SOLAPUR UNIVERSITY, SOLAPUR

NEW SYLLABUS FOR B.Sc. PART III (BIOTECHNOLOGY)

(w. e. f. JUNE 2009)

1. Eligibility for admission: A student who has been declared to have passed B.Sc. Part II successfully or is declared to be A.T.K.T., and has cleared B.Sc. Part I, is eligible to take admission to B.Sc. Part III.
2. Course structure: The course of Part III shall comprise of FOUR theory papers of 100 marks each, and a paper on English as per B.Sc.III structure; and THREE practicals of 50 marks each. In addition, the student shall have to submit a project report on a topic chosen by him/her in consultation with the teacher. The project report shall be of 50 marks. Thus the course total shall be of 700 marks.
3. Work load: Each theory paper shall be covered in 3 lectures per week (48/50 min. each). The practical will be covered in FIVE lecture periods per week per batch. There shall not be more than 12 students in each batch.
4. Project report: The work load of project report shall be taken into account for the teaching faculty. It shall be equivalent to that of one batch for practical (i.e.5 lecture periods per week/ batch). The project report, prepared under the guidance of the teacher, duly certified by him/her, shall be submitted for examination at end of the year, before the final (University Examination). It shall be examined by External examiners. The External Examiners appointed by the University shall consider the project report and allot marks out of 50.

5. The course structure will be as follows –

Subject code	Title of the paper	Theory	Marks	Lecture / Practical periods
BT 301	Genetic engineering	Theory	100	80 L
BT 302	Industrial Biotechnology	Theory	100	80 L
BT 303	Developmental Biotechnology	Theory	100	80 L
BT 304	Advanced Biotechnology	Theory	100	80 L
BP 311	Techniques in genetic engineering	Practical	50	20P
BP 312	Techniques in Industrial Biotechnology	Practical	50	20 P
BP 313	Techniques in Developmental Biotechnology	Practical	50	20P
BP 314	Project Work	Practical	50	20 P

BT 301: - Genetic Engineering

Section– I (40L)

Unit I

1) Genetic Engineering: Introduction, History, Scope 03L
2) Cloning Vectors – 07L
   Plasmids, Phages, Cosmids, Shuttle vectors, BAC, Yeast vectors,
   Vectors for plant and animals.
3) Outline of cloning strategies – 03L
   Construction of chemeric DNA, Cloning in bacteria and yeast.
4) Construction and screening genomic and C-DNA libraries. 03L
5) Insertion of foreign DNA fragment into a vector, Transfer of R-DNA into host, 04L

Selection of recombinant clones.

Unit II

1) Molecular Probes (Radioactive & non radioactive) 04L
   Preparation of genomic DNA probes, C-DNA probes, synthetic oligonucleotide probes, RNA probes, labeling of probes, Uses of probes.
2) Techniques used in R-DNA technology – 04L
   Agarose & Polyacrylamide gel electrophoresis, Southern, Northern and Western blotting.
3) Gene amplification – 02L
   PCR and its application.
4) Role of enzyme in gene cloning – 05L
   Restriction enonucleases – Classification & properties, Ligases, alkaline phosphatase, Reverse transcriptase, Terminal transferase, kinases.

5) Restriction maps and molecular marker – 05L

Restriction mapping, RELP, RAPD, AFLP, Chromosome walking, Chromosome jumping, Phage display.

SectionII (40L)

Unit III

Isolation, Sequencing & synthesis of genes: -

1) Isolation of genes – 08L

Genes with tissue specific expression, coding for unknown product, transposone tagging, mutant complementation.

2) Sequencing of genes – 07L

Maxam's and Gilbert's method, Sanger's dideoxy method, ligation mediated PCR, Automatic sequencing.

3) Synthesis of genes – 05L

Chemical synthesis of tRNA genes, precursor tRNa gene, interferon gene, gene synthesis machine.

Unit IV

1) Vector mediated gene transfer – 04L

Agrobacterium Ti and Ri

2) Direct gene transfer – 06L

Electroporation, microinjection & macroinjection, Bidistic. Lopisomes, Chemical methode.

