Solapur University, Solapur

B. Sc. Part – III Biotechnology Syllabus

Semester V & VI

(Credit and Grading System)

(w.e.f. June 2016)

SOLAPUR UNIVERSITY, SOLAPUR

Faculty of Science

Credit and Grading System

(w.e.f. June 2016)

- **Title of the Course:** B.Sc. Part-III
- **Subject:** Biotechnology
- **The Credit and Grading System:**

With the view to ensure worldwide recognition, acceptability, horizontal as well as vertical mobility for students completing undergraduate degree, Solapur University has implemented Credit and grading system of Evaluation at Undergraduate level. Credit is a numerical value that indicates students work load (Lectures, Lab work, Seminar, Tutorials, Field work etc.) to complete a course unit. In most of the universities 15 contact hours constitute one credit. The contact hours are transformed into credits. As per present norms, there are 3 contact hours per paper (subject) per week which works out to be 45 contact hours per paper (subject) per semester.

In Solapur University, for B.Sc.-III Biotechnology, there are 4 papers and Compulsory English. For B.Sc.-III Biotechnology, there are 3 contact hours per paper (subject) per week for each paper and Compulsory English carry 4 contact hours per week. Therefore, total contact hours per week are 16. Each paper has 45 contact hours, which are transformed into 3 credits. Moreover, the grading system of evaluation is introduced for B.Sc. course wherein process of Continuous Internal Evaluation is ensured. The candidate has to appear for Internal Evaluation of 30 marks and University Evaluation for 70 marks. It is 70+30 pattern of evaluation. It is applicable for theory and practical as well. The details regarding this evaluation system are as under.

- **Conversion of marks into Grades:**

A table for the conversion of the marks obtained by a student in each paper (out of 100) to grade and grade point is as given below:

Sr. No.	Range of Marks	Grade	Grade Point
1	80-100	O	10
2	70-80	A+	9
3	60-69	A	8
4	55-59	B+	7
5	50-54	B	6
6	45-49	C+	5
7	40-44	C	4
8	<39	FC	0(Failed in Term Exam)
9	<39	FR	0(Failed in Internal Assessment)

1. **Grade Point Average at the end of the Semester (SGPA)**

$$SGPA = \frac{(G_1 \times C_1) + (G_2 \times C_2) + \ldots\ldots\ldots\ldots..}{\Sigma Ci}$$

(Σ Ci= The total number of credits offered by the student during a semester)

2. **Cumulative Grade Point Average (CGPA)**

$$CGPA = \frac{(G_1 \times C_1) + (G_2 \times C_2) + \ldots\ldots\ldots\ldots..}{\Sigma Ci}$$

(Σ Ci= The total number of credits offered by the student upto and including the semester for which CGPA is calculated.)

3. **Final Grade Point Average (FGPA)**

It will be calculated in the similar manner for the total number of credits offered for the completion of the said course.

Where: C_i = Credits allocated for the i^{th} course.

G_i = Grade point scored in the i^{th} paper (subject)

4. Conversion of average grade points into grades:

SGPA/CGPA/FGPA	**Letter Grade**
9.5 – 10	O
8.5 – 9.49	A+
7.5 – 8.49	A
6.5 – 7.49	B+
5.5 – 6.49	B
4.5 – 5.49	C+
4.0 – 4.49	C
<3.99	FC / F
	FR

Syllabus Structure:

1. The University follows semester system.
2. An academic year shall consist of two semesters.
3. Each B.Sc. course shall consist of three years i.e. six semesters.
4. B.Sc. Part-III Biotechnology shall consist of two semesters: Semester V and Semester VI.

In semester V, there will be four papers of 100 marks for each with compulsory English. Similarly in Semester VI there will be four papers of 100 marks for each with compulsory English.

The scheme of evaluation of performance of candidates shall be based on University assessment as well as College internal assessment as given below. For B.Sc. Part-III Biotechnology Sem V & VI the internal assessment will be based on Unit tests, Home

assignment, viva, practicals, project work etc. as given below. Practical course examination of 100 marks for each course shall be conducted at the end of VIth semester. The practical examination of 100 marks shall also consist of 70 marks for University practical assessment and 30 marks for college internal assessment.

For University practical examination both the examiners will be External and will be appointed by the University. The internal practical assessment shall be done as per scheme given below.

6. Scheme of Evaluation

As per the norms of the grading system of evaluation, out of 100 marks, the candidate has to appear for college internal assessment of 30 marks and external evaluation (University assessment) of 70 marks. The respective B.O.S. may decide the nature of college internal assessment after referring to scheme given below or may be used as it is.

