

University of Pune

Two Years M.Sc. degree course in

BIOTECHNOLOGY

M.Sc. II BIOTECHNOLOGY

Syllabus for Affiliated Colleges

(To be implemented from Academic Year 2014-15)

Preamble:

Biotechnology has grown, extensively in last couple of decades. This advanced 'interdisciplinary' life science branch has a tremendous networking potential with modern cutting edge technology. This has given it a separate status in fundamental research as well as in modern industrial enterprise. Global and local focus has slowly shifted to not only current "Century of Knowledge" but also on to technology development and application in life sciences. In the milieu of research and industrialization for economic development and social change, biotechnology is an ideal platform to work.

The interdisciplinary nature of biotechnology flags involves many fundamental research fields from cell biology to molecular biology, from biochemistry to biophysics, from genetic engineering to stem cell research, from bioinformatics to genomics-proteomics, from environmental biology and to biodiversity, from microbiology to bioprocess engineering, from bioremediation to In silico drug discovery and so on. The proposed credit-based curriculum and grading system will even add much more to the existing interdisciplinary nature of biotechnology and will also offer many courses to the other branches of life science. The generative power of biological data is effectively harnessed by biotechnology like no other field. The relevance and application of these studies on living organisms and their bioprocesses is extensively covered in this field with the help of technology.

Economic and social renaissance is staged on biotechnology especially, since it's biomedical and cutting edge technological applications are tremendously powerful in shaping this century and exciting biofuture. Life science, IT industries and research institutes are always on a lookout for trained Biotechnologists as an efficient work force in fundamental research and industries. Education and research sectors require such interdisciplinary trained workforce to develop future generations of science leaders.

Introduction:

Master's in Biotechnology course syllabus is revised to cater to the needs of credit based-semester and grading system. The changing scenario of higher education in India and abroad is taken into consideration to make this syllabus more oriented towards current need of modern research and industrial sectors. The syllabus encompasses the fundamental academics at one end and latest technologies in life science at the other. Theory courses will help students develop their knowledge sets on various topics of biotechnology, to which, they are introduced at the undergraduate level. Extensive practical courses are designed to supplement the theory courses with hands on experimentation in wet-lab and on fields.

Empowerment of students to face research and industrial outlets is at the centre of this syllabus. Students having to select their own courses will develop the depth in specialization and also make them ready to face the cutting edge of life science establishment in the world without any further training. The colleges are encouraged to develop their own departmental courses based on available expertise, both, personnel and infrastructural.

We have prepared M.Sc. syllabus by keeping in vision the undergraduate curriculum. At the undergraduate level, students were introduced to many fundamental topics in life sciences such as molecular biology, developmental biology, fermentation technology, biodiversity, bioinformatics and tissue culture etc. At the post graduate level they will be exposed to the advanced principles of biochemistry, genetics, molecular and cell biology, environmental biology, microbiology, bioinformatics etc. along with technological advances and applications of basic principles to successfully carry out research and industrial developments. A research project/ industrial training modules are incorporated to provide a buffer zone for budding biotechnologists eager to enter the life science sector.

Objectives to be achieved:

- To help the students to build interdisciplinary approach
- To empower students to excel in various research fields of Life Sciences
- To inculcate sense of scientific responsibilities and social and environment awareness
- To help students build-up a progressive and successful career

Eligibility:

Students with B.Sc in Biotechnology securing a minimum of 55% marks.

M.Sc. Course structure

T/P	Code	Course title	Marks	Hours	Credits
Semester I					25
T	BT 101	Advanced Biological Chemistry	100	60	4
T	BT 102	Molecular Biology	100	60	4
T	BT 103	Environmental Biotechnology	100	60	4
T	BT 104	Cell Biology	100	60	4
P	BT 105	Exercises in Advanced Biological Chemistry	100	60	4
P	BT 106	Exercises in Molecular and Cell Biology	75	45	3
P	BT 107	Exercises in Environmental Biotechnology	50	30	2
Semester II					25
T	BT 201	Genetic Engineering	100	60	4
T	BT 202	Immunology	50	30	2
T	BT 203	Principles of Bacteriology and Virology	100	60	4
T	BT 204	Plant Biotechnology	100	60	4
P	BT 205	Exercises in Genetic Engineering	100	60	4
P	BT 206	Exercises in Immunology	50	30	2
P	BT 207	Exercises in Plant Biotechnology	75	45	3
P	BT 208	Exercises in Bacteriology and Virology	50	30	2
Semester III					25
T	BT 301	Animal Biotechnology	100	60	4
T	BT 302	Bioprocess engineering & Fermentation Technology	100	60	4
T	BT 303	Data Base Management and IPR in Biotechnology	50	30	2
T	BT 304	Advanced Genetics	75	45	3
T	BT 305	Bioinformatics	50	30	2
P	BT 306	Exercises in Animal Biotechnology	75	45	3
P	BT 307	Exercises in Bioprocess Engineering	75	45	3
p	BT 308	Exercises in Bioinformatics	50	30	2
T	BT 309	Seminars, Term paper writing	50	30	2
T	BT 310 [#]	Scientific Research and Communications	100	60	4
T+P	BT 311 [#]	Food Technology and Neutrigenomics	50+25	30+15	3
Semester IV					32
T	BT 401	Genomics and Proteomics	100	60	4
T	BT 402	Biochemical and biophysical techniques	100	60	4
P	BT 403	Exercises in Biochemical and Biophysical techniques	50	30	3
T+P	BT 404	Nanobiotechnology	50+25	30+15	3
T	BT 405	Stem Cell Technology and Regenerative Medicines	100	60	4
T	BT 406	Agricultural Biotechnology	100	60	4
P	BT 407	Project	250	150	10
T	BT 408 [#]	Bio-entrepreneurship	50	30	2

[#] = Departmental courses, T = theory courses, P = Practical courses,

T+P = Theory + Practical courses

The Project will consist of not more than ten percent of the total credits for the degree course. Students have to opt for minimum 75% credits from the parent department and remaining 25% can be opted from other department/s.

