIOCHEMISTRY, CELL BIOLOGY ANDCELL SIGNALING, PRINCIPLES OF HUMAN GENETICS,**  **MOLECULAR GENETICS)** | **L** | **T** | **P** | | | **C** |
| **CORE PRACTICAL-I** | | | **-** | **-** | **6** | | | **4** |
| **Pre-requisite** | | | **Basic knowledge in macromolecules and**  **genetic materials** | **Syllabus**  **Version** | | | **2021-22** | | |
| **Course Objectives:** | | | | | | | | | |
| The main objectives of this course are to:   1. Develop the knowledge in the area of disease diagnosis through various biochemical markers and its disease association. 2. Inculcate the cell culturing and visualization techniques for the distinguishing the normal and disease conditions. 3. Apply the principles of inheritance pattern and to study the structural alterations of chromosomes and DNA in diseased individuals. Practical and experimental knowledge will be gained from the hands-on experiments. 4. To understand the structural and functional aspect of Human Genomic DNA for studying the molecular mechanism behind genetic diseases and To perform various molecular techniques for understanding the genetic and epigenetic mechanism behind various human disease   progression | | | | | | | | | |
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| **Expected Course Outcomes:** | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | |
| 1 | Measure and interpret the biochemical markers and its association in diseases | | | | | | | K3 | |
| 2 | Visualize and culture the cells of cytology importance and interpret the diseases  association with it. | | | | | | | K3 | |
| 3 | Students can able to learn and understand the genetic pattern of a disease and the  significance of chromosomal change in evolution and illness. They can understand how mutations can affect gene dosage and function. | | | | | | | K5 | |
| 4 | Understand the properties and functions of every component present in the DNA  and perform basic molecular genetic tests to identify structural alterations in DNA | | | | | | | K3,K,  K5 & K6 | |
| 5 | Employ the techniques for their services in disease diagnosis in hospitals and  research institutes | | | | | | | K5 | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create | | | | | | | | | |
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| **MEDICAL BIOCHEMISTRY**   1. Determination of blood glucose 2. Estimation of total cholesterol 3. Estimation of total protein and albumin 4. Estimation of AST, ALT and ALP 5. Estimation of Urea 6. Estimation of Creatinine   **CELL BIOLOGY AND CELL SIGNALING**   1. Uses of Microscope and Micrometry 2. Preparation of blood smear 3. Counting of RBC and WBC using Haemocytometer 4. Slides for Mitosis and Meiosis 5. Preparation of medium and cultivation of Human cell lines 6. DNA Fragmentation Assay   **PRINCIPLES OF HUMAN GENETICS**   1. Pedigree analysis 2. Karyotyping 3. Buccal micronucleus 4. DSM pattern 5. MIM 6. Mitochondrial DNA isolation 7. Mitochondrial syndromes 8. Banding techniques 9. Case study analysis   **MOLECULAR GENETICS**   1. Isolation of Blood genomic DNA 2. Isolation of RNA 3. Isolation of plasmid DNA 4. Estimation of DNA and RNA 5. Restriction Digestion and Ligation 6. Southern blotting 7. Polymerase chain reaction 8. Retrieval of sequences from nucleic acid databases | | | |
|  | | **Total Lecture hours** | **108 hours** |
| **Book(s) for study** | | | |
| 1 | Concepts Of Genetics 10th Edition by Michael A Palladino and Michael K Cummings and | | |

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|  | William S Klug, Pearson |
| 2 | Brooker, R. J. 2014. Genetics: Analysis and Principles. 5th edition. McGraw Hill. |
| 3 | Cummings, M. R. 2014. Human Heredity: Principles and Issues. West Publishing  Company. |
| 4 | Principles Of Genetics 8th Edition by Gardner |
| 5 | Analytical Biochemistry, 3rd Edition. Holme, D.J and Peck, H. 1998. Pearson Education  Limited.1-501. |
| 6 | TomStrachan and Andrew. P.Read, Human Molecular Genetics, Bios‟ Scientific Pub UK.  (1996). |
| **Books for references** | |
| 1 | Alberts et al., Molecular Biology of the Cell 2nd Edition, Garland2007. |
| 2 | Snustad and Simmons, Principles of Genetics, 4th Edition, Wiley 2005. |
| 3 | Lewin, Genes IX, 9th Edition Jons and Bartlett 2007. |
| 4 | Modern experimental Biochemistry, 3rd Edition, Rodney Boyer. 2000. Benjamin Cummins.  1-480. |
| 5 | Amaldi, F., 1982. Practical Methods in Molecular Biology.: RF Schleif and PC Wensink. Springer-Verlag, New York, Heidelberg, Berlin, 1981, xiii+ 220 pp. DM69. 00, US  $32.20. |
| 6 | Schleif, R.F. and Wensink, P.C., 2012. *Practical methods in molecular biology*. Springer  Science & Business Media. |
| 7 | Davis, L., 2012. *Basic methods in molecular biology*. Elsevier. |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | |
| 1 | https://onlinecourses.swayam2.ac.in/cec20\_bt17/preview |
| 2 | https://nptel.ac.in/courses/102/104/102104052/ |
| 3 | https:/[/www.futur](http://www.futurelearn.com/courses/biochemistry)e[learn.com/courses/biochemistry](http://www.futurelearn.com/courses/biochemistry) |
| 4 | [https://bio.libretexts.org/Bookshelves/Genetics/Book%3A\_Online\_Open\_Genetics\_(Nickl](https://bio.libretexts.org/Bookshelves/Genetics/Book%3A_Online_Open_Genetics_(Nickle_and_Barrette-Ng)/08%3A_Techniques_of_Molecular_Genetics)  [e\_and\_Barrette-Ng)/08%3A\_Techniques\_of\_Molecular\_Genetics](https://bio.libretexts.org/Bookshelves/Genetics/Book%3A_Online_Open_Genetics_(Nickle_and_Barrette-Ng)/08%3A_Techniques_of_Molecular_Genetics) |
| 5 | <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2592051/> |
| 6 | <https://www.ncbi.nlm.nih.gov/books/NBK21248/?term=molecular%20Genetics> |
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| **Mapping with Programme Outcomes** | | | | | | | | | | |
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **M** | **M** | **M** | **M** | **S** | **S** | **S** | **S** | **S** | **S** |
| **CO2** | **M** | **S** | **M** | **M** | **S** | **S** | **S** | **S** | **S** | **S** |
| **CO3** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** |
| **CO4** | **M** | **M** | **M** | **M** | **S** | **S** | **S** | **S** | **S** | **S** |
| **CO5** | **M** | **M** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** |

\*S-Strong; M-Medium; L-Low

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| **Course code** | | **1EA** | **GENOMICS AND PROTEOMICS** | **L** | **T** | | **P** | | **C** |
| **ELECTIVE-I** | | | **4** | **-** | | **-** | | **4** |
| **Pre-requisite** | | | **Understanding about the Genomics and**  **Proteomics** | **Syllabus**  **Version** | | | | **2021-**  **2022** | |
| **Course Objectives:** | | | | | | | | | |
| The main objectives of this course are to:   1. To understand the genome organization of various organisms 2. To understand the corresponding protein and their functional role in various systems 3. To know the principles and working mechanism of all the genomic and proteomic techniques | | | | | | | | | |
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| **Expected Course Outcomes:** | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | |
| 1 | Able to understand the Genome organization | | | | | | | K1&K2 | |
| 2 | Understanding the Genome of prokaryotic and Eukaryotic system | | | | | | | K2 | |
| 3 | Capable of understanding the mechanism of protein product in every genes | | | | | | | K2&K3 | |
| 4 | Techniques used in genomics and proteomics study will be helpful in future  research by exploring many aspects of defective genes and their products. | | | | | | | K4&K5 | |
| 5 | Abe to understand the Biological Databases and their applications | | | | | | | K3&K6 | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create | | | | | | | | | |
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| **UNIT:1** | | **BASICS IN GENOMICS** | | | | **14 hours** | | | |
| Structure and organization of prokaryotic and eukaryotic genome*,* genetic and physical mapping. Assembly of a contiguous, DNAsequence*,*clonecontigapproach*,*whole genome shot gun  sequencing. | | | | | | | | | |
| **UNIT:2** | | **GENOME OF PROKARYOTIC AND EUKARYOTIC**  **ORGANISM** | | | | **14 hours** | | | |
| *E. coli*, *Arabidopsis thaliana* and *Musmusculus*. Evolution and structure of mitochondrial  genomes, mtDNA and mitochondrial diseases. Pharmacogenomics: High throughput screening for discovery and identification of drugs. Drug targets and development SNP analysis**.** | | | | | | | | | |
| **UNIT:3** | | **TRANSCRIPTOMICS** | | | | **14 hours** | | | |
| transcriptome*,* yeast transcriptome and the human transcriptome*,*link between the transcriptome  and proteome. Transcripts analysis*,* Serial analysis of gene expression (SAGE), non*–* array based whole transcriptome analysis, differential display*,*Yeast two hybrid systems. | | | | | | | | | |
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| **UNIT:4** | | **PROTEOMICS** | | | | **14 hours** | | | |
| Tools for proteome analysis*,*2D*,*PAGE, Mass spectrometry, MALDI*,*TOF, TANDOM*,*MS, LC*-*  MS, protein microarray Affinity purification of proteins and TAP tag. . Protein: Protein | | | | | | | | | |

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| interactions and uses of their databases. Peptide finger printing: Techniques for protein  purification, sequencing of proteins. | | | | |
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| **UNIT:5** | | **BIOLOGICAL DATABASES** | | **14 hours** |
| Overview, applications*,* gene and protein sequence databases*,*GenBank, EMBL, DDBJ, and PDB. Online databases InterPro, UniProt, Pride and PfamSequence alignment and sequence analysis**:** Concept of local and global sequence alignment, Pair– wise sequence alignment, BLAST*,*Multiple sequence alignment, homology, analogy. RNA Seq Data analysis, Metagenome analysis, Proteome  data analysis (Mascot and Peaks) | | | | |
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| **UNIT:6** | | **CONTEMPORARY ISSUES** | **2 hours** | |
| Expert lectures, online seminars – webinars | | | | |
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|  | | **Total Lecture hours** | **72 hours** | |
| **Text Book(s)** | | | | |
| 1 | Brown, T.A., 2006, Genomes, John Wiley and Sons, Pvt. Ltd., Singapore. | | | |
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| **Reference Books** | | | | |
| 1 | CampbellA,Heyer. 2004, Discovering Genomics, Proteomics and Bioinformatics, Pearson  Education, New Jersey. | | | |
| 2 | Liebler, Daniel,C.,2002, Introduction to proteomics tool for the new biology, Humana Press,  New Jersey. | | | |
| 3 | Lesk, A.M. 2007. Introduction to Bioinformatics, Oxford University Press, Oxford. | | | |
| 4 | Old, R.W. and Primrose, S.B. 2006. Principles of Gene Manipulation, Blackwell Science  Publication, Berlin. | | | |
| 5 | Pennington, S.R , Dunn,M,J., 2002, Proteomics from Protein sequence to function, Viva  Books Pvt., Ltd, New Delhi. | | | |
| 6 | Introduction to Bioinformatics, TramontanoA*,*Chapman and Hall. | | | |
| 7 | Understanding Bioinformatics, ZvelebilM and BaumJO*,*Taylor and Francis. | | | |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | | |
| 1 | <https://www.frontiersin.org/articles/10.3389/fgene.2020.00309/full> | | | |
| 2 | <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6325641/> | | | |
| 3 | https://journals.plos.org/ploscompbiol/article?id=10.1371/journal.pcbi.1005457 | | | |
| 4 | https:/[/www.ncbi.nlm.nih.gov/books/NBK21121/](http://www.ncbi.nlm.nih.gov/books/NBK21121/) | | | |
| 5 | <https://www.denbi.de/online-training-media-library/proteomics> | | | |
| 6 | https:/[/www.scienc](http://www.sciencedirect.com/science/article/pii/S1874391912001479)e[direct.com/science/article/pii/S1874391912001479](http://www.sciencedirect.com/science/article/pii/S1874391912001479) | | | |
| 7 | <http://www.bio.iitb.ac.in/~sanjeeva/e-learning-activities/> | | | |
| 8 | <https://swayam.gov.in/nd1_noc19_bt26/preview> | | | |

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| **Mapping with Programme Outcomes** | | | | | | | | | | |
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **S** | **S** | **S** | **M** | **M** | **M** | **M** | **M** | **S** | **S** |
| **CO2** | **S** | **S** | **S** | **S** | **M** | **S** | **M** | **M** | **S** | **S** |
| **CO3** | **M** | **M** | **S** | **M** | **L** | **S** | **M** | **M** | **L** | **S** |
| **CO4** | **S** | **M** | **S** | **L** | **M** | **S** | **S** | **M** | **S** | **S** |
| **CO5** | **M** | **M** | **M** | **L** | **L** | **S** | **S** | **M** | **S** | **S** |

\*S-Strong; M-Medium; L-Low

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| **Course code** | | **IEB** | **r-DNA TECHNOLOGY** | | **L** | **T** | **P** | | **C** |
| **ELECTIVE-I** | | | **4** | **-** | **-** | | **4** |
| **Pre-requisite** | | | **Basic understanding about DNA and other**  **prokaryotic and eukaryotic organisms** | | **Syllabus**  **Version** | | | **2021-**  **22** | |
| **Course Objectives:** | | | | | | | | | |
| The main objectives of this course are to:   1. To understand the concepts of gene cloning and vectors used. 2. To study the techniques available to reveal the structural architecture of the genetic materials. 3. To study the methods used for extracting and eluting the genetic material from biological samples. | | | | | | | | | |
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| **Expected Course Outcomes:** | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | |
| 1 | Describe the basics of genes, how it is being controlled by different biomolecules | | | | | | | | K1 |
| 2 | Gain knowledge to classify the restriction and modification enzymes and apply it for  genetic analysis and functioning. | | | | | | | | K2 |
| 3 | Understand the construction of gene library, role of different vectors and its biomedical  application in larger scale. | | | | | | | | K2 |
| 4 | Learn profound understanding about techniques that dissect the DNA, RNA and  Protein and use it for analyzing disease. | | | | | | | | K4 |
| 5 | Apply the recombinant techniques for production of health care materials. | | | | | | | | K3 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create | | | | | | | | | |
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| **Unit:1** | | **GENES AND ITS MODIFICATION ENZYMES** | | | **14 hours** | | | | |
| Genes within the cells, genetic elements that control gene expression, restriction and modification  enzymes (Restriction enzymes, DNA ligases, Klenow fragment, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase). | | | | | | | | | |
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| **Unit:2** | | **GENE LIBRARY AND VECTORS** | | | **16 hours** | | | | |
| Construction of genomic DNA Library, Design of linkers and adaptors. Characteristics of plasmid  and phage vectors, prokaryotic and eukaryotic expression vectors, Insect, Yeast and Mammalian vectors. | | | | | | | | | |
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| **Unit:3** | | **MOLECULAR BIOLOGY TECHNIQUES** | | **18 hours** | | | | | |
| DNA sequencing (Maxam and Gilbert, Sangers, Pyro, sequencing, Shotgun sequencing method)*,* Protein sequencing*,* RNA sequencing*,* Southern and Northern and Western blotting*,* Expressed Sequence Taq (EST), Tandem Repeats, *In situ* hybridization*,* Site*–*directed mutagenesis*,* DNA  labelling*,* DNA fingerprinting (RAPD*,* RFLP, AFLP), Metagenomics. | | | | | | | | | |

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| **Unit:4** | | **EXTRACTION AND EXPRESSION TECHNIQUES** | **12 hours** |
| Isolation of DNA, mRNA and total RNA*,* polymerase chain reactions (PCR) and modified PCR*,*  gene isolation*,* gene cloning*,* screening and expression of cloned gene*,* transposons and gene targeting*.* | | | |
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| **Unit:5** | | **APPLICATIONS OF r-DNA TECHNIQUES** | **10 hours** |
| Production of insulin, human growth factor*,* gene therapy (antisense and ribozyme technology),  human genome project and its application. Large scale gene expression analysis (Microarray for DNA and protein), Safety guidelines of recombinant DNA research. | | | |
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| **Unit:6** | | **Contemporary Issues** | **2 hours** |
| Expert lectures, online seminars – webinars | | | |
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|  | | **Total Lecture hours** | **72 hours** |
| **Text Book(s)** | | | |
| 1 | H.K. Das, Text Book of Biotechnology, 1st Ed, 2004, Wiley Publishers | | |
| 2 | Winter P.C., Hicker G.I., H.L. Fletcher. Instant notes: Genetics. 2nd Edition 2003. Viva’s Book  (Pvt) Ltd. | | |
|  | | | |
| **Reference Books** | | | |
| 1 | Old and Primrose, Principles of Gene Manipulation, 3rd Ed, Blackwell Scientific Publishers | | |
| 2 | Brown TA, Genomes, 3rd ed. Garland Science 2006 | | |
|  | | | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
| 1 | <https://swayam.gov.in/nd1_noc19_bt15/preview> | | |
| 2 | <https://nptel.ac.in/courses/102/103/102103013/> | | |
| 3 | <https://nptel.ac.in/courses/102/103/102103074/> | | |
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| **Mapping with Programme Outcomes** | | | | | | | | | | |
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **S** | **S** | **S** | **M** | **S** | **S** | **M** | **M** | **S** | **M** |
| **CO2** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **M** | **S** | **S** |
| **CO3** | **S** | **M** | **S** | **M** | **S** | **S** | **S** | **M** | **S** | **M** |
| **CO4** | **S** | **S** | **S** | **M** | **S** | **S** | **S** | **M** | **S** | **S** |
| **CO5** | **M** | **M** | **M** | **M** | **S** | **M** | **S** | **M** | **S** | **M** |

