

SOLAPUR UNIVERSITY SOLAPUR

Ph.D. THEORY COURSE WORK

IN

BIOTECHNOLOGY

(w.e.f. June-2016)

COURSE STRUCTURE

There shall be THREE theory papers each of 100 marks. The first two papers i.e. Paper I and Paper II will be compulsory whereas a student shall have to select any one paper from amongst three elective papers provided for paper III

Theory Component: Total Marks 300 marks

1. Paper – I (compulsory): Research Methodology and Information Communication Technology (Common Paper to all Faculties) -100 marks

2. Paper II (compulsory) Recent Trends in Biotechnology - 100 marks

3. Paper – III (Elective) Advanced Developments in Biotechnology -100 marks

The paper- III will have following Electives. Candidate may choose any one Paper.

A) **Paper – III (Elective)** Advanced Developments in Biotechnology (Plant Biotechnology)
OR

B) **Paper – III (Elective)** Advanced Developments in Biotechnology (Animal Biotechnology)
OR

C) **Paper – III (Elective)** Advanced Developments in Biotechnology (Microbial Technology and Bioprocess Engineering)

Solapur University, Solapur
Ph.D. Course Work Syllabus
Common Paper for Faculty of Science
(w.e.f. June 2016)
Paper No. I: Research Methodology and ICT

1. Scientific Method:

Block schematic of scientific approach, inductive and deductive logic schemes, imperial basis of laws, theory, hypothesis, deductive system, requirements of theory, dynamics of theory construction, rational explanation, scientific explanation, limits of scientific explanation.

2. Formulation of Research Problem:

Criteria of good research, types of research, significance, literature review, purpose, process of literature review, analysis of an article, search engine, formulation of research problems, accuracy of definition, objectives of research, research design, preparation of research article and thesis.

3. Process of Research:

Definitions of problem, planning of experiments, data collection and record keeping, results and discussions, presentation of research outcome as a research paper or filing patent.

4. Research Publications and Quality:

Indices, publications, types, Impact factor, calculation of Impact Factor, uses, calculation of immediacy Index, calculation, SCOPUS, h – index, advantages, criticism ISSN, ISBN.

5. ICT:

Various search engines available on internet, normal vs advanced search, key – words, formulation of search statement, Listing various journals in relevant topic, Science abstracts, e – database.

Application of Computers in research, internet browsing, tool bar options, provisions of MS – word, MS – Excel, MS – PowerPoint, Origin.

6. Fundamentals of Data Analysis and Statistical Methods: Types of data and various methods of data collection, Framing of questionnaires, various sampling methods. Statistical techniques for analyzing data: Measures of central tendency, measures of dispersion, measures of asymmetry (Skewness), measure of relationship, simple regression analysis, testing of hypotheses, chi- square test, analysis of variance (ANOVA) and Covariance (ANCOVA).

Reference Books:

1. Research Methods - Ram Ahuja, Rawat Publications
2. Philosophy of Science – Mario Bunge, Transaction Publishers
3. Research Methodology - Methods and Techniques, C. R. Kothari New Age
4. Fundamentals of Statistics - Goon, Gupta and Das Gupta (Vol. I & Vol. II)

Paper II

Recent Trends in Biotechnology

Unit I: Bioinformatics

- i) Introduction to Bioinformatics
- ii) Bioinformatics resources at NCBI.
- iii) Biological databases – Nucleic acid and protein databases.
- iv) Applications of Bioinformatics.

Unit II: Analytical Techniques

- i) Spectroscopy – UV Visible, IR, NMR, Mass Spectra.
- ii) Chromatography – Paper chromatography, TLC, Column chromatography – Gel filtration, ion exchange, affinity chromatography, Gas Chromatography, HPLC
- iii) Electrophoresis – Agarose, SDS PAGE, Native PAGE
- iv) Ultra Centrifugation

Unit III: Techniques in Genetic Engineering

- i) Molecular tools for genetic engineering
- ii) Types of PCR – RT PCR, Real time PCR
- iii) Molecular markers – RFLP, RAPD, VNTR,
- iv) Gene cloning & expression – restriction enzyme, vector and expression vector, cDNA library, blotting techniques, DNA sequencing.

Unit IV: Nano-Biotechnology

- i) Synthesis & characterization of nanoparticles – mechanical, chemical, biological.
- ii) Characterization of nanoparticles by UV, FTIR, SEM, TEM etc.
- iii) Applications of nano-biotechnology.

Unit V: Biosensors

- i) Concept, principle, organization & types of biosensors.
- ii) Biosensors – Health & medicine
- iii) Biosensors – Food technology & environmental monitoring
- iv) Bacterial biosensors, Array biosensors.