Semester – V

Theory: (100 marks)

University Examination (70 marks): No. of theory papers: 5

Internal Continuous Assessment: (30 marks)

Scheme of marking: 20 marks – Internal test
10 marks – Home assignment / tutorials / seminars /
group discussion / viva / field visit / industry visit.

Semester – VI

Theory: (100 marks)

University Examination (70 marks): No. of theory papers: 5

Internal Continuous Assessment: (30 marks)

Scheme of marking: 20 marks – Internal test
10 marks – Home assignment / tutorials / seminars /
group discussion / viva / field visit / industry visit.

Practical Examination: (100 marks)

University Examination (70 marks): No. of practical course 4 (3 + 1 Project Work)

Internal Continuous Assessment: (30 marks)

Scheme of marking: 20 marks – Internal test on any four practicals
10 marks – Lab Journal / Viva, attendance, attitude etc.

In addition, the students shall have to complete a project work on a topic chosen by him/her in consultation with the project coordinator. The project report should be submitted before practical examination and presented at the time of practical examination. This project work carries 100 marks.

Thus the course shall be of total 1400 marks including English.

7. Passing Standard

The student has to secure a minimum of 4.0 grade points (Grade C) in each paper. A student who secure less than 4.0 grade point (39% or less marks, Grade FC/FR) will be declared fail in that paper and shall be required to reappear for respective paper. A student who failed in University Examination (theory) and passed in internal assessment of a same paper shall be given FC Grade. Such student will have to reappear for University Examination only. A student who fails in Internal assessment and passed in University examination (theory) shall be given FR Grade. Such student will have to reappear for both University examination as well as internal assessment. In case of Annual pattern/old semester pattern students/candidates from the mark scheme the candidates shall appear for the same 70 marks of external examination and his performance shall be scaled to 100 marks.

SOLAPUR UNIVERSITY, SOLAPUR

Faculty of Science

Credit System Structure for B.Sc – III Biotechnology Theory

Semester – V

Paper No.	Title of Paper	Hrs/Week			Paper Marks	UA	CA	Credits
		L	T	P				
BT 301	Compulsory English	4	-	-	100	70	30	3
21	Plant Development	3	-	-	100	70	30	3
22	Animal Development	3	-	-	100	70	30	3
23	Bioinformatics and Nanotechnology	3	-	-	100	70	30	3
24	Recent Trends in Biotechnology	3	-	-	100	70	30	3
Total		16			500			15

Semester – VI

Paper No.	Title of Paper	Hrs/Week			Paper Marks	UA	CA	Credits
		L	T	P				
BT 302	Compulsory English	4	-	-	100	70	30	3
25	Tools and Techniques	3	-	-	100	70	30	3
26	Applications	3	-	-	100	70	30	3
27	Fermentation technology	3	-	-	100	70	30	3
28	Food and Dairy technology	3	-	-	100	70	30	3
Total		**16**			**500**			**15**

Practical Course (Annual)

Paper No.	Title of Paper	Hrs/Week			Paper Marks	UA	CA	Credits
		L	T	P				
8	Techniques in Developmental Biology		-	5	100	70	30	3
9	Techniques in Genetic Engineering & Modern Biotechnology		-	5	100	70	30	3
10	Techniques in Microbial Biotechnology		-	5	100	70	30	3
11	Project Work		-	5	100	70	30	3
Total				**20**	**400**			**12**

Abbreviations: L: lectures, T: tutorials, P: practicals; UA: University Assessment by End Semester Examination; CA: College Assessment by Internal Continuous Examination.

UA (University Assessment): University Theory paper shall be of 70 marks for 3:00 hrs duration

CA (College Assessment): The internal examination for theory and practical course.