Courses offered in Semester I and Semester II are core courses (equivalent to 50 credits) meaning that these are compulsory. From among the courses of semester III and IV one has to complete 50 credits (Of which 25 credits can be opted from other Department/s). Thus total 100 credits to be completed for obtaining degree in Biotechnology.

“Departmental courses” can be offered in the third or fourth semester up to 4 credits. For these courses both internal and semester end examination should be conducted by the respective Departments and the grade points and grade obtained should be informed to the University examination unit.

Examination pattern:

Each course will have:

50% marks for internal (i.e. in-semester) assessment.

50% of marks for semester-end examination conducted by University of Pune.

The student has to obtain forty percent marks in the combined examination of In-Semester assessment and Semester-End assessment with a minimum passing of thirty percent in both these separately.

Theory examination:

Internal examination: At least one internal assessment must be conducted for the one credit course. (four tests for four credits course)

Each credit will have an internal (continuous) assessment of 50% of marks and a teacher must select a variety of procedures for examination such as:

- Written Test and/or Mid Term Test (not more than one or two for each course)
- Term Paper;
- Journal/Lecture/Library notes;
- Seminar presentation;
- Short Quizzes;
- Assignments;
- Extension Work;
- An Open Book Test (with the concerned teacher deciding what books are to be allowed for this purpose)

External Examination:

Theory examination will be conducted for a period of maximum 45 minutes for each credit.

The Pattern of question paper for one credit course (12 Marks): There shall be a single question asked.

Question 1 3 out of 5 6 sub-questions, each of 4 marks; short answer type questions; answerable in 10 – 15 lines

The Pattern of question paper for two credit course (25 Marks): There shall be 2 questions in all.

Question 1 3 out of 5 sub-questions, each of 5 marks; short answer type questions; answerable in 10 – 15 lines

Question 2 1 out of 2 sub-questions, each of 10 marks; long answer type questions; answerable in 20-25 lines

The Pattern of question paper for three credit course (38 Marks): There shall be 3 questions in all.

Question 1 2 out of 4 sub-questions, each of 5 marks; short answer type questions; answerable in 10 – 15 lines

Question 2 4 out of 6 sub-questions, each of 5 marks; short answer type questions; answerable in 10 – 15 lines

Question 3 1 out of 2 sub-questions, each of 8 marks; long answer type questions; answerable in 20-25 lines

The Pattern of question paper for four credit course (50 Marks): There shall be 3 questions in all.

Question 1 4 out of 6 sub-questions, each of 5 marks; short answer type questions; answerable in 10 – 15 lines

Question 2 4 out of 6 sub-questions, each of 5 marks; short answer type questions; answerable in 10 – 15 lines

Question 3 1 out of 2 sub-questions, each of 10 marks; long answer type questions; answerable in 20-25 lines

Practical examination: Practical examination will be of the same duration as that of the practical exercises for that course. There shall be 10 marks for laboratory log book and journal, 10 marks for viva-voce. For practical course of four credits at least three experiments should be

asked. For the course of two/ three credits at least two experiments and for the course of single credit one experiment should be asked. Certified journal is compulsory for appearing for practical examination. There shall be two experts and two examiners per batch for the practical examination. One of the examiners will be external.

Setting question papers: Questions should be designed to test the conceptual knowledge and understanding of the basic concepts of the subject.

Examination rules.

If a student misses an internal assessment examination he/she will have a second chance with the permission of the teacher concerned. Such a second chance shall not be the right of the student; it will be the discretion of the teacher concerned to give or not to give second chance to a student to appear for internal assessment.

Students who have failed semester-end exam may reappear for the semester end exam only twice in subsequent period. The student will be finally declared as failed if she/he does not pass in all credits within a total period of four years. After that, such students will have to seek fresh admission as per the admission rules prevailing at that time.

A student cannot register for the third semester, if she/he fails to complete 50% credits of the total credits expected to be ordinarily completed within two semesters.

Evaluation:

Marks for all the examination have to be converted to the grade.

Each assignment/test will be evaluated in terms of grades. The grades for separate assignments and the final (semester-end) examination will be added together and then converted into a grade and later a grade point average.

The semester end and final grade sheets and transcripts will have only grades and grade points average.

On Completion of 100 credits by the student report card should display grade point and cumulative grade point average (CGPA).

Grading for individual course

Marks	Grade	Grade Point
100 to 75	O: Outstanding	06
74 to 65	A: Very Good	05
64 to 55	B: Good	04
54 to 50	C: Average	03
49 to 45	D: Satisfactory	02
44 to 40	E: Pass	01
39 to 0	F: Fail	00

Final grade points

Grade point	Final grade
05.00-6.0	O
04.50-4.99	A
03.50-4.49	B
02.50-3.49	C
01.50-2.49	D
00.50-1.49	E
00-00-0.49	F

Grade point average = Total of Grade Points Earned X Credit hrs for each course

(CGPA)

Total Credits Hours

Qualification of Teachers:

With minimum postgraduate degree in Microbiology/Zoology/Botany/Health Science/Environmental Science or other related branch of Life Science and NET/SET qualified as per UGC regulations. Preferably candidates with PhD degree should be appointed for post graduate teaching.

