SRI SANKARA ARTS AND SCIENCE COLLEGE (AUTONOMOUS)

ENATHUR, KANCHIPURAM – 631 561

CHOICE BASED CREDIT SYSTEM

M.Sc. DEGREE COURSE IN BIOTECHNOLOGY

CHOICE BASED CREDIT SYSTEM

1. CONDITIONS FOR ADMISSION:

A Candidate with a Bachelor's Degree in Science in the disciplines of Biotechnology,, Biology, Botany, Zoology, Microbiology, Genetics, Chemistry, Biochemistry, Physics, Agriculture from this University or B.E/B.TECH (Biotech), B.V.Sc, MBBS, BDS or an examination of some other University accepted by the Syndicate as equivalent thereto shall be permitted to appear and qualify for the M.Sc Degree Examination of this University after a course of two academic years in an Affiliated Colleges of this University.

2. DURATION OF THE COURSE:

The duration of the course is for two academic years consisting of four semesters. In order to be eligible for the award of the degree, the candidate should have successfully completed the course within THREE years reckoned from the date of enrolment for the first semester of the course.

3. STRUCTURE OF THE COURSE

The course is organized on semester basis with a total of four semesters. In first, second and third semesters, there are three **(core)** theory papers (9 hrs per week), one Core Practical (15hrs per week) and **Two elective/ optional papers**(4hrs per week), per semester and in the fourth semester, there are only one core theory papers (Research Methodology) (4hrs per week), a core project/ dissertation work constituting a total of 20 hrs per week, two electives (4hrs per week), and a Soft skill program (2hrs per week).

Elective paper: Each student will opt for a comprehensive, interactive course with one of the faculty member. The topic of specialization and course content will be determined by the dept/ course advisor.

Core Practical **Laboratory**: Independent practical shall be held under each component. It is recommended that the practical training be organized as an exercise rather than simple demonstration. The students must actually perform the experiments.

4. ELIGIBILITY FOR THE AWARD OF DEGREE:

A candidate shall be eligible for the award of the degree only if he/she has undergone the prescribed course of study in a college affiliated to the University for a period of not less than two academic years, passed the examination of all the four semesters prescribed earning 90 credits and fulfilled such conditions as have been prescribed therefore.

A candidate shall be eligible for the award of the degree only if he/she has undergone the prescribed courses on Soft Skills and internship in addition to the courses prescribed by the respective Board of Studies for the subject of the Masters Degree. For two years Master's Degree Programme, a candidate must undergo a minimum of 4 courses (4 x 2=8 credits) from the courses on Soft skills.

A two year Master's Degree student shall undergo 4-6 weeks (2 credits internship during the summer vacation of the First year and submit a report in the beginning of third semester. The report will be evaluated in third semester and the marks forwarded to the University along with third semester internal assessment (CIA) marks.

5. EXAMINATIONS:

There shall be four semester examinations: first semester examinations at the middle of the first academic year and the second semester examination at the end of the first academic year. Similarly, the third and fourth semester examinations shall be held at the middle and the end of the second academic year, respectively. Practical examination shall be conducted independently at the end of even semesters. For practical examination, a single comprehensive) (covering different courses offered during that semester) practical examination (6hrs per day) be held for each component of the core practical at the end of even semesters.

Examinations for the courses on soft skills will be held along with the semester examinations of the core and elective courses. There is no written examination for internship. A student must submit a report after completing the summer internship. The report will be evaluated by two examiners within the Department of the college/ institution.

6. COURSE OF STUDY AND SCHEME OF EXAMINATIONS:

FIRST SEMESTER

S. No.	Course Components	Name of Course	Semester	Inst. Hours	Credits	Exam HRS	Max. Marks	
							CIA	External
1.	Core Paper-1	Biochemistry	I	3	3	3	25	75
2.	Core Paper-2	Molecular Genetics	I	3	3	3	25	75
3.	Core Paper-3	Molecular Cell Biology	I	3	3	3	25	75
4.	Core Paper-4 Practical-I	Practical - I (A)Biochemistry (B)Molecular Genetics (C) Molecular Cell biology	I	15	10	6	40	60
5.	Paper-5* Elective	Bioinstrumentation	I	2	2	3	25	75
6.	Paper-6 * Elective	Biostatistics	I	2	2	3	25	75
7.	Paper-7 * Elective	Enzymology	I	2	2	3	25	75
8	Soft Skill - I		I	2	2	3	40	60
Total Credits : 25								

***Candidates can opt for any two Electives**

(Practical examination shall be conducted independently at the end of even semesters.)

SECOND SEMESTER

S. No.	Course Components	Name of Course	Semester	Inst. Hours	Credits	Exam HRS	Max. Marks	
							CIA	External
9.	Core Paper-8	Microbiology	II	3	3	3	25	75
10.	Core Paper-9	Plant & Animal Biotechnology	II	3	3	3	25	75
11.	Core Paper-10	Genetic Engineering	II	3	3	3	25	75
12.	Core Paper-11 Practical-II	Practical - II (A) Microbiology (B) Plant & Animal Biotechnology (C) Genetic Engineering	II	15	10	6	40	60
13.	Paper-12* Elective	Tissue Engineering	II	2	2	3	25	75
14.	Paper-13* Elective	Pharmaceutical Biotechnology	II	2	2	3	25	75
15.	Paper-14* Elective	Environmental Biotechnology	II	2	2	3	25	75
16.	Soft skill - II		II	2	2	3	40	60
Total credits: 25								

***Candidates can opt for any two Electives**

THIRD SEMESTER

S. No.	Course Comp	Name of Course	Semester	Inst. Hours	Credits	Exam HRS	Max. Marks	
							CIA	External
17	Core Paper-15	Bioinformatics	III	3	3	3	25	75
18	Core Paper-16	Immunology	III	3	3	3	25	75
19	Core Paper-17	Bioprocess Technology	III	3	3	3	25	75
20	Core Paper-18 Practical-III	Practical - III (A) Bioinformatics (B) Immunology (C) Bioprocess Technology	III	15	10	6	40	60
21	Paper-19 * Elective	Nano Biotechnology	III	2	2	3	25	75
22	Paper-20* Elective	Molecular Developmental Biology	III	2	2	3	25	75
23	Extra * disciplinary elective	Any Elective offered by other Depts.	III	2	3	3	25	75
24	Soft skill - III		III	2	2	3	40	60
25	**Internship	Internship in Industries or Research Laboratories related to Biotechnology Field	III		2		-	100
26	Elective offered to other Dept.	Principles of Gene Manipulation Technology	III	2	3	3	25	75
Total credits: 28								

(Practical examination shall be conducted independently at the end of even semesters.)

*__Candidates can opt for any one Elective and one Extra disciplinary elective__

____ Internship will be carried out during the summer vacation of the first year and the report will be evaluated by two examiners within the Department of the college/ institution. The marks should be sent to the University by the College and the same will be included in the Third Semester Marks Statement.

FOURTH SEMESTER

S. No.	Course Components	Name of Course	Semester	Inst. Hours	Credits	Exam HRS	Max. Marks	
							CIA	External
27	Core Paper-21	Research Methodology	IV	4	3	3	25	75
28	Paper-22* Elective	Stem Cell Biology	IV	2	2	3	25	75
29	Paper-23* Elective	Bioethics, Human rights and Social Issues	IV	2	2	3	25	75
30	Core Paper-24	Dissertation	IV	20	15		60	240 (40-work book, 150-Dissertation + 50- Viva)
31	Soft skill - IV		IV	2	2	3	40	60
Total credits: 22 / 24 *								

*__Candidates can opt for any one of the two Electives and the additional 2 hours shall be used for Dissertation work. However, additional elective paper can be opted for earning extra credits.__

The following procedure be followed for Internal Marks:

Theory Papers: Internal Marks : 25

Best Two tests out of 3	10 marks
Attendance	5 marks
Seminar	5 marks
Assignment	5 marks
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	25 marks

Practical: Internal Marks: 40

Attendance	- 5 marks
Practical Best Test 2 out of 3	- 25 marks
Record	- 5 marks
Viva	- 5 marks

Break-up Details for Attendance

Below 60%	- No marks
60% to 75%	- 3 marks
76% to 90%	- 4 marks
91% to 100%	- 5 marks

7. PROJECT EVALUATION:

Project : Project Work should be carried out as an individual project and actual bench work. The project work will begin from IIIrd Semester, and will continue through the VIth Semester. The project report (also work book shall be presented at the time of presentation and *viva voce*) will be submitted at the end of the IVth Semester and evaluated. For the conduct of the End Semester Examination and evaluation of Project Work the University will appoint External Examiners.

The project work dissertation carries a total of **300** marks and evaluation will be carried out by both internal and external evaluators. The average marks awarded by them will be considered. Project work book consisting of daily research activities, methods adopted, results recorded and

maintained by the candidate shall also be submitted along with dissertation for evaluation. The viva-voce examination is part of dissertation which carries marks as specified below.

The assignment of marks for Project is as follows:

Continuous Internal Assessment Marks	
Best 2 out of 3 presentations (Literature survey, Methodology and Results of the project work)	- 60 marks
Project work book	- 40 marks
Dissertation/	- 150 marks
Viva-voce	- 50 marks

8. REQUIREMENTS FOR PROCEEDING TO SUBSEQUENT SEMESTERS:

(i) Candidates shall register their names for the First semester examination after the admission in the PG courses.

(ii) Candidates shall be permitted to proceed from the First Semester upto the Final Semester irrespective of their failure in any of the Semester Examination subject to the condition that the candidates should register for all the arrear subjects of earlier semesters along with current (subject) Semester subjects.

(iii) Candidates shall be eligible to proceed to the subsequent semester, only if they earn sufficient attendance as prescribed therefore by the Syndicate from time to time.

Provided in case of candidate earning less than 50% of attendance in any one of the semester due to any extraordinary circumstance such as medical grounds, such candidates who shall produce Medical Certificate issued by the Authorised Medical Attendant (AMA), duly certified by the Principal of the College, shall be permitted to proceed to the next semester and to complete the course of study. Such candidate shall have to repeat the missed semester by rejoining after completion of final semester of the course, after paying the fee for the break of study as prescribed by the University from time to time.

9. PROCEDURE IN THE EVENT OF FAILURE

1. If a candidate fails in a particular subject (other than project work) he /she may appear for the University examination in that subject in the subsequent semester(s) and obtain pass marks.
2. In the event of failure in project work, the candidates will re-register for the project work and redo the project work in the subsequent semester and resubmit the dissertation afresh for evaluation. The Continuous Internal Assessment marks will be allotted freshly in this case.

