Solapur University, Solapur
M.Sc. Part-II Semester III & IV Genetics
(Revised semester pattern syllabus)
(w.e.f. June, 2014)
Syllabus for M.Sc. Part II Genetics

**SEMESTER- III (THEORY)**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title of the paper</th>
<th>Marks</th>
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<tbody>
<tr>
<td>GEN - 301</td>
<td>Immunology</td>
<td>100</td>
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<tr>
<td>GEN - 302</td>
<td>Molecular Medicine</td>
<td>100</td>
</tr>
<tr>
<td>GEN - 303</td>
<td>Analytical Instruments and Techniques</td>
<td>100</td>
</tr>
<tr>
<td>GEN - 304</td>
<td>Bioinformatics and Research Methodology</td>
<td>100</td>
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**SEMESTER- III (PRACTICAL)**

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<tr>
<th>Code</th>
<th>Title of the paper</th>
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<tbody>
<tr>
<td>GEN PR- 305</td>
<td>Immunology and Molecular Medicine</td>
<td>100</td>
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<tr>
<td>GEN PR- 306</td>
<td>Analytical techniques, Bioinformatics and Research Methodology</td>
<td>100</td>
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<tr>
<td></td>
<td>Seminar</td>
<td>25</td>
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<td>Total</td>
<td>625</td>
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**SEMESTER- IV (THEORY)**

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<tr>
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<tbody>
<tr>
<td>GEN - 401</td>
<td>Genetic Engineering</td>
<td>100</td>
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<tr>
<td>GEN - 402</td>
<td>Cancer Genetics and Animal Cell culture</td>
<td>100</td>
</tr>
<tr>
<td>GEN - 403</td>
<td>Agriculture Science and Seed Technology</td>
<td>100</td>
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<tr>
<td>GEN - 404</td>
<td>Industrial Biotechnology and IPR</td>
<td>100</td>
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**SEMESTER- IV (PRACTICAL)**

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<tbody>
<tr>
<td>GEN PR – 405</td>
<td>Genetic Engineering, Animal cell culture, Agriculture and Industrial Biotechnology</td>
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<tr>
<td>GEN PR – 406</td>
<td>Project</td>
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<td></td>
<td>Total</td>
<td>625</td>
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</table>

As per the credit system, the assessment of Theory paper of 100 marks weightage will be as: 70 marks theory assessment by University examination and 30 marks internal assessment by the Department. For internal assessment of candidate, periodical tests/seminars/ viva/oral / quiz etc. may be suitably adopted.
GEN 301: Immunology

UNIT 1

UNIT 2
Major Histocompatibility Complex: Introduction, Organization, MHC molecules and gene organization; B Cell Receptor, Organization of Immunoglobulin gene, Genetics of antibody diversity; T cell Receptor, Organization of T Cell Receptor. (9)

UNIT 3
Complement system: Introduction, Alternate and Classical pathway, Regulation; Cytokines: Introduction, Properties and their functions; B Cell generation, activation and differentiation; T Cell maturation, activation and differentiation. (9)

UNIT 4
Hypersensitivity: Autoimmunity: Organ specific and Systemic; Transplantation: Graft Rejection, Types of transplants, Immunosuppressive therapy; Cancer and Immune System. Vaccine: Various Types with their advantages and disadvantages, Recombinant vector vaccine; Aids and Other Immunodeficiency diseases; (10)

UNIT 5

BIBLIOGRAPHY
- Basic and Clinical Immunology; Stites et al., [Ed.] (1982) Lange.
- Immunology; Jan Klein [Ed.] (1990), Blackwell Science.
- Kuby-Immunology; Goldsby et al., (2000), WH Freeman &Co.
UNIT 1: Human Molecular Genetics
Human genome project; Sequence Architecture of human genome; Blood and Blood group Antigens; MHC Antigen – HLA; Identification and isolation of disease genes – Positional cloning, Functional cloning, Microarray technology; Pre-natal diagnosis - Chorionic villus sampling, Amniocentesis; Forensic testing - DNA fingerprinting, Paternity testing.