\*S-Strong; M-Medium; L-Low

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| **Course code** | | **--** | **MEDICAL PHYSIOLOGY** | **L** | **T** | | | **P** | **C** |
| **ELECTIVE I** | | | **4** | **-** | | | **-** | **4** |
| **Pre-requisite** | | | **Basic understanding human physiology** | **Syllabus Version** | | **2021-22** | | | |
| **Course Objectives:** | | | | | | | | | |
| The main objectives of this course are to:   1. Medical Physiology is a subject that mainly helps the learners to understand the morphology, function and so on. 2. To acquire a core scientific knowledge about humans as a physiological entity. 3. To apply basic physiology principles in the appropriate clinical context. | | | | | | | | | |
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| **Expected Course Outcomes:** | | | | | | | | | |
| On the successful completion of the course, students will be able to: | | | | | | | | | |
| 1 | Students will understand the organs and its specific parts and functions. | | | | | | K1 & K2 | | |
| 2 | It depicts them to understand the parameters of healthy and unhealthy nature of  the organs. | | | | | | K1 & K2 | | |
| 3 | It helps the students to know the disease condition through various structures and  physiological nature. | | | | | | K1 & K2 | | |
| 4 | It also helps the students to design the novel therapeutic approaches. | | | | | | K1 & K2 | | |
| 5 | It gives aware of physiological research to improve diagnoses and treatments of  diseases. | | | | | | K1 & K2 | | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create | | | | | | | | | |
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| **Unit: 1** | | **BLOOD AND CIRCULATION** | | | | **14 hours** | | | |
| Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis. Cardiovascular regulatory mechanisms, circulation through special regions. Total counting and differential counting using  hemoyctometer. | | | | | | | | | |
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| **Unit: 2** | | **CARDIOVASCULAR SYSTEM** | | | | **14 hours** | | | |
| Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG – its principle and  significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above. Measurement of blood pressure. | | | | | | | | | |
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| **Unit: 3** | | **RESPIRATORY SYSTEM** | | | | **14 hours** | | | |
| Comparison of respiration in different species, anatomical considerations, transport of gases,  exchange of gases, waste elimination, neural and chemical regulation of respiration. | | | | | | | | | |
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| **Unit: 4** | | **NERVOUS SYSTEM** | | | | **14 hours** | | | |

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| Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral  nervous system, neural control of muscle tone and posture. Vision, hearing and tactile response. | | | | |
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| **Unit: 5** | | **ENDOCRINE AND REPRODUCTIVE SYSTEM** | | **14 hours** |
| Endocrinology and Reproduction: Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes, neuroendocrine regulation. The adrenal medulla and adrenal cortex, hormonal control of calcium metabolism and the physiology of bone, The Pituitary gland, the gonads: development and functions of the reproductive system, Other endocrine organs. Quantitative  techniques for hormones. | | | | |
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| **Unit:6** | | **CONTEMPORARY ISSUES** | **2 hours** | |
| Expert lectures, online seminars – webinars | | | | |
|  | | | | |
|  | | **Total Lecture hours** | **72 hours** | |
| **Text Book(s)** | | | | |
| 1 | Human Physiology: An integrated Approach by Dee UnglaubSilverthorn. Published by Pearson. | | | |
| 2 | Gray’s Anatomy by Roger Warwick and Peter Williams. Published by Longman Group Ltd., | | | |
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| **Reference Books** | | | | |
| 1 | Textbook of Medical Physiology by A.C. Guyton and J.E. Hall. Published by W.B. Saunders  Company. | | | |
| 2 | [Physiology (3rd edition) by L.S. Costanzo. W.B. Saunders Company.](http://www.amazon.com/Physiology-Third-Studentconsult-com-Access-Costanzo/dp/1416023208/ref%3Dpd_bbs_sr_1/105-9990580-4993218?ie=UTF8&s=books&qid=1191359766&sr=8-1) | | | |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | | |
| 1 | <https://swayam.gov.in/nd2_cec20_bt19/preview> | | | |
| 2 | <https://www.classcentral.com/course/independent-anatomy-and-physiology-mooc-3757> | | | |
| 3 | <https://swayam.gov.in/nd2_cec20_bt21/preview> | | | |
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| **Mapping with Programme Outcomes** | | | | | | | | | | |
| **Cos** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **M** | **S** | **L** | **M** | **S** | **S** | **M** | **M** | **L** | **M** |
| **CO2** | **M** | **S** | **L** | **M** | **S** | **S** | **M** | **M** | **L** | **M** |
| **CO3** | **M** | **S** | **L** | **M** | **S** | **S** | **M** | **M** | **L** | **M** |
| **CO4** | **M** | **S** | **L** | **M** | **S** | **S** | **M** | **M** | **L** | **M** |
| **CO5** | **M** | **S** | **L** | **M** | **S** | **S** | **M** | **M** | **L** | **M** |

\*S-Strong; M-Medium; L-Low

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| **ourse code** | | **23A** | **HUMAN CYTOGENETICS** | **L** | **T** | | **P** | **C** |
| **CORE-V** | | | **4** | **-** | | **-** | **4** |
| **Pre-requisite** | | | **Basic understanding about human**  **classical and molecular cytogenetics Ve** | **Syllabus**  **rsion** | | **2021-2022** | | |
| **Course Objectives:** | | | | | | | | |
| The main objectives of this course are to:   1. Demonstrate an advanced knowledge on human cytogenetics and human diseases 2. Diagnose and interpret pathology of human chromosomes 3. Demonstrate a professional knowledge of the cytogenetic disorders and clinical diagnosis. 4. To understand the human karyotype in normal and diseased patients. 5. To study the mechanism of cancer progression and its genetic influence | | | | | | | | |
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| **Expected Course Outcomes:** | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | |
| 1 | The course would help in acquainting with case studies and the practice of  genetic counselingindividually. | | | | K1,K2 &K3 | | | |
| 2 | Basically cytogenetic studies are widely used for genetic testing of various diseases; hence the students will get trained in identifying different hereditary diseases and could analyze any chromosomal anomalies which  will be helpful in medicalpractice. | | | | K2,K3, K4  &K5 | | | |
| 3 | This course could help students to get placement in various hospitals and  R&D laboratories as technicians or genetic counsellors. | | | | K4, K5 &K6 | | | |
| 4 | The course outcome helps the students in availing opportunities in both  technical as well in computational biology (Artificial Intelligence). | | | | K1, K4 & K6 | | | |
| 5 | The course helps to understand the application of genetics in Medical  Practice | | | | K4, K5 &K6 | | | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create | | | | | | | | |
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| **Unit:1** | | **HISTORY OF HUMAN CHROMOSOME** | | **14 hours** | | | | |
| Denver conference (1940), Chicago conference (1966), Paris conference (1971), nomenclature of human chromosome, identification of human diploid chromosome, peripheral blood cultures; banding techniques: G,Q,C and R band identification of 23 pairs of human chromosomes by band  position. | | | | | | | | |
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| **Unit:2** | | **CHROMOSOMAL SYNDROMES** | | **14 hours** | | | | |
| Autosomal and sex chromosomal syndromes, structural chromosomal syndromes*,* molecular  pathology of monogenetic diseases*.* Inborn errors of metabolism: Phenylketonuria and Galactosemia. | | | | | | | | |

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| **Unit:3** | | **GENETICS IN MEDICAL PRACTICE** | **14 hours** |
| Genetic principles and their application in medical practice*;* case studies (Interacting with patients, learning family history and drawing pedigree chart), Interaction with patients to create the case report – Preparation of tribal case report - Artificial Intelligence – Introduction –Genetic  influence- Application of Artificial Intelligence in human genetics disorder diagnosis | | | |
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| **Unit:4** | | **PRENATAL DIAGNOSIS** | **14 hours** |
| Prenatal diagnosis: Chorionic villi sampling*,* foetoscopy, ultrascopy*,* amniocentesis. Postnatal diagnosis: Peripheral blood leucocyte culture*,* sister chromatid exchange*,* fragile site*,* Mitotic  index, Genetic Counseling. Mosaicism | | | |
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| **Unit:5** | | **CANCER CYTOGENETICS** | **14 hours** |
| Hereditary forms of cancer, oncogenes and cancer, chromosomes and cancer. Cancer and the  environment. Genetic predisposition to sporadic and non–sporadic cancer. Cytogenetic changes in different tumour types. | | | |
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| **Unit:6** | | **CONTEMPORARY ISSUES** | **2 hours** |
| Expert lectures, online seminars - webinars | | | |
|  | | | |
|  | | **Total Lecture hours** | **72 hours** |
| **Text Book(s)** | | | |
| 1 | DP Snustad and MJ Simmons (2012) Principles of Genetics, John Willey & Sons  Publication, 6th Edition | | |
| 2 | Human Genetics 5th Edition 2017 By Gangane | | |
| 3 | Principles Of Genetics 8th Edition by Gardner | | |
| **Reference Books** | | | |
| 1 | Alberts*et al.,* Molecular Biology of the Cell 2nd Edition, Garland2007. | | |
| 2 | Snustad and Simmons, Principles of Genetics, 4th Edition, Wiley'2005. | | |
| 3 | Lewin, Genes IX, 9th Edition Jons and Bartlett2007. | | |
| 4 | Textbook of Human Genetics: [The Yale journal of biology and medicine](https://www.researchgate.net/journal/0044-0086_The_Yale_journal_of_biology_and_medicine) 45(5) · Sep1972 | | |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
| 1 | <https://www.coursera.org/learn/genes> | | |
| 2 | [https://www.gfmer.ch/SRH-Course-2011/community-genetics/pdf/Cytogenetics-Dahoun-](https://www.gfmer.ch/SRH-Course-2011/community-genetics/pdf/Cytogenetics-Dahoun-2011.pdf)  [2011.pdf](https://www.gfmer.ch/SRH-Course-2011/community-genetics/pdf/Cytogenetics-Dahoun-2011.pdf) | | |
| 3 | <https://arup.utah.edu/media/andersen-introCyto-2018/lecture-slides.pdf> | | |
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| **Mapping with Programme Outcomes** | | | | | | | | | | |
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **S** | **S** | **M** | **M** | **S** | **M** | **M** | **M** | **M** | **M** |
| **CO3** | **S** | **S** | **S** | **S** | **S** | **S** | **M** | **S** | **M** | **S** |
| **CO3** | **M** | **M** | **S** | **S** | **M** | **S** | **S** | **M** | **S** | **S** |
| **CO4** | **S** | **S** | **S** | **M** | **M** | **S** | **M** | **M** | **M** | **M** |
| **CO5** | **S** | **M** | **M** | **M** | **M** | **M** | **M** | **M** | **M** | **S** |

\*S-Strong; M-Medium; L-Low

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| **Course code** | | **23B** | **MEDICAL GENETICS** | **L** | | | **T** | | **P** | **C** |
| **CORE-VI** | | | **4** | | | **-** | | **-** | **4** |
| **Pre-requisite** | | | **Basic Understanding in genetics** | **Syllabus**  **Version** | | | | **2021-22** | | |
| **Course Objectives:** | | | | | | | | | | |
| The main objectives of this course are to:   1. To have a thorough understanding about human genetic diseases, disorders and syndromes 2. To know the risks associated with genetic diseases, disorders and syndromes 3. To initiate the genetic counselling for the family members about the chances of inheriting the genetic disease to the following generations 4. To prevent common people from genetically inherited diseases | | | | | | | | | | |
|  | | | | | | | | | | |
| **Expected Course Outcomes:** | | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | | |
| 1 | Able to understand uniqueness of disorders and syndromes at the molecular  level. | | | | | | | | K1&K2 | |
| 2 | Capable of classifying genetic basis of Inborn errors of metabolism | | | | | | | | K2&K3 | |
| 3 | Improve the knowledge the field of Neurogenetic disorders. | | | | | | | | K3&K4 | |
| 4 | Capable of understanding the hematopoietic and eye disorder | | | | | | | | K5&K6 | |
| 5 | Able to differentiate various polygenic syndromes | | | | | | | | K3&K4 | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create | | | | | | | | | | |
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| **UNIT:1** | | **GENETIC BASIS OF SYNDROMES AND DISORDERS** | | | | | **14 hours** | | | |
| An overview of the genetic basis of syndromes and disorders. Monogenic diseases with well–  known molecular pathology: Cystic fibrosis, TaySach’s syndrome, Marfan syndrome. | | | | | | | | | | |
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| **UNIT:2** | | **INBORN ERRORS OF METABOLISM** | | | | | **14 hours** | | | |
| Genetic bases and Classification, Phenylketonuria, Maple syrup urine syndrome,  Mucopolysaccharidosis, Galactosemia. Genome imprinting Syndromes: PraderWilli and Angelman syndromes, Beckwith– Wiedemann Syndrome. | | | | | | | | | | |
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| **UNIT:3** | | **NEUROGENETIC DISORDERS** | | | **14 hours** | | | | | |
| CharcotMarieTooth syndrome, Spinal muscular atrophy. Syndromes due to triplet nucleotide expansion: Alzheimer’s disease,Autism spectrum disorder and Epilepsy and Seizures. Muscle  genetic disorders: Dystrophies (Becker Muscular Dystrophy) myotonias, myopathies. | | | | | | | | | | |
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| **UNIT:4** | | **HEMATOPOIETIC&EYEDISORDERS** | | | | **14 hours** | | | | |
| Overview of Blood cell types and haemoglobin, Sickle cell anemia, Thalassemia, Hemophilia. | | | | | | | | | | |

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| Genetic disorders of Eye: Colour Blindness, albinism Retinitis pigmentosa, Glaucoma, Cataracts,  aniridia. | | | |
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| **UNIT:5** | | **COMPLEX POLYGENIC SYNDROMES** | **14 hours** |
| Polygenic syndromes: Hyperlipidemia, Atherosclerosis, Diabetes mellitus, mitochondrial  syndrome, Management of genetic disorder**. Counseling for multifactorial disorders.** | | | |
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| **UNIT:6** | | **CONTEMPORARY ISSUES** | **2 hours** |
| Expert lectures, online seminars – webinars | | | |
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|  | | **Total Lecture hours** | **72 hours** |
| **Text Book(s)** | | | |
| 1 | Clinical Genetics, A short course by Wilson, 2000 | | |
| 2 | Principle and Practice of Medical Genetics, Rimoinet al., 2002. | | |
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| **Reference Books** | | | |
| 1 | Genes in Medicine, Rasko and Doumes, 1995. | | |
| 2 | An introduction human molecular genetics, Pasternack, 2000. | | |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
| 1 | <https://www.sciencedaily.com/releases/2019/06/190606133805.htm> | | |
| 2 | <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6947640/> | | |
| 3 | <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2845894/> | | |
| 4 | <https://www.sciencedirect.com/topics/medicine-and-dentistry/inborn-error-of-metabolism> | | |
| 5 | <https://swayam.gov.in/nd2_cec20_bt03/preview> | | |
| 6 | <https://swayam.gov.in/nd2_cec20_bt17/preview> | | |
| 7 | <https://swayam.gov.in/nd1_noc20_bt06/preview> | | |
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| **Mapping with Programme Outcomes** | | | | | | | | | | |
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **M** | **S** | **M** | **S** | **S** | **M** | **M** | **M** | **S** | **S** |
| **CO2** | **M** | **S** | **S** | **S** | **S** | **M** | **M** | **S** | **S** | **S** |
| **CO3** | **M** | **S** | **M** | **S** | **S** | **M** | **M** | **L** | **S** | **S** |
| **CO4** | **M** | **M** | **S** | **S** | **S** | **L** | **L** | **L** | **S** | **S** |
| **CO5** | **M** | **M** | **M** | **S** | **S** | **M** | **M** | **M** | **S** | **M** |

\*S-Strong; M-Medium; L-Low

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| **Course code** | | **23C** | **DEVELOPMENTAL AND BEHAVIORAL GENETICS** | | **L** | **T** | **P** | **C** |
| **CORE-VII** | | | **4** | **-** | **-** | **4** |
| **Pre-requisite** | | | **Basic understanding about organisms** | | **Syllabus Version** | | **2021-22** | |
| **Course Objectives:** | | | | | | | | |
| The main objectives of this course are to:   1. Study the basic developmental stages of the animal development and its associated internal cellular changes. 2. Understand the developmental morphogenetic and gene expression pattern in Drosophila models. 3. Reveal the information on behavioral changes and its associated disorders in human being. | | | | | | | | |
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| **Expected Course Outcomes:** | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | |
| 1 | Understand the basics developmental processes | | | | | | K2 | |
| 2 | Distinguish developmental events in Drosophila and humans | | | | | | K4 | |
| 3 | Identify how genes behave with respect to different developmental stages in different  organisms and significance in maintenance of genetic architect. | | | | | | K4 | |
| 4 | Describe the basic and advanced information’s about behavioral changes and its  associated disorders. | | | | | | K2 | |
| 5 | Discuss the basic and essential knowledge about disorders of behaviors and its  genetic basis. | | | | | | K2 | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create | | | | | | | | |
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| **Unit:1** | | **EARLY DEVELOPMENT** | | | **18 hours** | | | |
| Early development, Fertilization, Types of cleavage, Gastrulation: Cell movement and formation of germ layers in Frog, Chick and Mammals. Concept of Determination, Competence and Differentiation. *Drosophila*: Maternal genes and formation of body axes and signaling pathways in development, Segmentation genes, Homeotic genes function, Imaginal disc development and Sex  determinations. | | | | | | | | |
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| **Unit:2** | | **DEVELOPMENT IN VERTEBRATES** | | | **16 hours** | | | |
| Differentiation of germ cells and Gametogenesis, Fertilization and implantation, Development of vertebrate nervous system, formation of neural tube, Formation of brain regions, Axes formation, and HOX genes, Genetic determination of sex in mammals, Stages of human embryonic development.  Genetic basis of male and female infertility and Assisted Reproductive technology. | | | | | | | | |
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| **Unit:3** | | **GENETIC MANIPULATION DURING**  **DEVELOPMENT** | | **12 hours** | | | | |
| Programmed rearrangements in genes*,* Chromatin diminution, Endo replication cycles, Gene | | | | | | | | |

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| amplification, Congenital malformations and Teratogenesis, Epigenetic regulation. Regeneration,  Senescence, Embryonic stem cells and their applications. | | | |
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| **Unit:4** | | **BASICS OF BEHAVIOR AND ASSOCIATION** | **10 hours** |
| Nature and behavior, Genetic experiments to investigate animal behavior, Identifying genes for  behavior, Investigating the genetics of human behavior, Twin and adoption study design. | | | |
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| **Unit:5** | | **BEHVIORAL DISEASE AND DISORDERS** | **14 hours** |
| Cognitive study designs: Genetic and environmental manipulations, Learning and memory. Psychopathology, Dementia, Schizophrenia, Mood disorders, Anxiety disorders. Disorders of childhood personality and personality disorders*,* Antisocial personality, Criminal behavior. Cognitive disabilities, Mental retardation, Learning disorders, Communication disorders.Artificial Intelligence – Introduction – Neural networks - Application of Artificial Intelligence in Psychiatric disorder  diagnosis | | | |
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| **Unit:6** | | **CONTEMPORARY ISSUES** | **2 hours** |
| Expert lectures, Online seminars – Webinars | | | |
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|  | | **Total Lecture hours** | **72 hours** |
| **Text Book(s)** | | | |
| 1 | A Textbook of Developmental Genetics. Sharma &Chakraborty. 2012. Wisdom Press | | |
| 2 | Principles of Developmental Biology. Sally A. Moody. (Editor). 2007. Academic Press | | |
|  | | | |
| **Reference Books** | | | |
| 1 | Scott F. Gilbert, Developmental Biology*,* VIII edition, Sinauer Associates Inc., Publishers,  Sunderland, Massachusetts USA (2006). | | |
| 2 | Bruce Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, P. Walter (2008). Molecular Biology  of the cell, V edition, John Wiley and sons Inc., 2008. | | |
| 3 | Benjamin Lewin (2010), Genes X, Jones and Bartlett Publishers, England | | |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
| 1 | <https://swayam.gov.in/nd1_noc20_bt35/preview> | | |
| 2 | <https://nptel.ac.in/courses/102/106/102106084/> | | |
| 3 | <https://swayam.gov.in/nd2_cec20_ed13/preview> | | |
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| **Mapping with Programme Outcomes** | | | | | | | | | | |
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **M** | **S** | **M** | **M** | **S** | **M** | **S** | **M** | **S** | **M** |
| **CO2** | **M** | **S** | **M** | **M** | **S** | **S** | **M** | **M** | **S** | **S** |
| **CO3** | **S** | **S** | **M** | **M** | **S** | **M** | **S** | **M** | **M** | **S** |
| **CO4** | **M** | **M** | **M** | **M** | **S** | **S** | **M** | **M** | **M** | **M** |
| **CO5** | **S** | **S** | **M** | **M** | **S** | **S** | **M** | **S** | **S** | **S** |