M.Sc. Course structure

T/P	Code	Course title	Marks	Hours	Credits
Semester I					25
T	BT 101	Advanced Biological Chemistry	100	60	4
T	BT 102	Molecular Biology	100	60	4
T	BT 103	Environmental Biotechnology	100	60	4
T	BT 104	Cell Biology	100	60	4
P	BT 105	Exercises in Advanced Biological Chemistry	100	60	4
P	BT 106	Exercises in Molecular and Cell Biology	75	45	3
P	BT 107	Exercises in Environmental Biotechnology	50	30	2
Semester II					25
T	BT 201	Genetic Engineering	100	60	4
T	BT 202	Immunology	50	30	2
T	BT 203	Principles of Bacteriology and Virology	100	60	4
T	BT 204	Plant Biotechnology	100	60	4
P	BT 205	Exercises in Genetic Engineering	100	60	4
P	BT 206	Exercises in Immunology	50	30	2
P	BT 207	Exercises in Plant Biotechnology	75	45	3
P	BT 208	Exercises in Bacteriology and Virology	50	30	2
Semester III					25
T	BT 301	Animal Biotechnology	100	60	4
T	BT 302	Bioprocess engineering & Fermentation Technology	100	60	4
T	BT 303	Data Base Management and IPR in Biotechnology	50	30	2
T	BT 304	Advanced Genetics	75	45	3
T	BT 305	Bioinformatics	50	30	2
P	BT 306	Exercises in Animal Biotechnology	75	45	3
P	BT 307	Exercises in Bioprocess Engineering	75	45	3
p	BT 308	Exercises in Bioinformatics	50	30	2
T	BT 309	Seminars, Term paper writing	50	30	2
T	BT 310 [#]	Scientific Research and Communications	100	60	4
T+P	BT 311 [#]	Food Technology and Neutrigenomics	50+25	30+15	3
Semester IV					32
T	BT 401	Genomics and Proteomics	100	60	4
T	BT 402	Biochemical and biophysical techniques	100	60	4
P	BT 403	Exercises in Biochemical and Biophysical techniques	50	30	3
T+P	BT 404	Nanobiotechnology	50+25	30+15	3
T	BT 405	Stem Cell Technology and Regenerative Medicines	100	60	4
T	BT 406	Agricultural Biotechnology	100	60	4
P	BT 407	Project	250	150	10
T	BT 408 [#]	Bio-entrepreneurship	50	30	2

**# = Departmental courses, T = theory courses, P = Practical courses,
T+P = Theory + Practical courses**

BT 301: Animal Biotechnology (4C)

Sr. No.	Topic	Lecture (Total 60L)
1	Introduction to tissue culture: Definition, principle and significance of tissue culture. Maintenance of sterility and use of antibiotics, Detection of Mycoplasma and viral contaminants. Prevention of Cross contamination Logic of formulation of tissue culture media: natural, synthetic media, and sera. Sterilization of cell culture media and reagents. Introduction to the balance salt solutions and simple growth medium. Role of carbon dioxide in animal cell culture.	6
2	Various systems of tissue cultures with distinguishing features, advantages and limitations. Methodology: i. Primary culture: Behavior of cells, properties, utility with different examples ii. Explant culture. iii. Suspension culture.	5
3	Cell lines: Definition, establishment and maintenance. Normal and established cell lines: Their characteristic features and utility, Characteristics of cells in culture. Contact inhibition, anchorage (in) dependence, cell-cell communication , Cell senescence. Cell and tissue response to various factors,	5
4	Organ culture: Methods, behavior of organ explant, and utility of organ culture. Histotypic and organotypic cultures Organ transplants, tissue engineering	3
5	Growth studies: Cell proliferation, cell cycle, mitosis in growing cells. Freeze storing of cells and transport of cultures. Measurement of viability and cytotoxicity. Cell cloning and types of cloning, cell synchronization, micromanipulation, Cell transformation. Separation of cell types: Various methods: advantages and limitations; Flow cytometry. Nuclear transplantation, Cell hybridization, Transfection studies.	6
6	Application of animal cell culture for <i>in vitro</i> testing of drugs, in production of human and animal viral vaccines and pharmaceutical proteins. Mass production of biologically important compounds. Harvesting of products, purification and assays.	4

	Propagation of viruses (viral sensitivity of cell lines).	
7	Growing cells in serum free media, scaling up, Hybridoma & monoclonals	2
8	Stem cells – adult, embryonic, induced pluripotent stem cells: Concept, principles for identification, purifications, assessment of proliferation long-term maintenance and characterization.	10
9	Overview-livestock breed and their productivity, artificial breeding-methods and hazards, marker assisted breeding of livestock, Introduction to animal genomics, different methods for characterization of animal genomes, SNP, STR, QTL, RFLP, RAPD, genetic basis for disease resistance	7
10	Transgenic animals: artificial breeding – in vitro fertilization and embryo transfer technology, artificial insemination, germ cell storage, Genetic modifications – methods, Transgenic fish and mammals (Mice, Sheep). Gene targeting: Targeted gene transfer. Mouse models for human genetic disorders, Knockout mice.	10
11	Biosafety issues and Bioethics associated with developing transgenic animals	2

References:

1. R. Ian Freshney. Culture of Animal cells, 5rd Edition, 2010. A John Wiley & Sons, Inc., Publications, USA
2. R.W.Masters. Animal Cell Culture- Practical Approach, 3rd Edithion,2000, Oxford University Press. USA
3. Robert Lanza et al. *Essentials of Stem Cell Biology*”, Academic Press, 2nd edition, 2006.USA
4. Text book of Animal Husbandary, 8th edition, (1998) G.C. Banerjee,Oxford and IBH Publishin co.Pvt. Ltd. India
5. Molecular Biotechnology: 4th edition. (2010), Glick B.R., Pasternak J.J., Patten C. L., ASM press, USA
6. Gene Transfer to Animal Cells, 1st edition (2005), R. M. Twyman, Taylor & Francis USA.