3) Gene therapy – 06L

Diagnostic of genetic diseases – caused by protozoa & helminthes, STD using monoclonal antibodies, antenatal diagnosis of congenital diseases.

Gene therapy methods – Bone marrow transplantation, artificial akin.

4) Application of R-DNA technology – 04L

Production of insulin, Interferon, Hepatitis B caccine.

BT – 302 – Industrial Biotechnology

Section – I (40L)

Unit I

Introduction to fermentor (10L)

1) Structure, design, construction and operation of fermentor
2) Raw material for industrial fermentation.
   - molasses, corn steep liquor, sulfite waste liquor.
   - Optimization and screening for fermentation media.
   - Raw materials and Byproducts of fermentation industry.
   - Inoculum preparation.

Unit II

Application of Biotechnology in fermentation. (10L)

1) Screening for new metabolite.General, primary and secondary metabolite. Strain used in screening, Test systems.
2) Strain improvement mutation, selection of mutants, Recombination and gene manipulation.
3) Scale up of fermentation media.
4) Growth kinetics during fermentation.

Unit III

1) Detection and assay of fermentation products : Acids, vitamins, antibiotics.10L
2) Product recovery processes –Filtration and flocculation,Centrifugation,Precipitation Solvent extraction,Distillation,Crystallization

Unit IV (10L)

1) Patents and Intellectual property rights. History, composition, cost of patent.
2) Fermentation economics.
3) Application of computer in fermentation technology.

Section – II (40L)

Unit I

Application of fermentation technology in agriculture. (10L)

- Large scale production and application of
- Mushrooms, Bioinsecticides and Biofertilisers.

Unit II

Application of fermentation technology in pharmaceuticals. (10L)

- Large scale production and application of
- Penicillin, Lovastatin, Ergot alkaloide, Vit – B12 and B-carotene

Unit III

Application of fermentation technology in food and dairy. (10L)

Production processes and application of Single cell protein by using Bacteria, algae and fungi

Large scale production & applications of :-Citric acid, cheese, and Rennin.

Unit IV

Other fermentation process. (10L)

- Acetone production by using various substrates and its application
- L-lysine production and applications.
- Dextran & Xylan production and applications.

Reference: -

1) L.E.Casida – Industrial microbiology.
2) Wulf crueger & Anneliese crueger – Biotechnology
3) A.H.Patel – Industrial microbiology.
4) Peppler – Fermentation technology – vol – I & II
5) Whittaker and stanbusy – Principles in fermentation technology.

Bt-303 Developmental Biotechnology

Section I ANIMAL DEVELOPMENT

Unit -1 **15**

1. Gametogenesis and Fertilization of frog and chick

1.1 Gametogenesis

i) Definition

ii) Primordial germ cells

iii) Spermatogenesis

iv) Formation of spermatid

v) Spermatogenesis

vi) Oogenesis

vii) Previtellogenesis

vii) Vitellogenesis

viii) Hormonal control of Oogenesis

ix) Comparison of Spermatogenesis and Oogenesis

x) Polar bodies

1.2 Fertilization

i) Definition

ii) Significance of fertilization

iii) Physical factors involved in fertilization

iv) Chemical factors involved in fertilization

v) Cytological factors involved in fertilization

vi) Physical changes in fertilization

vii) Activation

viii) Theories of activation

2. Development types, patterns of cleavage, Planes of cleavage, Blastula, Gastrula in frog and chick up to formation of three germinal layers.