10. PASSING MINIMUM:

a) There shall be no Passing Minimum for Internal.

b) For External Examination, Passing Minimum shall be of 50 % (Fifty Percentage) of the maximum marks prescribed for the paper.

c) In the aggregate (External + Internal) the passing minimum shall be of 50% for each Paper/Practical/Project and Viva-voce.

d) Grading shall be based on overall marks obtained (internal + external).

11. CLASSIFICATION OF SUCCESSFUL CANDIDATES:

Candidates who secured not less than 60% of aggregate marks (Internal + External) in the whole examination shall be declared to have passed the examination in the First Class. All other successful candidates shall be declared to have passed in Second Class. Candidates who obtain 75% of the marks in the aggregate (Internal + External) shall be deemed to have passed the examination in First Class with Distinction, provided they pass all the examinations (theory papers, practicals, project and viva-voce) prescribed for the course in the First appearance.

12. GRADING SYSTEM: As per the existing TANSCHE Grading followed by all Post-graduate degree Courses under CBCS (w.e.f.2009-10).

13. RANKING:

Candidates who pass all the examinations prescribed for the course in the first appearance itself alone are eligible for Ranking / Distinction.

Provided in the case of candidates who pass all the examinations prescribed for the course with a break in the First Appearance due to the reasons as furnished in the Regulations under "Requirements for Proceeding to subsequent Semester" are only eligible for Classification.

14. PATTERN OF QUESTION PAPER:

Question paper pattern for M.Sc Biotechnology degree course for each semester will be given as follows.

For Theory Paper subjects

Part A

10 Objective questions or definitions of 2 marks covering all units of the syllabus (No choice will be given) 10x2=20Marks

Part B

5 Paragraph questions of 5 marks to be answered choosing one each from each unit following either/ or pattern 5x5=25 marks

Part C

Two Essay type questions of 15 marks to be answered choosing one from each Unit following either/ or pattern 2x15=30 marks

15. APPEARANCE FOR IMPROVEMENT:

Candidates who have passed in a theory paper / papers are allowed to appear again for theory paper / papers only once in order to improve his/her marks, by paying the fee prescribed from time to time. Such candidates are allowed to improve within a maximum period of 10 semesters counting from his/her first semester of his/her admission. If candidate improve his marks, then his improved marks will be taken into consideration for the award of Classification only. Such improved marks will not be counted for the award of Prizes / Medals, Rank and Distinction. If the candidate does not show improvement in the marks, his previous marks will be taken into consideration.

No candidate will be allowed to improve marks in the Practical, Project, Viva-voce, Field work.

16. TRANSITORY PROVISION:

Candidates who have undergone the course of study prior to the academic year 2015-2016 will be permitted to appear for the examinations under those Regulations for a period of three years i.e., up to and inclusive of April/May 2019 Examinations. Thereafter, they will be permitted to appear for the examination only under the Regulations then in force.

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SYLLABUS

Paper – 1			
Title of the paper	**Biochemistry**		
Category of the course	Year	Semester	Credits
Core	I	I	3

Unit-1

pH, pK – acid, base – biological buffer system – Water- Principles of thermodynamics. Carbohydrates: Nomenclature, classification, structure, chemical and physical properties of carbohydrates. Metabolisms: glycogenesis, glycogenolysis, gluconeogenesis, pentose phosphate pathway.

Unit-2

Lipids: Nomenclature, classification, structure, chemical and physical properties of fatty acids. Metabolisms: biosynthesis of fatty acids, triglycerols, phospholipids, glycol lipids. Cholesterol biosynthesis, bile acids and salt formation. Eicosanoids, s*phingolipids and* steroid hormones.

Unit- 3

Bioenergetics and Biological oxidation: Electron transport chain, oxidative phosphorylation, glycolysis, citric acid cycle, cori's cycle, glyoxalate pathway. Oxidation of fatty acids-mitochondrial and peroxisomal ß-oxidation, **α** and ω oxidation, oxidation of unsaturated and odd chain fatty acids, ketone bodies. Photosynthesis, urea cycle, hormonal regulation of fatty acids and carbohydrates metabolisms.

Unit – 4

Amino acids and Protein: Nomenclature, Classification, structure, chemical and physical properties of amino acids and proteins. Metabolisms: Biosynthesis of amino acids. Degradation

of proteins, nitrogen metabolisms and carbon skeleton of amino acids. Over all in born error metabolisms.

Unit- 5

Nucleic acids: Nomenclature, Classification, structure, chemical and physical properties of *purine and pyrimidines. In* de novo and salvage synthesis of purines, pyrimidine bases, *nucleosides and nucleotides.* Catabolisms of purines and pyrimidines bases. Synthetic analogues of nitrogenous bases.

Reference books:

- Philip Kuchel, Simon Easterbrook-Smith, Vanessa Gysbers, Jacqui M. Matthews, 2011. Schaum's Outline of Biochemistry, Third Edition (Schaum's Outline Series), McGraw-Hill.
- Sathyanarayana.U and U.Chakrapani., 2011. Biochemistry. Books and Allied private limited, Kolkata.
- Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, 2010. Biochemistry, Seventh Edition, W. H. Freeman.
- Albert Lehninger, David L. NelsonVoet Donald, Judith G.Voet and Charlotte W.Pratt., 2008. Principles of Biochemistry. John Wiley and sons, Inc., New Jersey.
- , Michael M. Cox, 2008. Lehninger Principles of Biochemistry, Fifth Edition, W. H. Freeman publishers.

Useful Web Sites:

mcdb-webarchive.mcdb.ucsb.edu/.../biochemistry/.../website-tourf.htm

www.biochemweb.org/

http://golgi.harvard.edu/biopages.html

webarchive.mcdb.ucsb.edu/sears/biochemistry/info/website-

Paper –2			
Title of the paper	**Molecular Genetics**		
Category of the course	Year	Semester	Credits
Core	I	I	3

Unit – 1

Genes and chromosomes, Colinearity of Genes and Proteins, Genetic code, Identification of DNA as the genetic material. The complexity of eukaryotic genome (introns, exons, repetitive DNA sequence, gene duplication and pseudogenes).

Unit – 2

Replication of DNA, DNA repair, Gene expression and regulation in prokaryotes and eukaryotes. Mutation: Spontaneous and virus induced mutation, Radiation induced mutation – Ionizing radiation, UV radiation.

Unit – 3

DNA repair mechanisms, (photoreactivation, excision, SOS, recombination and heat shock responses), xerodermapigmentosum, chemically induced mutation – Base analogs Nitrous acid, Acridines, Alkylating and hydroxylating agents. Chromosomal Abnormalities, Recombination - models.

Unit – 4

Discovery – early experiments of McClintock in maize – Insertion sequences in prokaryotes – complex transposons (ex. Tn3, Tn5, Tn9 and Tn10) – Mechanisms, control consequences and application of transposition by simple and complex elements.

Unit – 5

Allele frequencies and genotype frequencies, systems of mating, inbreeding, genetics and evolution – mutation and migration, random genetic drift.

Reference Books:

- Robert brooker, 2011. Genetics: analysis and principles, 4 edition, McGraw-Hill.
- Leland Hartwell, Leroy Hood, Michael Goldberg, Ann Reynolds, Lee Silver, 2010. Genetics: From Genes to Genomes, 4 edition, McGraw-Hill.
- Rastogi Smita and Neelam Pathak., 2010. Genetic engineering, Oxford University press, New Delhi.
- Karvita B. Ahluwalia., 2010. Genetics. New age international pvt ltd and Publishers, New Delhi.
- Molecular Biology of Genes. 4th edition by Watson, Hopkins, Roberts, Steitz, Weiner. 2004.
- The Cell – A molecular approach. 3rd edition by Geoffrey M. Cooper, Robert E. Hausman. 2003.
- Principles of Genetics. 8th edition by Gardner, Simmons and Snustad. 2002.
- Genetics Schaum's outline series. 4th edition by Susan Elrod – Tata McGraw Hill. 2002.
- Human Genetics – Concepts and applications by Lewis, R. 2001.

Useful Web Sites:

hmg.oxfordjournals.org/

learn.genetics.utah.edu/:

nrs-micro.mcgill.ca/micr338/

Paper – 3			
Title of the paper	**Molecular Cell Biology**		
Category of the course	Year	Semester	Credits
Core	I	I	3

Unit – 1

The molecules of a cell; Organelles of the eukaryotic cell and its functions; Biomembranes - structural organization, transport across membrane (Passive, Active and Bulk transport); Cell-

Cell adhesion- Cell junctions (Tight junctions, gap junctions, desmosomes, adherens); Extra cellular matrix (ECM)- components and role of ECM in growth.

Unit – 2

Microscopy- Bright field, Phase contrast, fluorescence; Electron (TEM, SEM and Tunneling SEM), Histochemistry – Microtomy, Fixation, embedding, sectioning and staining of tissues. Hybridization-FISH; Flow cytometry; Cell fractionation.

Unit – 3

Organization of Eukaryotic DNA in to chromosomes; DNA replication –mechanism; Transcription- basic mechanism in prokaryotes and eukaryotes; Post and co-transcriptional modifications; Translation in prokaryotes and eukaryotes; Post translational modifications; Protein sorting and secretion; Protein folding and degradation.

Unit – 4

Molecular basis of eukaryotic cell cycle, Regulation and cell cycle check points; Programmed cell death (Apoptosis); Cell-Cell signaling-signaling molecules, types of signaling, signal transduction pathways (GPCR-cAMP, IP_3, RTK, MAP Kinase, JAK-STAT, Wnt Pathway); Cancer-multistage cancer development, carcinogens, oncogenes and proto-oncogenes, tumor suppressor genes-Rb, p53.

Unit – 5

Microfilaments – Actin structure, Dynamics of actin assembly, Myosin and molecular motors. Intermediate filaments- types and functions. Microtubules- structure and dynamics, kinesin and dynein powered motors, focal adhesion points, microvilli and pseudopodial extensions.

Reference Books:

- Karp, G., 2009, Cell and Molecular Biology, Sixth edition, John Wiley & Sons, New York.
- David E.Sadva., 2009. Cell biology organelles structure and function, CBS publishers and distributors, New Delhi.

- Prakash S. Lohar , 2009. Cell and Molecular Biology
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, 2007. Molecular Biology of the Cell, Fifth edition. Garland Science.
- Lodish,H., Berk, A., Zipursky, S.L., Matsudaira, P., Kaiser, A., Krieger, Scott and Darnell, J. 2007. Molecular Cell Biology. Media Connected, sixth edition. W.H.Freeman and Company

- Geoffrey.M.Cooper, Robert.E.Hausman.2007.The Cell-A Molecular Approach, Fourth edition. Sinauer Associates.
- Luiz Carlos Uchoa, Janqueira, Jose, Carneiro. 2005. Basic Histology- Text and Atlas. McGraw-Hill Professional.
- Paul A, 2001, Text Book Of Cell And Molecular Biology 2edition Niyogi Books
- T.Fleming. 2002. Cell interactions: A practical approach – Second edition.
- Weaver. 2002. Molecular Biology, Second edition. McGraw-Hill.