BT 302 Bioprocess engineering & Fermentation Technology

Sr. No.	Topic	Lectures (Total 60)
1	<p>Introduction to fermentation and Basic aspects of bioengineering</p> <p>Introduction to fermentation: Fermentation , types.</p> <p>Basic Aspects of Bioengineering: Design of Fermenter/ bioreactors – Design aspects of Stirred tank reactor and non- mechanically agitated bioreactors (Air lift and Bubble column) Kinetics of operation of bioreactors: Batch, Fed Batch and Continuous processes. Design and operation of immobilized cell reactors.</p> <p>Mass transfer, Aeration and agitation of fermentation broth: Mass transfer: Concept of mass transfer, Molecular diffusion and role in bioprocess, Two – film theory, Convective mass transfer, volumetric mass transfer (<i>KLa</i> introduction), Liquid-Solid, Liquid-liquid and Gas- liquid mass transfer equations and significance in bioprocess. Aeration : Oxygen Uptake in cell cultures, Oxygen transfer from Gas bubble to Cell. Gas hold up, <i>KLa</i> importance, Determination of <i>KLa</i>, Factors affecting <i>KLa</i>. Agitation: Design of impellers and their flow patterns. Fermentation Broth rheology – Newtonian and Non Newtonian fluids, Factors affecting broth rheology, Power requirement for mixing Power number, Reynolds number, Flow regimes in fermentation tank (Laminar, turbulent and transition), Correlation between mass transfer coefficient and operating variables.</p>	15
2	<p>Fermentation Media, Sterilization and monitoring of process variables</p> <p>Media components and their optimization.</p> <p>Sterilization of media: Kinetics of destruction of microorganisms, indicator organism Del factor, designs of Batch and continuous sterilization (Del factor calculation), equipment used. Filter sterilization.</p> <p>Monitoring of process variables: Types of sensors, Measurement and control of various parameters (pH, Temperature, dissolved oxygen, microbial biomass, inlet and exit gases, fluid flow, Pressure, Foam)</p> <p>P.I. D. control, Computer control of variables.</p> <p>Scale Up and Scale Down.</p>	15
3	<p>Molecular Engineering</p> <p>Important strains and pathways –Mutation, Protoplast fusion, parasexual cycle and genetic engineering for strain improvements, product formation and inhibition pathways and their regulations; applications in medicine, agriculture and industry. Industrially important microorganisms, preservation, Culture collection centers</p>	10

4	<p>Production and Down stream processing</p> <p>Concept of primary (growth associated) and secondary metabolites (Growth non -associated) metabolites, kinetics of growth and product formation. Yield coefficient and efficiency.</p> <p>Downstream processing and unit operations, General strategy of downstream processing, Production, recovery (with principles of techniques involved) and applications of</p> <p>Vitamins (Vitamin C) Amino acids Enzymes Antibiotics Organic acids Vaccines Biotransformation product (steroid) Cheese. Exopolysaccharides.</p> <p>Effluent Disposal strategies used for Textile, dye, dairy, paper and pulp industries Applications of microbes as/in: chemical factories, mixed culture, probiotics, ore leaching, biofuels. Role of plant and animal cells in bioprocess. fermentation economics</p>	20
---	--	----

References:

1. Stanbury, P. F. and Whittaker, A. (1984) Principles of Fermentation technology, Pergamon press
2. Pepler, H. L 1979, Microbial Technology, Vol I and II, Academic Press.
3. Casida, L. E., 1984, Industrial Microbiology, Wiley Easterbs, New Delhi
4. Prescott. S.C and Dunn, C. G., 1983 Industrial Microbiology, Reed G. AVI tech books.
5. A. H. Patel. (1985), Industrial Microbiology, Macmillan India Ltd.
6. Crueger, W. and Crueger, A. (2005) A Text Book Of Industrial Biotechnology, Panima , New Delhi.
7. Satyanarayan U, Biotechnology, Arunabha Sen Books allied Publishers.
8. Schuler,M. and Kargi,F.Bioprocess Engineering -Basic Concept, Prentice Hall of India, New Delhi.
9. Bioprocess Engineering Principles - Pauline Doran, Academic Press 1995
10. Operational Modes of Bioreactors, BIOTOL series - Butter worth, Heinemann 1992
11. Bioreactor Design & Product Yield, BIOTOL series - Butter worth Heinemann 1992
12. Lydersen, Bioprocess Engineering : Systems, Equipment & Facilities

Ed. B. N.A. Delia & K.M. Nelson, John Wiley & Sons Inc,1993
12. Harrison,R, Todd, P(2006), Bioseparations science and Engineering, Oxford University Press

BT 303: Database Management and Intellectual Property Rights (2C)