UNIT 2: Genetic Diseases in Human
Cystic fibrosis, Duchenne muscular dystrophy, Haemoglobinopathies, Agammaglobulinemia, Marfan syndrome, Huntington's disease, Phenylketonuria, Down syndrome.

UNIT 3: Stem Cell as Regenerative medicine
Introduction; Stem cell sources; Unique properties of stem cells; Classification - Embryonic stem cells, Adult stem cells; Similarities and differences between adult and embryonic stem cells; Applications of Embryonic stem cells and ethical issues associated with it; Adult stem cell Differentiation, plasticity, types of adult stem cells; Stem cell specific transcription factors - Induced pluripotent stem cells (iPSC); Therapeutic applications as regenerative medicine.

UNIT 4: Gene Therapies
Introduction; Types of Gene therapy: Somatic and Germ line gene therapy, In-vivo and Ex-vivo gene therapy; Virus based vehicle for gene therapy, Non Viral Methods of Gene transfer.

UNIT 5: Pharmacogenetics
Steps involved in Drug Discovery/Design - Insilco method, Structure based method, Nature and Sources of drugs; Route of drug administration; Absorption and Bioavailability of drugs in system; Excretion of drugs from system; Pharmacogenetics study of drug.

BIBLIOGRAPHY
- Tom Strachan & Andrew P. Read. 2004, Human Molecular Genetics, 2nd Ed. John Wiley & Sons. (Asia) PTE Ltd.
GEN 303: Analytical Instruments and Techniques

Total Lectures - 45

UNIT 1: Microscopy
Introduction; Optical principles of Microscopy; Image formation by compound light microscope & electron microscope; Types of Microscopes - Inverted, Phase-contrast, Bright field, Dark field, Fluorescence microscope; Advanced Microscopy- Scanning electron Microscopy, Transmission electron Microscopy, Confocal Microscopy.

UNIT 2: Radioactivity

UNIT 3: Electrophoresis
Basic principle of electrophoresis; Factors affecting electrophoretic mobility; Support Media. Types of electrophoresis; Theory & Applications of Paper, Starch gel, Agarose, Cellulose Acetate, High Voltage, Pulse field gel electrophoresis, Native PAGE, SDS-PAGE, Isoelectric focussing, Electrophoresis on cellular gels, Capillary Electrophoresis; Blotting Techniques: Southern, Northern, Western Blotting, Dot Blot.

UNIT 4: Chromatography

UNIT 5: Spectroscopy

BIBLIOGRAPHY

- Methods of Enzymatic Analysis; Berg Meyer (1974) Vol. 1-X,
- Protein Purification Applications, S.L.V. Harris and Angal (1990) IRL Press.
- Protein Purification Methods, S.L.V. Harris and Angal (1989) IRL Press.
GEN 304: Bioinformatics and Research Methodology

Total lectures - 45

UNIT 1 Biological Databases
Structural and Sequence databases of Protein and Nucleic acids; NCBI data model – PUBs, SEQ-Ids, BIOSEQs, BIOSEQ-SETs, SEQ-ANNOT, SEQ-ESCR; Database file format – GenBank, SwissProt; Entrez System. (9)

UNIT 2 Sequence Alignments and Database Searching
Introduction and Types of alignments; The Evolutionary Basis of Sequence Alignment; The Modular Nature of Proteins; Optimal Alignment Methods; Substitution Scores and Gap Penalties; Statistical Significance of Alignments; Database Similarity Searching; FASTA; BLAST; Database Searching Artifacts; Position-Specific Scoring Matrices; Spliced Alignments; Method of Multiple Alignment; Tools to Assist the Analysis of Multiple Alignments; Collections of Multiple Alignments. (11)