Useful Web Sites:

Molecular Cell Biology, 6e

cellbiol.com/

Paper – 4 Practical I			
Title of the paper	**(A)Biochemistry (B) Molecular Genetics (C) Molecular Cell Biology**		
Category of the course	Year	Semester	Credits
Core	I	I	10

(A) Biochemistry - Practical

1. Basic calculations in Biochemistry – Normality, Molarity, Molality percent solutions (v/v, w/v).
2. Calibration of pH meter
3. Transition interval of commonly used pH indicators

4. Preparation of biological buffer - phosphate buffer
5. Extraction of Proteins from biological materials
6. Protein separation methods:-Ammonium sulphate Precipitation,
7. Membrane Dialysis ,
8. SDS PAGE
9. Urea-SDS PAGE for separation of low molecular weight proteins
10. Estimation of Proteins by Lowry's method
11. Estimation of Proteins by Biuret method
12. Estimation of Proteins by Bradford method
13. Estimation of RNA by orcinol method
14. Estimation of DNA by diphenylamine method
15. Estimation of Carbohydrate by Anthrone method
16. Purity check of DNA & RNA by UV Spectrophotometry - $A_{260/280}$
17. Separation of amino acids by Paper Chromatography
18. Separation of sugars by Paper Chromatography
19. Separation of amino acids by Thin layer chromatography
20. Separation of sugars by Thin layer chromatography
21. Thermal Denaturation of DNA and UV absorption studies

Demo Experiments

1. Gel permeation chromatography,
2. Affinity chromatography,
3. Ion–exchange chromatography
4. Western blotting

(B) Molecular Genetics - Practical

1. Isolation of DNA from bacteria
2. Isolation of DNA from plants
3. Isolation of DNA from animal tissue
4. Isolation of DNA from blood
5. Plasmid DNA isolation.

6. Agarose gel electrophoresis of DNA
7. Transer of DNA from gel – Southern Blotting
8. Isolation of RNA
9. Glyoxal denatured Agarose gel electrophoresis of RNA
10. Formaldehyde denatured Agarose gel electrophoresis of RNA
11. Urea denatured Agarose gel electrophoresis of RNA
12. Transfer of RNA from gel – Northern Blotting
13. Restriction digestion of DNA
14. Radiation induced genetic damage assessment (Root meristem of *Allium cepa*).
15. Chemical induced genetic damage assessment (Root meristem of *Allium cepa*).
16. Preparation of metaphase chromosomes form blood
17. G-banding and karyotyping.

(C) Molecular Cell Biology - Practical

1. Introduction to Microtome and types
2. Microtomy - Fixation of tissue
3. Microtomy - Embedding
4. Microtomy - Sectioning of tissue
5. H & E Staining of tissues
6. Histochemical staining to localize proteins
7. Histochemical staining to localize carbohydrates
8. Histochemical staining to localize lipids.
9. Subcellular fractionation and marker enzyme detection (mitochondria).
10. Giant chromosome studies in Chironomous larvae.
11. Meiotic study in flower buds and cockroach or grasshopper.
12. Preparation of tissue culture medium and membrane filtration;
13. preparation of single cell suspension from spleen and thymus;
14. Cell counting and cell viability;
15. Macrophage monolayer from PEC and measurement of phagocytic activity;
16. Trypsinization of monolayer and subculturing; Cryopreservation and thawing;
17. Role of serum in cell culture;

18. Preparation of metaphase chromosomes from animal cells;
19. Isolation of mRNA, genomic DNA;
20. MTT assay for cell viability and growth; Cell fusion with PEG.
21. embryonic development and stem cells (serpulid polychaete *Hydroides elegans/ chick/ frog*)

Reference Books:

Biochemistry:

- David A. Thompson and Cristina C. Thompson, 2009. Biochemistry Lab Manual, 1st Edition, CreateSpace Publisher,USA.
- David T. Plummer, 2008. An introduction to Practical Biochemistry, 3rd Edition, Tata McGraw-Hill Publishers, India
- Jayaraman J., 2008. Laboratory Manual in Biochemistry, 1st Edition, New Age International Publishers, India.

Useful Websites:

www.dundee.ac.uk/undergraduate/courses/**biochemistry**.htm

www.flipkart.com/**Practical**+**BiochemistryPractical**

Molecular Genetics:

- Thomas Robert Mertens, Robert L. Hammersmith. 2007. Genetics: laboratory investigations. Pearson Prentice Hall.
- Sue Carson, Dominique Robertson, 2005. Molecular Biology Techniques, Second Edition: A Classroom Laboratory Manual, 2nd Edition, Academic Press.
- Joe Sambrook, 2001. Molecular Cloning: A Laboratory Manual, Third Edition, Cold Spring Harbor Laboratory Press.
- Stefan Surzycki, 2000. Basic Techniques in Molecular Biology, 1st Edition, Springer
- Ernest Brown Babcock, Julius Lloyd Collins, 2010. Genetics Laboratory Manual. McGraw-Hill Book Company Inc.

Useful Websites:

www.amazon.com/Molecular-Genetics-Yeast- practical

www.emunix.emich.edu/~rwinning/genetics/tech.htm

www.mas.wur.nl/.../Specialisation+Animal+Breeding+and+Genetics/

Molecular Cell Biology:

- Dr. David A Thompson, 2009. Cell and Molecular Biology Lab Manual, 1st Edition, CreateSpace publishers.
- Quincy Quick. 2009. Cell and Molecular Biology Laboratory Manual. Quincy Quick Publishing,
- Julio E. Celis. 2006. Cell biology: a laboratory handbook, Elsevier Academic,
- Takehiko Koji, 2000. Molecular Histochemical Techniques (Springer Lab Manuals) 1st Edition, Springer.
- Lodish,H., Berk, A., Zipursky, S.L., Matsudaria, P., Baltimore, D. and Darnell, J. 2000. Molecular Cell Biology. Media Connected, W.H. Freeman and Company.
- *Mark Hill, 2011*. An educational resource for learning concepts in embryological development.
- Jan A. Pechenik1,John S. Pearse2 and Pei-Yuan Qian, 2010.
- Understanding the Effects of Low Salinity on Fertilization Success and Early Development in the Sand Dollar Echinarachnius parma Biol. Bull. 218:189-199

Wesites:

www.ask.com/Fetal+**Development**Get

www.nature.com/nrm/focus/index.html

php.med.unsw.edu.au/**embryo**logy/index.php?title...**Practical**

Paper – 5			
Title of the paper	**Bioinstrumentation**		
Category of the course	Year	Semester	Credits
Elective	I	I	2

Unit-1

Microscopic Techniques: Principles and Applications of Light, Phase Contrast, Fluorescence Microscopy, Scanning and Transmission Electron Microscopy, Scanning Tunneling Microscopy,

Atomic Force Miscroscopy, Confocal Microscopy, Cytophotomatry and Flow Cytometry, patch clamping.

Unit-2

Centrifugation: Preparative and Analytical Centrifuges, Sedimentation analysis RCF, Density Gradient Centrifugation. Chromatography Techniques: Theory and Application of Paper Chromatography, TLC, Gel Filtration Chromatography, Ion Exchange Chromatography, Affinity Chromatography, GLC, HPLC, FPLC

Unit-3

Electrophoretic Techniques: Theory and Application of PAGE, Agarose Gel Electrophoresis 2DE, Iso-electric Focusing, Immuno diffusion, Immuno Electrophoresis , ELISA , RIA , Southern , Northern and Western Blotting . PCR, Real time PCR, DNA/RNA Sequencing, Microarray (DNA, Proteins),.

Unit-4

Spectroscopic Techniques: Theory and Application of UV and Visible Spectroscopy, Fluorescence Spectroscopy, MS , NMR, ESR, Atomic Absorption Spectroscopy, X- ray Spectroscopy, LASAR , Raman Spectroscopy . MALDI MS.

Unit-5

Radio-isotopic Techniques: Introduction to Radioisotopes and their Biological Applications, Radioactive Decay – Types and Measurement , Principles and Applications of GM Counter, Solid and Liquid Scintillation Counter, Autoradiography, RIA, Radiation Dosimetry .

Reference books:

- Keith Wilson, John Walker, 2010. Principles and Techniques of Biochemistry and Molecular Biology (7th Edition), Cambridge University Press
- David L. Nelson, Michael M. Cox. Lehninger (2008). Principles of Biochemistry, Fifth edition W. H. Freeman, New York.

- Experiments in Biochemistry: A Hands-On Approach by Shawn O. Farrell, Ryan T. Ranallo, Paperback: 324 pages, Publisher: Brooks Cole.
- Metzler D.E. 2001, The chemical reactions of living cells –Academic Press. 2nd edition,
- Stryer L, , 1999, Biochemistry –W.H. Freeman & Company, New York. 1.
- 4th edition

Useful Websites:

http://golgi.harvard.edu/biopages.html

www.whfreeman.com/biochem

http.//www.harcourtcollege.com

Paper – 6			
Title of the paper	**Biostatistics**		
Category of the course	Year	Semester	Credits
Elective	I	I	2

Unit-1

Statistics – Scope –collection, classification, tabulation of Statistical Data – Diagrammatic representation – graphs – graph drawing – graph paper – plotted curve –Sampling method and standard errors –random sampling –use of random numbers –expectation of sample estimates – means – confidence limits – standard errors – variance. Measures of central tendency – measures of dispersion – skewness, kurtosis, moments.

Unit-2

Correlation and regression – correlation table – coefficient of correlation – Z transformation – regression – relation between regression and correlation. Probability – Markov chains applications – Probability distributions – Binomial (Gaussian distribution) and negative binomial, compound and multinomial distributions – Poisson distribution.

Unit-3

Normal distribution – graphic representation.– frequency curve and its characteristics –measures of central value, dispersion, coefficient of variation and methods of computation – Basis of Statistical Inference –Sampling Distribution – Standard error – Testing of hypothesis – Null Hypothesis –Type I and Type II errors.

Unit-4

Tests of significance for large and small samples based on Normal, t, z distributions with regard to mean, variance, proportions and correlation coefficient – chi-square test of goodness of fit – contingency tables – c^2 test for independence of two attributes – Fisher and Behrens 'd' test – 2×2 table – testing heterogeneity – r X c table – chi-square test in genetic experiments – partition X 2 – Emerson's method.