B.Sc. Biotechnology Part – III

Theory Syllabus

Semester V

Paper No. 21. Plant Development **40 Lectures**

Unit	Content	Lectures
I	**Gametophyte, Pollination and Fertilization in plants** Male gametophyte: pollen development and gene expression, male sterility, sperm dimorphism and hybrid seed production, pollen tube growth and guidance, pollen storage, pollen embryos. Female gametophytes, types of embryo sacs, structure of embryo sac cells. Pollination, pollen-pistil interaction and fertilization: floral characteristics. Mechanism of pollination and fertilization: vectors involved in pollination, breeding system, commercial considerations, structure of the pistil, pollenstigma interaction, sporophytic and gametophytic self-incompatibility (cytological, biochemical and molecular aspects), double fertilization, *in vitro* fertilization.	**10L**
II	**Seed development and fruit growth:** Endosperm development during early, maturation and desiccation stages, embryogenesis, ultrastructure and nuclear cytology, cell lineage during late embryo development, storage proteins of endosperm and embryo, embryo culture, dynamics of fruit growth, biochemistry and molecular biology of fruit maturation. Apomixes: Diplospory, apospory, causes, consequences and significance of Apomixes. Polyembryony: Classification causes, experimental induction and practical importance.	**10L**
III	**Plant patterning** Model of plant development – *Arabidopsis thaliana*. Root and shoot and floral patterning – 1. Introduction 2. Classification. 3. Theories of structural development. Diversity with respect to cell fusion and somatic cell genetics.	**7L**
IV	**Phytohormones:** Introduction, General account of phytohormone – Auxins, Gibberellins, Cytokinins, Abscisic acid (ABA), ethylene. Seed vernalization and Florigen hormone.	**5L**
V	**Tissue development in Plants** Cell growth and development, cell wall development, role of cytoskeleton in the development, patterns of development in primary xylem and phloem, development of stomata, periderm development, development in stem and root, Quiescent center and its role in development of primary tissues in lateral root development, leaf development, seed and fruit development.	**8L**

References:

1. Dubey, R.C, "A Textbook of Biotechnology", S. Chand & Company, New Delhi
2. R.C. Sobati, "Basics of Bio-technology", Vishal Publishing
3. Bhojwani and Bhatnagar, "Plant Embryology".
4. Cole, A.J. 1969. "Numerical Taxonomy". Academic Press, London.
5. Davis, P.H. and Heywood, V.M. 1973. "Principles of Angiosperm Taxonomy". Robert E. Kereiger Publ. New York.
6. Harrison, H.J. 1971. "New Concepts in Flowering Plant Taxonomy". Heiman Ednl. Books. Ltd., London.
7. Radford, A.E. 1986. "Fundamentals of Plant Systematics", Harper & Row Publ. USA.
8. Woodland, D.W. 1991. "Contemporary Plant Systematics". Prentice Hall, New Jersey
9. Klaus Kalthoff. Analysis of Biological development.

Paper No. 22. Animal Development **40 Lectures**

Unit	Content	Lectures
I	**History and Scope** Definition, Scope, History and Introduction to Developmental Biology, Theories in Developmental Biology: Preformation theories, Theory of epigenesist, Baer's law, Biogenic law, Germplasm theory of Weismann, Mosac theory of Roux, Regulative theory of Driesh, Gradient theory of Child and Organizers theory of Spemann.	5L
II	**Gametogenesis** Origin of primordial Germ cells in mammals, Male Gonad, Spermatogenesis: spermatids formation, spermiogenesis, Biochemical changes in spermatogenesis, Control of spermatogenesis, morphology of mature sperm. Discharge and Transportation of Gametes: Semination and sperm transport, Mechanism of semination, sperm discharge, transport of sperms, sperm viability, artificial insemination. Female Gonad: Compact and Saccular ovaries, Eggs and Oogenesis: introduction, Oogenesis in insects and mammals. Functions of ovarian tissues during growth phages. Ovulation: organs of ovulation and transportation in vertebrates, Time and regulation of ovulation.	11L
III	**Fertilization and Cleavage** Fertilization: Basic requirements and mechanism of fertilization, encounter of spermatozoa and ova, capacitation and contact, Acrosome reaction and penetration, activation of ovum, migration of pronuclei and amphimixis, post-fertilization changes in egg cytoplasm, mono- and polyspermic fertilization. Cleavage: cells involved, planes, patterns and rate of cleavage, influence of yolk, egg organization, cytokinesis in the cleavage, laws of cleavage, chemical changes during cleavage.	8L
IV	**Morulation, Blastulation, Fate maps, Gastrulation and Tubulation** Morulation, Blastulation in Centrolecithal egg, Blastulation in Isolecithal, microlecithal, Telolecithal, polylecithal egg. Construction of fate maps by natural and artificial marking. Gastrulation: general process, Epibolic and Embolic morphogenetic movement, General metabolism, hormonal action and gene activation during gastrulation.	8L
V	**Development in Model Organism** Introduction to Gradient theory, Introduction to embryonic adaptations in Amphioxus and frog. Introduction to Regeneration in microbes, protozoa, invertebrates and vertebrates. Introduction to differentiation levels (stem cell, tissues, organs and micro-environment), Introduction to Malignancy, Aging, Metamorphosis, Asexual reproduction and parthenogenesis.	8L

References:

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. Saunder 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. Klaus Kalthoff. Analysis of Biological development.
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. Chordate embryology and histology, S. Chands Simplified Course, S. Chand and Company Ltd.
12. Developmental Biology, 1984, Browder L.W., Saunders College Publications, U.S.A.