\*S-Strong; M-Medium; L-Low

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| **Course code** | | **23D** | **BIOSTATISTICS** | | **L** | **T** | | **P** | **C** |
| **CORE VIII** | | | **4** | **-** | | **-** | **4** |
| **Pre-requisite** | | | **Basic understanding research design, presentation**  **and interpretation of the results Ve** | | **Syllabus**  **rsion** | | **2021-**  **2022** | | |
| **Course Objectives:** | | | | | | | | | |
| The main objectives of this course are to:   1. The role of Biostatistics is tremendous in all branches of life sciences. 2. It serves as the base to analyze and understand the sample outcomes with comparative and probability based studies. | | | | | | | | | |
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| **Expected Course Outcomes:** | | | | | | | | | |
| On the successful completion of the course, students will be able to: | | | | | | | | | |
| 1 | Biostatistics is the tool to analyze and interpret the results of the biological research. This course helps the students to understand the role  of biostatistics. | | | K1, K2 & K3 | | | | | |
| 2 | The various methods of analysis have also been dealt in this course, which helps the students to get clear information’s regarding the  biostatistical analysis. | | | K1, K2, K3, K4  & K5 | | | | | |
| 3 | This course also deals with the computational tools of analysis for  biological research. | | | K1, K2, K3, K4  & K5 | | | | | |
| 4 | Better way to present the research data. | | | K1, K2, K3, K4  & K5 | | | | | |
| 5 | To derive positive interpretation and better outcomes of the results. | | | K1, K2, K3, K4  & K5 | | | | | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create | | | | | | | | | |
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| **Unit: 1** | | **STATISTICAL INVESTIGATION** | | | **14 hours** | | | | |
| Statistical population and sample in biological studies, variables, qualitative and quantitative measures, discrete and continuous series. Sampling methods: probability and non–probability methods, classification of data, representation of data, frequency distribution, tables, diagram and  graph. | | | | | | | | | |
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| **Unit: 2** | | **MEASURES OF CENTRAL TENDENCY**  **AND DISPERSION** | | | **14 hours** | | | | |
| Measures of central tendency: mean, median and mode. Measures of dispersion: range, mean deviation, quartile deviation, standard deviation, variance, standard error. Probability, addition and multiplication rules, Bayes theorem, Probability distribution: binomial, poisson and normal  distribution. | | | | | | | | | |

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| **Unit: 3** | | **CORRELATION, REGRESSION AND CHI-SQUARE** | **14 hours** |
| Correlation: types, methods of correlation, graphic method, Karl Pearson’s correlation, Spearman  Rank correlation. Regression analysis, equation, estimation of unknown value from known value. Chi–square test, test of independence, test for goodness of fit and homogenecity. | | | |
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| **Unit: 4** | | **TESTING SIGNIFICANCE** | **14 hours** |
| Testing of hypothesis: Null and alternate hypothesis, test for significance for large samples **–**  based on mean, standard deviation, correlation coefficient and test for significance for small samples. Vital Statistics. | | | |
| **Unit: 5** | | **ANOVA** | **14 hours** |
| ANOVA:One way and two way classification. Statistical analysis of Duncan’s multiple range test, weighted pair group method with arithmetic mean and unweighted pair group method with arithmetic mean methods. Software used in statistical analysis. Statistics in Human Genetics.  Artificial intelligence and data science. | | | |
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| **Unit:6** | | **CONTEMPORARY ISSUES** | **2 hours** |
| Expert lectures, online seminars – webinars | | | |
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|  | | **Total Lecture hours** | **72 hours** |
| **Text Book(s)** | | | |
| 1 | Biostatistics: A foundation for analysis in the Health Sciences by Wayne W. Daniel.  Published by Wiley India. | | |
| 2 | Statistics in Human Genetics by Pak Sham. Published by Aronald Publishers. | | |
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| **Reference Books** | | | |
| 1 | Statistical Methods (44th edition) by S.P. Gupta. Published by Sulton Chand and Sons  Publishers. | | |
| 2 | Introductory Statistics (7thEdition) by Prem S. Mann. Published by John Wiley and Sons  (ASIA) Pvt Ltd. | | |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
| 1 | <https://swayam.gov.in/nd1_noc20_ma22/preview> | | |
| 2 | <https://swayam.gov.in/nd2_cec20_mg04/preview> | | |
| 3 | <https://www.classcentral.com/course/swayam-probability-and-statistics-5228> | | |
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| **Mapping with Programme Outcomes** | | | | | | | | | | |
| **Cos** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **L** | **L** | **L** | **M** | **M** | **L** | **S** | **S** | **M** | **M** |
| **CO2** | **L** | **L** | **L** | **M** | **M** | **L** | **S** | **S** | **M** | **M** |
| **CO3** | **L** | **L** | **L** | **M** | **M** | **L** | **S** | **S** | **M** | **M** |
| **CO4** | **L** | **L** | **L** | **M** | **M** | **L** | **S** | **S** | **M** | **M** |
| **CO5** | **L** | **L** | **L** | **M** | **M** | **L** | **S** | **S** | **M** | **M** |

\*S-Strong; M-Medium; L-Low

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| **Course code** | | **23P** | **HUMAN CYTOGENETICS, MEDICAL GENETICS, DEVELOPMENTAL AND BEHAVIORAL GENETICS AND**  **BIOSTATISTICS** | **L** | **T** | **P** | | | **C** |
| **CORE PRACTICAL *–* II** | | | **-** | **-** | **6** | | | **4** |
| **Pre-requisite** | | | **Basic knowledge in chromosome, genetic**  **materials and developmental biology** | **Syllabus**  **Version** | | | **2021-22** | | |
| **Course Objectives:** | | | | | | | | | |
| The main objectives of this course are to:   1. The students will gain the ability to analyze and assess the genetic defects through performing cytogenetic techniques in fundamental molecular genetic 2. To motivate students in developing techniques and methods to identify mutations in genetic diseases. 3. Make awareness in use of model organism (Drosophila) for various developmental and behavioral analysis 4. Import the significance of statistics in research through practical exposure in SPSS software | | | | | | | | | |
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| **Expected Course Outcomes:** | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | |
| 1 | Student can gain the practical knowledge on chromosomes and its related aberrations. They can be able to expand their knowledge on the chromosomal basis of inheritance and would be able to identify the type of chromosomal alterations using various  cytogenetic techniques. | | | | | | | K5 | |
| 2 | Capable of performing tests that can identify the exact genetic modifications present in  different diseases that are rare and complicated | | | | | | | K4,K5,  K6 | |
| 3 | Observe the change in the behavior by applying the various developmental study  techniques | | | | | | | K6 | |
| 4 | Validate the quality of any data from the research for the precise identification of the  research outcomes | | | | | | | K3 | |
| 5 | Apply the cytogenetic, medical genetic and behavioral assays for diagnosis of diseases  and disorders | | | | | | | K3 | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create | | | | | | | | | |
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| **HUMAN CYTOGENETICS**   1. Problems related to Mendelian laws 2. Peripheral blood leukocyte culture for chromosomal studies 3. Sister chromatid exchange 4. Blood Micronucleus test 5. Chromosomal disorders: Numerical and Structural 6. COMET assay 7. Lymphoblastic stem cells | | | | | | | | | |

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| **MEDICAL GENETICS**   1. Gene polymorphism study using RAPD 2. Mutation identification by RFLP 3. DNA fragmentation Assay 4. Western blotting analysis 5. Detection of mutation by ARMS-PCR 6. Identification of the sickle cell anemia 7. Case study on eye disorders   **DEVELOPMENTAL AND BEHAVIORAL GENETICS**   1. Live Observation of *Drosophilla melanogaster* embryo 2. Study of gene expression during development with Lac*–*Z reporter gene in embryos 3. Live Observation of Chick embryo 4. Dissection and mounting of Imaginal disc of *Drosophila melanogaster* 5. Study of behavior in *Drosophila* model: 1. Climbing assay and 2. Flight assay 6. Dissection of brain of *Drosophila melanogaster* 7. Dissection and Visualization of Mitochondria in flight muscles 8. Case studies*,* learning disorders*,* Mental retardation   **BIOSTATISTICS**   1. Learning of SPSS software    1. Mean b) Standard Deviation c) Student t test d) chisquare test e) ANOVA 2. Graphad Prism software | | | |
|  | | **Total Lecture hours** | **108 hours** |
| **Book(s) for study** | | | |
| 1 | DP Snustad and MJ Simmons (2012) Principles of Genetics, John Willey & Sons  Publication, 6th Edition | | |
| 2 | Human Genetics 5th Edition 2017 By Gangane | | |
| 3 | Principles Of Genetics 8th Edition by Gardner | | |
| 4 | Key experiments in Practical developmental Biology. Maria-Beffa, M. and Knight, J. 2005.  Cambridge University Press | | |
| 5 | Molecular Cloning – A laboratory manual. 3rd Edition. Sambrook and Russel. Cold Spring  harbor laboratory Press. 2001.1-2331. | | |
| 6 | Principle and Practice of Medical Genetics, Rimoinet al., 2002. | | |
| **Books for Reference** | | | |
| 1 | Alberts et al., Molecular Biology of the Cell 2 nd Edition, Garland2007. | | |
| 2 | Snustad and Simmons, Principles of Genetics, 4th Edition, Wiley 2005. | | |
| 3 | Lewin, Genes IX, 9th Edition Jons and Bartlett 2007. | | |
| 4 | Methods in Molecular Biology-Genomics Protocol – Starkey, M.P. and Elaswarapu, R. | | |

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|  | 2001. Humana Press.1-538 |
| 5 | Maria-Beffa, M. and Knight. J. Key experiments in Practical developmental Biology. 2005.  Cambridge University Press. |
| 6 | Sharga, B.M., Pylypiv, D.B. and Feketa, V.P., MEDICAL BIOLOGY PRACTICALS.  GENETICS. |
| 7 | Gelehrter, T.D., Collins, F.S. and Ginsburg, D., 1998. *Principles of medical genetics*.  Lippincott Williams & Wilkins. |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | |
| 1 | https:/[/www.ncbi.nlm.nih.gov/pm](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1684083/)c[/articles/PMC1684083/](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1684083/) |
| 2 | https://fypuxumoboz.hotellewin.com/human-cytogenetics-book-14960yw.php |
| 3 | https://[www.sheffield.ac.uk/bms/undergrad/modules/bms6083](http://www.sheffield.ac.uk/bms/undergrad/modules/bms6083) |
| 4 | https:/[/www.jove.com/v/5325/an](http://www.jove.com/v/5325/an-introduction-to-developmental-genetics)-[introduction-to-developmental-genetics](http://www.jove.com/v/5325/an-introduction-to-developmental-genetics) |
| 5 | <https://www.ncbi.nlm.nih.gov/books/NBK61999/?term=MEDICAL%20Genetics> |
| 6 | <https://www.ncbi.nlm.nih.gov/books/NBK21766/?term=RFLP> |
| 7 | <https://www.ncbi.nlm.nih.gov/books/NBK21248/?term=RFLP> |
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| **Mapping with Programme Outcomes** | | | | | | | | | | |
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** |
| **CO2** | **M** | **M** | **M** | **M** | **S** | **S** | **S** | **S** | **S** | **S** |
| **CO3** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** |
| **CO4** | **L** | **S** | **L** | **S** | **S** | **S** | **M** | **S** | **S** | **S** |
| **CO5** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** |

\*S-Strong; M-Medium; L-Low

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| **Course code** | | **2EC** | **BIO INSTRUMENTATION** | **L** | | **T** | | **P** | **C** |
| **ELECTIVE–II** | | | **4** | | **-** | | **-** | **4** |
| **Pre-requisite** | | | **Basic understanding about Instrumentation** | **Syllabus Version** | | | **2021-22** | | |
| **Course Objectives:** | | | | | | | | | |
| The main objectives of this course are to:   1. To teach the principal, working mechanism and applications of instruments in biology,. 2. To learn to operate the instruments in different fields of biology. 3. To understand the imaging techniques useful for field of sciences. | | | | | | | | | |
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| **Expected Course Outcomes:** | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | |
| 1 | Learning of various types of centrifugation techniques | | | | | | | K1&K2 | |
| 2 | Able to understand the electrophoresis techniques and its applications | | | | | | | K3&K4 | |
| 3 | Inculcate the students with the knowledge of handling radioactive materials and  use | | | | | | | K4,K5&K6 | |
| 4 | Able to Understand the principles of spectrophotometry and importance | | | | | | | K4 | |
| 5 | It’s mainly used for students to learn basic principles, working mechanism and  applications of all microscopic techniques. | | | | | | | K5 | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create | | | | | | | | | |
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| **UNIT-1** | | **CENTRIFUGATION** | | | | **14 hours** | | | |
| Principles of centrifugation, different types of instruments, rotors and its applications. Chromatography: Principles and application of adsorption, partition and ion, exchange chromatography, gel filtration, affinity, high performance liquid chromatography and gas liquid  chromatography. | | | | | | | | | |
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| **UNIT-2** | | **ELECTROPHORESIS** | | | | **14 hours** | | | |
| : Moving boundary and zonal electrophoresis, gel electrophoresis (Native PAGE, SDS PAGE, agarose gel electrophoresis, Real Time PCR), isoelectric focusing technique.  Immunoelectrophoresis, ELISA and RIA. Sequencing: NGS and Sanger sequencing. | | | | | | | | | |
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| **UNIT-3** | | **RADIOACTIVITY AND IT’S APPLICATION** | | | **14 hours** | | | | |
| Disintegration of radionuclides, half–life of radioactive compounds, determination of radioactivity by Geiger Muller counter and scintillation counting, isotopic tracer techniques and autoradiography.  Applications of radio isotopes in biological and medical sciences. | | | | | | | | | |
| **UNIT-4** | | **SPECTROPHOTOMETRY** | | | **14 hours** | | | | |
| Beer, Lamberts law, extinction coefficient and its importance, design of colorimeter and  spectrophotometer. Flow Cytometry, Principles of atomic absorption spectrophotometry, circular | | | | | | | | | |

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| dichroism spectroscopy and its application in Biology. Principles and applications of x–ray  diffraction and NMR in structure determination. | | | | | | | | | | | | |
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| **UNIT-5** | | | **MICROSCOPE** | | | | | | | | **14 hours** | |
| Principles and Applications of Light, Phase Contrast, Fluorescence Microscopy, Scanning and Transmission Electron Microscopy, Confocal Microscopy, Cytophotometry and Flow Cytometry,  advances of microscopy. | | | | | | | | | | | | |
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| **UNIT-6** | | | **CONTEMPORARY ISSUES** | | | | | | | | **2 hours** | |
| Expert lectures, online seminars – webinars | | | | | | | | | | | | |
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|  | | | **Total Lecture hours** | | | | | | | | **72 hours** | |
| **Text Book(s)** | | | | | | | | | | | | |
| 1 | Instrumental methods of chemical analysis, P.K. Sharma | | | | | | | | | | | |
| 2 | Handbook of Biomedical Instrumentation, R.S. Khandpur, Tata McGraw Hill | | | | | | | | | | | |
|  | | | | | | | | | | | | |
| **Reference Books** | | | | | | | | | | | | |
| 1 | Skoog, D.A. et al., “Principles of Instrumental Analysis”, 5th Edition, Thomson / Brooks, Cole,  1998. | | | | | | | | | | | |
| 2 | Braun, R.D. “Introduction to Instrumental Analysis”, Pharma Book Syndicate, 1987. | | | | | | | | | | | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | | | | | | | | | | |
| 1 | <https://nptel.ac.in/courses/102/103/102103044/> | | | | | | | | | | | |
| 2 | [https://www.google.com/search?q=Electrophoresis+(Part+1)%3ABasic+Concept+of+Electroph](https://www.google.com/search?q=Electrophoresis%2B(Part%2B1)%3ABasic%2BConcept%2Bof%2BElectrophoresis%2C%2Bperformance%2Bof%2Belectrophoresis%2Band%2Bits%2Bapplications&oq)  [oresis%2C+performance+of+electrophoresis+and+its+applications&oq=](https://www.google.com/search?q=Electrophoresis%2B(Part%2B1)%3ABasic%2BConcept%2Bof%2BElectrophoresis%2C%2Bperformance%2Bof%2Belectrophoresis%2Band%2Bits%2Bapplications&oq) | | | | | | | | | | | |
| 3 | <https://nptel.ac.in/courses/108/105/108105064/> | | | | | | | | | | | |
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| Mapping with Programme Outcomes | | | | | | | | | | | | |
| **Cos** | | **PO1** | | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | | **L** | | **L** | **L** | **L** | **M** | **M** | **S** | **M** | **S** | **S** |
| **CO2** | | **M** | | **L** | **L** | **M** | **M** | **S** | **S** | **L** | **L** | **S** |
| **CO3** | | **L** | | **L** | **M** | **M** | **S** | **S** | **S** | **L** | **S** | **S** |
| **CO4** | | **L** | | **L** | **L** | **L** | **M** | **S** | **S** | **L** | **L** | **S** |
| **CO5** | | **L** | | **L** | **L** | **M** | **M** | **S** | **S** | **M** | **M** | **S** |