UNIT 3 Predictive Methods Using Sequences
Methods, Strategies and consideration for prediction of DNA Sequences; Tools – GRAIL, FGENEH/FGENES, MZEF, GENSCAN, PROCRUSTES; Prediction of Protein Sequence – Protein Identity Based on Composition, Physical Properties Based on Sequence, Motifs and Patterns, Secondary Structure and Folding Classes, Specialized Structures or Features, Tertiary Structure. (10)

UNIT 4 Essential Steps in Research
Definition and importance of Research; Experimental designs – Objectives, Literature collection; Literature citation; Hypothesis designing, Basic principles of experiments; Laboratory safety – Biohazardous agents, risk to human health and environment, safety measures, Safety in genetic engineering and laboratory of animals; Socio-economic and ethical consideration. (8)

UNIT 5 Research Report
Components of Research report; Use of tables and figures in research report; Formatting and typing of research report, Plagiarism. (7)

BIBLIOGRAPHY
- Atwood, T. K. and Parry-Smith, D. J, “Introduction to bioinformatics”.
- David Mount, “Bioinformatics (Sequence and Genome analysis)”, Cold spring, Harbour Laboratory Press
Practicals

SEMESTER- III  (Practical)

GEN PR 305 - Immunology and Molecular Medicine

1. Ouchterlony Immuno-diffusion.
3. Blood typing
4. Rocket Electrophoresis
5. ELISA
6. WIDAL test
7. VDRL test
10. RBC counting
11. WBC counting
12. Karyotyping Study of normal and abnormal cells
13. Study of Sickled RBCs.
15. Demonstration of Study of Flow cytometer
16. Case study of treatment of any disease using Gene therapy
17. Case study of treatment of any disease using Stem Cell Therapy
18. MTT Assay (Dimethylenezole Diphenyltetrazolium Bromide)
19. Separation of serum from plasma
20. Estimation of alkaline & acid phosphatase activity in blood plasma
GEN PR 306 - Analytical techniques and Bioinformatics

1. Detail study of Various parts of following microscopes
   - Compound Microscope
   - Inverted Microscope
2. Electrophoresis of Nucleic acid (DNA and RNA)
4. Gel documentation & photography
5. SDS-PAGE for protein mol. wt. determination
6. Gel permeassion chromatography
7. Separation of proteins by 2D gel electrophoresis.
8. UV spectra of protein/ Protein estimation using UV Spectroscopy
9. UV spectra of nucleic acid/ Nucleic acid estimation using UV Spectroscopy
11. Ascending Paper chromatography
   1. Leaf Pigment
   2. Amino Acids
12. TLC of Amino Acids.
13. Retrieval of amino acid/Gene sequence from NCBI/SRS from EBI and studying file format.
14. Studying of pair-wise alignment of given sequences by BLAST/FASTA.
15. Studying multiple alignment of given sequence by Clustalw (Offline tool)
17. Identification of Gene structure in genomic DNA by GENSCAN.
18. Prediction of Physical properties of proteins by online resources.
20. Prediction of secondary structure and folding classes of proteins.
21. 3D Structure prediction and validation of it.
22. Study of Plagiarism for given articles.
23. Practicals on Research methodology (Research papers/Posters etc.)
UNIT 1 Introduction & Commonly used techniques in Genetic Engineering
Introduction; Commonly used techniques: Chromosome walking, Molecular markers: RFLP, RAPD, AFLP, PCR and types. (8)

UNIT 2 Enzymes, Vectors & Probes in Cloning
Restriction Enzymes - Exonucleases, Endonucleases; Restriction Endonucleases - Classification & Properties; DNA Manipulating Enzymes - Nucleases, DNA Polymerases, RNA Polymerases, Reverse Transcriptase; Nucleic Acid modifying enzymes - Ligases, Alkaline Phosphatases, Terminal Transferases, Kinases; Gene Cloning Vectors - Properties & Structure of Plasmids, Cosmids, Phagemids, Shuttle Vector, BAC, YAC, Bacteriophages (λ and M13); Vectors for plants, animals and yeast; Molecular Probes (Radioactive & non radioactive) - Preparation of genomic DNA probes, C-DNA probes, synthetic oligonucleotide probes, RNA probes, methods of labelling probes; Uses of probes. (10)