Sr. No.	Topic	Lectures (Total 30)
1	Database Management	15
	Concept of Database, Organization of Database, Characteristics of Database, Types of databases relevant to Biotechnology,	4
	Principals of Data Management and data mining	2
	Essentials of Source Documentation: Maintaining and Managing Essential Documents; Recording and Reporting Non-Serious and Serious Adverse Events.	5
	Importance and application of Databases – With one example each (PubMed, PubChem, OMIM, CTR etc.)	4
2	Intellectual Property Rights	15
	Characteristics and Types of Intellectual Properties	2
	Tools of IPR- Introduction and types Treaties, Conventions, Laws, Acts, agreements pertaining to Biotechnology <i>in vogue</i> ,	4
	Tools of IPRs- 1. Patents- prerequisites for patenting, Biological Patents – a. Plant b. Animal c. Microbial patents 2. Process patents and Product patent with one case study each 3. Indian and International scenario	6
	Protection of Plant varieties and Plant breeders rights	1
	Industrial Designs- Designs of gadgets used in Biotechnology	2

2

References:

1. Dr. B.L.Wadehra 2011, Law Relating To Intellectual Property, Fifth Edition, *Universal Law Publishing Co.Pvt. Ltd.*
2. TIFAC 2002 Some questions and answers on Patents and Copyrights
3. H K Das 2010, Text book of Biotechnology, 4th edition, Wiley India Pvt. Ltd, New Delhi
4. H S Chawala 2009, Introduction to Plant Biotechnology, 3rd Edition, Science Publishers
5. Hirvani R 2009, Patents in Plant Breeding: Guarding the Green Gold- Biotech News issue vol 4., No.4
6. Ganguli Prabuddh 2001, Intellectual Property Rights, Tata McGraw-Hill Publishing Company Ltd.

7. World Intellectual Property Rights (WIPO) web site-
<http://www.wipo.int/portal/index.html.en>

BT 304 Advanced Genetics (3C)

Sr. No.	Topic	Lectures (Total 45L)
1	Genetics of plant breeding- Genetic basis and mechanisms of pre- and post zygotic incompatibility	5
2	Genetics of somaclonal variations	3
3	Genetics of apomicts	2
4	Genetics of androgenic plants	3
5	Cytoplasmic inheritance	3
6	Genetics of population with reference to Hardy –Weinberg principle and its applications,	4
7	Human genetics and methodologies Clinical genetics, diagnostic tools and techniques for human genetic disorder	10
8	Quantitative genetics, heritability of commercially important traits, QTL, inbreeding and estimation of inbreeding coefficient	5
9	Important model system in genetics and methodologies (<i>Drosophila</i> , <i>C. elegans</i> , zebrafish, arabidopsis)	10

References:

1. Williams EG, Clarke AE, Bruce Knox R (1994) – Genetic control of self incompatibility and reproductive development in flowering plants (Kluwer Academic Publ, Netherlands)
2. Franklin-Tong VE (2008) – Self incompatibility in flowering plants – evolution, diversity and mechanisms (Springer, Berlin Heidelberg)
3. Principles of plant genetics and breeding, 2nd edition(2012), Acquaah G, Wiley – Blackwell, UK
4. Developmental genetics, 1st edition, (2006) Miglani GS, IK International, India
5. Savidan Y, Carman JG, Dresselhaus T Eds (2001) – The flowering of apomixis: From mechanisms to genetic engineering (CIMMYT, IRD, European commission DG VI (FAIR)
6. Plant breeding: principles and methods, 11th edition (2009), B D Singh, Kalyani Publisher, India.
7. iGenetics, 3rd edition (2011), Peter Russel, Benjamin Cummings, USA
8. Strickberger MW (2006) - Genetics (Prentice Hall, India)
9. Hartl DL, Jones EW (2001) – Genetics: analysis of genes and genomes (Jones and Bartlett, Massachusetts)

BT 305: Bioinformatics (2C)

Sr. No.	Topic	Lectures (Total 30)
1	Introduction to Bioinformatics	10
	Concepts and applications	1
	Biological Databases- Concept, types, specialization, limitations, DBMS	2
	Data retrieval from various databases, Homology searching and their applications	2
	Sequence Alignments- Algorithms, Scoring Matrices, Multiple Sequence Alignment (MSA)	3
	Gene Annotation- Introduction	2
2	Molecular Modeling, Phylogenetic analysis	10
	Acquisition and visualization of molecular structures	3
	Energy optimization methods	2
	Sequence and Structure based predictions- Simulation of Molecular interactions	2
	Phylogenetic analysis and tree construction methods	3
3	Structural Bioinformatics	10
	Protein structure basics, Ramachandran plot, Protein structure- function relationship, SCOP and CATH	3
	Introduction to: Protein motifs and domain prediction, Protein profiles and Hidden Markov Model (HMM) Drug target finding.	4
	Immunoinformatics – databases, epitope prediction and vaccinology.	3

References:

1. A text book of bioinformatics (2008) **Sharma, Munjal and Shankar**. *Rastogi Publications, Meerut*.
2. An introduction to Bioinformatics Algorithms (2004) **Neil Jones, Pavel Pevzner** *Bradford Book, The MIT Press, USA*
3. Bioinformatics - From Genomes to Drugs (2001) **Thomas Langauer (editor)** *Wiley-VCH; 1st edition, New York*
4. Bioinformatics-Sequence and Genome Analysis (2004) **David W Mount** *Cold Spring Harbor Laboratory Press; 2nd edition, USA*
5. BLAST (2003) **Joseph Bedell, Ian Korf, Mark Yandell**. *O'Reilly Media, USA*
6. Discovering genomics, Proteomics and Bioinformatics (2006) **A. Malcolm Campbell, Laurie J. Heyer** *Pearson-Benjamin Cummings; 2nd edition, USA*
7. Essential Bioinformatics (2006) **Jin Xiong** *Cambridge University Press; 1st edition, Cambridge*
8. Genome analysis and bioinformatics (2009) **Sharma T R I.K.** *International Publishing House Pvt. Limited, Delhi*
9. Introduction to Bioinformatics (2008) **Arthur M. Lesk** *OUP, Oxford*
10. Introduction to genetic analysis (2008) **Griffiths et al** *W. H. Freeman, New York*
11. Introduction to genomics (2007) **Arthur M. Lesk** *OUP, Oxford*
12. Immunoinformatics (2008) **Schönbach, Ranganathan, Brusic** *Springer, New York*
13. Lehninger Principles of Biochemistry (2008) **Nelson David, Cox Michael W. H.** *Freeman 5th edition, New York*
14. Principles of proteomics (2004) **Twyman Richard** *Taylor & Francis, UK*
15. Protein Structure Prediction, methods and protocol (2000) **David M. Webster** *Springer, New York*
16. Proteomics from protein sequence to function (2001) **Pennington SR, Dunn MJ., Stephen R** *BIOS Scientific publication, Oxford, UK*
17. Intellectual property rights: basic concepts (2009) **M M S Karki** *Atlantic Publishers & Distributors, New Delhi*

BT 306: Exercises in Animal Biotechnology (3C)

Sr. No	Topic	Practical (9Px 5H)
1	Initiation of cell culture from chick embryo	2
2	Subculture and maintenance of established cell line in laboratory	1
3	Growth studies by viable cell count analysis	2
4	Effect of growth factors on cell proliferation	2
5	Chromosome preparation from cell line	2

BT 307: Exercises in Bioprocess Engineering (3C)

Sr. No.	Topic	Practical (9Px5H)
1	Screening and identification (Genus Level) of a production strain (enzyme /antibiotic) from soil samples.	1
2	Maintenance of the isolated production organism (Agar slants/ glycerol stocks /soil culture/ lyophilization) at least two methods.	1
3	Optimization of different parameters of the isolated organism (conventional and Statistical design).	1
4	Inoculum build up of the isolated organism for use in bench top fermentation	1
5	Study of Working of lab bench fermenter (with production of enzyme or antibiotic using screened organism),Study of different parts and assembly of the bench top fermenter.	1
6	Assay of product formed (Bioassay or Enzyme assay).	1
7	Solid state fermentation : Lab scale production of a product.	1
8	Biosorption of dyes or metals using dead biomass. <i>Aspergillus niger</i> or brewer's yeast cells could be grown in liquid media, harvested and killed by autoclaving. Dried biomass to be used for biosorption (both the organisms are suitable for adsorbing Congo Red).	1
9	Demonstration of working of industrial fermenters by visiting fermentation industry.	1

BT 308: Exercises in Bioinformatics (2C)

Sr. No.	Topic	Practicals (10P x 3H)
1	Publicly available Database study and searching PubMed, NCBI, DDBJ, EMBL, UniProt, PDB	1
2	Retrieval of sequences and Sequence analysis by: BLAST, FASTA	1
3	Multiple Sequence Analysis: ClustalW (JalView), MUSCLE, T-Coffee	1
4	Phylogenetic tree construction: Phylip, FIGTREE	1
5	Visualization and study of 3D molecular structures – RASMOL, Swiss PDB viewer	1
6	Potential energy calculations- Swiss PDB viewer	1
7	Mutation and energy minimization of proteins- Swiss PDB viewer	1
8	Homology Modeling- Swiss PDB viewer, ExPASy	1
9	Protein classification, domain identification, signature matching - PFAM, Prodom, Prosite	1
10	IMGT database search for IG, TR and MH	1

BT 401: Genomics and Proteomics (4C)

Sr. No.	Topic	Lectures (Total 60)
I	Genomics	15
	Genomics and Proteomics overview, omes and omics, Concepts and applications	1
	Genome overview at the level of Chromosome (with model organisms example);	5
	Strategies for large scale DNA sequencing- Whole genome analysis techniques, Next generation sequencing methods; Organization, structure and mapping of genomes (with model organisms example)	3
	Comparative genomics - Goals, bioinformatics of genome annotation, methods and limitations.	3
	Structural genomics –Goals, methods, applications.	
	Functional genomics –Goals, methods, applications.	3
2	Transcriptomics and Microarray	10
	Introduction to transcriptomics and expression profiling	2
	DNA and RNA Microarray –Preparation, working and analysis. Microarray databases and bioinformatics tools.	5
	Investigative techniques –EST, SAGE, SNP	3
3	Applications	5
	In basic research and medical genetics,	2
	Metagenomics,	1
	Toxicogenomics,	1
	Pharmacogenomics,	1
	Gene disease association.	
II	Proteomics	30
	Proteomics – introduction, concept and applications;	3
	Introduction, Concept, application, advantages and limitations of Expressional Proteomics,	2
	Functional Proteomics, Structural Proteomics-with at least one explanatory example for each.	5
5	Techniques in Proteomics	

	Protein separation techniques, Strategies in protein identification, 2D Gel electrophoresis, Isoelectric Focusing (IEF). Mass spectrometry in proteomics – Principle, techniques, components and variations (HPLC, ESI, MALDI- TOF, FT-MS, MS/MS, Quadrupole) and analysis, applications. Protein- Protein interactions- experimental and computational- two hybrid, Phage display; Protein Microarray- Preparation, working and analysis. Proteomics and Microarray databases and allied bioinformatics tools.	2 7 6
6	Applications Peptidomics/Drug discovery, Toxicoproteomics, Biomarkers in disease diagnosis, Identification and characterization of novel proteins.	2 1 1 1