3. Role of genes in competence, determination and differentiation, patterning.

Unit-2 15

1. Ageing and Apoptosis

1.1 Ageing

i) Senescence

ii) Cognitive effects

iii) Terminology

iv) Theories – Biological theories and Non-biological theories

v) Measure of age

1.2 Apoptosis

i) Discovery and etymology

ii) Functions- Cell termination, Homeostasis, Development and
Lymphocyte interactions

iii) Process –Mitochondrial regulation, Direct signal transduction,
Execution and Removal of dead cells

iv) Implication in disease- Defective apoptotic pathways,
HIV progression and viral infection

2. Cancer and teratogenesis

2.1 Cancer i) Introduction ii) Origin of cancer iii) Properties of cancer cells iv) Tumor progression v) Sites of infection vi) Metastasis vii) Types of cancer viii) Causes of cancer ix) Diagnosisx) Treatmentxi) Oncogenesis

2.2 Teratogenesis

i) Genetic teratogenesis in animals and

ii) Environmental teratogenesis

iii) Teratogenesis due to Drugs, radiation, infection,
autoimmunization, malnutrition

iv) Specificity of teratogenesis

Unit -3 **10**

3. Stem cells, Gene Cloning, Transgenic technology

3.1 Stem cells

i) Properties

ii) Embryonic stem cells

iii) Adult stem cells

iv) Stem cell therapy

3.2 Gene Cloning

i) Gene Cloning method

ii) Cloning in mammals

iii) Applications of cloning

3.3 Transgenic technology

i) Definition

ii) Transgenic Mice and sheep

iii) Applications of Transgenic technology

SECTION II Plant development and Virology

Unit-I

Plant embryogenesis, Meristem and Phytohormone 10

1) Gametophyte in Angiosperms : Brief outline of development of Male and female gametophyte in
2) Embryogenesis : .Emryogeny . Development of monocot embryo. Development of dicots embryo

3) Organogenesis:

a) Principles, Concept and Applications of Somatic embryogenesis

b) Protoplast culture: Importance, Isolation of protoplasts, method of protoplast culture, culture media, Growth and division of protoplast, regeneration of plants. . Apomixes: Diplospory, apospory, causes, consequences and significance of Apomixes

Polyembryony : Classification causes, experimental induction and practical importance.

Meristem: 1. Introduction 2. Classification. 3. Theories of structural development.

4) Phytohormones: . Introduction, General account of Phytohormone Auxins.Gibberellins

5) Cytokinins

6) Abscisic acid (ABA)

Unit- II 10

Plant patterning

Model of plant development – Arabidopsis. Root and shoot patterning. Floral patterning. Diversity – cell fusion somatic cell genetics

UNIT III **10**

Virology

1) General features, nomenclature and classification of viruses

2) Morphology and Ultrastructure: capsids and their arrangements, types of envelopes.

3) Virus related agents (viriods and prions)

4) Bacterial viruses: Life cycle of Mu, T4 and Lambda, One step growth curve, transcription, DNA replication, phage typing

5) Animal viruses: General features and life cycle of RNA viruses (Picorna and HIV) and DNA viruses (Pox and Adeno)

6) Plant viruses: TMV, BMV,

Unit -IV 10

Biodiversity and Biosystematics Biodiversity

Unit-I: Biodiversity and its Conservation

- Alpha (α) and Beta (β) biodiversity
- Extinction and endangered species
- Reasons of concern for loss of biodiversity
- Steps to preserve biodiversity
- *In situ* and *ex situ* conservation of biological diversity

- Conservation laws : Polices and laws

Biosystematics

1. Characters of biosystematics, concept and population concept.
2. Types of taxonomy: Numerical taxonomy, chemotaxonomy, omega taxonomy.
3. Tools and techniques with respect to microorganisms, plants and animals.

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. SaunderAssociates 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 Publicaions, 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
16. Genetic Engineering, Sandhya Mitra. Macmillan.
17. Plant Embryology by Bhojwani and Bhatnagar.
18. Plant Taxonomy by V.N. Naik
19. Cole, A.J. 1969. Numerical Taxonomy. Academic Press, London.
20. Davis, P.H. and Heywood, V.M. 1973. Principles of Angiosperm Taxonomy. Robert E. Kereiger Publ. New York.
21. Harrison, H.J. 1971. New Concepts in Flowering Plant Taxonomy. Heiman Ednl. Books. Ltd., London.
22. Radford, A.E. 1986. Fundamentals of Plant Systematics, Harper & Row Publ. USA.
23. Woodland, D.W. 1991. Contemporary Plant Systematics. Prentice Hall, New Jersey
24. Environmental Studies by A.K. Asthana
25. Negi, S.S. 1993. Biodiversity and its Conservation in India.
26. Richard B. Primack. 1993. Essentials of Conservation Biology.
27. Hall, R.D. (Ed.) 1999. Plant Tissue Culture: Techniques and Experiments,Academic Press, New York.
28. Bhojwani, S.S. and Razdan, M.K. 1996. Plant Tissue Culture: Theory and Practice (a revised edition). Elsevier Science Publishers, New York, USA. Bojwani, S.S. 1990. Plant Tissue Culture: Applications and Limitations,Elsevier Science Publisher, New York, US