UNIT 3 Recombinant DNA Technology
Construction of r-DNA Molecules - Isolation of Vector and donor DNA and its purification; Assembly of gene of interest and vector DNA; Introduction to genomic library; Construction of Genomic library; C-DNA library construction; Preparation of primers and probes; Screening of Recombinant Cell - Direct Screening, Indirect Screening, Colony hybridization, Immuno-Screening; Expression of cloned DNA in E.coli - Designing of E.coli Expression vector, Promoter, terminator, origin of replication, regulation of gene expression by promoter. Fusion protein. (9)

UNIT 4 Cloning and Transformation methods
Methods of direct transformation - PEG mediated microinjection, particle bombardment, electroporation, CaCl₂; Methods of indirect transformation - Agrobacterium tumefaciens and A. rhizogenes; DNA sequencing: Maxam’s and Gilbert’s method, Sanger’s dideoxy method, Automated DNA sequencing. (8)

UNIT 5 Applications of Genetic Engineering
rDNA Technology in Human Health - Production of recombinant hormones, insulin, HGH, Hepatitis-B recombinant vaccine production; Synthesis of Human Interferon and Growth hormone; GE in Plants - Insect- resistant plants, Herbicide-resistant plants, Development of salt stress tolerant plants, plant as edible vaccines, Modification of food plants taste (Sweetness); GE in Animals - Transgenic sheep and mice (mice as model for Alzheimer disease and overproduction of proteins); GE in Microbes - Diagnosis of Malaria, Trypanosoma cruzi and sickle-cell anemia, Vector vaccines (Directed against viruses and bacteria). (10)
BIBLIOGRAPHY

- Recombinant DNA: Genes and Genomes - A Short Course, 3rd Edition, James D.
**GEN 402: Cancer Genetics and Animal cell culture**

**Total Lecture – 45**

**UNIT 1 Introduction to Cancer Biology**
Cancer cell vs. Normal cell; Hallmarks of cancer cell; Cell cycle - Regulation of Cell cycle and pRb tumor suppressor; P53 tumor suppressor; Tumor suppressor genes; Oncogenes and Proto-Oncogenes; Factors activating proto-oncogene to oncogene; Tumor Virus; Physical and Chemical Carcinogenesis; Introduction to Epigenetics, Epigenetics in cancer. (9)

**UNIT 2 Cancer Progression**
Apoptosis mechanism, Apoptotic Pathways; Metastasis, Clinical significances of invasion, Metastatic cascade, Basement membrane disruption; Theory of invasion, Proteinases and tumour cell invasion; Angiogenesis and its sequence of events in detail. (9)

**UNIT 3 Diagnostic and Treatment**
Methods of diagnosis - Chemotherapy, Radiation Therapy, Immunotherapy- use of immunotoxins in cancer therapy, Retroviral drugs, Anti-angiogenic Drug; Drugs based on Epigenetics (Acetylation of Histones and Methylation of DNA) (8)

**UNIT 4: Introduction of Animal Tissue Culture**
Introduction; Infrastructure of Animal Tissue Culture Laboratory; Characteristics of cells in culture; Media - Natural & Synthetic Media; Primary culture- Cell line (Finite, Infinite, and Continuous); Disaggregation of tissue, Organ culture & its types; Cell culture – initiation, cultivation of animal cell in mass in Bioreactors; Biology of cell culture, evolution of culture dynamics and maintenance of cell lines. (10)

**UNIT 5: Viability & Micromanipulation**
Viability – measurement of viability and cytotoxicity; Cell cloning – cell synchronization, cell cloning, micromanipulation, Cell Transformation and applications of animal cell culture; In vitro fertilization – embryo transplant techniques and their applications.
Commonly used cell line- MCF7, HeLa, CHO,BHK (9)