References:

1. Bioinformatics - From Genomes to Drugs (2001) Thomas Langauer (editor) Wiley-VCH; 1st edition
2. Bioinformatics-Sequence and Genome Analysis (2004) David W Mount Cold Spring Harbor Laboratory Press; 2nd edition
3. Broad-based Proteomics strategies : a practical guide to proteomics and functional screening David R M Graham et al J.Physiol 2005, 563.1, 1-9
4. Comparative Genomics Webb Miller et al Annu.Rev.Genomics Hum.Genet 2004, 5, 15-56
5. Discovering genomics, Proteomics and Bioinformatics (2006) A. Malcolm Campbell, Laurie J. Heyer Benjamin Cummings; 2nd edition
6. DNA microarrays and gene expression (2002) P Baldi and G W Hatfield Cambridge University Press
7. Essential Bioinformatics (2006) Jin Xiong Cambridge University Press; 1st edition
8. Functional Genomics : Methods and Protocols (2003) M J Brownstein, A B Khodursky Humana Press
9. Genome analysis and bioinformatics (2009) Sharma T R I.K. International Publishing House Pvt. Limited
10. Genome and proteome annotation: organization, interpretation and integration G A Reeves et al J.Roy.Soci. 2009,6, 129-147
11. Introduction to genetic analysis (2008) Griffiths et al W. H. Freeman
12. Introduction to genomics (2007) Arthur M. Lesk OUP Oxford
13. Principles of proteomics (2004) Twyman Richard Taylor & Francis
14. Protein Expression : A practical approach (series 1999) editor B. D. Hames Oxford University Press
15. Proteomics from protein sequence to function (2001) Pennington SR, Dunn MJ., Stephen R BIOS
16. Review: Protein identification methods in Proteomics Kris Gavaert and Joel Vandekerckhove Electrophoresis 2000, 21, 1145-1154
17. Transcriptomics (2003) Virendra Gomase VDM Publishing.

BT 402: Advanced Biochemical and Biophysical techniques (4C)

Sr.No.	Topic	Total (60L)
1	Microscopic techniques: Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, cryotomy scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze- fracture methods for EM, image processing methods in microscopy, confocal microscopy, single cell imaging.	15
2	Histochemical and Immunotechniques - Antibody generation, Detection of antigen using ELISA, RIA, Western blot, Immunoprecipitation, Flowcytometry and immunofluorescence ,detection of antigens in living cells, <i>in situ</i> localization by techniques such as FISH and GISH.	15
3	Advanced spectroscopy: Introduction, principle and analysis using UV/visible spectrophotometer, fluorescence spectroscopy, circular dichroism, NMR and ESR spectroscopy , Molecular structure determination using X-ray diffraction, X ray crystallography and NMR, Molecular analysis using light scattering, mass spectrometry and GC-MS, and surface plasma resonance methods, IR.	15
4	Advanced chromatography and Electrophoresis: Introduction, principle and analysis using HPTLC,HPLC,GLC, Affinity chromatography and its types IEF and 2 D electrophoresis Applications of the above techniques	10
5	Radio isotopes techniques- Radio assay (nature of radioactivity, units, decay, half life, detection/measurement), scintillation counting, safety aspects of use of radio isotopes.	5

References Books:

1. Principles and Techniques of Biochemistry and Molecular Biology,7th edition, (2010), Wilson K.M., Walker J.M., Cambridge University Press, UK
2. Biophysics. 1st edition (2002), Pattabhi V and Gautham N. Kluwer Academic Publisher, USA.
3. Biochemical spectroscopy. Vol 46 of Methods in Enzymology. (1995) Kenneth Sauer. Academic Press, USA
4. Modern experimental biochemistry. 3rd edition. (2000) Rodney Boyer. Prentice Hall Publisher, USA.
5. Analytical Biochemistry, 3rd edition, (1998), David Holmes, H.Peck , Prentice Hall, UK.

BT 403: Exercises in biochemical and biophysical techniques (2C)

Sr. No.	Topic	Any 6 Practicals (6PX5H)
1	In situ detection of proteins by Immunofluorescence microscopy	1
2	Gel filtration- Separation of mixture of proteins.	1
3	Ion exchange chromatography – Separation of mixture of amino acids	1
4	Affinity chromatography-e.g. separation of IgG from Serum by protein A sepharose chromatography	1
5	ELISA	1
6	2D Electrophoresis for separation of proteins	2

BT 404: Nanobiotechnology (T+P: 3C)

Sr. No.	Topic	Lectures Total 30
1	Introduction to Nanoworld, Nanoscience and Nanotechnology Nanoparticles, nanowires, thin films and multilayers, Applications in various fields viz. Physical and Chemical, Materials, Life Sciences. Nanobiotechnology: Introduction, Biomolecules as nanostructures and their applications in nanotechnology viz. Biosensors, separation of cells and cell organelles, cancer therapy, gene therapy etc.	8
2	Synthesis of nanostructure: Physical methods –mechanical methods, methods based on evaporation , sputter deposition, chemical vapour deposition (CVD), electric arc deposition. Chemical methods - synthesis of nanoparticles by colloidal route, microemulsion, sol-gel method, chemical precipitation, pyrolysis. Biological methods -Synthesis using microorganism, synthesis using plant extracts, use of proteins and template like DNA.	8
3	Properties and Characterization of nanomaterials: Optical (UV-Vis / Fluorescence), X-ray diffraction, Imaging and size (Electron microscopy, Light scattering , Zetapotential), Surface and composition (ECSA, EDAX, AFM/STM), Magnetic, Electrical and Electrochemical.	8
4	Functionalization of Nanoparticles for biological applications: Proteins- Lipids-RNA-DNA, Protein targeting –small molecules / Nanomaterial-Protein interaction. Nanomaterial-cell interaction – manifestation of surface modification (polyvalency), Lipid nanoparticles for Drug Delivery, Inorganic Nanoparticles for Drug Delivery, metal / Metallic oxide nanoparticles (antibacterial/ antifungal/antiviral).	6