Unit-5

Tests of significance –t tests – F tests – Analysis of variance – one way classification – Two way classification, CRD, RBD, LSD. Spreadsheets – Data entry –mathematical functions – statistical function – Graphics display – printing spreadsheets – use as a database word processes – databases – statistical analysis packages graphics/presentation packages.

References Books:

- Veer bala Rastogi. 2011. Fundamentals of Biostatistics. Ane books Pvt Ltd, Chennai.
- Rosner,B (2005), "Fundamentals of Biostatistics", Duxbury Press.
- Warren,J; Gregory,E; Grant,R (2004), "Statistical Methods in Bioinformatics",1st edition, Springer
- Milton,J.S.(1992),. "Statistical methods in the Biological and Health Sciences", 2nd edition ,Mc Graw Hill,
- Sundar Rao P. S.S., Jesudian G. & Richard J. (1987), "An Introduction to
- Biostatistics", 2nd edition,. Prestographik, Vellore, India,.
- Zar, J.H. (1984) "Bio Statistical Methods", Prentice Hall, International Edition

Useful Websites :

www.statsoft.com/textbook/

biosun1.harvard.edu/

www.bettycjung.net/Statsites.htm

www.ucl.ac.uk/statistics/biostatistics

Paper – 7			
Title of the paper	**Enzymology**		
Category of the course	Year	Semester	Credits
Elective	I	I	2

Unit 1

Introduction to enzymes, Classification, nomenclature and general properties like effects of pH, substrate and temperature on enzyme catalysed reactions. Extraction Isolation and purification of enzymes by precipitation, centrifugation, chromatography and electrophoresis methods.

Unit 2

Kinetics of catalysed reaction : Single substrate reactions, bisubstrate reactions, concept of Michaelis - Menten, Briggs Haldane relationship, Determination and significance of kinetic constants, Limitations of Michaelis-Menten Kinetics, line weaver burk plot, Hanes wolf equation , Eadie hoofstee equation ,Inhibition of enzyme activity.

Unit 3

Enzyme catalysis : enzyme specificity and the concept of active site, determination of active site. Stereospecificity of enzymes. Mechanism of catalysis: Proximity and orientation effects, general acid-base catalysis, concerted acid - base catalysis, nucleophilic and electrophilic attacks, catalysis by distortion, metal ion catalysis.

Unit 4

Theories on mechanism of catalysis.-Mechanism of enzymes action: mechanism of action of lysozyme, chymotrypsin, carboxypeptidase and DNA polymerase. Multienzymes system, Mechanism of action and regulation of pyruvate dehydrogenase and fatty acid synthetase complex.

Unit 5

Coenzyme action. Enzyme regulation: General mechanisms of enzyme regulation, Allosteric enzymes, sigmoidal kinetics and their physiological significance, Symmetric and sequential modes for action of allosteric enzymes. Reversible and irreversible covalent modification of enzymes, Immobilized enzymes and their industrial applications.Clinical and industrial applications of enzymes, Enzyme Engineering

Reference Books:

- Nicholas C.Price and Lewis Stevens., 2010. Fundamentals of Enzymology. Oxford University Press, New Delhi.
- Lehninger, Nelson and Cox, 2005, Principles of Biochemistry - 4th edition, WH Freeman and Company, New York, USA.
- Principles of Biochemistry with human focus - Garrett and Grisham, 2002, Harcourt College Publishers, Orlando, Florida, USA.
- Geoffrey L, Zubay, Biochemistry -, 1998, 4th edition.
- - Donald Voet, Judith Voet and Pratt, 1995, Fundamentals of Biochemistry, 2nd edition.
- Harper's Biochemistry - Murray et al, 2000, 25th edition, Appleton and Lange Publishers.

Useful Websites :

www.lsbu.ac.uk/biology/enztech/

www. lsbu.ac.uk/biology/enzyme/

http://www.aetlted.com/tech/applications.html

Paper – 8			
Title of the paper	**Microbiology**		
Category of the course	Year	Semester	Credits
Core	I	II	3

Unit-1

Microbial Taxonomy, systematics, identification: Taxonomical hierarchy- species- type strains: culture collections; binomial nomenclature; system of classification- phenetic, numerical taxonomy. General characteristics used in classification- five kingdom, six kingdom and eight kingdom systems. Classification of microbes using DNA analysis, proteins, rRNA analysis and phylogeny.

Unit-2

Staining methods – Gram, Acid fast, Metachromatic granules, nuclear staining, capsule, silver impregnation, Flagella and other special staining methods. Sterilization and disinfection methods and their quality control. Size, shape, composition and structure of prokaryotic (bacteria, actinomycetes, archaea and blue green algae).

Unit -3

Size, shape, composition and structure of eukaryotic cells (algae, fungi and protozoans). Nutritional requirements for growth. Growth media and pure culture techniques. Symbiosis, Mutualism, Parasitism, Commensalism and endophyte. Structure of virus and prions. Measurement of growth and enumeration of cells – Techniques of pure culture.

Unit -4

Introduction to Medical parasitology – classification, host-parasite relationships, pathogenic mechanisms, transmission life cycle, lab diagnosis, treatment etc. for the following: Protozoa – Entamoeba, Aerobic and Anaerobic amoebae causing human diseases. Toxoplasma, cryptosporidium and other protozoan parasites causing infections in man. Leishmania, Trypanasoma, Giardia, Trichomonas, Balantidium.

Unit – 5:

Role of microorganisms in food production (SCP) dairy and non-dairy products. Fuel (ethanol), pharmaceuticals (antibiotics), biofertilizers (BGA), biopesticides (*Bacillus thuringenesis*), biopolymers, biosurfactants, vitamin B12, protease, glutamic acid. Secondary metabolites. Biogas production, biocomposting and biotransformation.

Reference Books:

- Joanne Willey, 2010. Prescott's Microbiology, eighth edition, McGraw Hill, Newyork.
- P.C. Trivedi, S. Pandey, S. Bhadauria, 2010. Text Book of Microbiology, Pointer Publishers, Jaipur, India.
- Michael J. Pelczar, IR., E;C;S;Chan and Noel R.Kreig., 2004., fifth Ed., 27th reprint. Microbiology, Tata McGRAW – Hill, New Delhi.
- Presscot, Harley & Klein, 2002, Microbiology, fifth edition, McGraw Hill, Newyork.

Useful Websites:

www.microbiologyplace.com/

www.microbe.net/microbiology-web-resources/

Paper – 9			
Title of the paper	**Plant & Animal Biotechnology**		
Category of the course	Year	Semester	Credits
Core	I	II	3

Unit-1

Introduction of plant tissue culture, composition of media, Micropropagation, organogenesis, somatic embryogenesis, haploid and triploid production, protoplast isolation and fusion, hybirid and cybrid, synthetic seed production, secondary metabolic production.

Unit-2

Plant Transformation -- Direct transformation by electroporation and particle gun bombardment. - Agrobacterium, Ti plasmid vector. Theory and techniques for the development of new genetic traits, conferring resistance to biotic and abiotic. Plant engineering towards development of enriched food products, plant growth regulators.

Unit – 3

Animal health – disease diagnosis, hybridoma technique, monoclonal antibodies, application of probes for disease diagnosis of existing and emerging animal diseases. Prophylaxis - Vaccines, Oral vaccines – DNA Vaccines in animal disease. Cell culture: primary and established culture; organ culture; tissue culture;

Unit – 4

Disaggregation of tissue and primary culture; cell separation, Slide and coverslip cultures, flask culture, test tube culture techniques, cell synchronization, cryo preservation. Scaling up of animal cell culture, cell line and cloning – micromanipulation and cloning, somatic cell cloning. Karyotyping; measuring parameters for growth, measurement of cell death, apoptosis and its determination, cytotoxicity assays.

Unit – 5

Nuclear magnetic resonance methods of monitoring cell metabolism- culturing animal cells in fluidised bed reactors- GPI- Anchored fusion proteins- harvesting GPI- anchored proteins from CHO cells- Hematopoietic cells for cellular and gene therapy. Transgenic animals: Production and application; transgenic animals in livestock improvement, transgenic animals as model for human diseases.

Reference Books:

- Razdan.M.K., 2011. Plant tissue culture. Oxford and IBH publishing Company Pvt. Ltd, New delhi.
- Chawla.H.S., 2010. Introduction to plant biotechnology. Oxford and IBH publishing company pvt. Ltd, New delhi.

- Ian Freshney, 2010. Culture of animal cells. 6th edition., Wiley-Blackwell publishers.
- Slater,2008. Plant Biotechnology: The Genetic manipulation of plants, Second Edition, Oxford University Press, USA.
- Ralf Portner, 2007. Animal cell biotechnology: Methods and protocols. 2nd edition, Humana Press, New Jersey
- J.D.Watson, M.Gillman, J.Witknowski and M.Zoller, 2006. Recombinant DNA. 3rd edition., W.H.Freeman.
- .K. Dass. 2005, Text book of Biotechnology, Second Edition, Wiley Dreamtech, India (P) Ltd.
- H.Kreuzer & A.Massey. 2001. Recombinant DNA and Biotechnology: A guide for teachers Second Edition. ASM press, Washington.
- M.Sudhir. 2000. Applied Biotechnology & Plant Genetics. Dominant publishers & Distributors.
- Genetic Engineering of Animals by (Ed) A.Puhler, VCH Publishers, Weinheim, FRG, 1993.
- Animal Cell culture – Practical approach. Ed. John R.W.Masters, Oxford.2004.
- Concepts in Biotechnology D. Balasubramaniam, Bryce, Dharmalingam, Green, Jayaraman Univ. Press, 1996

Useful Websites:

biotech.dpu.edu.in/dept_PlantAnimalBio.aspx

www.animalbiotechnology.org/default.asp?news_id=1266...

www.biotechnology4u.com/basic_concepts_human_genome_poject.html

www.nationalaglawcenter.org/readingrooms/biotechnology/

ouhsc.edu/biotechhighschool/what.html

Paper – 10			
Title of the paper	**Genetic Engineering**		
Category of the course	Year	Semester	Credits
Core	I	II	3

Unit – 1

Gene cloning – Genetic engineering tools – Nucleic acid manipulating enzymes. Promoters, Selectable markers and reporters used in rDNA technology. Restriction digestion, Ligation, Transformation, Selection of Recombinants.Construction of gene libraries.

Unit – 2

E.Coli vectors - pBR322 and its derivatives; Cloning vectors for gram-negative bacteria - ColE1, p15A, R1, IncPα, pSC101; Lambda bacteriophage vectors, filamentous phages, Cosmids, Phasmids, Phagemids. Cloning in gram-positive bacteria (*Bacillus subtilis*).