\*S-Strong; M-Medium; L-Low

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| **Course code** | | **2ED** | **NANOBIOLOGY** | **L** | | | **T** | **P** | **C** |
| **ELECTIVE-II** | | | **4** | | | **-** | **-** | **4** |
| **Pre-requisite** | | | **Basic understanding about nanoparticles**  **and nanotechnology** | **Syllabus**  **Version** | | | | **2021-22** | |
| **Course Objectives:** | | | | | | | | | |
| The main objectives of this course are to:   1. Understand the origin, development and application of Nanotechnology. 2. Measure the level of development of Nanotechnology in healthcare sectors. 3. Estimate the dispersal and cause of nanoparticle in the environment and associated health hazards. | | | | | | | | | |
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| **Expected Course Outcomes:** | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | |
| 1 | Understand the foundation and advancement of nanotechnology | | | | | | | K2 | |
| 2 | Apply the methods and instruments used for nanoparticle synthesis and  characterization. | | | | | | | K3 | |
| 3 | Distinguish the nanoparticles and its application in healthcare industry such as  treatment and therapies. | | | | | | | K4 | |
| 4 | Create the awareness about the route of entry of nanoparticle into our body | | | | | | | K5 | |
| 5 | Distinguish merit and demerits of nanoparticles of clinical significance | | | | | | | K4 | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create | | | | | | | | | |
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| **Unit:1** | | **INTRODUCTION TO NANOTECHNOLOGY** | | | | **12 hours** | | | |
| Introduction and History of Nanotechnology, Emergence of Nanotechnology*,* carbon age*,* new  form of carbon, Challenges in Nanotechnology, Occurrence of cells and systems in Nanoscale. | | | | | | | | | |
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| **Unit:2** | | **SYNTHESIS AND ANALYSIS OF NANOPARTICLES** | | | | **14 hours** | | | |
| Synthesis of metals (Au, Ag) and Metal oxides (TiO2, CeO2, ZnO) Nanoparticles. Characterization Techniques: Infra red spectroscopy (IR), UV*–*visible*,* Absorption and Diffraction analyses X*–*ray diffraction. Scanning Electron Microscope (SEM) with Energy Dispersive Spectroscopy*,* Transmission Electron Microscopy (TEM), Atomic Adsorption  Spectroscopy. | | | | | | | | | |
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| **Unit:3** | | **NANODIAGNOSTICS AND BIOSENSORS** | | | **14 hours** | | | | |
| Nanomolecular diagnostics and Biosensor. Nanodiagnostics: Optamers, nanochips, Nanoparticles for molecular diagnostics*,* DNA nanomachines*,* CNT biosensor*,* application of nanodiagnostics,  Nanodevices for health care industries. | | | | | | | | | |
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| **Unit:4** | | **NANOPHARMACEUTICALS** | | | **16 hours** | | | | |

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| Nanobiotechnology for drug discovery*,* peptide drugs for cancer and diabetes*,* nanoparticle based drug delivery, Sustainable release, micelles, lipid nanoparticles*,* vaccination*,* nanocell therapy*,*  and Gene therapy. | | | |
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| **Unit:5** | | **HEALTH IMPACT OF NANOMATERIALS** | **14 hours** |
| Bionanoparticles*,* Toxicity of nanomaterials in health care industries. Handling of Nanomaterials*,*  entry routes into the human body: Lungs*,* inhalation*,* deposition and translocation*,* intestinal tract*,* skin and eye. Nanoparticle interaction with biological membrane*,* Neurotoxicology. | | | |
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| **Unit:6** | | **CONTEMPORARY ISSUES** | **2 hours** |
| Expert lectures, online seminars – webinars | | | |
|  | | | |
|  | | **Total Lecture hours** | **72 hours** |
| **Text Book(s)** | | | |
| 1 | Textbook of Nanoscience and Nanotechnology. T. Pradeep. 2012. McGraw Hill Education  (India) Private Limited | | |
|  | | | |
| **Reference Books** | | | |
| 1 | Kewal K. Jain, The Hand book of Nanomedicine, Humana Press, Springer 2008. | | |
| 2 | Dr. ParagDiwan and Ashish Bharadwaj (Eds), Nano Medicines, Pentagon Press, 2006 | | |
| 3 | C.N.R. Rao, A. Muller, A.K. Cheetham (Eds), The chemistry of nanomaterials: Synthesis,  properties and applications, Wiley VCH VerlagGmbh and Co, Weinheim, 2004. | | |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
| 1 | <https://swayam.gov.in/nd1_noc19_bt23/preview> | | |
| 2 | <https://nptel.ac.in/courses/102/107/102107058/> | | |
| 4 | <https://nptel.ac.in/courses/118/107/118107015/> | | |
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| **Mapping with Programme Outcomes** | | | | | | | | | | |
| **Cos** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **L** | **L** | **L** | **L** | **L** | **S** | **S** | **M** | **M** | **S** |
| **CO2** | **L** | **L** | **M** | **L** | **L** | **S** | **S** | **M** | **M** | **S** |
| **CO3** | **L** | **L** | **M** | **M** | **S** | **M** | **S** | **M** | **M** | **S** |
| **CO4** | **L** | **L** | **L** | **M** | **S** | **M** | **M** | **M** | **S** | **M** |
| **CO5** | **L** | **L** | **M** | **M** | **S** | **M** | **S** | **M** | **S** | **M** |

\*S-Strong; M-Medium; L-Low

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| **Course code** | | **--** | **PHARMACOGENOMICS AND CHEMINFORMATICS** | **L** | | | **T** | **P** | **C** |
| **ELECTIVE II** | | | **4** | | | **-** | **-** | **4** |
| **Pre-requisite** | | | **Basic understanding about bioinformatics** | **Syllabus Version** | | | **2021-22** | | |
| **Course Objectives:** | | | | | | | | | |
| The main objectives of this course are to:   1. This course gives an introduction to the application of genetic and genomic methods to explain about the drug response and the genetic basis for variation in that response. 2. It will give the students a wide viewpoint on the emergence Pharmacogenomics as a new field and also provides the approaches into the growing importance in the clinical therapeutics and future drug design. 3. It has been described as the application of informatics methods to solve chemical problems. It | | | | | | | | | |
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| **Expected Course Outcomes:** | | | | | | | | | |
| On the successful completion of the course, students will be able to: | | | | | | | | | |
| 1 | Understanding the basics of Pharmacogenomics will facilitate the students to better  understand and manage the new genomics based tools for the best treatment choices. | | | | | | | K1,  K2 & | |
| 2 | The genetic basis of variability in the drug response can contribute to the drug efficacy and toxicity, adverse drug reactions as well as the drug-drug interactions. | | | | | | | K1,  K2 & K3 | |
| 3 | To impart knowledge on chemical databases, various advanced techniques and tools,  which employed in computational drug discovery. | | | | | | | K1 &  K2 | |
| 4 | To impart knowledge about computation tools available in research. | | | | | | | K1 &  K2 | |
| 5 | Make understanding about the database available and retrieving data. | | | | | | | K1 &  K4 | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create | | | | | | | | | |
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| **Unit: 1** | | **PHARMACOGENOMICS** | | | | **14 hours** | | | |
| Pharmacogenomics: Introduction, basic concepts about genetics diseases. Personalized medicine: Introduction and importance. The genetics of therapeutic targets and gene based targets.  Pharmacogenomics – necessity in drug designing. | | | | | | | | | |
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| **Unit: 2** | | **DRUG ANALYSIS** | | | | **14 hours** | | | |
| Drug response to patients, structural influence in the Drug response. Efficacy and metabolism of drugs. Pharmacogenomics *vs.* Structural Pharmacogenomics. Drug metabolism pathways and  adverse drug reactions. | | | | | | | | | |
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| **Unit: 3** | | **TOOLS FOR PHARMACOGENOMIC ANALYSIS** | | | **14 hours** | | | | |
| Tools for pharmacogenomic analysis. Pharmacokinetics, Pharmacodynamics. Process in Structural | | | | | | | | | |

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| Pharmacogenomics – Target Structure optimization, Validation, lead identification, ADME  prediction, synthesis, assays and Clinical trials. | | | |
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| **Unit: 4** | | **CHEMINFORMATICS** | **14 hours** |
| Cheminformatics: Introduction, origin and scope, applications in drug discovery and development,the old bottlenecks and HTS Technologies, Combinatorial chemistry. Recent  Development and Challenges in Cheminformatics. | | | |
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| **Unit: 5** | | ***IN SILICO* APPROACH** | **14 hours** |
| *In silico* chemistry: Data processing and data output problems. Molecular modeling, structure and substructure searches, Pubchem, compound databases, structural file conversion, smiles. Molecular drawer chemsketch, JAVA Mol. editor, drug like liners, molecular properties and bioactivity prediction. Computer-assisted structure elucidation. Database mining for computer-  assisted knowledge discovery. | | | |
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| **Unit:6** | | **CONTEMPORARY ISSUES** | **2 hours** |
| Expert lectures, online seminars – webinars | | | |
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|  | | **Total Lecture hours** | **72 hours** |
| **Text Book(s)** | | | |
| 1 | Genetics, Genomics, Proteomics & Bioinformatics, by Rajeev Tyagi and Yougesh Kumar.  Published by Mangalam Publishers and Distributors. | | |
| 2 | Pharmacogenetics by Ian P. Hall and MunirPir Mohamed. Taylor and Francis. | | |
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| **Reference Books** | | | |
| 1 | Pharmacogenomics An Introduction and Clinical Perspective. BY Joseph S. Bertino, Angela  Kashuba, Joseph D. Ma, UweFuhr, C. Lindsay DeVane. Published by Mc-Grow Hill Publications. | | |
| 2 | Chemoinformatics: Basic Concepts and Methods by Thomas Engel, Johann Gasteiger.  Published by John Willey and Sons. | | |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
| 1 | <https://swayam.gov.in/nd1_noc20_bt10/preview> | | |
| 2 | <https://swayam.gov.in/nd2_cec20_bt03/preview> | | |
| 3 | [https://www.classcentral.com/course/swayam-bioinformatics-algorithms-and-applications-](https://www.classcentral.com/course/swayam-bioinformatics-algorithms-and-applications-10031)  [10031](https://www.classcentral.com/course/swayam-bioinformatics-algorithms-and-applications-10031) | | |
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| **Mapping with Programme Outcomes** | | | | | | | | | | |
| **Cos** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **S** | **S** | **S** | **S** | **S** | **M** | **S** | **M** | **L** | **M** |
| **CO2** | **S** | **S** | **S** | **S** | **S** | **M** | **S** | **M** | **L** | **M** |
| **CO3** | **S** | **S** | **S** | **S** | **S** | **M** | **S** | **M** | **L** | **M** |
| **CO4** | **S** | **S** | **S** | **S** | **S** | **M** | **S** | **M** | **L** | **M** |
| **CO5** | **S** | **S** | **S** | **S** | **S** | **M** | **S** | **M** | **L** | **M** |

\*S-Strong; M-Medium; L-Low

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| **Course code** | | **33A** | **IMMUNOGENETICS** | **L** | | **T** | **P** | **C** |
| **CORE-IX** | | | **4** | | **-** | **-** | **4** |
| **Pre-requisite** | | | **Basic understanding about blood cells and**  **antigen** | **Syllabus**  **Version** | | | **2021-22** | |
| **Course Objectives:** | | | | | | | | |
| The main objectives of this course are to:   1. Understand the basics of immune cells, development and maturation. 2. Create ability to distinguish different types of Immunoglobulin and role of HLA in transplantation. 3. Teach the background information of vaccines, its development, uses and the techniques to   measure the quantity in clinical diagnosis | | | | | | | | |
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| **Expected Course Outcomes:** | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | |
| 1 | Understand the basic architect of immunology such as Immunity, immune cells  and organs. | | | | | | K2 | |
| 2 | Write the role of immune response stimulating proteins | | | | | | K3 | |
| 3 | Differentiate the pathways involved in defending the antigen and other immune  modulating members | | | | | | K4 | |
| 4 | Understand the background informations about the vaccine preparation | | | | | | K3 | |
| 5 | Analyse the antigen and antibody interacts and how their interaction will be  visualized in ELISA and immunoelectrophoresis | | | | | | K2 | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create | | | | | | | | |
|  | | | | | | | | |
| **Unit:1** | | **BASICS OF IMMUNOLOGY** | | | **18 hours** | | | |
| Historical perspective, lymphoid organs, lymphocytes. Cells of immune system, T and B cell activation and maturation, Haematopoiesis, Haematopoitic stem cells, apoptosis and necrosis. Immunoglobulins, Class switching, Antigens. The molecular basis of antigen and antibody  interactions. Types of immunity and immune responses. | | | | | | | | |
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| **Unit:2** | | **PATHWAYS AND IMMUNOREGULATORS** | | | **10 hours** | | | |
| Cytokines, interleukins, complement system*,* the classical pathway, alternate pathway and the  membrane attack pathway. Immunostimulation, Immunosupression and its clinical significance, Immunopotentiation*,* adjuvants | | | | | | | | |
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| **Unit:3** | | **MHC AND DISEASE IMMUNOLOGY** | | **16 hours** | | | | |
| Immunogenetics in anthropology, MHC gene in man and mouse, Genomic map, gene expression,  antigen presentation and processing by MHC class I and class II molecules. Tissue typing and | | | | | | | | |

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| organ transplantation, HLA assays, Immunoinformatics. Autoimmune diseases and application of Artificial Intelligence in autoimmune disease, Transplantation Immunology, Tumour Immunology,  Immunobiology of HIV infection. | | | |
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| **Unit:4** | | **VACCINES** | **14 hours** |
| Immunization, active and passive. Vaccines: whole organism vaccine, synthetic peptide vaccine, multivalent subunit–vaccine, anti idiotype vaccine, designer vaccine, edible vaccine, DNA vaccine, recombinant vector vaccine. Production and applications of monoclonal antibodies, genetically  engineered monoclonal antibodies, Abzymes, Vaccinomics and Adversomics. | | | |
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| **Unit:5** | | **IMMUNOTECHNIQUES** | **12 hours** |
| Immunoprecipitation, ImmunoelectrophoresisRadioimmuno Assay, ELISA, Immunofluoresence  technique, Immune–histochemistry, Karyotyping. | | | |
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| **Unit:6** | | **CONTEMPORARY ISSUES** | **2 hours** |
| Expert lectures, online seminars – webinars | | | |
|  | | | |
|  | | **Total Lecture hours** | **72 hours** |
| **Text Book(s)** | | | |
| 1 | Essential Immunogenetics. A. R. Williamson and M.W. Turner. 1987. Blackwell Scientific  Publication | | |
|  | | | |
| **Reference Books** | | | |
| 1 | Kuby, J., 2008, Immunology, W.H. Freeman and Co., New York. | | |
| 2 | Roit, I.N., Brostaff, J.J. and Male, D.K., 2007, Immunology, C. Mosby, St. Louis. | | |
| 3 | Murphy, K., Travers, P., and M. Walport. 2008. 7th- Jane way’s- Immunobiology-Garland  Science (Taylor and Francis) | | |
|  | | | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
| 1 | <https://swayam.gov.in/nd2_cec20_bt05/preview> | | |
| 2 | <https://swayam.gov.in/nd1_noc20_bt43/preview> | | |
| 4 | <https://nptel.ac.in/courses/102/105/102105083/> | | |
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| **Mapping with Programme Outcomes** | | | | | | | | | | |
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **M** | **S** | **S** | **M** | **S** | **S** | **S** | **L** | **M** | **S** |
| **CO2** | **M** | **M** | **L** | **L** | **S** | **S** | **S** | **M** | **M** | **S** |
| **CO3** | **S** | **S** | **M** | **L** | **S** | **S** | **S** | **M** | **S** | **M** |
| **CO4** | **M** | **M** | **M** | **L** | **S** | **S** | **S** | **M** | **S** | **S** |
| **CO5** | **M** | **S** | **M** | **L** | **S** | **S** | **S** | **M** | **S** | **S** |

\*S-Strong; M-Medium; L-Low

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| **Course code** | | **33B** | **CANCER GENETICS** | **L** | | | **T** | **P** | **C** |
| **CORE-X** | | | **4** | | | **-** | **-** | **4** |
| **Pre-requisite** | | | **Basic Understanding in cell biology and**  **cancer genetics** | **Syllabus**  **Version** | | | | **2021-22** | |
| **Course Objectives:** | | | | | | | | | |
| The main objectives of this course are to:   1. To understand the various types of cancers and their prevalence 2. To understand the molecular basis and functional aspect of various genes involved in progression of cancer 3. To make them find out various pathways involved in various cancers and to equip the   students with the existing and novel therapeutic approaches for controlling cancer growth | | | | | | | | | |
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| **Expected Course Outcomes:** | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | |
| 1 | Able to understand the status of Cancer worldwide and types. | | | | | | | K1&K2 | |
| 2 | Capable of Understanding the transformation and progression cancer | | | | | | | K2&K4 | |
| 3 | Able to understand the role of genes in cancer developments | | | | | | | K2 | |
| 4 | Inculcating the knowledge in the field of chromosome abnormalities in cancer  progression | | | | | | | K4&K5 | |
| 5 | Able to understand familial association of cancer | | | | | | | K5&K6 | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create | | | | | | | | | |
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| **UNIT:1** | | **CANCER HISTORY AND TYPES** | | | | **14 hours** | | | |
| scope and current scenario of cancer research. Cancer: Types and their prevalence, Carcinoma, Lymphoma and Malignancy. Classification based on tissue types. Molecular biology of tumor  invasion and metastasis. | | | | | | | | | |
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| **UNIT:2** | | **CELL TRANSFORMATION AND TUMOURIGENESIS** | | | | **14 hours** | | | |
| oncogenes, tumour suppressor genes, DNA repair genes and genetic instability, epigenetic & Post translational modifications, telomerase activity, centrosome malfunction. Tumour  progression: angiogenesis and metastasis. | | | | | | | | | |
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| **UNIT:3** | | **ONCOGENES AND HUMAN CANCERS:** | | | **14 hours** | | | | |
| Role of proto– oncogenes in regulating cell growth and survival, mechanisms of activation of oncogenes, retro viral activation , point mutations, fusion genes, gene amplification, chromosome rearrangements, promoter insertion, tumour suppressor genes . Cell cycle and Cancer ,  Knudson’s two hit hypothesis. | | | | | | | | | |
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| **UNIT:4** | | **CHROMOSOME ABNORMALITIES** | **14 hours** |
| Chronic myeloid leukemia, Chronic lymphocytic leukemia, Acute myeloid leukemia, Acute lymphoblastic leukemia, Myelodysplastic syndromes, Myeloproliferative disorders, Hodgkin’s  disease, non Hodgkin’s lymphoma, Burkitt’s lymphoma. | | | |
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| **UNIT:5** | | **FAMILIAL CANCERS, BIOMARKERS AND**  **THERAPY** | **14 hours** |
| **Familial cancers, Biomarkers and Therapy** : Retinoblastoma, Wilm’stumour, Li– Fraumeni syndrome, Colorectal cancer and Breast cancer. Cancer therapy: At cellular, gene and protein level. Stages of cancer – TNM classification. Principles of cancer biomarker and their  applications, chemotherapeutics for cancer, Phytotherapy for cancer. Advance therapies in cancer | | | |
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| **UNIT:6** | | **CONTEMPORARY ISSUES** | **2 hours** |
| Expert lectures, online seminars – webinars | | | |
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|  | | **Total Lecture hours** | **72 hours** |
| **Text Book(s)** | | | |
| 1 | The Biology of Cancer, R.A. Weinberg, Garland Science, Taylor and Francis Group, 2007. | | |
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| **Reference Books** | | | |
| 1 | Cancer Biology,3rd ed., R.J.B. King and M.W. Robbins, Pearson Education Ltd., 2006. | | |
| 2 | Cancer cytogenetics,chromosomal and molecular genetic aberrations of tumor cells,3rd ed.,  S.Heim and F. Mitelman, Wiley,Blackwell Inc., 2009. | | |
| 3 | Human cytogenetics: malignancy and acquired abnormalities,a practical approach,3rd ed.,  D.E. Rooney, Oxford University Press, 2001. | | |
| 4 | ISCN 2013 An International System for Human Cytogenetic Nomenclature (2013),Recommendations of the International Standing Committee on Human Cytogenetic  Nomenclature, L.G. Shaffer, J. McGowan,Jordan and M. Schmid, S. Karger, 2013. | | |
| 5 | Introduction to the Cellular and Molecular Biology of Cancer,4th ed., M.A. Knowles and  P.J. Selby, Oxford University Press, 2005. | | |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
| 1 | <https://swayam.gov.in/nd2_cec20_ma14/preview> | | |
| 2 | <https://www.sciencedirect.com/science/article/pii/S0753332220304479> | | |
| 4 | <https://pubmed.ncbi.nlm.nih.gov/30671672/> | | |
| 5 | <https://www.ncbi.nlm.nih.gov/books/NBK9963/> | | |
| 6 | <https://oncologypro.esmo.org/education-library/esmo-e-learning-and-v-learning> | | |
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| **Mapping with Programme Outcomes** | | | | | | | | | | |
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **L** | **L** | **L** | **S** | **S** | **S** | **M** | **L** | **S** | **M** |
| **CO2** | **M** | **S** | **M** | **S** | **S** | **S** | **M** | **M** | **M** | **S** |
| **CO3** | **S** | **S** | **M** | **S** | **S** | **S** | **L** | **M** | **S** | **S** |
| **CO4** | **S** | **M** | **S** | **S** | **S** | **S** | **M** | **L** | **M** | **S** |
| **CO5** | **M** | **S** | **M** | **S** | **S** | **M** | **L** | **L** | **S** | **M** |