BT – 304 – Advanced Biotechnology

Unit I

Bioinformatics

Introduction, definition, scope,

Primary databases, EMB net, hixton hall, mIPS, UCL, SRS,

The NCBI – Enter

Primary sequence databases-

Nucleic acid seq databases – EMBL, DBJ, Genebank

Protein sequence databases – Swiss – PROT, TrEMBL, NRL – 3D.

Composite Protein sequence databases –

NRDB, OWL, MIPSX, SEISS-PROT + TrEMBL [Introductory only].

Secondary databases –

PROSITE, PRINTS, BLOCKS, PROFILES, Pfam

Structure classification databases –

SCOP, CATH, PDB sum.

Pairwise alignment

The dayhoff mutation data matrix

The BLOSUM matrices

Global alignment – the Needleman & wunsch algorithm

Local alignment – the smith – waterman algorithm.

Fasta, BLAST, Gapped BLAST, PSI-BLAST.

Unit II

Global gene analysis: -

Reverce northern, macroarray, DNA microarray – spotted and oligonucleotide technology, medical and academic applications.

Protein microarray

Tube gel experiment – 2 D gel electrophoresis

Staining and quantification of differentially expressed spots-

- denatured gradient gel electrophoresis, HPLC, HPLC combined with spectroscopy, MALOI, TOF, metallic labeling, I CAT.

Biochips – Antibody array, antigen array, Sandwitched array – known examples of kinases

Unit III

Antibody and protein engineering –

Site directed mutagenesis – Primer extentin – single primer, two primer, doping primer.

Hybrodoma – mouse/redent – technology & limitation

Construction of chimeric antibodies, Humanized antibody

Examples of applications of monoclonal antibody in medicine –

Protein engineering –

Engineering of temperature tolerant and effective oxidizing subtilisin for textile application.

Engeneering of human growth hormone to facilitate better receptor interaction – through phage display

Unit IV

Nanotechnology-

Introduction – size matters, fundamental science behind nanotechnology – electrons, atoms & ions, metals, biosystem quantum mechanics & quantum ideas.

Tools to make nanostructures –

Nanoscale lithography, E-beam lithography, molecular synthesis, self assembly, polymerization, tools to imagine nanoscale behaviors

Smart materials, sensors, nanoscale biostructures, self healing structures, catalysts, heterogeneous nanostructures, encapsulation, consumer gods.

Sensors – Natural nanoscale sensors, Biosensors, Electronic noses.

Biomedical applications-

Drugs, drug delivery, Photodynamic thory, molecular motors, neuro – electronic interfaces, protein engineering, shedding new light in cells : nanoluminescent tags

Reference: - Introduction to bioinformatics – Attwood and pary - smith

Principles of gene manipulation and genomics – 7th edition primrose and Twyman

R-DNA technology – Watson 2nd edition.

Nanotechnology – A gentle introduction to the next big idea – Mark Ratner, Daniel Ratner.

Principles of gene manipulation and genomics – 7th edition primrose and Twyman

B.Sc – III (Biotechnology) **Theory Examination**

Nature of question paper and distribution of marks for both the sections

Section I

Q.1. Multiple choice type questions (each carry one mark) (10)

Q.2.Essay type question (10)

OR

Q.2 Essay type question (10)

Q.3 Essay type question (10)

OR

Essay type question (10)

Q.4. Write short notes on any four of the six (20)

Section II

(As in section I)

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 (2) places of Microbiological interest(Pharmaceutical industry, Dairy, Research institutes etc) and submit the report of their visit at rhe time of examination.