Paper No. 23. Bioinformatics and Nanotechnology **40 Lectures**

Unit	Content	Lectures
I	**Introduction Bioinformatics** History – concept; Various applications of bioinformatics; Nomenclature and code letters of DNA and protein sequences, directionality of sequences, genomics DNA, cDNA, organellar DNA, ESTs, GSTs, other biomolecules; NCBI, Entrez, PubMed, PMC, EMBnet, SRS.	**5L**
II	**Biological Databases [Introductory only]** 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; Secondary Protein databases: - PROSITE, PRINTS, BLOCKS, PROFILES, Pfam, IDENTIFY; Structure classification databases: - SCOP, CATH, PDBsum; Structural Databases: - PDB, NDB, MMDB.	**8L**
III	**Sequence Analysis and Tools** Evolutionary basis for sequence analysis; Alignments – types and methods (only strategy required no detail algorithm); Tools for alignment– BLAST, FASTA, CLUSTALx; Tools in analysis of – genes, proteins, regulatory sequences, phylogenetic relationship, prediction of function of unknown genes.	**8L**
IV	**Nanotechnology** Introduction, Size of Matter, fundamental science behind nanotechnology (electron, atoms and ions, molecules, metals, other materials, biosystem, molecular recognition, electrical conduction, optics, quantum mechanics and quantum idea); Applications in – Drug, drug delivery, photodynamic therapy, neuro-electronic interference, sensors and biosensors, cleaning environment (for heavy metal & Bioremediation)	**9L**
V	**Tools in Nanotechnology** Tools for measuring nanostructures – Scanning probe instruments, spectroscopy, electrochemistry, electron microscopy. Tools to make nanostructures – Nanoscale lithography, dip pen lithography, E-beam lithography, nanosphere liftoff lithography, molecular synthesis, self assembly, nanoscale crystal growth, polymerization, nanobricks and building blocks. Tools to imagine nanoscale behaviors. NanoCAD Brief Introduction to Physical, Chemicals, Biological and hybrid methods of Nanomaterial synthesis.	**10L**

References:

1. C.S.C. Murthy, "Bioinformatics", Himalaya Publishing House, Mumbai.
2. S. Ignacimuthu, S.J., "Basic Bioinformatics", Narosa Publication House, PVT., LTD.
3. R. Sunderlingam, V. Kumaresan, "Bioinfrmatics", Saras Publication.
4. Attwood and Pary Smith, "Introduction to bioinformatics", Pearson Publication.
5. R. C. Dubey, "Biotechnology", S. Chand Publication & Company LTD.
6. Mark Ratner, Daniel Ratner, "Nanotechnology, A Gentle introduction to the next big idea", Pearson Publication
7. Charles P. *et al.*, "Introduction to Nanotechnology", Willey Interscience, A John Willey & Sons, INC., Publication.
8. Sulbha Kulkarni, "Nanotechnology: Principles and Practices".

U. Satyanarayan, U Chakrapani "Biochemistry", Books and allied Private LTD

8. V. Sree Krishna, "Bioethics and Biosafety in Biotechnology", New Age International

Publishers.
9. Richard D Dart, “Medical Toxicology”, 3rd Ed. Pippincott Williams & Wilkins
10. Ernest Hodgson, “A textbook of Modern Toxicology”, Willey Interscience, A John Willey & Sons, INC., Publication.
11. Hans-Joachim Jordening, Josef Winter, “Environmental Biotechnology: Concepts and applications”, Willey Interscience, A John Willey & Sons, INC., Publication.