Unit VI: Biosafety & Bioethics

- i) Guidelines for Biosafety
- ii) Institutional Biosafety committee
- iii) Institutional animal ethics committee
- iv) Bioethics (Animal/Human).

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. Nicholls, Cambridge University Press (2006).
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. 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).
6. V. Sree Krishna, "Bioethics and Biosafety in Biotechnology", New Age International Publishers.
7. Hans-Joachim Jordening, Josef Winter, "Environmental Biotechnology: Concepts and applications", Willey Interscience, A John Willey & Sons, INC., Publication.
8. C.S.C. Murthy, "Bioinformatics", Himalaya Publishing House, Mumbai.
9. Attwood and Pary Smith, "Introduction to bioinformatics", Pearson Publication.
10. Mark Ratner, Daniel Ratner, "Nanotechnology, A Gentle introduction to the next big idea", Pearson Publication
11. Charles P. et al., "Introduction to Nanotechnology", Willey Interscience, A John Willey & Sons, INC., Publication.
12. Sulbha Kulkarni, "Nanotechnology: Principles and Practices".
13. Upadhyay Nath - Biophysical chemistry

3. Paper – III (Elective) Advanced Developments in Biotechnology -100 marks

The paper- III will have three following Electives. Candidate may choose any one Paper - III of the A, B and C.

A) Paper – III (Elective) Advanced Developments in Biotechnology (Plant Biotechnology)

Unit- I: Introduction to plant tissue culture

Definition, History ,Cellular totipotency, techniques in plant tissue culture.

Infrastructure and Organization of Plant Tissue Culture Laboratory- General and aseptic laboratory- different work areas,

Equipments and instruments required, other requirements.

Aseptic Techniques- Washing and preparation of glassware's, packing and sterilization, media sterilization, surface sterilization, aseptic workstation, precautions to maintain aseptic conditions.

Culture Medium- Nutritional requirements of explant, PGR and their invitro roles, composition of basal M.S. medium and media preparation.

Unit- II. Culture Techniques

Callus culture techniques-Introduction, principle, protocol, morphology and internal structure, genetic variations, applications.

Somatic Embryogenesis- Introduction, principle, protocol, factors affecting, applications, limitations.

Organogenesis- Introduction, principle, protocol, applications.

Organ Culture Technique- Introduction, principle, protocol, applications, with respect to root tip culture, leaf culture, ovary and ovule culture.

Unit- III. Anther and Pollen Culture Technique

Introduction, principle, protocol, factors affecting, applications. Micropropagation- Introduction, stages of Micropropagation, factors affecting, advantages and applications. Different Pathways of Micropropagation- Axillary bud proliferation, somatic embryogenesis, organogenesis, meristem culture.

Unit- IV Suspension Culture Technique

Introduction, principle, protocol, types, growth measurement, viability test, synchronization, applications.

Unit- V. Production of Secondary Metabolites

Introduction, types of secondary metabolites, principle, systems of culture, optimization of yield, commercial aspects, applications, limitations.

Unit -VI. Plant Protoplast Culture

History, Principle, protocol for isolation Mechanical and Enzymatic, protoplast culture methods, viability test applications.

References:-

- 1] Introduction to plant tissue culture- M.K. Razdan
- 2] Plant tissue culture-Theory & practice-S.S.Bhojwani & M.K. Razdan
- 3] Micropropagation- Deberg & Zimmermann
- 4] Plant tissue culture-Kalyankumar Dey

- 5] Biotechnology- B.D. Singh
- 6] A text book of Biotechnology- R.C. Dubey
- 7] Plant tissue culture-U.Kumar
- 8] Plant cell, tissue & organ culture-Gam Borg & Phillips
- 9] Fundamentals of Biotechnology- S.S. Purohit
- 10] Plants cell Tissue & organ culture-Rennet & Bajaj
- 11] Biotechnology- H.S. Chawla
- 12] Crop Improvement In biotechnology- H.S.Chawla

B) Paper – III (Elective) Advanced Developments in Biotechnology (Animal Biotechnology)

Unit I Animal cell culture

Basic principles of animal cell culture
- requirements for animal cell and tissue,
In vitro fertilization –applications.
Maintenance and applications of cell culture,
Trypsinization,
Cell separation.

Unit II Growth media

Natural media, Basal salt solution (BSS)
Minimum Essential Medium (MEM),
Serum dependent defined media ,
Serum independent defined media

Unit III Cell cloning

Hybridoma - technology,
Production of monoclonal antibodies.
Cell synchronization,
Cell cloning
Cell Viability – measurement of viability

Unit IV Biotechnological Applications

Transgenic Animals,
Genetically Engineered Vaccines,
Cryopreservation of cells (general),
Applications of stem cells

Unit V Cryopreservation

Basic principles of cryopreservation,
Types of cryopreservation technique,
Cryopreservation of gametes, Applications of cryopreservation

Unit VI Vermitechnology

Earthworms and their environment, diversity, distribution and biology.
Vermiculture
Vermitechnology: Role of earth worms in organic waste disposal and
biomagnification of nutrients
Different methods of vermicomposting, Nutritive value of vermicompost,
Vermiwash.