\*S-Strong; M-Medium; L-Low

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| **Course code** | | **33C** | **NEUROGENETICS AND EPIGENETICS** | **L** | | **T** | | **P** | **C** |
| **CORE-XI** | | | **4** | | **-** | | **-** | **4** |
| **Pre-requisite** | | | **Basic understanding about Neurological**  **functions** | **Syllabus**  **Version** | | | | **2021-**  **2022** | |
| **Course Objectives:** | | | | | | | | | |
| The main objectives of this course are to:   1. Neuroscience is study of nervous system, whose ultimate goal is to understand higher brain function at a variety of levels. 2. This course provides the learners with current knowledge about common neuro diseases and disorders from both a basic research and a clinical perspective 3. Epigenetics explain the key concepts of what epigenetics is, types of epigenetic modifications,   the importance of epigenetics and how it can be related to disease. It also discusses how diet can have an impact on health and disease through epigenetics. | | | | | | | | | |
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| **Expected Course Outcomes:** | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | |
| 1 | Being a human genetics student, able learn about nervous systems and their  functions | | | | | | K2&K1 | | |
| 2 | Understand the diseases associated with nervous systems | | | | | | K2&K5 | | |
| 3 | Inculcate the knowledge on degenerative brain diseases | | | | | | K3&K4 | | |
| 4 | The epigenetic basis of the nervous disorders is discussed along with the  associated risks that help the students to attain knowledge regarding the same. | | | | | | K4 | | |
| 5 | Capable of understanding the epigenetics disease and therapy | | | | | | K3&K6 | | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create | | | | | | | | | |
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| **Unit:1** | | **ORGANIZATION OF THE NERVOUS SYSTEM** | | | **14 hours** | | | | |
| Organization of the nervous system. Histology of the nervous tissue: supporting cells and neurons. Neurophysiology: Resting membrane potential, Membrane potentials and signals. Synapse, postsynaptic potentials and synaptic integration. Neurotransmitters and receptors. Neuroendocrine  system. Mimicking Nervous System Advance Artificial Intelligence. | | | | | | | | | |
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| **Unit:2** | | **NEUROLOGICAL DISEASES** | | | **14 hours** | | | | |
| Autosomal (recessive and dominant) and X–linked neurological diseases. Neurodegenerative diseases, Unstable mutation (repeat expansion) causing spinocerebellar ataxias, Huntington’s disease, Myotonic dystrophy, Fragile–X syndrome. Metabolic defects causing neurological diseases  (Tay–Sach’s and Gaucher’s diseases).Diagnostic procedures for assessing neurogenetic diseases. | | | | | | | | | |
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| **Unit:3** | | **DEGENERATIVE BRAIN DISEASES** | | **14 hours** | | | | | |

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| Degenerative brain diseases: Cerebrovascular accidents, stroke, Parkinson disease and Alzheimer’s disease: history, causes, signs, symptoms, pathophysiology, diagnosis, preventions and  management. Therapeutics and novel therapeutics | | | |
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| **Unit:4** | | **MECHANISMS OF EPIGENETIC MODIFICATION** | **14 hours** |
| Epigenetics: Mechanisms of DNA methylation, histone modifications, chromosomal position effect and gene variegation, epigenetic control of gene activity, analysis of gene–specific DNA methylation, methods of assessing genome–wide DNA methylation. Model organism of epigenetics:  Drosophila | | | |
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| **Unit:5** | | **EPIGENETICS DISEASE AND THERAPY** | **14 hours** |
| Effects of diet and environmental agents on epigenetic processes. Role of epigenetic in immune  diseases and disorders. Imprinting disorders in humans. Epigenetic therapy. | | | |
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| **Unit:6** | | **CONTEMPORARY ISSUES** | **2 hours** |
| Expert lectures, online seminars – webinars | | | |
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|  | | **Total Lecture hours** | **72 hours** |
| **Text Book(s)** | | | |
| 1 | Human Anatomy and Physiology by Elaine N. Marieb and KatjaHoehn, 2012.Published by  Pearson Publisher. | | |
| 2 | Textbook of Medical Physiology (11th edition) by Arthur C Guyton and John E Hall, 2006.  Published by Elsevier Publications. | | |
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| **Reference Books** | | | |
| 1 | Handbook of Epigenetics by Tollefsbol T, 2011. Published by Elsevier Publications | | |
| 2 | Epigenetics by David C. Allis, Marie–Laure Caparros et al., 2015. Published by Cold Spring  Harbor Laboratory Press. | | |
| 3 | Practical Guide to Neurogenetics by Thomas T. Warner and Simon R. Hammans, 2009.  Published by Elsevier Ltd. | | |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
| 1 | <https://swayam.gov.in/nd1_noc19_bt24/preview> | | |
| 2 | [https://www.nextbigfuture.com/2018/12/will-mimicking-the-nervous-system-advanceartificial-](https://www.nextbigfuture.com/2018/12/will-mimicking-the-nervous-system-advanceartificial-intelligence.html)  [intelligence.html](https://www.nextbigfuture.com/2018/12/will-mimicking-the-nervous-system-advanceartificial-intelligence.html) | | |
| 3 | <https://link.springer.com/chapter/10.1007/978-3-642-22887-2_27> | | |
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| **Mapping with Programme Outcomes** | | | | | | | | | | |
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **M** | **M** | **M** | **S** | **S** | **S** | **L** | **M** | **M** | **M** |
| **CO2** | **M** | **M** | **M** | **S** | **S** | **S** | **L** | **M** | **M** | **M** |
| **CO3** | **M** | **M** | **M** | **S** | **S** | **S** | **L** | **L** | **L** | **L** |
| **CO4** | **L** | **L** | **L** | **S** | **S** | **M** | **L** | **L** | **M** | **M** |
| **CO5** | **S** | **S** | **M** | **S** | **S** | **M** | **L** | **L** | **S** | **S** |

\*S-Strong; M-Medium; L-Low

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| **Course code** | | **33D** | **BIOETHICS AND BIOSAFETY** | **L** | | **T** | | **P** | **C** |
| **CORE–XII** | | | **4** | | **-** | | **-** | **4** |
| **Pre-requisite** | | | **Basic understanding about Intellectual Property Rights, Biosafety regulation and**  **bioethics** | **Syllabus Version** | | | **2021-2022** | | |
| **Course Objectives:** | | | | | | | | | |
| The main objectives of this course are:   1. To study the details about the equipment to acquire the basic knowledge of handling instruments. 2. To acquire the knowledge on biosafety levels. 3. To know the procedure of obtaining ethical clearance. 4. To obtain knowledge on Good Laboratory Practice. 5. To gain knowledge on IPR and patents in biological research. | | | | | | | | | |
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| **Expected Course Outcomes:** | | | | | | | | | |
| On the successful completion of the course, students will be able to: | | | | | | | | | |
| 1 | Understand the ethical guidelines and biosafety procedures when handling  human samples and animal models. | | | | | K1, K2& K5 | | | |
| 2 | The importance of bioethics will be acknowledged during the course. | | | | | K2, K3 & K4 | | | |
| 3 | Students will be well-trained in operating instruments and handling samples. | | | | | K3,K4, K5 | | | |
| 4 | The course aims in good practice for students to work in the laboratory. | | | | | K2, K3 & K5 | | | |
| 5 | Helps to obtain knowledge on Intellectual Property Right in research and  development. | | | | | K2, K3 & K6 | | | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create | | | | | | | | | |
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| **Unit:1** | | **INTRODUCTION TO BIOETHICS** | | | **14 hours** | | | | |
| Introduction to bioethics in biotechnology*,* Positive effects*,* Negative effects*,* Toxic soils,  Biological Pest Controls. Fast Growing Trees*,* Fast Growing fish*,* food safety*,* Environmental, Economic and Social Concerns. | | | | | | | | | |
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| **Unit:2** | | **BIOSAFETY REGULATIONS** | | | **14 hours** | | | | |
| National and International Guidelines. Introduction, Regulation of framework in various countries,  USA, European Union, Canada, Australia, South Africa, Asian Region including India. | | | | | | | | | |
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| **Unit:3** | | **CPCSEA GUIDELINES FOR LABORATORY**  **ANIMAL FACILITY** | | | **14 hours** | | | | |
| Goal*,* Animal procurement*,* Quarantine, Sterilization*,* Surveillance, Animal care and technical  personnel*,* Multiple surgical procedures on single animal*,* Duration of experiments*,* Physical facilities*,* Environment*,* Animal husbandry*,* Activity*,* Food*,* Bedding*,* Water*,* Sanitation and | | | | | | | | | |

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| cleanliness*,* Assessing the effectiveness of sanitation*,* Waste disposal*,* Pest control*,* Emergency  measures. | | | |
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| **Unit:4** | | **GLP AND BIOETHICS** | **14 hours** |
| Introduction*,* National Good Laboratory Practice (GLP) Programme*,* The GLP authority functions*,*  quality standards for Clinical Trials*,* Clinical Trials worldwide. | | | |
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| **Unit:5** | | **INTELLECTUAL PROPERTY RIGHTS** | **14 hours** |
| An Introduction*,* Origin of the Patent Regime*,* Early patterns Act and History of Indian Patent System. The Present Scenario*,* Basis of Patentability*,* Patent Application Procedure in India*,* Patent Granted Under Convention Agreement*,* Patent Procedure*.* Artificial Intelligence – Introduction –  Intellectual Property Rights - Application of Artificial Intelligence in Intellectual Property Rights | | | |
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| **Unit:6** | | **CONTEMPORARY ISSUES** | **2 hours** |
| Expert lectures, online seminars – webinars | | | |
|  | | | |
|  | | **Total Lecture hours** | **72 hours** |
| **Text Book(s)** | | | |
| 1 | Bioethics, by Shaleesha A. Stanley (2008). Published by Wisdom Educational | | |
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| **Reference Books** | | | |
| 1 | IPR, Bioethics and Biosafety by [DeepaGoel,](https://www.google.co.in/search?tbo=p&amp%3Btbm=bks&amp%3Bq=inauthor%3A%22Deepa%2BGoel%22) [ShominiParashar.](https://www.google.co.in/search?tbo=p&amp%3Btbm=bks&amp%3Bq=inauthor%3A%22Shomini%2BParashar%22) Pearson Education India | | |
| 2 | Bioethics and Biosafety by M.K. Satheesh (2008). I. K. International PvtLtd | | |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
| 1 | <https://link.springer.com/chapter/10.1007/978-981-10-0875-7_24> | | |
| 2 | [https://books.google.co.in/books/about/Biosafety\_and\_Bioethics.html?id=IiqPrFYzRMMC&r](https://books.google.co.in/books/about/Biosafety_and_Bioethics.html?id=IiqPrFYzRMMC&redir_esc=y)  [edir\_esc=y](https://books.google.co.in/books/about/Biosafety_and_Bioethics.html?id=IiqPrFYzRMMC&redir_esc=y) | | |
| 3 | https://books.google.co.in/books/about/Bioethics\_and\_Biosafety.html?id=xP9dzbSBTZQC | | |
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| **Mapping with Programme Outcomes** | | | | | | | | | | |
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **M** | **M** | **S** | **M** | **M** | **M** | **M** | **S** | **M** | **S** |
| **CO3** | **M** | **S** | **S** | **M** | **S** | **M** | **S** | **M** | **M** | **M** |
| **CO3** | **S** | **M** | **M** | **M** | **M** | **M** | **M** | **M** | **S** | **S** |
| **CO4** | **S** | **M** | **S** | **S** | **M** | **M** | **M** | **M** | **M** | **M** |
| **CO5** | **M** | **M** | **M** | **M** | **M** | **S** | **S** | **M** | **M** | **M** |

\*S-Strong; M-Medium; L-Low

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| **Course code** | | **33P** | **IMMUNOGENETICS, CANCER GENETICS, EPIGENETICS,**  **BIOETHICS AND BIOSAFETY** | **L** | **T** | **P** | | | **C** |
| **CORE PRACTICAL *–* III** | | | **-** | **-** | **6** | | | **4** |
| **Pre-requisite** | | | **Basic knowledge in immunology,**  **cancer, genetics and bioethics** | **Syllabus**  **Version** | | | **2021-22** | | |
| **Course Objectives:** | | | | | | | | | |
| The main objectives of this course are to:   1. Equip the learners with immunotechniques for understanding the antigen antibody interaction and its use in disease diagnosis 2. Understand the functional and genetic aspect of various types of cancers and their prevalence among various races and perform various techniques for understanding the cancer stages and genetics behind its progression 3. Highlight and give hands on exposure in the epigenetic techniques for understanding mechanisms behind certain genetic changes 4. To introduce basic concepts of ethics and safety that are essential for different disciplines of   science and procedures involved and protection of intellectual property and related rights. | | | | | | | | | |
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| **Expected Course Outcomes:** | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | |
| 1 | Distinguise the various immunological reactions for the diagnosis of diseases  and disorders | | | | | | | K4 | |
| 2 | Analyze the genetic defect behind the different cancer types and their corresponding molecular mechanism and apply and evaluate various assays and  tests to develop testing kits for early diagnosis | | | | | | | K3,K4,  K5 & K6 | |
| 3 | Decipher the mode of epigenetic mechanisms creates the genetic changes | | | | | | | K4 | |
| 4 | Follow the ethics and safety measures in all areas of research and realize the  importance of IPR. | | | | | | | K3 | |
| 5 | Develop the self-sufficiency to be eligible for any medical or diagnostic works | | | | | | | K6 | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create | | | | | | | | | |
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| **IMMUNOGENETICS**   1. Serum antigen antibody interaction 2. Blood grouping test 3. Electrophoretic separation of serum proteins 4. Complement mediated haemolysis 5. Isolation and enumeration of lymphocytes from human blood 6. Determination of lymphocyte viability by Trypan blue dye exclusion test 7. Estimation of serum lysozyme and total peroxidase secretion 8. Detection of Antibody using ELISA | | | | | | | | | |

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| **CANCER GENETICS**   1. Preparation of Culture room and Media preparation. 2. Human Blood Lymphocyte Culture 3. Cell Proliferation Assay (MTT) 4. Isolation of DNA from Tissues 5. cDNA Synthesis for MMP2 gene 6. MAP Kinase activity (Demonstration) 7. Sequence similarity analysis for protein and nucleic acid using online bioinformatics tools 8. Topoisomerase relaxation assay 9. Telomerase enzyme activity   **EPIGENETICS**   1. DNA methylation analysis    1. Bisulfide conversion    2. High resolution melt analysis    3. Examination of different DNA methylation condition using Restriction assay   **BIOETHICS AND BIOSAFETY**   1. Visit to Research institutes holding animal house facility 2. Visit to medical hospitals and report submission 3. IPR*,* Group discussion*,* report submission 4. Obtain human ethical committee clearance 5. Visit of tribal 6. Video for demonstration of Bio-safety cabinet BSL-I, II, III | | | |
|  | | **Total Lecture hours** | **108 hours** |
| **Text Book(s)** | | | |
| 1 | Analytical Biochemistry, 3rd Edition. Holme, D.J and Peck, H. 1998. Pearson Education  Limited.1-501. | | |
| 2 | Analytical Biochemistry, 3rd Edition. Holme, D.J and Peck, H. 1998. Pearson Education  Limited.1-501. | | |
| 3 | Molecular Cloning – A laboratory manual. 3rd Edition. Sambrook and Russel. Cold Spring  harbor laboratory Press. 2001.1-2331. | | |
| 4 | Cancer Biology, 3rd ed., R.J.B. King and M.W. Robbins, Pearson Education Ltd., 2006. | | |
| 5 | Bioethics, by Shaleesha A. Stanley (2008). Published by Wisdom Educational | | |
| **Reference Books** | | | |
| 1 | Modern experimental Biochemistry, 3rd Edition, Rodney Boyer. 2000. Benjamin Cummins.  1-480. | | |