Paper No. 24. Recent Trends in Biotechnology **40 Lectures**

Unit	Content	Lectures
I	**Immobilization** Introduction to immobilization of enzyme; Support or Carrier, its properties; Limitations and advantages of immobilized enzymes, Methods of immobilizations with their advantages and disadvantages – Carrier binding (physical adsorption, ionic and covalent binding), Cross-linking, Entrapment (Lattice type, microencapsulation); Cell immobilization; Industrial applications of immobilized enzymes – Penicillinase, Glucose isomerase, Lactase, dihydropyrimidinase, DL-amino acid racimase, Lipase, Renin, glucose oxidase, cholesterol oxidase.	**7L**
II	**Enzyme and Metabolic Engineering** Site directed mutagenesis, Cassette mutagenesis, PCR-site directed mutagenesis, random mutagenesis, Strategy for enzyme engineering, Solvent engineering, Industrial applications of enzyme engineering; Introduction to metabolic engineering, Basic principle, Defining problem (changes to be incorporated), Analysis of metabolic network [metabolic flux analysis, metabolic control analysis (MCA), flux control coefficient from transient metabolite, top down MCA], pathway synthesis, Implementation changes, analysis of changes.	**9L**
III	**Environmental Remedies** Bioremediation: Biochemical, and ecological foundations of Bioremediation, *Ex-situ* and *In-situ* bioremediation; Phytoremediation technology for soil decontamination; Bioaugmentation, Biofiltration, Bioleaching; Industrial wastewater biotreatment technologies.	**8L**
IV	**Toxicological studies** Principles of toxicology, Types of toxic substances - degradable and nondegradable; Xenobiotics – types, hazardous effects, general features; Entry of xenobiotics to human body – entry through inhalation, skin absorption, in digestion and injection; Lethal and sub-lethal doses; Analysis of NOEL, LD_{50}, LC_{50} and MLD; Detoxification in human body – detoxification mechanisms, organs of detoxification.	**8L**
V	**Bioethics** Introduction to bioethics, Bioethics of biodiversity, ethics of resource management, ethical issues of Human genome project, ethics involved in stem cell research, ethics and human cloning, ethics in xenotransplantation – animal rights, allocation of resources and distributive justice.CCAC guidelines on animal welfare.	**8L**

References:

1. S. M. Bhatt, "Enzymology and Enzyme technology", S. Chand & Company LTD.
2. Trevor Palmer, Philip Bonner, "Enzymes – Biochemistry, Biotechnolgy, Clinical chemistry", 2nd Ed. Affiliated East-West Press Private Limited, New Delhi.
3. Martin L.Yarmush, "Biotechnology for Biomedical Engineers – Principles and Applications in Engineering Series", CRC Press, Boca Raton London New York Washington,D.C.
4. R. C. Dubey, "A Text book of Biotechnology", S. Chand & Company LTD.
5. B. D. Singh, "Biotechnology", Kalyani Publishers.
6. U. Satyanarayan, U Chakrapani "Biotechnology", Books and allied Private LTD

7. U. Satyanarayan, U Chakrapani “Biochemistry”, Books and allied Private LTD
8. V. Sree Krishna, “Bioethics and Biosafety in Biotechnology”, New Age International Publishers.
9. Richard D Dart, “Medical Toxicology”, 3rd Ed. Pippincott Williams & Wilkins
10. Ernest Hodgson, “A textbook of Modern Toxicology”, Willey Interscience, A John Willey & Sons, INC., Publication.
11. Hans-Joachim Jordening, Josef Winter, “Environmental Biotechnology: Concepts and applications”, Willey Interscience, A John Willey & Sons, INC., Publicatio

B.Sc. Biotechnology Part – III

Theory Syllabus

Semester VI

Paper No. 25. Tools and Techniques **40 Lectures**

Unit	Content	Lectures
I	Genetic Engineering: Introduction, milestones and scope, basic techniques: Types of Electrophoresis, Blotting techniques for Nucleic acids and proteins, principles of autoradiography, Dot Blot technique, Molecular markers: DNA Fingerprinting, DNA Foot-Printing RFLP, RAPD, AFLP, PCR and its types.	**9L**
II	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, use of plant and animal viruses as vectors, Probes: Genomic DNA probes, cDNA probes, synthetic oligonucleiotide probes, RNA probes, methods of labeling probes.	**10L**
III	DNA transfer techniques: Transformation, Transfection and Transduction, Cloning strategies: Cloning from mRNA in plasmid and bacteriophage vector, cloning from genomic DNA, 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.	**8L**
IV	Cloning in Prokaryotes and Eukaryotes: Methods of direct transformation: PEG mediated microinjection, particle bombardment, electroporation. Methods of indirect transformation: Agrobacterium mediated gene transfer techniques.	**7L**
V	Methods of DNA sequencing: Maxam's and Gilbert's method, Sanger's dideoxy method, Ligation mediated sequencing, Automated DNA sequencing, chromosome walking and Primer Walking.	**6L**

References:

1. An Introduction to Genetic Engineering, 2nd Edition, Desmond S.T. Nicholl, Cambridge University Press (2006).
2. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 3rd Edition, B.R. Glick and J.J. Pasternak, ASM Press (2007)
3. Principles of Gene Manipulation and Genomics, 7th Edition, S.B. Primrose and R.M. Twyman, Blackwell Publishing (2006)
4. Molecular Biotechnology, 2nd Edition, S.B. Primrose, Panima Publishing (2001)
5. Introduction to Biotechnology, Low Price Edition, W.J. Thieman and M.A. Palladino, Peaeson 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, 3rd Edition, James D

Paper No. 26. Applications **40 Lectures**

Unit	Content	Lectures
I	Genetic Engineering in Environment: 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, Silage fermentation), Utilization of cellulose: components of lignocelluloses	**9L**
II	Genetic Engineering in Microbes: Microbial biosynthesis of Rubber, Engineering Xanthomonas for Xanthan Gum production, Vaccines for diseases: subunit vaccines, peptide vaccine, Attenuated vaccines, Vector vaccines directed against viruses and bacteria.	**9L**
III	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, plants as edible vaccines.	**10L**
IV	Genetic Engineering in Animals: Transgenic sheep and mice, Cloning livestock by nuclear transfer, Nucleic acid as Therapeutic agents: Antisense RNA, Antisense oligonucleotides, chimeric RNA-DNA molecules, Interfering RNA, Gene therapy for cystic fibrosis.	**7L**
V	Genetic Engineering for Industrially important Enzymes: Examples of increasing enzyme activity, stability, specificity and altering multiple properties. synthesis of Human Interferon and Growth hormone	**5L**

References:

1. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 3rd Edition, B.R. Glick and J.J. Pasternak, ASM Press (2007) .
2. An Introduction to Genetic Engineering, 2nd Edition, Desmond S.T. Nicholl, Cambridge University Press (2006).
3. Principles of Gene Manipulation and Genomics, 7th Edition, S.B. Primrose and R.M. Twyman, Blackwell Publishing (2006)
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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, 3rd Edition, James D. Watson, James, Richard M. Myers,Amy A. Caudy, Jan A. Witkowski, W. H. Freeman (2006).

Paper No. 27. Fermentation Technology **40 Lectures**

Unit	Content	Lectures
I	**Bioreactors/fermenters and media :** 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, Types of Fermentation media, media sterilization, inoculum media, screening for fermentation media. Inoculum preparation. Microbial growth Kinetics.	**10L**
II	**Screening:** Introduction, Primary and secondary screening. Strain Improvement. Preservation and maintenance of industrial strains, Culture Collection Centers for Microorganisms, Scale up of fermentation. Detection and assay of fermentation products: Physical- chemical assays, Biological assays.	**10L**
III	**Types of Fermentations:** (Introduction, Advantages and Limitations, Basic aspects of Process Biotechnology, Fermentor Design , Industrial applications of process of): Batch fermentation, Continuous Fermentation, Submerged ,Solid state Fermentations, Anaerobic Fermentations	**5L**
IV	**Downstream processes:** Solid-liquid separation, coagulation and Flocculation, Filtration, Centrifugation, Disintegration methods, Precipitation, Solvent extraction, Distillation, Purification by Chromatographic Techniques, Product Formulation. Fermentation economics. Application of computer in fermentation technology.	**10L**
V	**Microbial production of industrial products:** (Micro-organisms involved, production media,fermentation conditions, product recovery and applications of): Citric acid, Ethanol, Penicillin,Vitamin B_{12}, amylase, bioinsecticide (*Bacillus thurigiensis*).	**5L**

References:

1. Casida L. E. (1991). Industrial Microbiology, New Age international Ltd.
2. Crueger W. and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd 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. 2nd edition, Elsevier Science Ltd.
5. Peppler H.J., Perlman D. (2004). Microbial technology-Fermentation Technology, second edition, Volume I and II, Academic Press.
6. H.A.Modi(2009):Fermentation Technology Vol.I And Vol.II,Pointer Publishers

Paper No. 28. Food and Dairy Technology **40 Lectures**

Unit	Content	Lectures
I	**Food Microbiology:** 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	**10L**
II	**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.	**10L**
III	**Methods for the Microbiological examination of foods:** Indicator organisms, Direct Examination, Cultural techniques, Enumeration methodsplate 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	**10L**
IV	**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, and Verification. Quality Systems: BS 5750, and ISO 9000 series.	**4L**
V	**Fermented dairy and other food Products-** Yoghurt, Cheese, Sauerkraut, Beer, Vinegar, Bread, Pickles.	**6L**

References:

1. Food Microbiology (1995)-Adams M.R.and Moss, M.O., New Age International Limited.
2. Food Microbiology –Frazier, W.C., Westhoff, D.C. IVth edition, Tata McGraw Hill Publisher.
3. Industrial Microbiology by A. H. Patel, Mac Millan India Pvt. Ltd.
4. Modern Food Microbiology VIth edition- James M Jay. An Aspen publication.
5. Applied Dairy Microbiology –Elmer Marth and James Steele 2nd edition, publisher Marcel Dekker
6. MicrobialTechnologyVolumeII-PepplerandPerlman,Academic Press

B.Sc. Biotechnology Part – III

Practical Syllabus

Annually Once

Practical Course No. 8. Techniques in Developmental Biology

Sr. No.	Name of Practical
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 (Slide/ICT)
5	Temporary / Permanent preparation of Chick embryos.
6	To estimate oxygen consumption in aquatic animal in relation to temperature.
7	Study Teratogenic effect on development of Frog / Chick embryo
8	Preparation of temporary slide to study histology by microtomy technique.
9	Study of histopathological permanent slides of different types of cancer
10	Study of dissection of Rat/Frog to observe reproductive system. (By ICT)
11	Study of developmental phases in human (By ICT)
12	Study of style and sigma
13	Study of different type of embryos.
14	Pollen germination in *In-situ* condition
15	Study of pollen germination by T.T.C. or Acetocarmine test
16	Collection of seed and storage of seeds for seed bank
17	Study of floral patterning in any suitable flower.
18	To study types of ovules (by permanent slides)
19	To study male gametophytes (by permanent slides)
20	Study Visit / Excursion. Visit to Zoological and botanical interested areas are compulsory. A report of one of the visits is to be submitted at the time of practical examination. Precaution should be taken as per the guidelines of Higher education in safeguard of students at the time of excursion.

References:

1. P. S. Verma, “A manual of Practical Zoology of Chordate”, S. Chand & Company LTD.
2. P. S. Verma, “A manual of Practical Zoology of invertebrates”, S. Chand & Company LTD.
3. Agarwal and Jindal, “Practicals in Vertebrate Zoology”, Pragati Prakashan, Meerut.
4. S. S. Lal, “Practical Zoology”, Vol-3, Rastogi Publication, Meerut.
5. Dr. V. S. Shirshyad, N. B. Yemul, “Laboratory Manual of Botany”.
6. D. A. Kadam *et al*., “Steps in Practical Botany”, Rayat Prasadak, Prakashan, Satara.
7. A Bendre, A Kumar, “A text book of Practical Botany – II”, Rastogi Publication, Meerut.

Practical Course No. 9. Techniques in Genetic Engineering and Modern Biotechnology

Sr. No.	Name of Practical
1	Isolation of genomic DNA from yeast and its quantification.
2	Isolation of Plasmid DNA from yeast/bacteria and its quantification.
3	Construction of restriction map of plasmid DNA
4	Calculation of molecular weight of digested DNA
5	DNA amplification by PCR
6	Preparation of single stranded DNA template
7	Restriction mapping of DNA
8	Ligation theory and ligation of DNA
9	Isolation of RNA from bacteria and its estimation.
10	Reporter gene assay (β- Gal)
11	Study of Southern blotting
12	Study of Northern blotting
13	Searching for literature at NCBI
14	Retriving of gene sequence from GenBank
15	Retriving of gene sequence through SRS
16	Performing sequence similarity by BLAST
17	Performing sequence similarity by FASTA
18	Determining phylogenetic tree from CLUSTALx
19	Synthesis of ZnO nanoparticles
20	Synthesis of Silver nanoparticles

References:

1. S. John Vennison, “Laboratory Manual for Genetic Engineering”, PHI Learning Private LTD.
2. Sambrook J. and Russell D. W., “Molecular cloning: A Laboratory manual”, 3rd Ed. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
3. Hoisington D *et al.*, “Laboratory protocols: CIMMYT Applied Biotechnology Centre”, 2nd Ed. Mexico, D.F.: CIMMYT.
4. Ausubel F. M. *et al*., “Current Protocols in Molecular Biology”, Vol-1, John Wiley & Sons., Inc. Brooklyn, New York.
5. https://www.ncbi.nlm.nih.gov
6. https://www.ebi.ac.uk
7. https://www.clustal.org
8. Sulbha Kulkarni, “Nanotechnology: Principles and Practices”