Unit – 3

Cloning in yeast *Saccharomyces cerevisae* – Life cycle and types of vectors; Eukaryotic vectors – SV40 (molecular genetics and expression); Specialized cloning vector for cDNA; Synthesis of specific RNA in vitro; Vectors for cloning promoters and terminators; vectors with adjustable copy number.

Unit – 4

Nucleic acid hybridization techniques; Molecular probes (Types of probes and its construction); probe labeling – Nick translation, End labeling and Random primer labeling. Polymerase chain reaction and its variants; DNA fingerprinting; DNA sequencing first generation sequencing methods (Maxam and Gilbert sequencing, Sanger's Dideoxy sequencing, Pyrosequencing, PCR based sequencing and hybridization sequencing).Second generation sequencing methods.

Unit – 5

Site directed mutagenesis; DNA microarray; chromosome walking and jumping.Molecular techniques in prenatal diagnosis gene therapy, Pharmaceutical products (Vaccine, Humulin, etc), Crop improvement – pesticide resistance, herbicide resistance, transgenic animals and GM foods.

Reference Books:

1. T.A.Brown, 2010. Gene cloning and DNA analysis: An introduction, 6th edition, Wiley-Blackwell.
2. Sandy B.Primrose and Richard Twyman, 2006. Principles of Gene Manipulation and genomics, 7th edition, Wiley-Blackwell.
3. Lewin, 2009. Genes X, 10th edition, Jones & Barlett Publishers
4. Raymond Rodriguez and David T.Denhart – 2003.Vectors – A survey of molecular cloning vectors and their uses –
5. Errst-L. Winnacker – 1987.From genes to clones – Introduction to Gene Technology,
6. Ed. David V. Geoddel – 2002.Gene Expression technologies. Methods in enzymology (Vol.185) –
7. William Rezmikff, Lamy Gold – 2002.
8. William Wu, Michael J.Welsh, Peter B.Kaufrmar, Helen H.Zhang – 2001. Methods in Gene Biotechnology .

Useful Websites:

y.asu.edu/photosyn/courses/bio_343/lecture/geneng.html

pbc.its.edu.in/Home/Genetic-Engineering-Lab.aspx bioenerg

www.ehow.com/how_4474017_use-bacteria-genetic-engineering.html

Paper – 11 - Practical II			
Title of the paper	**(A) Microbiology (B) Plant and Animal Biotechnology (C) Genetic Engineering**		
Category of the course	Year	Semester	Credits
Core	I	II	10

(A) Microbiology-Practical

1. Sterilization of glassware using dry heat- hot air oven
2. Sterilization of media using moist heat – autoclave
3. Filter sterilization
4. Liquid media preparation – nutrient broth
5. Solid media preparation – SDA plates
6. Preparation of Agar slants
7. Streak plate method
8. Pour plate method
9. Spread plate method
10. Serial dilution agar plate method
11. Isolation of microbes from soil
12. Isolation of microbes from water
13. Isolation of microbes from air
14. Isolation of microbes from plant surface.
15. Isolation of pure culture of *E.coli*,
16. Isolation of pure culture of *Aspergillus niger*,
17. Isolation of pure culture of *Streptomyces*.
18. Preparation of bacterial smear and fixation
19. Gram staining and morphological characterization of microbes.
20. Negative staining of bacteria
21. Determination of growth curve of bacteria – *E.coli*
22. IMViC test of enteric bacteria.

(B) Plant and Animal Biotechnology - Practical:

1. Plant tissue culture media preparation
2. Plant tissue culture sterilization techniques.
3. Generation of Callus from leaf
4. Generation of Callus from root
5. Generation of Callus from bud

6. Generation of Callus from shoot apex
7. Maintenance of callus culture.
8. Cell suspension culture
9. Anther culture
10. Pollen culture
11. Embryo culture.
12. Isolation of plant protoplast
13. Culture of plant protoplast.
14. Protoplast viability test.
15. Localization of nucleus using nuclear stain.
16. *Agrobacterium* culture maintenance and isolation of plasmid DNA.
17. Mass culture of *Chlorella /Spirulina*
18. Introduction to Animal Cell culture: Procedure for handling cells and medium.
19. Cleaning and sterilization of glassware and plastic tissue culture flasks
20. Preparation of tissue culture media
21. Preparation of sera for animal cell culture
22. Preparation of single cell suspension from chicken liver (Primary cell culture).
23. Trypsinization of established cell culture.
24. Cell counting and viability - staining of cells a) Vital Staining (Trypan blue, Erythrosin B) b) Giemsa staining.
25. MTT Assay

(C) Genetic Engineering - Practical

1. Preparation of plasmid DNA by alkaline lysis method.
2. Agarose gel electrophoresis
3. Silver staining of gels
4. Methylene blue DNA staining
5. Elution of DNA from agarose gel.
6. Restriction enzyme digestion.
7. Restriction mapping of plasmid DNA.
8. Ligation.

9. Competent cell preparation
10. Transformation and selection of recombinants.
11. Cloning of fragments in PBR322
12. Insertional inactivation/Blue white screening
13. RAPD
14. RFLP
15. Amplification of DNA - PCR
16. Determination of molecular weight of DNA.

Reference Books:

Microbiology:

- Alfred Brown. 2010. Benson's Microbiological Applications: Laboratory Manual in General Microbiology, Complete Version. Tata McGraw-Hill company, New Delhi.
- John Harley. 2010. Microbiology Lab Manual. Tata McGraw-Hill company, New Delhi.
- Aneja.K.R, 2007. Experiments in Microbiology, Plant pathology and Biotechnology, 4th Edition, New Age International Publishers, India.
- James Cappuccino and Natalie Sherman, 2004. Microbiology: A Laboratory Manual (7th Edition), Benjamin Cummings.
- William Michael O'Leary. 1989 Practical handbook of microbiology**,** CRC Press, - 681 pages.

Useful Websites

www.ehow.com/how_5547641_write-lab-report-microbiology.html

Microbiology N200

Plant and Animal Biotechnology:

- Sue Carson, Heather Miller, D. Scott Witherow. 2011. Molecular Biology Techniques: A Classroom Laboratory Manual. Academic Press, London. Third Edition.
- R. Ian Freshney, 2010. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 6th Edition, Wiley-Blackwell.

- S.S. Purohit. 2010. A Laboratory Manual of Plant Biotechnology (2Nd Ed.). Agrobios (India), Pvt Ltd, New Delhi.
- Jack G.Chirikjian, 2009. Plant Biotechnology, Animal Cell culture Immunobiotechnology, 1st Edition, CBS Publishers, India.
- C. C. Giri, Archana Giri. 2007. Plant Biotechnology: Practical Manual. I. K. International Pvt Ltd, New Delhi.

Useful Websites

Plant Genetic Engineering: Methodology; www.bio.bg. ac.rs ...

www.imgge.bg.ac.rs

www.imgge.bg.ac.rs/?lang=en&p=edukacija

Genetic Engineering:

- S.J. Vennison. 2009.Laboratory Manual for Genetic Engineering. PHI Learning Pvt. Ltd. New Delhi.
- Aneja.K.R, 2007. Experiments in Microbiology, Plant pathology and Biotechnology, 4th Edition, New Age International Publishers, India.
- Sue Carson, Dominique Robertson, 2005. Molecular Biology Techniques, Second Edition: A Classroom Laboratory Manual, 2nd Edition, Academic Press.
- Joe Sambrook, 2001. Molecular Cloning: A Laboratory Manual, Third Edition, Cold Spring Harbor Laboratory Press.
- Stefan Surzycki, 2000. Basic Techniques in Molecular Biology, 1st Edition, Springer

Useful websites

pbc.its.edu.in/Home/Genetic-Engineering-Lab.aspx bioenerg

www.ehow.com/how_4474017_use-bacteria-genetic-engineering.html

www.britannica.com/EBchecked/topic/228897/genetic-engineering

Paper – 12			
Title of the paper	**Tissue Engineering**		
Category of the course	Year	Semester	Credits
Elective	I	II	2

Unit – 1

Basic biology of tissue engineering: The basis of growth and differentiation-morphogenesis and tissue engineering.

Unit – 2

In vitro control of tissue development-Growth factors-Tissue engineering bioreactors-Tissue assembly in microgravity-*In vitro* synthesis of Tissue and organs.

Unit – 3

Organotypic and histotypic models of engineered tissues-Biomaterials in tissue engineering-Approaches to transplanting engineered cells and tissue engineering.

Unit –4

Bioartificial pancreas-Hepatassist liver support system-Heamatopoietic system: Red blood cell substitutes-Renal replacement devices- Musculoskeletal system.

Unit – 5

Structural tissue engineering-Bone regeneration through cellular engineering-Brain implants-Neural stem cells-Periodontal applications- -Artificial Womb.

Reference Books:

- Sylvia, S. Mader, 2011, Human Biology, Twelfth edition, Mc Graw Hill, USA.
- Robert P. Lanaza, Robert Langer and Joseph Vacanti, 2007. Principles of Tissue Engineering. Third edition Academic Press.

- Micklem.H.S., Loutit John.F., 2004, Tissue grafting and radiation, Academic Press, New York..
- Penso.G., Balducci.D., 2004.Tissue cultures in biological research,Elsevier, Amsterdam.
- Cecie Starr, 1996, Biology, Third edition , Wordsworth, America..

Useful Websites

www.nuigalway.ie/anatomy/tissue_engineering.html

Paper – 13			
Title of the paper	**Pharmaceutical Biotechnology**		
Category of the course	Year	Semester	Credits
Elective	I	II	2

Unit – 1

Introduction to concepts and technologies in pharmaceutical biotechnology and industrial applications. Biopharmaceuticals expressed in plants.

Unit – 2

Industrial development and production process. Scientific, technical and economic aspects of vaccine research and development. DNA vaccines: from research tools in mice to vaccines for humans.

Unit – 3

Characterization and Bioanalytical aspects of recombinant proteins as pharmaceutical drugs- Biogeneric drugs. Therapeutic proteins – special pharmaceutical aspects.

Unit – 4

Pharmaceutical and pharmacodynamics of biotech drugs- Formulation of biotech products- Rituximab: clinical development of the first therapeutic antibody for cancer.

