

# **Solapur University Solapur**

## **B. Sc. III Biotechnology Syllabus 2012 (SEMESTER PATTERN)**

**SOLAPUR UNIVERSITY, SOLAPUR****REVISED SYLLABUS FOR B.Sc. PART III (BIOTECHNOLOGY)****(Semester Pattern)****(w. e. f. JUNE 2012)**

**Course structure:** The B.Sc Part III(Biotechnology) will have two semesters viz. Sem V and Sem VI. Each semester shall comprise of four theory papers of 50 marks each, and a paper on English as per B.Sc.III structure of science faculty; and THREE practical courses of 50 marks each. In addition, the students shall have to complete a project work on a topic chosen by him/her in consultation with the concerned teacher. The project report should be submitted before practical examination and presented at the time of practical examination. Thus the course shall be of total 700 marks.

1. The detailed course structure will be as follows:

<b>Subject code</b>	<b>Title of the paper</b>	<b>Theory</b>	<b>Marks</b>	<b>Lecture / Practical periods</b>
	<b>Semester- V</b>			
BT 301	Genetic Engineering: Tools and Techniques	Theory	50	40 L
BT 302	Fermentation technology	Theory	50	40 L
BT 303	Plant Development	Theory	50	40 L
BT 304	Bioinformatics	Theory	50	40 L
	<b>Semester- VI</b>			
BT 305	Genetic Engineering: Applications	Theory	50	40 L
BT 306	Food and Dairy Technology	Theory	50	40 L
BT 307	Animal Development	Theory	50	40 L
BT 308	Nanobiotechnology	Theory	50	40 L
	<b>Practical Courses</b>			
BP 311	Techniques in Genetic Engineering	Practical	50	20 P
BP 312	Techniques in Fermentation Technology	Practical	50	20 P
BP 313	Techniques in Developmental Biology	Practical	50	20 P
BP 314	Project Work	Practical	50	20 P

**B.Sc. III (Biotechnology)****Semester- V****BT 301: Genetic Engineering: Tools and Techniques****Unit I****10 periods**

**Genetic Engineering:** Introduction, milestones and scope. Basic techniques: agarose electrophoresis, polyacrylamide electrophoresis, pulsed-field gel electrophoresis, southern blotting, northern blotting, western blotting, principles of autoradiography, Dot Blot technique, chromosome walking, DNA Foot-Printing, Molecular markers: DNA Fingerprinting, RFLP, RAPD, AFLP, basic PCR and types.

**Unit II****10 periods**

**Enzymes in cloning:** Nucleases, DNA polymerases, RNA polymerases, Reverse transcriptase, Ligases, Nucleic acid-modifying enzymes. Cloning Vectors: Properties of best vector, Plasmids, Phages, Cosmids, Shuttle vectors, BAC, Specific vectors for: plants, animals and yeast. Probes: Genomic DNA probes, cDNA probes, synthetic oligonucleotide probes, RNA probes, methods of labeling probes.

**Unit III****10 periods**

**Getting DNA into cells:** Transformation and Transfection, Packaging phage DNA in vitro. Cloning strategies: Cloning from mRNA in plasmid and bacteriophage vector, cloning from genomic DNA, Advanced cloning strategies: cloning large DNA fragments in BAC and YAC vectors. Selection and screening of recombinants: use of chromogenic substrates, insertional inactivation, and complementation of defined mutations, Screening using nucleic acid hybridization: nucleic acid probes and screening clone banks.

**Unit IV****10 periods**

**Cloning and Transformation methods in Prokaryotes and Eukaryotes:** Methods of direct transformation: PEG mediated microinjection, particle bombardment, electroporation. Methods of indirect transformation: *Agrobacterium tumefaciens* and *A. rhizogenes*. DNA sequencing: Maxam's and Gilbert's method, Sanger's dideoxy method, Ligation mediated sequencing, Automated DNA sequencing, Primer Walking.