Reference Books:

1. Cell (A Molecular approach): Cooper , G. M.
2. Cell and Molecular Biology (1996) Karp, G.
3. Molecular Biotechnology (1996) Pasternak
4. Freshney, Culture of Animal Cells, 5th Edition, Wiley-Liss, 2005 2. Ed. John R.W. Masters,
5. Animal Cell Culture - Practical Approach, 3rd Edition, Oxford University Press, 2000.
6. Louis-Marie Houdebine, Transgenic Animals: Generation and Use, 1st Edition, CRC Press, 1997.
7. Lewin B. 2007. Genes IX. Oxford University Press.
8. Edwards, C.A & P.J Bohlen, 1996. Biology and ecology of earthworms III Edn. Chapman & Hall N.Y.U.S.A. 2. Edwards, C.A & J.R Lofty
9. Vermicology – The Biology of earthworm, 1997 Chapman & Hall Publications N.Y.U.S.A. 3.
10. Lee, K.E. 1985. Earthworms their ecology and relationships

C) Paper – III (Elective) Advanced Developments in Biotechnology (Microbial Technology and Bioprocess Engineering)

UNIT-I: Microbial biotechnology

Scope and techniques, Bioprospecting of microbial diversity, Isolation and preservation of industrially important microorganisms. Genomics, Transcriptomics, Proteomics, Metabolomics, metagenomics and Systems Biology.

Unit-II: Microbial biomass production

Production of proteins and enzymes in bacteria, yeast and fungus, recombinant and synthetic vaccines. Microbial polysaccharides and polyesters, Microbes as biocontrol agents, microbial insecticides (Baculoviruses, entomopathogenic fungi, *Bacillus thuringiensis*, *Bacillus sphaericus* *Bacillus popillae*, Microbe derived inhibitors.

Microbial biomass production, utilization of plant biomass by microorganisms. ethanol production, antibiotics. Metabolic engineering.

Unit-III: Bioprocess engineering

Introduction to bioprocess engineering, Design of a basic fermenter, bioreactor configuration, design features, individual parts. Reactors for specialized applications: Tube reactors, packed bed reactors, fluidized bed reactors. Sterilization of Bioreactors, nutrients, air supply, products and effluents, process variables and control, scale-up of bioreactors. Strain improvement for the selected organism: mutation and screening of improved cultures, Preservation of cultures after strain improvement programme.

Unit-IV: Microbial fermentation process

Fermentation process: Growth of cultures in the fermenter, Importance of media in fermentation, media formulation and modification. Kinetics of growth in batch culture, continuous culture with respect to substrate utilization, specific growth rate, steady state in a chemostat, fed-batch fermentation, yield of biomass, product, substrate utilization kinetics. Fermentation process: Inoculum development. Storage of cultures for repeated fermentations, scaling up of process from shake flask to industrial fermentation.

Unit-V: Downstream processing:

Biomass separation by centrifugation, filtration, flocculation and other recent developments. Cell disintegration: Physical, chemical and enzymatic methods. Extraction: Solvent, two phase, liquid extraction, whole broth, aqueous multiphase extraction. Concentration by precipitation, ultra-filtration, reverse osmosis. Drying and crystallization. Effluent treatment.

Reference books

1. Sullia S. B. and Shantharam S: (1998) General Microbiology, Oxford & IBH Publishing Co. Pvt.Ltd.
2. Glaser A.N & Nilaido.H (1995) Microbial Biotechnology, W.H Freeman & Co.
3. Prescott and Dunn (1987) Industrial Microbiology 4th Edition, CBS Publishers & Distributors.
4. Prescott and Dunn (2002) Industrial Microbiology, Agrobios (India) Publishers.

5. Crueger W. & Crueger A. (2000) A text of Industrial Microbiology, 2nd Edition, PanimaPublishing Corp. Stanbury P.F, Ehitaker H, Hall S.J (1997) Priciples of Fermentation Technology., Aditya Books (P) Ltd.
6. S.N.Jogdan (2006) Industrial Biotechnology, Himalaya Publishing House
7. Microbial Biotechnology (1995) Alexander n. Glazer Hiroshi Nikaido W.H.Freeman and Company
8. Molecular Biotechnogy: Principles and Applications of Recombinant DNA –Bernaral R.
9. Glick and Jack J. Pastemak ASM Press. Washington, D.C (1994).
10. Fungal Ecology and Biotechnogy (1993) Rastogi Publicaions, Meerut.