Unit – 5

Somatic gene therapy – advanced biotechnology products in clinical development-Nonviral gene transfer systems in somatic gene therapy- Xenotransplantation in pharmaceutical biotechnology, Pharmaceutical enzymes

Reference Books:

- Harbans lal, 2011. Pharmaceuticals biochemistry. CBS Publishers and distributors Pvt. Ltd, Chennai.
- Carlos A. Guzmán and Giora Z. Feuerstein, 2009. Pharmaceutical Biotechnology, 1st edition, Springer.
- Daniel Figeys (Ed.). 2005. Industrial Proteomics: Applications for Biotechnology and Pharmaceuticals. Wiley, John & Sons, Incorporated.
- Kayser, O and Muller R.H.. 2004. Pharmaceutical Biotechnology-Drug Discovery and Clinical Applications. WILEY-VCH
- Leon Shargel, Andrew B. C. Yu, Susanna Wu-Pong, and Yu Andrew B. C. 2004. Applied Biopharmaceutics & Pharmacokinetics. McGraw-Hill Companies
- Stefania Spada, Garywalsh. 2004. Directory of approved biopharmaceutical
- Gary Walsh. 2003. Biopharmaceutical, Biochemistry & Biotechnology.
- Heinrich Klefenz. 2002. Industrial pharmaceutical biotechnology.
- Thomas Lengauer (Ed.). 2002. Bioinformatics – from Genomes to Drugs. Volume I& II. Wiley-VCH.
- John F. Corpenter (editor), Mark C. Manning. 2002. Rational Design of stable formulation Theory and Practice (Pharmaceutical Biotechnology). Plenum, US. Ist edition.
- D.I.A. Crommelin, et al., 2002. Pharmaceutical Biology. Amazon prime publications.
- Werner Kalow, Urs A Meyer and Rachel F. Tyndale. 2001. Pharmacogenomics. CPL press.

Useful Websites

TopBiotechnologyandPharmaceuticalsWebSites/.../Default.aspx

Research in Pharmaceutical Biotechnology (RPB) Online

Paper – 14			
Title of the paper	**Environmental Biotechnology**		
Category of the course	Year	Semester	Credits
Elective	I	II	2

Unit – 1

Biofilm Kinetics: Completely mixed biofilm reactor-Soluble microbial products and inert biomass-Special-case biofilm solution. Reactor types - batch reactor - continuous-flow stirred-tank reactor with effluent recycle.

Unit – 2

Plug-flow reactor - plug-flow reactor with effluent recycles-Reactors with recycle of settled cells - Using alternate rate models - Linking stoichiometric equations to mass balance equations - Engineering design of reactors - Reactors in series.

Unit – 3

Denitrification: Physiology of denitrifying bacteria-Tertiary denitrification-One-sludge denitrification - Waste water treatment systems - Anaerobic & Aerobic - Drinking-water treatment: Anaerobic treatment by methanogenesis - uses for methanogenic treatment-Reactor configurations - Special factors for the design of anaerobic sludge digesters.

Unit – 4

Detoxification of Hazardous chemicals: Factors causing molecular recalcitrance - Synthetic organic chemical classes - Energy metabolism versus co-metabolism - Electron donor versus electron acceptor - Minimum substrate concentration (S_{min}) Biodegradation of problem environmental contaminants.

Unit – 5

Bioremediation: Engineering strategies for bioremediation - Evaluation bioremediation - Sewage and waste treatment - Pollution monitoring, control and remediation (petroleum Industry, Paper Industry, chemical industry etc.) Biomass from the wastes.

Reference Books:

- Gareth M. Evans, Gareth G. Evans, Judy Furlong – 2011. **Environmental biotechnology:** theory and application John Wiley & Sons, Ltd. West Sussex, UK
- M. Moo-Young, W.A. Anderson, A.M. Chakrabarty, 2010. Environmental Biotechnology: Principles and Applications. Springer.
- M. H. Fulekar, 2010 Environmental Biotechnology, by Science Publishers Department of Life Sciences, University of Mumbai, India,
- Stanley E. Manahan, 2009. Environmental Chemistry, Ninth Edition, CRC Press.
- Environmental chemistry 5th edition by A.K.De. 1997.
- Bruce E. Rittmann and Perry L. McCarty. 2001.Environmental Biotechnology :Principles and applications. McGraw Hill, Newyork.
- Ahmed N, Qureshi, F.M. and Khan, O.Y. 2001.Industrial and Environmental Biotechnology. Horizon Press.
- Ahmed N, Qureshi, F.M. and Khan, O.Y. 2001.Industrial and Environmental Biotechnology. Horizon Press.

Useful Websites:

lbewww.epfl.ch/LBE/Default_E.htm

http://lbe.epfl.ch · LAB ORGANISATION

Paper – 15			
Title of the paper	**Bioinformatics**		
Category of the course	Year	Semester	Credits
Core	II	III	3

Unit-1

Bioinformatics data – nucleic acid sequence, protein sequence, protein structure, genomic, proteomic and metabolomic information, Bioinformatics databases – types, design, file formats, access tools with examples, Bioinformatics tools and Resources – free online tools, downloadable free tools, software packages, internet, Bioinformatics books and Journals, Bioinformatics web-portals

Unit-2

Sequence alignment basics, match, mismatch, similarity, scoring an alignment, gap penalty, protein vs DNA alignments, Dot-matrix alignment, Pairwise alignment – global and local alignment algorithms, Multiple sequence alignment-progressive alignment and Iterative alignment algorithms, consensus sequence, patterns and profiles,Database searching: Pairwise alignment based rigorous algorithm (Smith and Waterman) and Heuristic algorithms (FASTA and Blast). Multiple sequence alignment based database searching – PSI- Blast, PAM and Blosum matrices

Unit-3

Bioinformatics for genome sequencing, EST Clustering and analyses, Finding genes in prokaryotic and eukaryotic genomes, Regulatory sequence analysis, Bioinformatics for Genome maps and markers, Bioinformatics for understanding Genome variation, Protein structure prediction and classification, Bioinformatics in support of Proteomic research

Unit-4

Molecular visualization tools – Rasmol, Chime and Spdb viewer – Structure analysis tools – VAST and DALI, Structural biology - Homology modeling, Bioinformatics for micro array designing and transcriptional profiling, Bioinformatics for metabolic reconstruction, Bioinformatics for phylogenetic analysis.

Unit-5

Medical application of Bioinformatics – disease genes, Drug Discovery – History – Steps in drug discovery – Target Identification – Target Validation – QSAR – Lead Identification – Preclinical

pharmacology and toxicology – ADME – Drug designing – Rational drug design – Computer aided drug design – Ligand based approach – Target based approach.

Reference Books:

- DassanayakeS.Ranil, Y.I.N. Silva Gunawardene., 2011. Genomic and Proteomic Techniques, Narosa Publishing House Pvt. Ltd, New Delhi.
- Thiagarajan B, Rajalakshmi.P.A. , 2009. Computational Biology, MJP publishers, Chennai.
- BosuOrpita, SimminderKaurThukral., 2007. Bioinformatics Databases, Tools and Algorithms, Oxford University press, New Delhi.
- Rastogi.S.C, Mendiratta.N, Rastogi.P., 2004. Bioinformatics methods and applications., Prentice-Hall of India private limited, New Delhi.
- Lohar s. Prakash., 2009. Bioinformatics, MJP Publishers, Chennai.
- Stephen misener and Stephen A. Krawetz., 2000. Bioinformatics methods and protocols, Humana press Inc, New Jersey.
- Durbin.R, S.Eddy, A.Krogh and G.Mitchison, 1998. Biological sequence analysis, Cambridge university press, Cambridge.

Useful Websites:

www.google.co.in - Search for database or tool name and find help file.

Paper – 16			
Title of the paper	**Immunology**		
Category of the course	Year	Semester	Credits
Core	II	III	3

Unit-1

Histroy and overview of the immune system. Types of immunity - innate, acquired, passive and active, self vs nonself discrimination. Physiology of immune response: HI and CMI specificity

and memory. Cells and organs of the immune system – Lymphoid tissue, origin and development. Hematopoiesis, differentiation of lymphocytes.

Unit-2

Lymphocyte-sub-populations of mouse and man. T and B cells, APC cells, lymphokines, Phagocytic cells, macrophage, dendritic cells, K and NK Cells. Nature and biology of antigens, epitopes, haptens, adjuvents. Immunoglobulins- structure, distribution and function, Isotypic, Allotypic and Idiotypic variants, generation of antibody diversity.

Unit-3

Antigen antibody reactions. Monoclonal antibody production and its applications. Types of vaccine and vaccination schedule. Role of MHC antigens in immune responses, Structure and function of class I and class II MHC molecules. MHC antigens in transplantation and HLA tissue typing.

Unit-4

Effector mechanisms in immunity - macrophage activation, cell mediated cytotoxicity, cytotoxicity assay. Hypersensitivity reactions and types. The complement system, mode of activation, classical and alternate pathway, biological functions of C proteins.

Unit-5

Immunotechniques- precipitation, Single and double immuno diffusion, Immuno fluorescence, RIA and ELISA, FACS, Western blot, Agglutination tests – Direct and Indirect, Widal's test, VDRL test. Purification of antibodies, Quantitation of immunoglobulin by RID, EID and nephelometry.

Reference Books:

- Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, 2011. Roitt's Essential Immunology, 12 edition, Wiley-Blackwell. USA.
- Kannan. I., 2010. Immunology. MJP Publishers, Chennai.
- Abbas, A.K., A.H.L. Lichtman and S.Pillai, 2010. Cellular and Molecular

Immunology. 6th Edition. Saunders Elsevier Publications, Philadelphia.

- Seemi Garhat Bashir, 2009. Text Book of Immunology, PHI Learning Pvt. Ltd. New Delhi.
- Thomas J. Kindt, Barbara A. Osborne and Richard A. Goldsby, 2006. Kuby Immunology, 6th edition, W. H. Freeman & Company.
- Nandini Shetty, 1996, Immunology: introductory textbook - I. New Age International, New Delhi.

Useful Websites:

www.library.csusm.edu/course guides/biology

www.immunologylink.com

http://www.wiley.com/college/bio/karp12791/weblinks.html

Paper – 17			
Title of the paper	**Bioprocess Technology**		
Category of the course	Year	Semester	Credits
Core	II	III	3

Unit – 1

Aerobic and anaerobic fermentation processes and their application in the field of biotechnology industry. Solid substrate, slurry fermentation and its application. Microbial cell culture. Whole cell immobilization.

Unit – 2

Types of bioreactors: Submerged reactors, surface reactors, mechanically agitated reactors, non-mechanically agitated reactors. Design of fermentors – body construction. Production of citric acid, penicillin and insulin.

Unit – 3

Introduction to bioproducts and bioseparation. Primary recovery process: Cell disruption methods. Cell lysis and Flocculation: Osmotic and mechanical methods of lysis. Flocculation by electrolysis;polymorphic flocculation.