**REFERENCE BOOKS**

1. An Introduction to Genetic Engineering, 2<sup>nd</sup> Edition, **Desmond S.T. Nicholl**, Cambridge University Press (2006).
2. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 3<sup>rd</sup> Edition, **B.R. Glick and J.J. Pasternak**, ASM Press (2007)
3. Principles of Gene Manipulation and Genomics, 7<sup>th</sup> Edition, **S.B. Primrose and R.M. Twyman**, Blackwell Publishing (2006)
4. Molecular Biotechnology, 2<sup>nd</sup> Edition, **S.B. Primrose**, Panima Publishing (2001)

5. Introduction to Biotechnology, Low Price Edition, **W.J. Thieman and M.A. Palladino**, Peason Education (2007)
6. Genetic Engineering : Principles And Practice, **Sandhya Mitra**, Macmillan India (1996)
7. Genetic Engineering: Principles and Methods, **Setlow J.K.**, Kluwer Academic Publishers. (2000)
8. Genetic Engineering, **Yount L.**, Gale Group (2002)
9. Molecular Cloning: A Laboratory Manual (Volume - I, II & III) **Sambrook J., D.W. Russell**, Cold Spring Harbor Laboratory Press (2001)
10. Gene Cloning and DNA Analysis: An Introduction, 4th edition, **Brown T. A.**, Blackwell Science Inc (2001)
11. Recombinant DNA: Genes and Genomes - A Short Course, 3<sup>rd</sup> Edition, **James D.**

**BT 302: Fermentation Technology****Unit I:****10 periods**

**Bioreactors/fermenters:** Introduction, Basic functions of a fermenter, Components of a typical fermenter, operation of the fermenter. Fermentation Media: Introduction, Characteristics of an ideal fermentation medium, raw materials used, media sterilization, inoculum media, screening for fermentation media. Inoculum preparation. Microbial growth Kinetics.

**Unit II:****10 periods**

**Screening:** Introduction, Primary and secondary screening. Strain Improvement. Preservation and maintenance of industrial strains. Scale up of fermentation. Detection and assay of fermentation products: Physical- chemical assays, Biological assays.

**Unit III:****10 periods**

**Downstream processes** – Filtration and flocculation, Centrifugation, Precipitation, Solvent extraction, Distillation, Crystallization. Fermentation economics. Application of computer in fermentation technology.

**Unit IV:****10 periods**

**Microbial production of industrial products** (micro-organisms involved, production media, fermentation conditions, product recovery and applications): Citric acid, Ethanol, Penicillin, Vitamin B<sub>12</sub>, amylase, bioinsecticide (*Bacillus thuringiensis*).

**REFERENCE BOOKS:**

1. Casida L. E. (1991). Industrial Microbiology, New Age international Ltd.
2. Crueger W. and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2<sup>nd</sup> edition. Panima Publishing Co. New Delhi.
3. Patel A. H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury P. F, Whitaker A. and Hall S. J. (2006). Principles of Fermentation Technology. 2<sup>nd</sup> edition, Elsevier Science Ltd.
5. Peppler H.J., Perlman D. (2004). Microbial technology-Fermentation Technology, second edition, Volume I and II, Academic Press.

## BT 303: Plant Development

### Unit I 10 periods

**Plant Embryology and Development:** Development of gametophyte - Development of Male and female gametophyte in angiosperm. Embryogenesis - Development of monocot and dicot. Polyembryony - Classification, causes and application. Apomixis - Diplospory, Apospory, its causes and application

### Unit II 10 periods

**Organogenesis and Phytohormones:** Somatic embryogenesis - Concept and Applications. Protoplast culture - Isolation of protoplast and regeneration of plants. Phytohormones- Introduction, General account of Phytohormones: Auxins, Gibberellins, cytokinins, Abscissic acid and Ethylene.

### Unit III 10 periods

**Plant patterning and Photoperiodism:** Model of plant development – *Arabidopsis thaliana*. Root, shoot & floral patterning. Flowering hormone (florigen). Seed vernalization.

### Unit IV 10 periods

**Biodiversity and Plant virology:** Introduction and types of biodiversity. Loss, conservation, method of Biodiversity. Introduction and classification of viruses. Study of Plant viruses - TMV and BMV

### REFERENCE BOOKS:

1. A Textbook of Biotechnology, Dubey, R.C, S. Chand & Company, New Delhi
2. Basics of Bio-technology, R.C. Sobati, Vishal Publishing
3. Genetic Engineering, Sandhya Mitra. Macmillan.
4. Plant Embryology by Bhojwani and Bhatnagar.
5. Plant Taxonomy by V.N. Naik
6. Cole, A.J. 1969. Numerical Taxonomy. Academic Press, London.
7. Davis, P.H. and Heywood, V.M. 1973. Principles of Angiosperm Taxonomy.  
Robert E. Kereiger Publ. New York.
8. Harrison, H.J. 1971. New Concepts in Flowering Plant Taxonomy. Heiman  
Ednl. Books. Ltd., London.
9. Radford, A.E. 1986. Fundamentals of Plant Systematics, Harper & Row Publ. USA.
10. Woodland, D.W. 1991. Contemporary Plant Systematics. Prentice Hall, New Jersey
11. Environmental Studies by A.K. Asthana
12. Negi, S.S. 1993. Biodiversity and its Conservation in India.