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: 20 marks
2) Two minor experiment: 10 marks each
3) Journal : 5 marks.

Total marks:

Practical I : 45 Marks

Practical II : 45 Marks

Practical III : 45 Marks

Practical IV : Project work

Total Marks : 200

BP – 311 – Techniques in Genetic Engineering.

1) Isolation of plasmid DNA.
2) Calculation of molecular weight of digested DNA.
3) Construction of restriction map of plasmid DNA.
4) Isolation & quantitation of genomic DNA, total RNA
5) Ligation theory and ligation of DNA.
6) Preparation of single stranded DNA template.
7) Preparation and development of competent cell system.
8) Transformation of *E.coli* and selection of recombinants.
9) Restriction mapping of DNA.
10) Reporter gene assay (b- Gal)
11) Southern blotting technique.
12) DNA amplification by PCR.
13) Agrobacterium mediated transformation and Gus expression.
14) Concept of database, accessing database.
15) Searching for gene and protein sequences & accessing information from web.
16) Information from genome BLAST, FASTA.
17) Demonstration and visit to DNA sequencing labrotary

BP – 312 – Techniques in industrial Biotechnology

1. Production and recovery of citric acid by *Aspergillus niger*.
2. Assay of citric acid.
3. Estimation of protein and sugar from mushroom.
4. Cultivation of mushroom.
5. Biological assay of antibiotic.
6. Biological assay of vitamins.
7. Isolation of UV induced auxotrophic mutants by replica plate technique.
8. Isolation of Antibiotic producing microorganisms from soil by crowded plate technique.
9. Estimation of fat from milk by Gerber's method.
10. Production and recovery of Amylase.
11. Assay of Amylase.
12. Isolation and identification of reserve food material from bacterial culture.
13. Estimation of carbohydrate of bacteria.
14. Production of Bioinsecticides by using B.thuringenesis.
15. Production of Biofertilisers – Azotobacter.
16. Production of Biofertilisers – Rhizobium.
17. Estimation of milk sugar by Benedict's method.

Practical BP-313

1. Study different types of viruses-Avian Influenza, Chickenpox, Smallpox, Rabies, Poliomyelitis, Hepatitis and Aids.
2. Study of different types of sperms by smear technique- Frog, Hen, Rat and Human
3. Sperm motility test
4. Study of different types of eggs - Insects, Amphioxus, Frog and Hens egg.
5. Study of Cleavage, Blastula and Gastrula –Frog and Hen
6. Temporary / Permanent preparation of Chick embryos.
7. Study Teratogenic effect on development of Frog / Chick embryo
8. To estimate the oxygen consumption in aquatic animal in relation to temperature.
9. Study of histopathological permanent slides of different types of cancer
10. Estimation of DNA by calorimetric / Spectrophotometric method
11. Study of style and sigma
12. Study of different type of embryos.
13. Pollen germination in In-situ condition.
14. Study of pollen germination by T.T.C.or Acetocarmine test.
15. To study Hot spots of India in India map.
16. To study phytogeographycal regions of India in India map
17. Collection of seed and storage of seeds for seed bank
18. To study types of ovules .(by permanent slides)
19. To study male gametophytes.(by permanent slides)
20. To study TMV electron microphotograph.
21. Study Tour / Excursion. Visit to Zoological and botanical interested areas is compulsory. A report of one of the visits is to be submitted at the time of practical examination.

BP 314: Project Report 5 L/week/Batch

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, the Principal 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 50.

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..

Distribution of Marks for practical examination

For practical I, II, III, IV each.

4) One major experiment: 20 marks
5) Two minor experiment: 10 marks each
6) Journal : 5 marks.

Total marks:

Practical I : 45 Marks
Practical II : 45 Marks
Practical III : 45 Marks
Practical IV : Project work

Total Marks : 200