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| 2 | Methods in Molecular Biology-Genomics Protocol – Starkey, M.P. and Elaswarapu, R.  2001. Humana Press.1-538 |
| 3 | Current Protocols in Immunology. John Donovan and Patricia Brown. 1995. John Wiley &  Sons, Inc. |
| 4 | IPR, Bioethics and Biosafety by Deepa Goel, Shomini Parashar. Pearson Education India |
| 5 | Bioethics and Biosafety by M.K. Satheesh (2008). I. K. International PvtLtd |
| 6 | Bunz, F., 2008. Principles of cancer genetics (Vol. 1). New York, NY, USA:: Springer. |
| 7 | Haber, D.A. ed., 2010. Principles of clinical cancer genetics: a handbook from the  Massachusetts General Hospital. Springer. |
| 8 | Matloff, E., 2013. Cancer principles and practice of oncology: handbook of clinical cancer  genetics. Lippincott Williams & Wilkins. |
|  | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | |
| 1 | https://link.springer.com/chapter/10.1007/978-981-10-0875-7\_24 |
| 2 | https://books.google.co.in/books/about/Biosafety\_and\_Bioethics.html?id=IiqPrFYzRMMC  &redir\_esc=y |
| 3 | https://books.google.co.in/books/about/Bioethics\_and\_Biosafety.html?id=xP9dzbSBTZQC |
| 4 | <https://www.nature.com/articles/35077207> |
| 5 | <https://www.thelancet.com/journals/lanonc/article/PIIS1470-2045(11)70092-4/fulltext> |
| 6 | <https://www.cancergeneticsjournal.org/> |
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| **Mapping with Programme Outcomes** | | | | | | | | | | |
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **S** | **S** | **S** | **M** | **S** | **S** | **S** | **S** | **S** | **S** |
| **CO2** | **M** | **M** | **S** | **M** | **S** | **S** | **S** | **S** | **S** | **S** |
| **CO3** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **M** |
| **CO4** | **L** | **L** | **L** | **S** | **M** | **M** | **L** | **S** | **M** | **M** |
| **CO5** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** |

\*S-Strong; M-Medium; L-Low

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| **Course code** | | **3EC** | **STRESS AND BIOMARKERS** | | **L** | **T** | | **P** | | **C** |
| **ELECTIVE III** | | | **4** | **-** | | **-** | | **4** |
| **Pre-requisite** | | | **Basic understanding about stress physiology and**  **toxicology Ve** | | **Syllabus**  **rsion** | | | | **2021-**  **2022** | |
| **Course Objectives:** | | | | | | | | | | |
| The main objectives of this course are to:   1. The topics are introductory in nature and build the ability to learn how human system works in stressed conditions under the influence of various internal and external stimuli. 2. The curriculum of pathology aims at preparing the learners in basic understanding of diseases and their pathogenesis with reference to stress by using biomarkers. 3. Toxicology is a vast, multidisciplinary subject encompassing various other basic fields of science.   Not all toxicity effects are well understood, many of them unpin themselves into stress. Hence, it | | | | | | | | | | |
|  | | | | | | | | | | |
| **Expected Course Outcomes:** | | | | | | | | | | |
| On the successful completion of the course, students will be able to: | | | | | | | | | | |
| 1 | Next to neurology, it is necessary for the human genetics student to learn about  the substances produced by the nervous system; this has been discussed in this course. | | | | | | K1 & K2 | | | |
| 2 | The functions of the substances produced by the nervous system have also been discussed in this course which helps the students to obtain clear knowledge on the  same. | | | | | | K1 & K2 | | | |
| 3 | The biomarkers that indicates the malfunctioning of the body parts has to be known by the life science students, which has also been discussed by this course. | | | | | | K1 & K2 | | | |
| 4 | Understanding about the neurological effects associated with stress. | | | | | | K1 & K2 | | | |
| 5 | Learn basic research and toxicity test. | | | | | | K1, K2,  K3 & K5 | | | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create | | | | | | | | | | |
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| **Unit: 1** | | **STRESS PHYSIOLOGY** | | | **14 hours** | | | | | |
| Factors contributing to stress, physiological systems respond to stress. Principle pathways linked to steroidal hormones. Biomarkers: Introduction and types of biomarkers acting based on organ and  tissue specific and non–specific. | | | | | | | | | | |
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| **Unit: 2** | | **BIOMARKERS** | | | **14 hours** | | | | | |
| Methods for identifying biomarkers: Biomarker selection and development. Significance of biomarkers in oxidative stress, metabolic biomarkers, immunological biomarkers and physiological  biomarkers. Blood chemistry and histopathology. Heat shock proteins. | | | | | | | | | | |
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| **Unit: 3** | | **NEUROENOCRINE BIOMARKERS** | | **14 hours** | | | | | | |
| Neuroendocrine biomarkers: The primary physiological factor that determine the neuroendocrine  stress response, Stress relaxation and receptors, arterial pressure and regulation, functions of cortisol in stress and inflammation, methodological and procedural factors that influence the measurement | | | | | | | | | | |

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| and assessment of circulating hormone levels in the blood. | | | |
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| **Unit: 4** | | **STRESS AND NEUROLOGICAL EFFECTS** | **14 hours** |
| Promising new vistas for chronic stress characterization, metabolomics, ultrastructure modifications in mitochondria. Neuroanatomy changes seen under stressed conditions. Neuropsychic disorders characteristic features, disease progression, treatment and control. Stress management using  Artificial intelligence. | | | |
| **Unit: 5** | | **TOXICOLOGY** | **14 hours** |
| Chemical stress and Toxins: Introduction, definition, sub disciplines, environmental toxicants, routes of entry of xenobiotics. Toxicity tests: Bioassay, basic requirements, test organisms, test procedures and data analysis joint toxicity. Types of acute toxicity tests and chronic toxicity tests, terminologies  used in toxicity tests and need for conducting toxicity tests. | | | |
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| **Unit:6** | | **CONTEMPORARY ISSUES** | **2 hours** |
| Expert lectures, online seminars – webinars | | | |
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|  | | **Total Lecture hours** | **72 hours** |
| **Text Book(s)** | | | |
| 1 | The Nervous System: The basic of neurosciences by Donald B. Tower and Roscoe O. Brady. Published  by Raven Press Publishers. | | |
| 2 | Human Anatomy and Physiology by Elaine N. Marieb. Published by The Benjamin/Cummings  Publishing Company, Inc. | | |
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| **Reference Books** | | | |
| 1 | Text book of Medical Physiology (11th edition) by Arthur C Guyton and John E Hall. Published  by Elsevier Publications. | | |
| 2 | Principles of Biochemical Toxicology (4th edition) by J.A. Timbrell. Taylor and Francis.  Published by CRC Press. | | |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
| 1 | <https://swayam.gov.in/nd1_noc19_ge26/preview> | | |
| 2 | <https://ciet.nic.in/swayam_psychology03_module08.php> | | |
| 3 | <http://ugcmoocs.inflibnet.ac.in/ugcmoocs/view_module_pg.php/697> | | |
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| **Mapping with Programme Outcomes** | | | | | | | | | | |
| **Cos** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **M** | **S** | **M** | **M** | **S** | **S** | **S** | **S** | **S** | **L** |
| **CO2** | **S** | **S** | **M** | **M** | **S** | **S** | **S** | **S** | **S** | **L** |
| **CO3** | **S** | **S** | **M** | **M** | **S** | **S** | **S** | **S** | **S** | **L** |
| **CO4** | **M** | **S** | **M** | **S** | **S** | **M** | **S** | **S** | **S** | **L** |
| **CO5** | **M** | **M** | **L** | **M** | **S** | **S** | **S** | **S** | **S** | **L** |

\*S-Strong; M-Medium; L-Low

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| **Course code** | | **3ED** | **STEM CELL BIOLOGY** | | **L** | | **T** | | **P** | **C** |
| **ELECTIVE-III** | | | **4** | | **-** | | **-** | **4** |
| **Pre-requisite** | | | **Basic understanding about Stem Cells,**  **characterization and its applications Ve** | | **Syllabus**  **rsion** | | | **2021-**  **2022** | | |
| **Course Objectives** | | | | | | | | | | |
| The main objectives of this course are to:   1. Understanding key implications of stem cell research. 2. Relate the importance of stem cells to the development and maintenance of multicellular organisms. 3. To describe how stem cells can be used for medical purposes. 4. To understand how defects in stem cell behavior can lead to medical problems. 5. To understand complex molecular, cellular, and genetic techniques used to investigate stem cell biology. | | | | | | | | | | |
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| **Expected Course Outcomes** | | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | | |
| 1 | Describe the characteristics of stem cells and the different types of stem cells | | | | | K2 | | | | |
| 2 | Understand the isolation process and culturing of stem cells. | | | | | K3 | | | | |
| 3 | Understand basic biology/mechanisms and applications of stem cells | | | | | K3 | | | | |
| 4 | To obtain knowledge and understanding the behavior of stem cells in laboratory. | | | | | K2, K3 & K4 | | | | |
| 5 | To gain knowledge and understand the mechanism of techniques involved in stem  cell research | | | | | K2, K3 & K6 | | | | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create | | | | | | | | | | |
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| **Unit:1** | | **INTRODUCTION TO STEM CELLS** | | | **14 hours** | | | | | |
| Introduction to stem cells and basis of stemness; Embryonic stem cells, adult stem cells, hematopoietic  stem cells, mesenchymal stem cells, cancer stem cells, induced pluripotent stem cells. | | | | | | | | | | |
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| **Unit:2** | | **EMBRYONIC STEM CELLS** | | | **14 hours** | | | | | |
| Isolation, characterization and maintenance of embryonic stem cells. Serum and feeder free culture of  human embryonic stem cells | | | | | | | | | | |
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| **Unit:3** | | **MESENCHYMAL STEM CELLS** | | **14 hours** | | | | | | |
| Introduction to mesenchymal stem cells; properties; isolation and characterization; Differentiation of  mesenchymal stem cells into various lineages | | | | | | | | | | |
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| **Unit:4** | | **INDUCED PLURIPOTENT STEM CELLS (iPSCs)** | | **14 hours** | | | | | | |
| Introduction to iPSC technology; Reprogramming iPSCs: integration and non-integration methods;  Advantages and disadvantages of iPSCs | | | | | | | | | | |
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| **Unit:5** | | **APPLICATIONS OF STEM CELLS** | | **14 hours** | | | | | | |
| Neurodegenerative diseases, spinal cord injury, eye diseases; Ethical and regulatory issues in the use  of stem cells | | | | | | | | | | |
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| **Unit:6** | | **CONTEMPORARY ISSUES** | **2 hours** |
| Expert lectures, online seminars – webinars | | | |
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|  | | **Total Lecture hours** | **72 hours** |
| **Text Book(s)** | | | |
| 1 | Handbook of Stem Cells, 2nd Edition, Atala A &Lanza R, Academic Press, 2012 | | |
| 2 | Essential of Stem Cell Biology, 3rd Edition, Lanza R, et al, Elsevier Academic Press, 2013 | | |
| 3 | Translational Approaches in Tissue Engineering & Regenerative Medicine, Mao JJ, et al, Artech House, 2007 | | |
| 4 | Stem Cell Repair and Regeneration, Volume-2, Habib NA, Levièar NY, Gordon M, Jiao L  &FiskN, Imperial College Press, 2007. | | |
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| **Reference Books** | | | |
| 1 | Stem Cells Handbook, Edited by Stewart Sell, Human Press, 2010 | | |
| 2 | Human embryonic stem cells, Edited by Arlene Y. Chiu, MahendraRao, Human 5. Press, 2011. | | |
| 3 | Stem cell basics and application Ed. By K. D. Deb and S. M. Totey, Tata McGraw Hill Pvt. Ltd,  2011. | | |
| 4 | Stem cell Biology: Daniel R. Marshak, Richard Lavenham Gardner, David I. Gottlieb - 2001 | | |
| 5 | Essentials of Stem cell Biology: Robert Lanza, John Gearhart, Brigid Hogan - 2009 | | |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
| 1 | <https://www.coursera.org/learn/stem-cells> | | |
| 2 | <https://online.stanford.edu/courses/xgen204-stem-cell-therapeutics> | | |
| 3 | <https://www.classcentral.com/course/advances-stem-cells-13105> | | |
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| **Mapping with Programme Outcomes** | | | | | | | | | | |
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **S** | **S** | **M** | **M** | **M** | **M** | **M** | **S** | **M** | **M** |
| **CO3** | **S** | **S** | **M** | **S** | **M** | **S** | **M** | **M** | **S** | **S** |
| **CO3** | **S** | **M** | **M** | **M** | **S** | **M** | **S** | **M** | **M** | **M** |
| **CO4** | **M** | **M** | **S** | **M** | **M** | **L** | **M** | **S** | **M** | **L** |
| **CO5** | **M** | **M** | **M** | **M** | **M** | **M** | **M** | **M** | **M** | **M** |

\*S-Strong; M-Medium; L-Low

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| **Course code** | | **-** | **FORENSIC BIOLOGY** | | **L** | **T** | **P** | | **C** |
| **ELECTIVE – III** | | | **4** | **-** | **-** | | **4** |
| **Pre-requisite** | | | **Knowledge in genetics** | | **Syllabus Version** | | | **21 -22** | |
| **Course Objectives:** | | | | | | | | | |
| The main objectives of this course are to:   1. To understand the forensic ethics, rules and regulations for investigation of crime 2. To understand the techniques of investigation 3. To analyse the biological evidences through DNA processing 4. To know the legal standards of forensics 5. To study the tools and applications of forensics | | | | | | | | | |
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| **Expected Course Outcomes:** | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | |
| 1 | Able to understand the forensic science disciplines and their functions | | | | | | K1 | | |
| 2 | Understand about the crime and investigation techniques | | | | | | K3&K4 | | |
| 3 | Capable of knowing the different types of genetic markers that are used for  forensic genetic analysis and interpretation | | | | | | K4&K5 | | |
| 4 | Able to understand the forensic profiling and their importance | | | | | | K5&K6 | | |
| 5 | Inculcate the knowledge on various tools and applications in Forensic Biology | | | | | | K6&K3 | | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create | | | | | | | | | |
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| **UNIT:1** | | **INTRODUCTION TO FORENSICS** | | | **14 hours** | | | | |
| Forensic science principles, forensic science disciplines and their functions. Basics, Rules, Ethics, Laws, Procedures, Cross Examinations, Investigating the Crime Scene- Crime scene and  evidence collection and processing. | | | | | | | | | |
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| **UNIT:2** | | **INVESTIGATION TECHNIQUES** | | | **14 hours** | | | | |
| Crime Detection Devices, LA-ICP-MS, Alternative Light Photography, Forensic Carbon-14, Dating,High-Speed Ballistics Photography, 3D Forensic Facial Reconstruction, DNA, Sequencer,  Magnetic Fingerprinting and Automated Fingerprint Identification (AFIS). | | | | | | | | | |
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| **UNIT:3** | | **DNA DETECTION TECHNIQUES** | | **14 hours** | | | | | |
| DNA Isolation, quantification and quality assessment from hard and soft tissues.RFLP, PCR amplifications, Amp-FLP, sequence polymorphism, Y-STR, Mitochondrial DNA. Evaluation of  results, frequency estimate calculations and interpretation, Determining the allelic frequency. | | | | | | | | | |
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| **UNIT:4** | | **FORENSIC PROFILING** | | **14 hours** | | | | | |
| History of DNA profiling applications in disputed paternity cases, missing person’s identity,child  swapping, civil immigration, legal perspectives – legal standards for admissibility of DNA | | | | | | | | | |

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| profiling – procedural & ethical concerns, status of development of DNA profiling in India &  abroad. Overlapping genes and multiple gene families, VNTRs, STRs, Mini STRs , SNPs. | | | |
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| **UNIT:5** | | **TOOLS AND APPLICATIONS** | **14 hours** |
| Introduction Basics of gene prediction, pattern recognition, gene prediction tools, Tools for microarray analysis and application, Algorithm for identifications of homology.CombinedDNA Index System (CODIS).Scope of analysis in forensic science laboratories/institutions.Legendries  and their contributions in the field of forensic science. | | | |
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| **Unit:6** | | **CONTEMPORARY ISSUES** | **2 hours** |
| Expert lectures, online seminars – webinars | | | |
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|  | | **Total Lecture hours** | **72 hours** |
| **Text Book(s)** | | | |
| 1 | Barnett P.D. (2001), Ethics in Forensic Science: ProfessionalStandards for the Practice of  Criminalistics, CRC press. | | |
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| **Reference Books** | | | |
| 1 | B. A. J.Fisher, D. R. Fisher;“Techniques of Crime SceneInvestigation, 8th Edition”, CRC  Press London, 2012. | | |
| 2 | Alan Gunn. Essential Forensic Biology, 2nd Edition, 2nd edition,Wiley-Blackwell 2009. | | |
| 3 | Henry C. Lee and R.E. Gaensslen; (1990), DNA and otherPolymorphism in Forensic  Science, Year book Medical Publishers, Inc. | | |
| 4 | F. Toroni, S. Bozza, A. Biedermann, P. Garbolino; “Data analysis inForensic Science”,  Wiley, 2010. | | |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
| 1 | <https://www.semanticscholar.org/paper/Artificial-Intelligence-in-Forensic-Sciencehinnikatti/> | | |
| 2 | <https://ieeexplore.ieee.org/document/8701416> | | |
| 4 | <https://www.sciencedirect.com/science/article/pii/S1877050920302672> | | |
| 5 | <https://swayam.gov.in/nd2_cec20_ge10/preview> | | |
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| **Mapping with Programme Outcomes** | | | | | | | | | | |
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **L** | **L** | **L** | **S** | **M** | **L** | **M** | **M** | **S** | **S** |
| **CO2** | **L** | **M** | **M** | **S** | **S** | **L** | **M** | **M** | **S** | **S** |
| **CO3** | **M** | **M** | **M** | **S** | **S** | **L** | **M** | **L** | **S** | **S** |
| **CO4** | **M** | **M** | **M** | **S** | **S** | **L** | **M** | **M** | **S** | **S** |
| **CO5** | **M** | **M** | **M** | **S** | **S** | **L** | **M** | **M** | **S** | **S** |