Unit – 4

Filtration: Principles, Conventional, Crossflow filtration. Sedimentation: Principles, Sedimentation coefficients. Extraction Principles, Liquid – liquid extraction, aqueous two phase extraction, supercritical fluid extraction.

Unit – 5

Membrane separation – ultrafiltration, precipitation methods: liquid-liquid extraction, aqueous two phase extraction. Drying –Principles and operation of vacuum dryer, shelf dryer, rotary dryer, freezer and spray dryer. Formulation methods.

Reference Books:

- Min-tze Liong, 2011. Bioprocess Sciences and Technology. Nova Science Pub Inc.
- Michael L.Shuler, Fikret Kargi. 2003. Bioprocess Engineering. PHI publishers.
- P.A.Belter, E.L.Cursler, and W.S.Hu. 1988.Bioseparation: Downstream processing for Biotechnology. John Wiley and sons.
- R.G. Harrison, P.Todd, SR.Rudge and D.P. Petrides. 2003. Bioseparation science and engineering. Oxford Press.

Useful Websites:

www.wildfermentation.com/

John Schollar and Benedikte Watmore, Practical Fermentation-a technical guide

web.mit.edu/professional/short.../fermentation_technology.html

Paper – 18 Practical-III			
Title of the paper	**(A) Bioinformatics (B) Immunology (C) Bioprocess Technology**		
Category of the course	Year	Semester	Credits
Core	II	III	10

(a) Bioinformatics-practical

1. Sequence retrieval from Genbank
2. Sequence retrieval from Uniprot.
3. Sequence identity search- Sequence similarity search using BLAST
4. Sequence similarity search using FASTA
5. Sequence similarity search using PSI BLAST
6. Sequence similarity search using PHI- BLAST.
7. Prediction of signal sequence using SignalP online tool
8. Pattern Search (Domains & Motifs) using Pfam
9. ORF gene Search - Genscan
10. Sequence translation using ExPASy translate tool
11. Characterization of retrieved protein sequence by ProtParam tool.
12. Pair-wise global sequence alignment using EBI-EMBOSS Needleman-Wunsch tool
13. Pair-wise local sequence alignment using EBI-EMBOSS Smith-Waterman tool
14. Multiple sequence alignment using EBI-CLUSTALW2.
15. PHYLOGENY- Phylogenetic tree using PHYLIP.
16. Prediction of secondary protein structure using GOR (Garnier-Osguthorpe-Robson) server.
17. Prediction of tertiary protein structure using SWISS-MODEL Server
18. Validation of the predicted structure using PROCHECK server
19. Molecular visualization of proteins using RASMOL.
20. Docking of small molecule with protein structure using Hex software.
21. Docking of two proteins using PatchDock (Protein-Protein docking) tool.
22. Retrieval of *E.Coli* glycolytic pathway from KEGG.

(b) Immunology - practical

1. Identification of various immune cells from human peripheral blood.
2. Lymphocyte separation and identification
3. Determination of lymphocyte viability by trypan blue method
4. WBC counting
5. Preparation of serum and plasma
6. Electrophoretic profile of human serum in native PAGE
7. Preparation of cellular antigen – human RBC
8. Preparation of antigen-adjuvent mixture for production of polyclonal antibody
9. Isolation of IgG molecule from serum
10. Immunodiagnostics: CRP
11. Immunodiagnostics: ASO
12. Immunodiagnostics: Widal
13. Immunodiagnostics: RF
14. Immunodiagnostics: Blood grouping and typing
15. Immunodiagnostics: hCG
16. ELISA
17. Radial Immunodiffusion
18. Ouchterlony Immunodiffusion
19. Immunoelectrophoresis
20. Rocket electrophoresis
21. Counter current immunoelectrophoresis.
22. bioassays for cytokines
23. Radioimmunoassays (Demonstration)

(c) Bioprocess Technology - Practical

1. Parts and design of fermenter
2. Solid state fermentation
3. Submerged fermentation
4. Foaming and antifoaming agents
5. Media preparation and sterilization

6. Isolation of industrially important microorganisms for microbial processes.
7. Conservation of Bacteria by Lyophilization.
8. Production and estimation of protease
9. Production and estimation of amylase.
10. Production of wine using grapes
11. Production of penicillin
12. Determination of penicillin activity
13. Citric acid production
14. Use of alginate for cell immobilization.
15. Media standardization (C:N ratio) for maximum biomass production of an industrially important microorganism.
16. Cell disruption (Sonication)
17. Aqueous Two Phase Extraction of enzymes.

Reference Books:

Bioinformatics:

- David Posada, 2009. Bioinformatics for DNA Sequence Analysis (Methods in Molecular Biology), 1st Edition, Humana Press.
- Lohar s. Prakash., 2009. Bioinformatics, MJP Publishers, Chennai.
- Bosu Orpita, Simminder Kaur Thukral., 2007. Bioinformatics Databases, Tools and Algorithms, Oxford University press, New Delhi.
- Richard J. Simpson. 2003. Proteins and Proteomics: A Laboratory Manual. CSHL Press, New York.
- Andreas D. Baxevanis, B. F. Francis Ouellette. 2001. Bioinformatics: a practical guide to the analysis of genes and proteins. John Wiley and Sons, New York.
- Stephen misener and Stephen A. Krawetz., 2000. Bioinformatics methods and protocols, Humana press Inc, New Jersey.
- Durbin.R, S.Eddy, A.Krogh and G.Mitchison, 1998. Biological sequence analysis, Cambridge university press, Cambridge.

Useful websites

bioinformatics.oxfordjournals.org/

www.bioinformatics.org/

www.bioinformaticsonline.org/

Immunology:

- Jack G.Chirikjian, 2009. Plant Biotechnology, Animal Cell culture Immunobiotechnology, 1st Edition, CBS Publishers, India.
- A. Nigam. 2007. Lab Manual of Biochemistry, immunology and biotechnology. Tata McGraw-Hill Education, New Delhi.
- Noel R. Rose, Robert G. Hamilton, Barbara Detrick. 2002. Manual of clinical laboratory immunology. ASM Press,
- Frank C Hayand Olwyn M R Westwood 2002 Practical ImmunologyBlackwell Science Oxford UK
- Iván Lefkovits. 1997. Immunology methods manual: the comprehensive sourcebook of techniques. Academic Press.
- Catherine Sheehan. 1997. Clinical immunology: principles and laboratory diagnosis. Lippincott,
- Myers, 1994. Immunology: A Laboratory Manual, 2nd Edition, McGraw-Hill.

Useful Websites

https://www.mc.vanderbilt.edu/root/vumc.php?site=immunocore

http://www.hhmi.org/biointeractive/vlabs/immunology/index.html (The Virtual immunology lab)

Bioprocess technology:

- Cornelia Kasper, Martijn van Griensven, Ralf Pörtner, Mohamed Al-Rubeai. 2008. Advances in biochemical engineering/biotechnology, Volume 112. Springer, Berlin.
- P. Chellapandi. 2007. Laboratory manual in industrial biotechnology. Pointer Publishers.
- Aneja.K.R, 2007. Experiments in Microbiology, Plant pathology and Biotechnology, 4th Edition, New Age International Publishers, India.

- Michael C. Flickinger, Stephen W. Drew. 1999. Encyclopedia of bioprocess technology: fermentation, biocatalysis, and bioseparation. John Wiley,

Useful Websites

www.ncbe.reading.ac.uk/ncbe/protocols/PDF/FermTG.pdf

www.wildfermentation.com/

John Schollar and Benedikte Watmore, Practical Fermentation-a technical guide

web.mit.edu/professional/short.../fermentation_technology.html

Paper – 19			
Title of the paper	**Nanobiotechnology**		
Category of the course	Year	Semester	Credits
Elective	II	III	2

Unit-1

Nanotechnology – concept of Nanotechnology-advances – Nanochemistry- classification of nanomaterials- . Nanostructures and dynamics of biocompatible materials -fullerenes-nanoparticles-nanotubes- colloidal gold- nanostructures. Nanophysics- quantum dot- quantum wire- quantum point contact- nanocrystals..

Unit-2

Nanomedicine and Nanobiology- Nanaomaterials and drug delivery- cancer diagnosis and therapy- surgery- invivo therapy- neuro- electronic interface- cell repair machines-nanotechnology devices-nanoparticles- dendimers- nanorobots- nubot- nanoshell.

Unit-3

Bioactive Nanomaterial in bone grafting and tissue engineering- bone repair- bone grafting-Nanocomposites in bone replacement therapy -synthetic biomaterials- hydroxy apatite in bone grafting- synthesis of HA and applications.

Unit-4

Molecular nanotechnology, molecular assemble, nanofactories, self replication, DNA based artificial nanostructures. Biosensors, Nanorobots, nanobiosensor – DNA sensor- optical Biosensor Biochips and their application. Nanofibers and their application in tissue engineering..

Unit-5

Industry applications -Nanomaterials in consumer markets, Electronics, photonics, nano-opto, MEMS, Microarray, nano-bio applications ,Computing technologies - present and future , Carbon Nanotube Technologies (CNT). Environment and social issues.

Reference Books:

- Nanotechnology, S.Shanmugam, Mjp publication. 2011.
- Advanced nanomaterials, kurt E. geckeler, Hiroyuki Nishide , Wiley-VHC.2010.
- Nanotechnology and tissue engineering. T.Laurencin, Lakshmi S. Nair, CRC press. 2012.
- Handbook of carbon nanomaterials. Francis D souza, Karl M. Kadish. World scientific publishing co. pte. ltd. 2011.
- Oded Shoseyov (Editor), Ilan Levy, 2010. NanoBioTechnology: BioInspired Devices and Materials of the Future, Humana Press.
- Chad A. Mirkin and Christof M. Niemeyer, 2007. Nanobiotechnology II: More Concepts and Applications, Wiley-VCH.
- Challa S.S.R.Kumar (Ed). 2006. Biologicals and pharmaceutical nanomaterials, Wiley-VCH Verlag Gmbh & Co, KgaA.
- K.K.K.Jain 2006. Nanobiotechnology in Molecualr Diagnostics: Current Techniques and Applications Horizon Bioscience
- Niemeyer, C.M., Mirkin, C.A. (Eds). 2004. Nanobiotechnology Concepts, Applications and Perspectives, Wiley-VCH, Weinheim.

Useful Websites

http://www.zyvex.com/nano

www.fda.gov/nanotechnology/

www.nature.com/nnano/

Paper – 20			
Title of the paper	**Molecular Developmental Biology**		
Category of the course	Year	Semester	Credits
Elective	II	III	2

Unit – 1:

Gamete cells: Dynamics of the Sperm and Egg, Spermatogenesis, Oogenesis, Sperm and oocyte maturation, Instructive and permissive interactions, competence, epithelial- mesenchymal interactions. Important signaling pathways in vertebrate development.