13. Richard B. Primack. 1993. *Essentials of Conservation Biology*.
14. Hall, R.D. (Ed.) 1999. *Plant Tissue Culture: Techniques and Experiments*, Academic Press, New York.
15. Bhojwani, S.S. and Razdan, M.K. 1996. *Plant Tissue Culture: Theory and Practice* (a revised edition). Elsevier Science Publishers, New York, USA. Bhojwani, S.S. 1990. *Plant Tissue Culture: Applications and Limitations*, Elsevier Science Publisher, New York, US



## BT 304: Bioinformatics

### Unit I 10 periods

**Introduction and scope of Bioinformatics**, Application of Bioinformatics, Concept of Genomics and Proteomics. Primary sources of databases - EMB net, hixton hall, MIPS, UCL, SRS; NCBI – Entrez, PubMed.

### Unit II 10 periods

**Biological Databases** – Nucleic acid sequence databases:- EMBL, DDBJ, GenBank; Primary Protein sequence databases:- PIR, MIPS, Swiss – PROT, TrEMBL, NRL – 3D; Composite Protein sequence databases: - NRDB, OWL, MIPSx, SWISS-PROT + TrEMBL [Introductory only]; Secondary Protein databases: - PROSITE, PRINTS, BLOCKS, PROFILES, Pfam, IDENTIFY; Structure classification databases: - SCOP, CATH, PDBsum.; Structural Databases: - PDB, NDB, MMDB.

### Unit III 10 periods

**Methods of sequence alignment** – Pairwise alignment and Multiple alignment. Pairwise alignment: - Global alignment – Needleman & Wunsch algorithm, Local alignment – Smith & Waterman algorithm; Scoring matrices – Dayhoff mutation data matrix, BLOSUM matrices. Tools for alignment: FASTA, BLAST.

### Unit IV 10 periods

**Multiple alignment** - Progressive method, Iterative method, dynamic programming, statistical method for aiding alignment. Tool for alignment: CLUSTAL X/W. Application of multiple alignment. Gene prediction programs, Gene prediction in prokaryotes and eukaryotes.

### REFERENCE BOOKS:

1. Introduction to bioinformatics – Attwood and Parry - Smith
2. Bioinformatics (Sequence and Genome analysis) – David Mount – Cold Spring Harbour Laboratory Press.

**B.Sc. III (Biotechnology)**  
**Semester- VI**

**BT 305 - Genetic Engineering: Applications**

**Unit I**

**10 periods**

**Genetic Engineering in Environmental Biotechnology:** Microbial degradation of Xenobiotics, Genetic engineering of Biodegradative pathways (manipulation by transfer of plasmids and gene alteration), Utilization of starch and sugars (Production of fructose and alcohol, *Zymomonas mobilis*, Silage fermentation), Utilization of cellulose: components of lignocelluloses, Isolation and manipulation of prokaryotic and eukaryotic cellulose genes. Enzymes: Examples of increasing enzyme activity, stability, specificity and altering multiple properties.

**Unit II**

**10 periods**

**Genetic Engineering in Microbes:** Diagnosis of Malaria, Trypanosoma cruzi and sickle-cell anemia, synthesis of Human Interferon and Growth hormone, Monoclonal antibodies in the treatment of Brain Tumors, Vaccines: subunit vaccines (Foot and Mouth Disease, peptide vaccine), Attenuated vaccines (Cholera, Leishmania), Vector vaccines (Directed against viruses and bacteria), Production of L-Ascorbic acid, Synthesis of Novel antibiotics, Engineering *Xanthomonas* for Xanthan Gum production, Microbial synthesis of Rubber.

**Unit III**

**10 periods**

**Genetic Engineering in Plants:** Insect-resistant plants, Herbicide-resistant plants, Development of salt stress tolerant plants, Senescence (fruit ripening and flower wilting)-tolerant plants, Modification of plant nutritional contents (Amino acids and Iron), Modification of food plants taste (Sweetness), plant as bioreactor for polymers, plant as edible vaccines, altering lignin content, Genetic engineering of Nitrogenase gene cluster.