Practical Course No. 10. Techniques in Microbial Biotechnology

Sr. No.	Name of Practical
1	Introduction to laboratory Fermentor
2	Screening of Antibiotic producing microorganisms from soil by crowded plate technique
3	Biological assay of antibiotic by paper disc method
4	Production, recovery and assay of citric acid by *Aspergillus niger*.
5	Production, recovery of Amylase.
6	Assay of amylase
7	Production of sauerkraut by microorganisms
8	Production of Bioinsecticides by using *B.thuringienesis.*
9	Enumeration of bacteria in milk by Standard Plate Count
10	Qualitative analysis of milk sample by Methylene Blue Reduction Time Test.
11	Determination of efficiency of pasteurization of milk by alkaline phosphatase test.
12	Isolation of spoilage microorganisms from spoiled vegetables/fruits
13	Isolation of lipolytic microorganisms from butter.
14	Isolation of lactic acid bacteria from the curd sample.
15	Estimation of milk sugar by Benedict's method.
16	Assay of growth factor.(Vitamin)
17	Determination of Minimum inhibitory concentration of antibiotic against test microorganism by tube-dilution technique.
18	Production of wine from any fruit.
19	Determination of Calcium in milk
20	Determination of Magnesium in milk

References:

1. K.R. Aneja, "Experiments in Microbiology, Plant pathology and biotechnology", 4th Edition, New Age Publications.
2. Ashish Verma, "Laboratory Manual for Biotechnology", 1st Edition 2014, S. Chand Publications
3.R.C. Duby, "Practical microbiology", S. Chand Publications

Practical Course No. 11. Project Work

The project report is to be prepared by the student on the subjects in consultation with the Project coordinator in the year. The project work is carried out in group of maximum 4-5 students or individually. 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 student should visit two places of Biotechnological interest (Pharmaceutical industry, Dairy, Research institutes, Food processing industry, Botanical or Zoological place etc.) and submit the report of their visit at the time of practical examination in practical course No. 11: Project Work. The excursion report should be duly certified by the Head of the Department. For this 15 marks are allotted in course Practical Course No. 11.Project Work.

Examination Pattern

The examination for theory papers are conducted semester wise while for practical conducted annually once as per University Time Table.

A) Theory Examination : Nature of Theory question paper for each theory paper.

Solapur University, Solapur

Nature of Question Paper For Semester Pattern

Faculty of Science

Time:- 3 hrs **Total Marks-70**

Q. No.1) Multiple choice questions (14)

1) ----------

a) b) c) d)

2)

3)

4)

5)

6)

7)

8)

9)

10)

11)

12)

13)

14)

Q.No.2) Answer any SEVEN of the following (14)

i)

ii)

iii)

iv)

v)

vi)

vii)

viii)

ix)

Q.No.3 A) Answer any Two of the following (10)

i)

ii)

iii)

B) Write the Answer/Solve/Problem/Note (04)

Q.No.4) Answer any Two of the following (14)

i)

ii)

iii)

Q.No.5) Answer any Two of the following (14)

i)

ii)

iii)

B) 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 is to produce their journal at the time of practical examination. Candidate has to visit two places of Biotechnological interest (Pharmaceutical industry, Dairy, Research institutes, Food Processing industry, Botanical or Zoological place etc.) and submit the visit report dully signed by tour in-charge and duly certified by Head of the department at the time of practical examination in practical course 11: Project Work.

Distribution of Marks for practical examination: (Practical course 8, Practical course 9, Practical course 10**)**

1) Two major experiment: 30 marks (i.e. 15 marks each)
2) Two minor experiment: 20 marks (i.e. 10 marks each)
4) Viva voce: 10 marks
3) Journal: 10 marks

Total marks 70 marks

Distribution of Marks for Project Work (Practical course 11**):**

The report shall be examined by the External examiners (appointed by the University) who will assign marks out of 50 for project work as follows:

1) Selection of the project topic - 10 marks
2) Project methodology - 10 marks
3) Project Writing - 15 marks
4) Oral presentation and Viva - 15 marks

Total: 50 marks

Tour report: 20 marks

Total marks 70 marks

Practical Course 8 : 100 Marks [UA:70 Marks + CA: 30 Marks]
Practical Course 9 : 100 Marks [UA:70 Marks + CA: 30 Marks]
Practical Course 10: 100 Marks [UA:70 Marks + CA: 30 Marks]
Practical Course 11: 100 Marks [UA:70 Marks + CA: 30 Marks(20 Marks: Internal entire year lab assessment+ 10 Marks- Field visit related to project topic)]

Note: University exam assessment comprises of 55 marks of project and 15 marks for excursion.

Total Marks: 200 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.