Unit – 2

Fertilization: Fate Maps, Nieuwkoop center, molecular role of organizer, Types of fertilization, Molecular recognition of egg and sperm, fusion and prevention of polyspermy, rearrangement of egg cytoplasm and activation of egg.

Unit – 3

Cleavage and gastrulation: Cleavage in Xenopus, Chick and mammals, Regulation of cleavage cycle. Morphogenetic movements, Gastrulation in Xenopus, chick and mammals.

Unit – 4

Vertebrate Development: Formation of the neural tube, mechanism of vertebrate eye development, myogenesis, and hematopoiesis.

Unit – 5

Drosophila Maternal effect genes, induction at single cell level - differentiation of photoreceptors in ommatidia. Developmental disorders – Spina bifida, Anenecephaly, and craniorachischis, Cyclopia, Thanotrophic dysplasia.

Reference Books:

- Scott F.Gilbert, 2010. Developmental Biology, 9th edition, Sinauer Associates Inc.
- Subramoniam, T. 2002. Developmental Biology. 1st edition. Narosa publications.
- Richard M.Twynman, 2001 Developmental Biology. (2nd edition), Viva Publications, New Delhi.
- Wolpert, L., 1998 Principles of Development. Oxford Publications, New York.

Useful Websites:

sackler.tufts.edu/.../Cell-Molecular-and-Developmental-Biology

www.devbio.com/

Elective offered to other Department.			
Title of the paper	**Principles of Gene Manipulation Technology**		
Category of the course	Year	Semester	Credits
Elective	II	III	3

Unit – 1

Restriction enzymes, DNA modifying enzymes, cloning vectors, prokaryotic hosts-Creating Recombinant DNA Molecules-Isolation and Cloning of genes.-Construction of representative cDNA and genomic libraries-polymerase chain reaction (PCR) and applications-Southern / Northern blotting analysis.

Unit – 2

Construction of representative cDNA and genomic libraries- polymerase chain reaction (PCR) and applications- Southern/Northern bloting analysis, RFLP, RAPD, AFLP analysis. Genomics-Structural genomics-Gene mapping-Comparative genomics -Functional genomics -Gene expression -EST's-DNA arrays.

Unit – 3

Gene transfers - Introduction of Foreign Genes into Cells: electroporation, biolistic transfer, Transfection, selectable markers, microinjection, embryonic stem cells, reporter transgenes, Homologous recombination - "knock-ins / outs".

Unit – 4

Transgenics- Approaches to transgenesis: Microinjection / Embryonic stem cells/Sperm-mediated transfer -Mammalian cloning by nuclear transfer - "Dolly" as an example. Production of transgenic sheep, cattle, pigs and plants. - BT cotton, Transgenesis and growth- performance in farm livestock, & plants-The growth hormone in both bovine and porcine systems.

Unit – 5

Edible vaccines, Disease resistance in transgenic organisms, Pest and herbicide resistant plants. The Mx gene system for anti-viral disease resistance in animals. Issues in Genetic Engineering - Biosafety of transgenic organisms.-Food safety of GMOs-Environmental safety .

Recommended Texts:

- T.A.Brown, 2010. Gene cloning and DNA analysis: An introduction, 6th edition, Wiley-Blackwell.
- Sandy B.Primrose and Richard Twyman, 2006. Principles of Gene Manipulation and genomics, 7th edition, Wiley-Blackwell.
- Strachan, T. and Read, A.P. Human Molecular Genetics 2 (2nd edition), BIOS Scientific Publications, John Wiley and Sons , Toronto, Canada. 1999
- Old, R,W. and Primrose, S.B., Principles of Gene Manipulation (5th edition) Blackwells Scientific Publications, Oxford, U.K. 1997
- Watson, J.D., Gilman, M., Witkowski, J., and Zoller, M., Recombinant DNA (2nd edition),Scientific American Books, W.H. Freeman and Co., New York, N.Y., U.S.A.

Useful Websites:

books.google.com/books/about/Principles_of_gene_manipulation.html?id...

www.knockoutmouse.org/.../wellcome-trust-advanced-course-genetic- manipulation-es-cells-31-october-13-november-2011

Paper – 21			
Title of the paper	**Research Methodology**		
Category of the course	Year	Semester	Credits
Core	II	IV	3

Unit-1

Research Methodology - An Introduction: Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Importance of knowing how research is done, Research Process, Criteria of good research. Defining the Research Problem; Research Design; Sampling Design; Methods of Data Collection; Processing and Analysis of Data; Sampling Fundamentals; Testing of Hypothesis.

Unit-2

Writing the Research Report (Thesis and publications**)**: Components of research report - Title, Authors, Addresses, Abstract, Keywords, Introduction, Materials and Methods, Results, Discussion, Summary, Acknowledgements and Bibliography.

Unit-3

Analysis of Variance components (ANOVA) for fixed effect model; Total, treatment and error of squares, Degrees of freedom, Confidence interval; ANOVA for random effects model, Estimation of variance components, Model adequacy checking. Two factor Factorial Design, Basic definitions and principles, main effect and interaction, response surface and contour plots, General arrangement for a two factor factorial design; .

Unit 4

Spreadsheet Tool: Introduction to spreadsheet application, features and functions, Using formulas and functions, Data storing, Features for Statistical data analysis, Generating charts/ graph and other features.

Unit-5

Tools used may be Microsoft Excel, Open office or similar tool. Presentation Tool: Introduction to presentation tool, features and functions, Creating presentation, Customizing presentation, Showing presentation. Tools used may be Microsoft Power Point, Open Office or similar tool.Web Search: Introduction to Internet, Use of Internet and WWW, Using search engine like Google, Yahoo etc, Using advanced search techniques.

Reference Books:

1. Montgomery, Douglas C. (2007), 5/e, Design and Analysis of Experiments, (Wiley India).
2. Montgomery, Douglas C. & Runger, George C. (2007), 3/e, Applied Statistics & Probability for Engineers (Wiley India).
3. Kothari C.K. (2004), 2/e, Research Methodology- Methods and Techniques (New Age International, New Delhi).
4. Krishnaswamy, K.N., Sivakumar, Appa Iyer and Mathiranjan M. (2006), Management Resarach Methodology; Integration of Principles, Methods and Techniques (Pearson Education, New Delhi).
5. The complete reference Office Xp – Stephan L. Nelson, Gujulia Kelly (TMH).
6. Basic Computer Science and Communication Engineering – R. Rajaram (SCITECH).

Useful Websites

www.ask.com/Methodology+Research
www.qmethod.org/

Paper – 22			
Title of the paper	**Stem Cell Biology**		
Category of the course	Year	Semester	Credits
Elective	II	IV	2

Unit – 1

Stem cells - Definition, Characterization, Pluripotency, Self renewal and differentiation.

Unit – 2

Stem cell niche, Niche specification - *Drosophila* germ line stem cells. Adult stem cell from amniotic fluid, cord blood and tooth primordial.

Unit – 3

Characteristics of stem cell- cell cycle, Ras\Raf pathway, PI3K cell signaling, p53 check points, Role of LIF pathway in cell cycle control.

Unit – 4

Chromatin modification and transcriptional regulation, chromatin modifying factors, Chromosomal inactivation.

Unit – 5

Therapeutic applications of Embryonic stem cells, Bone marrow stem cells, Adipose derived stem cells and Hematopoietic stem cells in Heart regeneration and neural defects. Ethics in human stem cell research.

Reference Books:

- Vemuri C. Mohan., 2010. Stem Cell assay. Humana press, New jersey.
- Ann A.Kiessling "Human Embryonic Stem Cells" Jones and Bartlett Publishers, Inc. second edition, (2006).
- Robert Lanza: "Essentials of Stem Cell Biology" Academic Press (2005).
- Kursad Turksen : "Adult Stem Cells" Humana Press, Inc (2004).
- James Thomson *et al* : "Handbook of Stem Cells: Embryonic/Adult and Fetal Stem Cells", vol 1 & 2; Academic Press (2004).
- Institute of Medicine (Corporate Author): "Stem Cells and The Future Of Regenerative Medicine" National Academy Press (2002).

Useful Websites:

stemcells.nih.gov/

www.nature.com/nature/stemcells/

www.cell.com/cell-stem-cell/

Paper – 23			
Title of the paper	**Bioethics, Human Rights and Social Issues**		
Category of the course	Year	Semester	Credits
Elective	II	IV	2

Unit – 1

Introduction: Historical development of Human Rights and Human Relations – International and National. International Instruments: United Nation Commission for Human Rights,

Unit – 2

European Convention for Human Rights, UDHR, Civil and Political Rights-National Instruments: National and State Instruments: Development of Human Rights – Article 21 of Indian Constitution.

Unit – 3

Human Relations: Political relations, Ethnic and Communal relations, Socio-cultural relations, Organization relation etc., and related Human Rights. Economics of Human Rights and Relations – Adam Smith's thoughts on moral sentiments.

Unit – 4

Student's Activity: Assignment/Case study/Term paper etc.,

Unit – 5

Impact of gene cloning and Bioethics. Intellectual Property Rights (IPR) and patents, biosafety, containment facilities for Genetic Engineering experiments, Regulations on field experiments and release of GMO's (Genetically Modified Organisms), labeling of GM (Genetically Modified) Foods.

Reference Books:

- Sree Krishna, V., 2007. Bioethics and Biosafety in Biotechnology, 1st Ed. New Age International Publishers, New Delhi.
- Trayror, P.C., Frederic.R. and Koch, M. 2002. Biosafety. Board of Trustees, Michigan State University, USA.
- Benjamin Lewin, 2000, Genes VII, First edition, Oxford, New York.
- Paul R.C., 2000.Situations of Human Rights in India. Efficient offset printers.
- Beauchamp, T.L. and Leroy, W.1999.Contemporary issues in bioethics. Wardsworth publishing Co. Belmont, California.
- Bishop.M.J and Rawlings, 1987, Nucleic acid and protein sequence analysis, First, IRL Press, England.
- William, S Klug and Michel, R Cummings, 2003, Concepts of Genetics, Seventh edition, Pearson Education, Singapore.
- Paul, R.C., 2000.Situations of Human Rights in India, Efficient Offset printers,
- Marc Galanter, Social Inequality.
- Adam Smith, Theory of Moral Sentiments.
- Kretch & Crutchfield, Social Psychology.

Useful Websites:

bioethicsweb.ac.uk/

www.intute.ac.uk/bioethicsweb/

blog.bioethics.net/

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