**Unit IV**

**10 Periods**

**Genetic Engineering in Animals:** Transgenic sheep and mice (mice as model for Alzheimer disease and overproduction of proteins). Nucleic acid as Therapeutic agents: Antisense RNA, Antisense oligonucleotides, chimeric RNA-DNA molecules, Interfering RNA, Gene therapy for cystic fibrosis. Cloning livestock by nuclear transfer, *Xenopus* oocytes as a heterologous expression system, Mammalian glycosylation and processing of precursor proteins in Insect cells.

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1. An Introduction to Genetic Engineering, 2<sup>nd</sup> Edition, **Desmond S.T. Nicholl**, Cambridge University Press (2006)
2. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 3<sup>rd</sup> Edition, **B.R. Glick and J.J. Pasternak**, ASM Press (2007)

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7. Genetic Engineering: Principles and Methods, **Setlow J.K.**, Kluwer Academic Publishers. (2000)
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10. Gene Cloning and DNA Analysis: An Introduction, 4th edition, **Brown T. A.**, Blackwell Science Inc (2001)
11. Recombinant DNA: Genes and Genomes - A Short Course, 3<sup>rd</sup> Edition, **James D. Watson, James, Richard M. Myers, Amy A. Caudy, Jan A. Witkowski**, W. H. Freeman (2006)

## BT 306: Food and Dairy Technology

### Unit I

**10 periods**

**Food and Microorganisms:** Chemical and physical properties of food affecting microbial growth (intrinsic and extrinsic factors). Microbial spoilage of different food products- cereals and cereal products ,sugar and sugar products, vegetables and fruits , meat and meat products, eggs and poultry, fish and sea products. General methods of food preservation: Asepsis, use of high temperatures, use of low temperatures, drying, food additives, radiation.

### Unit II

**10 periods**

**Milk Microbiology:** Milk - Definition, composition and constituents of milk, Normal flora of milk, Microbial spoilage of different milk products. Pasteurization of milk - Methods of Pasteurization – LTH, HTST, and UHT. Phosphatase test for determination of efficiency of Pasteurization. Fermented dairy and other food Products-Yoghurt, Cheese, Sauerkraut, Beer, Vinegar, Bread, Pickles.

### Unit III

**10 periods**

**Methods for the Microbiological examination of foods:** Indicator organisms, Direct Examination, Cultural techniques, Enumeration methods-plate counts, Most Probable Number Counts, Dye reduction tests-MBRT, Resazurin Test, Rapid methods for detection of specific organisms and Toxins- Immunological methods, DNA/RNA methodology.

### Unit IV

**10 periods**

**Controlling the Microbiological quality of foods:** Quality and criteria, Control at source-training, Facilities and operations, equipment cleaning and disinfection, Hazard Analysis and Critical Control Points (HACCP): Establishment of CCP Criteria, Monitoring procedures for CCPs, Protocols for Deviations, Record Keeping, Verification. Quality Systems: BS 5750, and ISO 9000 series.

### REFERENCE BOOKS:

- 1) Food Microbiology (1995)-Adams M.R. and Moss, M.O., New Age International Limited.
- 2) Food Microbiology –Frazier, W.C., Westhoff, D.C. IV<sup>th</sup> edition, Tata McGraw Hill Publisher.
- 3) Industrial Microbiology by A. H. Patel, Mac Millan India Pvt. Ltd.
- 4) Modern Food Microbiology VI<sup>th</sup> edition- James M Jay. An Aspen publication.
- 5) Applied Dairy Microbiology –Elmer Marth and James Steele 2<sup>nd</sup> edition, publisher Marcel Dekker Inc.

**BT 307: Animal Development****Unit I****10 periods**

**Gametogenesis and Fertilization of frog and chick:** **Gametogenesis-** Definition, Primordial germ cells, Spermatogenesis, Formation of spermatid, Spermatogenesis, Oogenesis, Previtellogenesis, Vitellogenesis, Hormonal control of Oogenesis, Comparison of Spermatogenesis and Oogenesis, Polar bodies. **Fertilization-** Definition, Significance of fertilization, Physical factors involved in fertilization, Chemical factors involved in fertilization, Cytological factors involved in fertilization, Physical changes in fertilization, Activation, Theories of activation. Development types, patterns of cleavage, Planes of cleavage, Blastula, Gastrula in frog and chick up to formation of three germinal layers.