**BIBLIOGRAPHY**
- The Biology of Cancer, Robert Weinberg, Garland Science; 2 edition;2010
- Vogel F. Chemical mutagenesis Spinger and Verlag.
- Sanberg A. A. 1980, The Chromosome in Human Cancer And Leukemia
- Stich H. F. Carcinogens and Mutagens in EnvironmentCRC press.
- Animal Cell Biotechnology
  - Ian Freshney (4th Edition)
  - Buttler. 2nd Edition
GEN 403: Agriculture Science and Seed Technology

UNIT 1 Plant Physiology

Plant physiology and its significance in agriculture; Physical properties and chemical constitution of protoplasm; plant cell water relation - imbibition, surface tension, diffusion, osmosis; Absorption and translocation of water and nutrients; Transpiration; Guttation; Mineral deficiencies and their symptoms; Photo respiration; Plant Growth hormones – Auxins, Gibberellins, Abscisic acid, Cytokinins, Pheromones; Growth inhibitors and their use in agriculture; Tropism in plants photoperiodism and vernalization; Seed dormancy and germination, Fruit ripening process and its control. Crops grown in India and their types

UNIT 2 Soil Science and Agricultural Chemistry

Soil as a medium of plant growth and its composition; Soil Types in India; Mineral and organic constituents of soil and their role in crop production; Chemical, physical and microbiological properties of soil; Essential plant nutrients, Principles of soil fertility and its evaluation for judicious use of fertilizers;

UNIT 3 Responses of crops to nutrient deficiency and pathogens

Phosphorous and Iron deficiencies, Heavy metal stress and non optimal pH-acid and calcareous soil; Physiological and molecular biology of heavy metal tolerance; Physiological and molecular responses of plants to water stress, salinity stress, temperature stress (heat and cold), Photo oxidative stress; Plant responses to pathogen and herbivores – biochemical and molecular basis of host plant resistance; Bio composting; Organic manure and Bio fertilizers; Water soluble fertilizers; Bio pesticides: microbes and plants, Biominearization. Steps involved in Mushroom Cultivation.

UNIT 4 Seed Technology

Seed technology and its importance; production processing and testing of seeds of crop plants; seed storage, seed certification; role of National Seeds Corporation (NSC) in production; New seed policy and seed control order, Terminator Technology.

UNIT 5 Animal Husbandry

Importance of livestock in agriculture; relationship between plant and animal husbandry; mixed farming; animal breeding; breeds of indigenous and exotic cattle, buffaloes, goats, sheep, and poultries and their potential for milk, egg, meat and wool production.

BIBLIOGRAPHY

- Thomas L Rost, Michael G Barbour, Terence M Murphy and C Ralph, Stocking Plant
Biology (with InfoTrac), 2005.


GEN 404: Industrial Biotechnology and Intellectual Property Rights

UNIT 1 Bioprocessing in Industry
Introduction; Basic design of fermenter and various parts of fermenter; Types of fermenter; Batch, Fed Batch, Continuous fermentation method; Media Formulation; Methods of preservation and improvement of Industrially Important organism; Microbes exploited commercially - *Saccharomyces, Lactobacillus, Penicillium, Acetobacter, Bifidobacterium*. (9)

UNIT 2 Upstream and Downstream Processing
Upstream Process - Media formulation and Media Optimization; Sterilization of medium, fermenter, feed, liquid waste; Bioprocess control and monitoring variables such as temperature, agitation, pressure, pH; Downstream process - Filtration, Centrifugation, Cell disruption (Physical and Chemical), Liquid –Liquid Extraction, Supercritical fluid extraction; Purification by chromatography and ultra filtration; Drying, Crystallization; Steps Involved in Industrial production of Penicillin, Vitamin B12, Ethanol. (10)

UNIT 3 Industrial Impacts on Environment
Sources and Pollutants of Air pollution; Control measures of air pollution; Sources and Pollutants of Water pollution; Concept of DO, COD, BOD. Dissolved oxygen concentration as an indicator of water quality; Chemical Toxicants from Industry; Treatment and disposal of effluents – Physical treatment, Chemical treatment, Biological treatment; Disposal site. (9)