\*S-Strong; M-Medium; L-Low

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| **Course code** | | | **43A** | **GENETIC COUNSELING (SELF STUDY)** | | **L** | **T** | **P** | | **C** |  |
| **CORE-XIII** | | | | **4** | **-** | **-** | | **4** |
| **Pre-requisite** | | | | **Basic understanding about Genetic Counseling** | | **Syllabus**  **Version** | | | **2021-**  **22** | |
| **Course Objectives:** | | | | | | | | | | |
| The main objectives of this course are to:   1. Provides learners with the appropriate knowledge, experience and Skills to become motivated genetic counselors. 2. Provide exposure to coursework, including: clinical training, hospital visits, case studies and seminars, to develop their personalized skills towards understanding and handling of genetically inherited disorder subjects. 3. Promote graduates prepared to work in a variety of interdisciplinary clinics as well as in areas of   research or commercial genetics laboratories relevant to genetic counseling and human genetics. | | | | | | | | | | |
|  | **Expected Course Outcomes:** | | | | | | | | | |  |
|  | On the successful completion of the course, student will be able to: | | | | | | | | | |  |
|  | 1 | Understand the Pedigree for Genetic counseling | | | | | | K2 | | |  |
|  | 2 | Analyze the basic pedigree patterns of humans for diagnosis | | | | | | K4 | | |  |
|  | 3 | Differentiate inheritance patterns of human | | | | | | K3 | | |  |
|  | 4 | Use genetic counseling public awareness | | | | | | K2&K5 | | |  |
|  | 5 | Able to understand the components of genetic counseling | | | | | | K4&K5 | | |  |
|  | **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create | | | | | | | | | |  |
| **UNIT:1** | | | **HISTORY OF HUMAN GENETICS** | | | **14 hours** | | | | |  |
| Pedigrees*,* gathering family history*,* Pedigree symbols*,* Construction of pedigrees*,* Presentation of  molecular genetic data in pedigrees*,* Pedigree charts for different inheritance patterns.. | | | | | | | | | | |
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| **UNIT:2** | | | **COMPLICATIONS TO THE BASIC PEDIGREE**  **PATTERNS** | | | **14 hours** | | | | |
| Genomic imprinting and uniparentaldisomy*,* Spontaneous mutations*,* Mosaicism and chimerism*,*  Male lethality*,* X*–*inactivation*,*Consanguinity and its effects in the pedigree pattern*.* | | | | | | | | | | |
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| **UNIT:3** | | | **INHERITANCE** | | **14 hours** | | | | | |
| Monozygotic and dizygotic twins and adoption studies*,* Polygenic inheritance of continuous  (quantitative) traits, normal growth charts, Dysmorphology*,* Polygenic inheritance of discontinuous (dichotomous) traits*,* Genetic susceptibility in complex traits | | | | | | | | | | |
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| **UNIT:4** | | | **GENETIC COUNSELING** | | **14 hours** | | | | | |
| Historical overview and components of genetic counseling. Indication for and purpose*,* Information  gathering and construction of pedigree Medical genetic evaluation (Basic components of medical | | | | | | | | | | |

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| history, past medical history, social and family history). | | | |
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| **UNIT:5** | | **COMPONENTS OF GENETIC COUNSELING** | **14 hours** |
| Physical examination, Patterns of inheritance, risk assessment and counseling in common  Mendelian and multifactor syndromes. Prenatal and postnatal screening: noninvasive methods and invasive methods. Indications for chromosomal testing. | | | |
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| **UNIT:6** | | **CONTEMPORARY ISSUES** | **2 hours** |
| Expert lectures, online seminars – webinars | | | |
|  | | | |
|  | | **Total Lecture hours** | **72 Hours** |
| **Text Book(s)** | | | |
| 1 | 1. Genetics*,* A Conceptual Approach, 4thed., B.A. Pierce, Palgrave Macmillan, 2012. | | |
|  | | | |
| **Reference Books** | | | |
| 1 | Emery’s Elements of Medical Genetics, 14thed., P.D. Turnpenny and S. Ellard, 2012. | | |
| 2 | 6. Practical Genetic Counseling *–* 7  ed., P. S. Harper, CRC Press., 2010. | | |
|  | | | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
| 1 | <https://kidshealth.org/en/parents/genetic-counseling.html> | | |
| 2 | <https://www.ncbi.nlm.nih.gov/books/NBK115552/> | | |
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| **Mapping with Programme Outcomes** | | | | | | | | | | |
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **M** | **M** |
| **CO2** | **S** | **S** | **S** | **S** | **S** | **M** | **M** | **M** | **M** | **M** |
| **CO3** | **S** | **S** | **M** | **S** | **S** | **M** | **M** | **M** | **M** | **L** |
| **CO4** | **L** | **S** | **M** | **S** | **S** | **M** | **M** | **M** | **M** | **M** |
| **CO5** | **L** | **S** | **M** | **S** | **S** | **L** | **L** | **M** | **L** | **L** |

\*S-Strong; M-Medium; L-Low

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| **Course code** | | **GS09** | **GENETICS AND SOCIETY** | **L** | **T** | **P** | | **C** |
| **SUPPORTIVE - I** | | | **2** | **-** | **-** | | **2** |
| **Pre-requisite** | | | **Basics in genetics** | **Syllabus Version** | | **2021-22** | | |
| **Course Objectives:** | | | | | | | | |
| The main objectives of this course are to:   1. To know the impact of genetic diseases on the society 2. To make students aware about the ethical and legal issues behind genetic research 3. To have a better understanding about the social impact on various kinds of research associated with genetics | | | | | | | | |
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| **Expected Course Outcomes:** | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | |
| 1 | Able to understanding about the impact of genetics in medicine and society | | | | | | K2 | |
| 2 | Inculcate the knowledge to understanding about the genetic makeup of Human | | | | | | K2&K3 | |
| 3 | Capable of understanding the human Genome project and applications | | | | | | K2 | |
| 4. | Able to understand the ethical and legal issues involved in genetics | | | | | | K3&&K  4 | |
| 5. | Able to understand the modern genetics tools and their uses | | | | | | K2&K3 | |
|  | | | | | | | | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create | | | | | | | | |
|  | | | | | | | | |
| **UNIT:1** | | **HISTORY AND IMPACT OF GENETICS IN MEDICINE AND**  **SOCIETY** | | | | **6 hours** | | |
| The history and impact of Genetics in Medicine and Society*,* Medical Genetics*,* Early beginnings*,*  Centre for Genetics and Society around the world*,* an overview | | | | | | | | |
| **UNIT:2** | | **GENETIC ASSOCIATION OF DISEASES** | | | | **6 hours** | | |
| Genes and Pedigrees in a Population. Creation of Awareness about Genetic diseases and disorders.  Genetic Testing (Prenatal & Postnatal) | | | | | | | | |
| **UNIT:3** | | **HUMAN GENOME PROJECT** | | | | **5 hours** | | |
| Human Genome Project*,* Beginning and Organization of the HGP*,* Sequencing of the Human  Genome, Promises and Achievements.*,* Diversity Project | | | | | | | | |
| **UNIT-4** | | **ETHICAL AND LEGAL ISSUES** | | | | **5 hours** | | |
| Ethical, Legal and Social issues of the HGP*,* Other Genome Projects initiated as a direct  consequence of HGP completion*,* Human Genome | | | | | | | | |
| **UNIT:3** | | **ADVANCES IN MODERN GENETICS** | | | | **10 hours** | | |
| Advances in Modern Genetics: Some of the areas of concern in Modern Genetics*,* GM crops, | | | | | | | | |

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| personal DNA data, GeneTherapy, Pharming, Ethical and Legal issues in Medical Genetics. | | | |
| **UNIT:4** | | **CONTEMPORARY ISSUES** | **2 hours** |
| Expert lectures, online seminars – webinars | | | |
|  | | **Total Lecture hours** | **36 hours** |
| **Text Book(s)** | | | |
| 1 | Genetics*,*A Conceptual Approach, 4th ed., B.A.Pierce, PalgraveMacmillan, 2012. | | |
| 2 | Emery’s Elements of Medical Genetics, 14th ed., P.D.Turnpenny and S.Ellard,  ChurchillLivingstone, 2012. | | |
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| **Reference Books** | | | |
| 1 | Introduction to Genetics*,* A Molecular Approach, T. Brown, Garland Science, 2012 | | |
| 2 | Genome Duplication*,* Concepts, Mechanism, Evolution and Disease, M.L. De Pamphilis and  S.D. Bell, Garland Science, 2011. | | |
| 3 | Human Molecular Genetics, 4th ed., T.Strachan and A.Read, Garland Science, Taylor and  Francis Group, 2011. | | |
| 4 | A Guide to Genetic Counseling*,*2nd ed., W.R.Uhlmann, J.L.Schuette and B.M.Yashar, Wiley*,*  Blackwell, 2009. | | |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
| 1 | <https://portal.e-lfh.org.uk/Component/Details/465515> | | |
| 2 | <https://www.e-lfh.org.uk/programmes/genomics-education-programme/> | | |
| 3 | <http://www.bionet.nsc.ru/ICIG/CHM/books/Hartl_Jones_Genetics.pdf> | | |
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| **Course code** | | **GS89** | **PRINCIPLES OF GENETICS** | **L** | **T** | | **P** | | **C** |
| **SUPPORTIVE-II** | | | **2** | **-** | | **-** | | **2** |
| **Pre-requisite** | | | **Basic understanding about Mendelian**  **genetics and inheritance pattern of Ve chromosomes.** | **Syllabus**  **rsion** | | | | **2021-2022** | |
| **Course Objectives:** | | | | | | | | | |
| The main objectives of this course are to:   1. To provide the knowledge about the genetic influence and history of human genetics and Mendelian laws to the students for their curriculum development and knowledge enrichment. 2. To understand the principles and mechanisms of the inheritance from one generation to the next. 3. To understand the inheritance mechanism by scientific experimentation. 4. To get updated with the knowledge on genetic diseases and the researchapproaches. 5. To understand and apply the knowledge on human inherited disorders. | | | | | | | | | |
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| **Expected Course Outcomes:** | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | |
| 1 | Gain knowledge on fundamentals of genetics and its impact. | | | | | K1, K2 | | | |
| 2 | Identify the genetic diseases and its inheritance pattern. | | | | | K3, K5 | | | |
| 3 | The course would be helpful for the students to get placed in government  hospitals and private medicallaboratories. | | | | | K3, K4 & K5 | | | |
| 4 | This course helps to obtain knowledge on the genetic diseases and its research  approach towards treatment options. | | | | | K3, K4 & K6 | | | |
| 5 | The students can gain knowledge on the pattern of inheritance from learning  the pedigree analysis | | | | | K3, K5& K6 | | | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create | | | | | | | | | |
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| **Unit:1** | | **MENDELIAN LAWS** | | **6 hours** | | | | | |
| Mendelian Laws (law of segregation*,* law of independent assortment*,* law of segregation and  independent assortment; test-cross; back cross. | | | | | | | | | |
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| **Unit: 2** | | **INHERITANCE** | | **6 hours** | | | | | |
| Monogenic traits, autosomal inheritance, Sex*–*linked inheritance, mitochondrial inheritance. | | | | | | | | | |
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| **Unit:3** | | **INTERNATIONAL SYSTEM OF HUMAN**  **CHROMOSOME NOMENCLATURE** | | **8 hours** | | | | | |
| International system of Human Chromosome Nomenclature; Structural and Numerical alterations.  Chromosomal basis and non-chromosomal basis of sexdetermination. | | | | | | | | | |
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| **Unit:4** | | **INHERITANCE PATTERN AND PEDIGREE**  **ANALYSIS** | **6 hours** |
| Pedigree analysis: family history, pedigree symbols, construction of pedigrees; Complications to the  basic pedigree patterns. | | | |
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| **Unit: 5** | | **AUTOSOMAL AND SEX-LINKED INHERITANCE** | **8 hours** |
| Autosomal and Sex-linked inheritance; consanguinity and its effects; Mosaicism and chimerism,  male lethality, X–inactivation. | | | |
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| **Unit:6** | | **CONTEMPORARY ISSUES** | **2 hours** |
| Expert lectures, online seminars – webinars | | | |
|  | | **Total Lecture hours** | **36 hours** |
| **Text Book(s)** | | | |
| 1 | [Principles of Genetics*,* 6th ed. (Course Smart),](http://www.amazon.com/Principles-Genetics-CourseSmart-Peter-Snustad/dp/0470903597/ref%3Dsr_1_1?s=books&amp%3Bie=UTF8&amp%3Bqid=1358748853&amp%3Bsr=1-1&amp%3Bkeywords=Principle%2Bof%2Bgenetics) D.P. Snustad and M.J. Simmons, John Wiley  and Sons,2012. | | |
| 2 | Principles Of Genetics 8th Edition by Gardner | | |
| 3 | Human Molecular Genetics 4e (PB) by Strachan, Routledge Taylor and Francis group | | |
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| **Reference Books** | | | |
| 1 | Human Genetics 5th Edition 2017 By Gangane | | |
| 2 | Genetics: A molecular perspective,1st edition W.S. Klug and M.R. Cummings, Benjamin  Cummings,2002 | | |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
| 1 | <https://dmhuk8np1ucwy.cloudfront.net/wp-content/uploads/2015/08/CH25-lm.pdf> | | |
| 2 | https://nptel.ac.in/courses/102/104/102104052/ | | |
| 3 | [https://www.coursera.org/learn/genetics-evolution?ranMID=40328&ranEAID=7bhGe75fA](https://www.coursera.org/learn/genetics-evolution?ranMID=40328&ranEAID=7bhGe75fA%20Q8&ranSiteID=7bhGe75fAQ8-GHJVooGTS0D2rg9M08o2uA&siteID=7bhGe75fAQ8-GHJV%20ooGTS0D2rg9M08o2uA&utm_content=15&utm_medium=partners&utm_source=linkshare&utm_campaign=7bhGe75fAQ8) [Q8&ranSiteID=7bhGe75fAQ8-GHJVooGTS0D2rg9M08o2uA&siteID=7bhGe75fAQ8-GHJV](https://www.coursera.org/learn/genetics-evolution?ranMID=40328&ranEAID=7bhGe75fA%20Q8&ranSiteID=7bhGe75fAQ8-GHJVooGTS0D2rg9M08o2uA&siteID=7bhGe75fAQ8-GHJV%20ooGTS0D2rg9M08o2uA&utm_content=15&utm_medium=partners&utm_source=linkshare&utm_campaign=7bhGe75fAQ8) [ooGTS0D2rg9M08o2uA&utm\_content=15&utm\_medium=partners&utm\_source=linkshare&ut](https://www.coursera.org/learn/genetics-evolution?ranMID=40328&ranEAID=7bhGe75fA%20Q8&ranSiteID=7bhGe75fAQ8-GHJVooGTS0D2rg9M08o2uA&siteID=7bhGe75fAQ8-GHJV%20ooGTS0D2rg9M08o2uA&utm_content=15&utm_medium=partners&utm_source=linkshare&utm_campaign=7bhGe75fAQ8)  [m\_campaign=7bhGe75fAQ8](https://www.coursera.org/learn/genetics-evolution?ranMID=40328&ranEAID=7bhGe75fA%20Q8&ranSiteID=7bhGe75fAQ8-GHJVooGTS0D2rg9M08o2uA&siteID=7bhGe75fAQ8-GHJV%20ooGTS0D2rg9M08o2uA&utm_content=15&utm_medium=partners&utm_source=linkshare&utm_campaign=7bhGe75fAQ8) | | |
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| Course code | | **GS106** | **GENETIC TOXICOLOGY** | **L** | | **T** | **P** | **C** | |
| **SUPPORTIVE-III** | | | **2** | | **-** | **-** | | **2** |
| **Pre-requisite** | | | **Basic understanding about mutagens and**  **mutations** | **Syllabus**  **Version** | | | **2021-**  **22** | | |
| **Course Objectives:** | | | | | | | | | |
| The main objectives of this course are to:   1. Inculcate principles and guidelines in mutagenicity and genotoxic agents. 2. Cater various assays and procedures involved in mutagens evaluation. 3. Create the awareness about the effect of genotoxic agents and mutagens on health and nature. | | | | | | | | | |
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| **Expected Course Outcomes:** | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | |
| 1 | Understand the basic principles and guidelines in mutagen monitoring and testing | | | | | | K2 | | |
| 2 | Classify the genotoxic agents and relate the genetic defects with mutagens | | | | | | K4 | | |
| 3 | Apply the assays and methods for measuring the toxic agents for its genetic effects | | | | | | K3 | | |
| 4 | Gain the understanding on health effects of genotoxic agents/mutagens | | | | | | K2 | | |
| 5 | Collect the genotoxic agents that can affect the developing embryo | | | | | | K5 | | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create | | | | | | | | | |
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| **Unit:1** | | **PRINCIPLES ANG GUIDELINES** | | | **8 hours** | | | | |
| General Principles of Mutagenicity, Testing and Regulatory Control of Environmental Chemicals.  Monitoring of Chemical Mutagens in the environment | | | | | | | | | |
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| **Unit:2** | | **GENOTOXIC AGENTS** | | | **6 hours** | | | | |
| Classification of Genotoxicagents.Genetic effects of environmental agents and Genotoxic agents in  various occupations. | | | | | | | | | |
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| **Unit:3** | | **ASSAYS AND METHODS** | | **7 hours** | | | | | |
| Various assay procedures to determine genotoxicity*,* Methods of evaluation of mutagens*,* Microbial  to mammals. | | | | | | | | | |
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| **Unit:4** | | **HEALTH EFFECTS OF MUTAGENS** | | **7 hours** | | | | | |
| Epidemiological approach to evaluate genetic hazards: Occupational Epidemiology and  Reproduction | | | | | | | | | |
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| **Unit:5** | | **HEALTH EFFECTS IN NEW BORN** | | **6 hours** | | | | | |
| Monitoring for genetic disease in the new born: Transplacentalgenotoxic agents | | | | | | | | | |
| **Unit:6** | | **CONTEMPORARY ISSUES** | | **2 hours** | | | | | |