**Unit-II****10 Periods**

**Ageing-** Ageing, Senescence, Cognitive effects, Terminology, Theories – Biological theories and Non-biological theories, Measure of age. **Apoptosis:** Discovery and etymology, Functions- Cell termination, Homeostasis, Development and Lymphocyte interactions. Process –Mitochondrial regulation, Direct signal transduction, Execution and Removal of dead cells. Implication in disease- Defective apoptotic pathways, HIV progression and viral infection

**Unit-III****10 Periods**

**Cancer:** Introduction, Origin of cancer, Properties of cancer cells, Tumor progression, Sites of infection, Metastasis, Types of cancer, Causes of cancer, Diagnosis, Treatment, Oncogenesis. **Teratogenesis:** Genetic teratogenesis in animals, Environmental teratogenesis, Teratogenesis due to Drugs, radiation, infection, autoimmunization, malnutrition. Specificity of teratogenesis. **Stem cells:** Properties, Embryonic stem cells, Adult stem cells, Stem cell therapy.

**Unit - IV****10 Periods**

**Gene Cloning:** Gene Cloning method, cloning in mammals, Applications of cloning. **Transgenic technology:** Definition, Transgenic Mice and sheep, Applications of Transgenic technology. **Developmental Genetics:** Introduction to Developmental Genetics, Role of genes in competence, determination and differentiation, patterning.

**REFERENCE BOOKS:**

1. An Introduction to Embryology 1981, Balinsky B.L., Saunders College, Philadelphia.
2. Developmental Biology; Patterns/Principles/Problems, 1982, Saunders J. W. Collier MacMillan, Publishers, London.
3. Developmental Biology, 1997, 3rd Edition, Gilbert S.F. Saunderson Associates Inc. U.S.A.
4. Developmental Biology, 1992 3rd edition, Browder L.W. Erickson C.A. & Williams, R.J. Saunders College, Publications, London.
5. A Text Book of Embryology, Dr. Puranik P. G., S. Chand & Co.

6. Developmental Biology, 1984, Browder L.W., Saunders College Publications, U.S.A.
7. Development of Chick embryo, 1972, Lillie.
8. Developmental Biology, 1991, 3rd Edition, Sinaur Associates, Inc. U.S.A.
9. A Text Book of Embryology (Developmental Biology) Dr. N. Arumugam, Saras Publication, Kanyakumari.
10. Chordate Embryology, P.S. Verma and V.K. Agarwal S. Chand and Company LTD., New Delhi.
11. Biotechnology K. Kumarresan, Saras Publication, Kanyakumari
12. Molecular Biology & Genetic Engineering, L.M Narayanan Saras Publication
13. Chordate embryology and histology, S. Chands Simplified Course, S. Chand and Company Ltd.
14. A Textbook of Biotechnology, Dubey, R.C, S. Chand & Company, New Delhi
15. Basics of Bio-technology, R.C. Sobati, Vishal Publishing

**BT 308: Nanobiotechnology****Unit I****10 periods**

**Introduction to Nanoscience:** Importance and fundamental science behind nanotechnology. Quantum mechanics and Quantum theory.

**Unit II****10 periods**

**Properties of Nanomaterials:** Mechanical properties, Structural Properties, Optical Properties, melting and electric conductivity of nanoparticles. Techniques used in Nanobiotechnology: Analytical techniques- microscope, Diffraction techniques, Spectroscopies, Electronic and magnetic measurements, Optical microscope, Atomic force microscope, Electron microscope- SEM & TEM.

**Unit III****10 Periods**

**Methods for Synthesis of Nanoparticles:** Physical, Chemicals, Biological and hybrid methods (with special reference to mechanical method, evaporation method, Colloidal & Sol-gel using microorganisms, plant extracts, microemulsions.).

**Unit IV****10 Periods**

**Applications of Nanoparticles:** Tools to make nanostructures, Nanoscale lithography, E-beam lithography, molecular synthesis, self assembly. Drug and Gene delivery for human health, Biosensors and sensors, cleaning environment (for heavy metal & Bioremediation).

**REFERENCE BOOKS:**

- Nanotechnology: Principles and Practices, Sulbha Kulkarni
- Nanotechnology – A gentle introduction to the next big idea, Mark Ratner & Danier Ratner
- Essential Bioinformatics, JIN XIONG

**Practical Examination:**

A) The practical examination will be conducted on four (4) consecutive days for not less than 6 hours on each day of the practical examination.