UNIT 4 Bioremediation & Energy
Bioremediation of soil and water; Biodegradation of toxic wastes from industry; Bioaugmentation; Bioleaching; Phytoremediation.
Energy Crisis and Non Conventional Sources – Energy crisis in India, Conventional sources, Non conventional sources. (8)

UNIT 5 Intellectual Property Rights (IPR)
Introduction; Protection of intellectual property; World organizations; Forms of protection – Copyright, Trademark, Trade secrets and Patent; Patent application; Patenting of biological material; Patenting procedure in India; Geographical indications. Union for the Protection of New Varieties of Plants (UPOV), Advantages and disadvantages of Plant breeders right (PBR). (9)

BIBLIOGRAPHY
- Gautam, N. C., Food Biotechnology in Comprehensive Biotechnology, Vol. 6.,
- Gutierrez – Lopez, G. F. et. al., Food Science and Food Biotechnology.
- Maheshwari, D. K. et. al., Biotechnological applications of microorganisms,
- Stanbury, P. F. et. al., Principles of Fermentation Technology, 2nd Edition,
Practicals

SEMESTER- IV  (Practical)

GEN PR 405 - Genetic Engineering, cell culture, Industrial & Agriculture Technology

1. Estimation of BOD from water sample.
2. Estimation of COD from water sample.
3. Effect of industrial effluents on seed germination and plant growth.
4. Crude protein purification using Filtration, Centrifugation and Dialysis.
5. Study of fermenter and its various parts
6. Isolation of Mitochondrial/ Chloroplast DNA
7. Isolation of genomic DNA from Yeast / Plant cell / Animal Cell and verify using electrophoresis
8. Isolation and quantification of total RNA from Yeast / Plant cell / Animal Cell and verify using electrophoresis
9. Molecular weight determination of digested DNA.
10. Construction of restriction map of plasmid DNA.
11. Ligation theory and ligation of DNA.
12. Southern blotting technique.
13. DNA amplification by PCR
14. Reporter gene assay (β- Gal)
15. DNA Fingerprinting: Using RAPD techniques
16. Aseptic Transfer technique in animal Cell Culture
17. Preparation of Balanced Salt Solution and pH standards for animal cell culture.
18. Trypsinization methods in animal cell culture -
   A. Warm Trypsinization   B. Cold Trypsinization
19. Chick Embryo Culture / Lymphocyte Culture.
20. Determination of growth curve of a microorganism - Compute specific growth rate
21. Laboratory techniques to measure water and nutrient uptake in plants.

SEMESTER- IV  (Practical/Project)

Gen Pr 406 – Project

Students have to start the research project during III Semester and submit and present during the practical examination of IV semester.
Your Uninstaller is 1st smart "Drag and Uninstall" uninstaller software, that removes unneeded applications on your computer very fast. It has a unique ability to uninstall programs by simply dragging their icons into the Your Uninstaller icon. You may also find the application you want to uninstall through a unique search function. It's as easy as using the recycle bin. Just a drag-drop and the program you don't want will disappear from your computer. As well as everything the unwanted program brings! University Relations works with clients across campus to develop creative projects and marketing strategies that advance UNI and its colleges, departments and programs. Initiatives include (but are not limited to): Publications: UR's staff of writers/editors/project managers, graphic designers and the photojournalist work with campus offices to produce high-profile publications (printed and electronic). Your Uninstaller can uninstall any application as well as repair uninstalls that have failed. Your Uninstaller is a suite of utilities that can find a place in any Windows user's toolbox. The core purpose of the tool is to uninstall applications. Of course, the Windows OS has this feature built-in, but the process isn't always perfect and sometimes applications don't play nice. That's where Your Uninstaller comes in, and it can be used before or after the fact. One way that Your Uninstaller really shines is speed. It's fast!