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| Expert lectures, online seminars – webinars | | | |
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|  | | **Total Lecture hours** | **36 hours** |
| **Text Book(s)** | | | |
| 1 | Handbook of Mutagenicity Test Procedures. Kilbey, B.J., Lehgator, M., Nichols, W and  Ramel, C (1984) Elsevier. | | |
|  | | | |
| **Reference Books** | | | |
| 1 | Hsu, T.C (1982). Cytogenetic Assays of Environmental Agents.), Oxford and IBH, New Delhi. | | |
| 2 | Hollaender. A, and Serres F.J., Chemical Mutagens*,* Principles and Methods for their  Detection. Volume 1*–* 10, Plenum Press | | |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
| 1 | [https://www.criver.com/products-services/safety-assessment/toxicology-services/genetic-](https://www.criver.com/products-services/safety-assessment/toxicology-services/genetic-toxicology?region=3701)  [toxicology?region=3701](https://www.criver.com/products-services/safety-assessment/toxicology-services/genetic-toxicology?region=3701) | | |
| 2 | <https://www.atsdr.cdc.gov/training/toxmanual/modules/1/lecturenotes.html> | | |
| 3 | <https://ec.europa.eu/health/ph_projects/2003/action3/docs/2003_3_09_a21_en.pdf> | | |
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| **Course code** | | **--** | **DEVELOPMENTAL GENETICS** | **L** | | **T** | **P** | **C** |
| **BU-MOOCS** | | | **2** | | **-** | **-** | **2** |
| **Pre-requisite** | | | **Basic understanding about gametes and**  **fertilization** | **Syllabus**  **Version** | | | **2021-22** | |
| **Course Objectives:** | | | | | | | | |
| The main objectives of this course are to:   1. Bestow the basic developmental stages of the animals 2. Giveclear understanding about the morphogenetic movements and brain development 3. Create the key knowledge in the area of Drosophila genetics | | | | | | | | |
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| **Expected Course Outcomes:** | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | |
| 1 | Understand the basic developmental processes | | | | | | K2 | |
| 2 | Distinguish developmental events occur in Sea urchin, Mammals | | | | | | K4 | |
| 3 | Write the morphogenetic movements and how it helps in the early development of  Frog and Chick | | | | | | K3 | |
| 4 | Identify the key changes occur in the developing embryo during development. | | | | | | K2 | |
| 5 | Apply the knowledge of Drosophila development for employing it as model  organisms | | | | | | K3 | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create | | | | | | | | |
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| **Unit:1** | | **EARLY DEVELOPMENT** | | | **6 hours** | | | |
| Cleavage – Characteristics – Planes of Cleavage - Types of Cleavage – Gastrulation –  Characteristics – Morphogenetic movements - Gastrulation in Frog – Chick | | | | | | | | |
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| **Unit:2** | | **FERTILIZATION IN SEA URCHIN** | | | **4 hours** | | | |
| Fertilization in Sea Urchin: Sperm attraction –acrosomal reaction – recognition of the egg- Fusion of the egg and sperm- The fast block to polysphermy – Slow block to polysphermy- Fusion of  genetic materials | | | | | | | | |
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| **Unit:3** | | **DEVELOPMENT IN DROSOPHILA** | | **4 hours** | | | | |
| Fertilization - Cleavage – Gastrulation - Maternal genes and formation of body axes -  Segmentation genes - Imaginal disc development | | | | | | | | |
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| **Unit:4** | | **FERTILIZATIO IN MAMMALS** | | **6 hours** | | | | |
| Early development – Implantation - Development of vertebrate nervous system, Formation of  neural tube, Formation of brain regions | | | | | | | | |
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| **Unit:5** | | **DEVELOPMENTAL PROCESS** | **8 hours** |
| Differentiation of germ cells and gametogenesis - , Fertilization in Mammals: Internal Fertlization –  Capacitation – Chemotaxis – Recognition of zona pellucid – Activation of mammalian egg. | | | |
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| **Unit:6** | | **CONTEMPORARY ISSUES** | **2 hours** |
| Expert lectures, online seminars – webinars | | | |
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|  | | **Total Lecture hours** | **30 hours** |
| **Text Book(s)** | | | |
| 1 | S.A. Moody (Edit), Principles of Developmental Genetics, 2007. Academic Press (Elsevier) | | |
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| **Reference Books** | | | |
| 1 | Scott F. Gilbert, Developmental Biology*,* VIII edition, Sinauer Associates Inc., Publishers,  Sunderland, Massachusetts USA (2006). | | |
| 2 | Bruce Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, P. Walter (2008). Molecular Biology  of the cell, V edition, John Wiley and sons Inc., 2008. | | |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
|  | <https://swayam.gov.in/nd1_noc20_bt35/preview> | | |
| 2 | <https://nptel.ac.in/courses/102/106/102106084/> | | |
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| **Mapping with Programme Outcomes** | | | | | | | | | | |
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **M** | **M** | **S** | **M** | **S** | **S** | **M** | **M** | **L** | **L** |
| **CO2** | **M** | **M** | **M** | **M** | **S** | **M** | **M** | **M** | **S** | **M** |
| **CO3** | **M** | **S** | **M** | **M** | **S** | **M** | **M** | **M** | **M** | **M** |
| **CO4** | **M** | **M** | **M** | **M** | **M** | **M** | **M** | **M** | **M** | **M** |
| **CO5** | **S** | **S** | **S** | **S** | **M** | **M** | **M** | **M** | **S** | **S** |

\*S-Strong; M-Medium; L-Low

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| **CYTOGENETICS TECHNIQUES** | | | | | |
| **Name of the Department** | | | | Human Genetics and Molecular Biology | |
| **Name of the Faculty Member i/c**  **With Complete Address with Phone and e- mail** | | | |  | |
| **Inter / Intra Department Course** | | | | Intra Department | |
| **Duration of the Course** | | | | 30 Hours | |
| **Eligibility** | | | | Any life Science Degree | |
| **Number of Candidates to be Admitted** | | | | 15 | |
| **Registration Procedure** | | | | Enroll through BU admission process | |
| **Job Opportunities:** | | | | | |
| 1. Cytogeneticists jobs include genetics research companies and university laboratories. 2. Government institutes and non-profit organizations also hire cytogeneticists 3. Job opportunities in hospitals, pharmaceutical companies and other health service centers hire for cytogeneticists | | | | | |
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| **The objectives of the Course are:** | | | | | |
| The main objectives of this course are to: | | | | | |
| 1 | To provide a working knowledge of cytogenetics, the preparation of materials for study, and the  importance of chromosomal variations in structure and number in human diseases. | | | | |
| 2 | Diagnose and interpret pathology of human chromosomes | | | | |
| 3 | Demonstrate a professional knowledge of the cytogenetic disorders and clinical diagnosis. | | | | |
| 4 | To understand the human karyotype in normal and diseased patients. | | | | |
| 5 | To study the mechanism of disease progression and its genetic influence | | | | |
| **Course Content** | | | Lecture / Practical / Project / Internship | | |
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| **Module 1** | | **Classical Cytogenetics**  Pedigree analysis, Peripheral blood leukocyte culture for chromosomal studies, G-banding, C-banding, R-banding, Karyotyping, Microscopy - operation and maintenance of bright-field microscopy, inverted and fluorescence microscopy.  Each fellow is expected to conduct cytogenetic analysis for atleast 2 cases per week and review/interpret the abnormal cases vs control samples during this training module. The fellow should document his/her  roles in every case that he/she is involved. | | | **6 hours** |
| **Module 2** | | **Molecular Cytogenetics**  FISH (Fluorescent In-situ Hybridization), CGH (Comparative genomic | | | **6 hours** |

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|  | | hybridization), aCGH (Array comparative genomic hybridization).  Each fellow is expected to process and analyze at least 2 cases per week and review/interpret the results for abnormal vs control samples using FISH, CGH and aCGH during this training module. The fellow should  document his/her roles in every case that he/she is involved. |  |
| **Module 3** | | Sex chromatin analysis (buccal mucosa, hair bud), Buccal micronucleus, Blood Micronucleus test and COMET assay.  Each fellow is expected to process and analyze at least 2 cases per week  and review/interpret the results and should document his/her roles in every case that he/she is involved. | **6 hours** |
| **Module 4** | | **Case study analysis:** Interacting with patients, learning family history and preparation of pedigree chart.  The participating fellows will be involved in patient’s direct contact to obtain information regarding family history and expected to prepare pedigree chart for the participants involved and preparation of case  reports. | **6 hours** |
| **Module 5** | | Prenatal diagnosis: Chorionic villi sampling, foetoscopy, ultrascopy, amniocentesis. Postnatal: sister chromatid exchange, fragile site, Mitotic index and Genetic Counselling.  Each fellow is expected to process and analyze at least 2 cases per week and review/interpret at least 20 cases (normal vs abnormal) during this training module. The fellow should document his/her roles in every case that he/she is involved. The fellow will be trained to conduct genetic  counselling for the needed patients. | **6 hours** |
|  | |  | **30 Hours** |
| **Book(s) for Study** | | | |
| 1 | DP Snustad and MJ Simmons (2012) Principles of Genetics, John Willey &amp; Sons  Publication, 6th Edition | | |
| 2 | Human Genetics 5th Edition 2017 By Gangane | | |
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| **Book(s) for reference** | | | |
| 1 | Alberts et al., Molecular Biology of the Cell 2 nd Edition, Garland 2007. | | |
| 2 | Snustad and Simmons, Principles of Genetics, 4th Edition, Wiley&#39; 2005. | | |
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| **Related Online Contents** | | | |
| 1 | https://[www.coursera.org/learn/genes](http://www.coursera.org/learn/genes) | | |
| 2 | https://[www.gfmer.ch/SRH-Course-2011/community-genetics/pdf/Cytogenetics-Dahoun-](http://www.gfmer.ch/SRH-Course-2011/community-genetics/pdf/Cytogenetics-Dahoun-)  2011.pdf | | |
| 3 | https://arup.utah.edu/media/andersen-introCyto-2018/lecture-slides.pdf | | |
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| **MOLECULAR DIAGNOSTICS TOOLS** | | | | | |
| **Name of the Department** | | | | Human Genetics and Molecular Biology | |
| **Name of the Faculty Member i/c**  **With Complete Address with Phone and e- mail** | | | |  | |
| **Inter / Intra Department Course** | | | | Intra Department | |
| **Duration of the Course** | | | | 30 Hours | |
| **Eligibility** | | | | Any life Science Degree | |
| **Number of Candidates to be Admitted** | | | | 15 | |
| **Registration Procedure** | | | | Enroll through BU admission process | |
| **Job Opportunities:** | | | | | |
| 1. Students will become independently carry out their research projects for Ph.D 2. Students will be eligible to work in research companies and university laboratories. | | | | | |
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| **The objectives of the Course are:** | | | | | |
| The main objectives of this course are to: | | | | | |
| 1 | Selection of an appropriate diagnostic method/tool for a particular disease condition and  sample type | | | | |
| 2 | Adequate knowledge about recent advances and technological developments in the field of  diagnostics | | | | |
| 3 | Practical knowledge of various diagnostic tools used in healthcare, industry and research | | | | |
| 4 | Expertise to perform any diagnostic test with an ability to in troubleshoot | | | | |
| **Course Content** | | | Lecture / Practical / Project / Internship | | |
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| **Module 1** | | **Introduction to Molecular Diagnostics**  History of diagnostics, Age of molecular diagnostics, Significance, Scope, Rise of diagnostic industry in Indian and global scenario. | | | **6 hours** |
| **Module 2** | | **Biomarkers in disease diagnostics**  FDA definition of disease markers, Role of markers in Disease diagnosis. Approaches and methods in the identification of disease markers, predictive value, diagnostic value, emerging blood markers for sepsis, tumour & cancer markers, markers in  inflammation and diagnosis of cytoskeletal disorders. | | | **6 hours** |
| **Module 3** | | ***Molecular Oncology Mitochondrial disorders***  Cancer – Benign and Malignant neoplasms, multifactorial disposition, Cancer pathogenesis, positive and negative mediators of neoplastic development, Proto-oncogenes, Oncogenes and Tumorsuppressors.Allele  loss and loss of Heterozygosity.Mitochondrial inheritance, Mitochondrial | | | **6 hours** |

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|  | | myopathy, lactic acidosis, MELAS, LHONs, identity testing. |  |
| **Module 4** | | **Immunodiagnostic techniques**  Introduction, Radioactive isotopes, DNA reporters, fluorogenic reporters, electro-chemiluminescent tags & label free immunoassays. Immunoassays – precipitation, agglutination hemagglutination, RIA, ELISA, RIA, MELISA and specific applications. Quantum dots. Immunohistochemistry – principle and  techniques. | **6 hours** |
| **Module 5** | | **Advance Molecular Diagnostics**  Chromosomal techniques, DNA and RNA sequencing, In situ hybridization, Microarray analysis, Western blot analysis, Protein mass spectroscopy, Imaging based diagnosis, Biochemical testing,  Histopathology ,Flow cytometry and Blood cell screening | **6 hours** |
|  | |  | **30 Hours** |
| **Book(s) for Study** | | | |
| 1 | DP Snustad and MJ Simmons (2012) Principles of Genetics, John Willey & Sons Publication,  6th Edition | | |
| 2 | Human Genetics 5th Edition 2017 By Gangane | | |
| 3 | Principles Of Genetics 8th Edition by Gardner | | |
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| **Book(s) for reference** | | | |
| 1 | An introduction to Human Molecular Genetics by Pasternak et al., John Wiley & Sons | | |
| 2 | Human Chromosomes by Miller &Tharman, Springer Publishing Company, | | |
| 3 | Molecular Cell Biology: Darnell J, Lodish H and Baltimore D | | |
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| **Related Online Contents** | | | |
| 1 | <https://dmhuk8np1ucwy.cloudfront.net/wp-content/uploads/2015/08/CH25-lm.pdf> | | |
| 2 | https://nptel.ac.in/courses/102/104/102104052/ | | |
| 3 | <https://dmhuk8np1ucwy.cloudfront.net/wp-content/uploads/2015/08/CH25-lm.pdf> | | |
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| **CELL CULTURE TECHNIQUES** | | | | | |
| **Name of the Department** | | | | **HUMAN GENETICS AND MOLECULAR**  **BIOLOGY** | |
| **Name of the Faculty Member i/c**  **With Complete Address with Phone and e- mail** | | | |  | |
| **Inter / Intra Department Course** | | | | **Intra Department Course** | |
| **Duration of the Course** | | | | **30 Hours** | |
| **Eligibility** | | | | **Any life science Degree** | |
| **Number of Candidates to be Admitted** | | | | **15** | |
| **Registration Procedure** | | | | **Enroll through BU admission portal** | |
| **Job Opportunities:** | | | | | |
| The students who enroll in this value added course will learn how to culture the cell lines of different type’s tissues which is essential for the any kind of morpho and molecular studies. It helps the students to get wide knowledge and it enhances cell interaction, cytotoxicity and cell signaling studies. It increases the  opportunity to get to work in state and central institutions and various research projects. | | | | | |
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| **The objectives of the Course are:** | | | | | |
| The main objectives of this course are to: | | | | | |
| 1 | Understand the basic principles of Cell Culture techniques | | | | |
| 2 | Provide theoretical and practical knowledge in relation to animal cell culture techniques. | | | | |
| 3 | Gain practical skills to subculture animal cells and quantify cell growth | | | | |
| **Course Content** | | | Lecture / Practical / Project / Internship | | |
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| **Module 1** | | Cell culture III (cell differentiation, cell quantification, cytotoxicity  and viability). | | | **6 hours** |
| **Module 2** | | Cell culture techniques (types of tissue culture, primary cultures vs. finite vs. immortalized cell lines, finite cell lines, immortal cell lines,  primary cultures). | | | **6 hours** |
| **Module 3** | | Culture vessels & media development, Serum-free medium  development & sterilization | | | **6 hours** |
| **Module 4** | | Cell separation, characterization, differentiation &  transformation Contamination, cryo-preservation & cyto- toxicity | | | **6 hours** |
| **Module 5** | | Introduction to tissue engineering, Biomaterials: natural materials,  polymers, Biomaterials: hydrogels, ceramics, scaffold fabrication | | | **6 hours** |
|  | |  | | | **30 Hours** |
| **Book(s) for Study** | | | | | |

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| 1 | Molecular Cloning – A laboratory manual. 3rd Edition. Sambrook and Russel. Cold Spring harbor  laboratory Press. 2001.1-2331. |
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| **Book(s) for reference** | |
| 1 | Modern experimental Biochemistry, 3rd Edition, Rodney Boyer. 2000. Benjamin Cummins. 1-480. |
| 2 | Methods in Molecular Biology-Genomics Protocol – Starkey, M.P. and Elaswarapu, R. 2001. Humana  Press.1-538 |
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| **Related Online Contents** | |
| 1 | <https://onlinecourses.nptel.ac.in/noc20_me04/preview> |
| 2 | https://nptel.ac.in/courses/102/104/102104059/ |
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| **DROSOPHILA CULTURE AND REARING** | | | | | |
| **Name of the Department** | | | | **HUMAN GENETICS AND MOLECULAR**  **BIOLOGY** | |
| **Name of the Faculty Member i/c**  **With Complete Address with Phone and e-mail** | | | |  | |
| **Inter / Intra Department Course** | | | | **Intra Department Course** | |
| **Duration of the Course** | | | | **30 Hours** | |
| **Eligibility** | | | | **Any life science Degree** | |
| **Number of Candidates to be Admitted** | | | | **15** | |
| **Registration Procedure** | | | | **Enroll through BU admission portal** | |
| **Job Opportunities:** | | | | | |
| The students who enroll in this value added course will learn how to rear the Drosophila and culture it for different generations. Drosophila is a model organism used by many researchers for studying the genetic disease through various behavioral assays due to sequence similarity with human genes. So learning the rearing skill and practical handling of behavioral assays give them self-sufficiency and give them courage to independently work for their doctoral thesis. It also give the learners a eligibility work in various disease model projects as JRF, SRF and get opportunity work in central government institutions. Besides, if they start doing it with different types of species for different disease model flies, they can supply the flies for research works and they  become entrepreneur in the field. | | | | | |
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| **The objectives of the Course are:** | | | | | |
| The main objectives of this course are to: | | | | | |
| 1 | learn the basic developmental stages of the *Drosophila melanogaster* | | | | |
| 2 | Understand the requirement for raising the colonies of *Drosophila melanogaster* | | | | |
| 3 | Use the *Drosophila melanogaster* for the behavioral assays | | | | |
| **Course Content** | | | Lecture / Practical / Project / Internship | | |
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| **Module 1** | | Identification of Male and Female – Egg – Embryo – Larval  stages and Pupa – Life Cycle | | | **5 hours** |

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| **Module 2** | | Drosophila: Media preparation - Culture Conditions – Basic  requirements – Safety Conditions | **5 hours** |
| **Module 3** | | Drosophila: Maternal Genes, Segmentation Genes and its role  in Development | **6 hours** |
| **Module 4** | | Drosophila: Live observation of Embryo | **2 hours** |
| **Module 5** | | Drosophila: Dissection of larval Brain | **2 hours** |
| **Module 6** | | Drosophila: Dissection of adult brain | **2 hours** |
| **Module 7** | | Drosophila: Behavioral assays - Flight assay | **2 hours** |
| **Module 8** | | Drosophila: Behavioral assays - Climbing assay | **2 hours** |
| **Module 9** | | Drosophila: Dissection of thorax for mitochondria – Theory | **2 hours** |
| **Module 10** | | Drosophila: Dissection of thorax for mitochondria - Practical | **2 hours** |
|  | |  | **30 Hours** |
| **Book(s) for Study** | | | |
| 1 | Principles of Developmental Biology. Sally A. Moody. (Editor). 2007. Academic Press | | |
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| **Book(s) for reference** | | | |
| 1 | Scott F. Gilbert, Developmental Biology*,* VIII edition, Sinauer Associates Inc., Publishers,  Sunderland, Massachusetts USA (2006). | | |
| 2 | Bruce Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, P. Walter (2008). Molecular  Biology of the cell, V edition, John Wiley and sons Inc., 2008. | | |
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| **Related Online Contents** | | | |
| 1 | <https://swayam.gov.in/nd1_noc20_bt35/preview> | | |
| 2 | <https://nptel.ac.in/courses/102/106/102106084/> | | |
| 4 | <https://swayam.gov.in/nd2_cec20_ed13/preview> | | |
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