B) Each candidate must produce a certificate from the head of the department in his/her college stating that he/she has completed in a satisfactory manner the practical course on the guidelines laid down from time to time by Academic council on the recommendation of Board of studies and has been recorded in his/her observation in the laboratory journal and written a report on each exercise performed. Every journal is to be checked and signed periodically by a member teaching staff and certified by the Head of the department at the end of the year. Candidate are to produce their journal at the time of practical examination. Candidate have to visit two places of Biotechnological interest (Pharmaceutical industry, Dairy, Research institutes etc.) and submit the report of their visit at the time of practical examination in practical course BP 314: Project Work. The report should be duly certified by the Head of the Department.

**Distribution of Marks for practical examination:****For practical I, II, III, IV each.**

- 1) One major experiment: 25 marks
- 2) Two minor experiment: 10 marks each i.e. 20 marks
- 3) Journal: 5 marks for each practical course.

Practical I : 50 Marks

Practical II: 50 Marks

Practical III: 50 Marks

Practical IV: Project work: 40 marks + Study Tour Report: 10 marks = 50 marks

**Total Marks : 200**



## Practical course :

### BP 311: Techniques in Genetic Engineering

- 1) Isolation of DNA from yeast.
- 2) Calculation of molecular weight of digested DNA.
- 3) Construction of restriction map of plasmid DNA.
- 4) Isolation & quantitation of genomic DNA.
- 5) Isolation and quantification of total RNA.
- 6) Ligation theory and ligation of DNA.
- 7) Preparation of single stranded DNA template.
- 8) Restriction mapping of DNA.
- 9) Reporter gene assay (b- Gal).
- 10) DNA amplification by PCR.
- 11) Concept of database, accessing literature database from NCBI.
- 12) Searching for gene and protein sequences & accessing information from web.
- 13) Gene comparison by BLAST.
- 14) Gene comparison by FASTA.
- 15) Synthesis of ZnO nanoparticles.
- 16) Synthesis of Silver nanoparticles.

### BP 312 : Techniques in Fermentation Technology

1. Production, recovery and assay of citric acid by *Aspergillus niger*.
2. Biological assay of antibiotic.
3. Screening of Antibiotic producing microorganisms from soil by crowded plate technique.
4. Production of sauerkraut by microorganisms.
5. Production, recovery of Amylase.
6. Assay of amylase.
7. Production of Bioinsecticides by using *B.thuringensis*.
8. Estimation of milk sugar by Benedict's method.
9. Determination of Calcium in milk.
10. Determination of Magnesium in milk.
11. Qualitative analysis of milk sample by Methylene Blue Reduction Time Test.
12. Enumeration of bacteria in milk by Standard Plate Count.
13. Determination of efficiency of pasteurization of milk by alkaline phosphatase test.
14. Isolation of lactic acid bacteria from the curd sample.
15. Isolation of lipolytic microorganisms from butter.
16. Isolation of spoilage microorganisms from spoiled vegetables/fruits.

**BP 313: Techniques in Developmental Biology**

1. Study of different types of sperms by smear technique- Frog, Hen, Rat and Human.
2. Sperm motility test.
3. Study of different types of eggs - Insects, Amphioxus, Frog and Hens egg.
4. Study of Cleavage, Blastula and Gastrula –Frog and Hen.
5. Temporary / Permanent preparation of Chick embryos.
6. Study Teratogenic effect on development of Frog / Chick embryo.
7. To estimate the oxygen consumption in aquatic animal in relation to temperature.
8. Study of histopathological permanent slides of different types of cancer.
9. Study of style and stigma.
10. Study of different type of embryos.
11. Pollen germination in In-situ condition.
12. Study of pollen germination by T.T.C.or Acetocarmine test.
13. To study Hot spots of India in India map.
14. To study phytogeographical regions of India in India map.
15. Collection of seed and storage of seeds for seed bank.
16. To study types of ovules. (By permanent slides).
17. To study male gametophytes. (By permanent slides).
18. To study TMV electron microphotograph.

**BP- 314: Project Report**

The project reports are to be prepared by the students on the subjects in consultation with the Project coordinator in the year. The coordinator will guide the students in selecting the topic of the project, working of the experiments, results of the same and writing the report. The report shall be signed by the coordinator and shall be submitted to the University at the time of the University Practical examination of B.Sc.Part III.

The report shall be examined by the External examiners (appointed by the University) who will assign marks out of 40 as follows:

- Selection of the project topic – 10 marks
- Project methodology - 05 marks
- Project Writing -10 marks
- Oral presentation and Viva – 15 marks

Theory and practical shall form separate heads of passing. The candidate shall be declared to have successfully completed the three year degree course only on passing in all the heads of passing of B.Sc. Part I, II and III.