Reference Books:

1. Nanotechnology; Principals and Practices by Sulabha K. Kulkarni, (2009 Revised edition), Capital Publishing company , New Delhi.
2. Biological Nanostructures and Application of Nanostructures in Biology by Michael A. Strosio and Mitra Dutta (2004) , Kulwer Academic Publishers,
3. BioNanotechnology, Elisabeth S. Papazoglou, Aravind Parthasarathy, First Edition (2007), Morgan & Claypool Publishers' series.
4. Bionanotechnology, by David S. Goodsell (2004), John Wiley & Sons, Inc, Publication.

Sr.No.	Topic	1 Credit (5P x 3H)
1	Synthesis of Al ₂ O ₃ nanoparticles using Sol Gel method.	1
2	Synthesis of semiconductor (ZnS, CdS etc.) nanoparticles by Chemical method.	1
3	Synthesis of nanoparticles using Biological process.	1
4	Detection of nanoparticles in colloidal solutions using UV-Vis absorption technique.	1
5	Analysis of AFM, SEM and TEM pictures.	1

BT 405: Animal Development and Stem Cell Technology (4C)

Sr. No.	Topic	Lecture (60L)
1	Gametogenesis and fertilization: Mechanisms of Fertilization, Acrosome reaction, blocks to polyspermy, egg activation (capacitation).	8
2	Early embryonic development: Metabolic activation, cytoplasmic rearrangement	2
3	Patterns of cleavages and blastulation in Drosophila, sea urchin, frog, chick, mouse and human	4
4	Cell –cell interaction and signaling during morphogenesis in early embryo; Pattern formation	4
5	Fate maps and gastrulation in vertebrate & invertebrate models	5
6	Neurulation and primordial organ rudiments, neural crest cells.	3
7	Molecular mechanisms of animal development (homeotic genes, DNA methylation and epigenetic gene regulation)	3
8	Cellular basis of differentiation, trans-differentiation, metaplasia and regeneration, cell lineages	3
9	Stem cells and their role in development,	1
10	Stem cell self-renewal and pluripotency: molecular mechanisms Cell cycle regulation in stem cells Stem cell niches	6
13	Stem cell lineage tracing	2
14	Isolation, characterization and maintenance of embryonic stem cells, adult stem cells, embryonic germ cells, embryonic carcinoma cells	4
15	Induced pluripotent stem cells	2
16	Hematopoietic stem cells, neuronal stem cells,	2
17	Stem cells in tissue engineering, Gene therapy and therapeutic application of stem cells Neurodegenerative disorders, spinal cord injury, diabetes, burns and orthopedic applications of stem cells	4
18	Genetic Manipulation of stem cells , overview of different methods of introduction of a viz. micronuclear injection method, transduction with recombinant retroviruses, targeted gene insertion, cre-LoxP recombination and production of transgenic animals	5
19	Human cloning and Bioethics	2

References:

1. Development Biology, 9th edition, (2010), Gilbert S.F.(Sinauer Associates, USA)
2. Principles of Development, 4th edition (2010), Wolpert L and Tickle C, Publisher: Oxford University Press, USA.

3. Essentials of Stem Cell Biology, 2nd edition, (2009) Robert Lanza, et al. Elsevier Academic Press, USA
4. Stem cells and the future of regenerative medicine, 1st edition, (2002), National research council and Institute of medicine, National Academic press, Washington DC
5. Molecular Biotechnology: 4th edition. (2010), Glick B.R., Pasternak J.J., Patten C. L., ASM press, USA

BT 406: Agricultural Biotechnology (4C)

Sr. No.	Topic	Lecture (Total 60L)
1	Crop improvement – Advantages of biotechnological methods over conventional methods of crop improvement. a) Homozygous plant production through anther & pollen culture b) Embryo rescue & embryo culture in rearing viable hybrid embryos c) Endosperm culture & production of triploids d) Apomixis e) Induced Polyembryony f) Somaclonal and gametoclonal variations and their applications in crop improvement	15
2	Use of bioreactors in plant production & Scale-up Marker assisted selection – introduction to markers (RFLP, AFLP, microsatellites, RAPD, QTL), generation of maps using markers, case studies of MAS, virus indexing	15
3	Transgenics in crop improvement – stress tolerance, risk assessment w.r.t. high and low impact crops, chloroplast manipulations for production of therapeutic proteins, vaccines, antibodies and increased production), future crops	15
4	Case studies in agro-biotechnology –one each from following crops a) cereal, b) pulse, c) oil seed d) ornamental e) vegetable . Agricultural biotechnology and agribusiness.	15

References:

1. Hou CT, Shaw JF (2009) – Biocatalysis and agricultural biotechnology, CRC Press, USA
2. Agricultural biotechnology, 1st edition, (2008) Rawat H, Oxford Book Co, India.
3. Agrobiotechnology and plant tissue culture, Bhojwani SS, Soh WY, Oxford & IBH Publ, India
4. Agricultural biotechnology, (2005), Kumar HD, Daya Publ House, India
5. Plant molecular breeding, (2009), Newbury HJ, John Wiley and Sons., USA.
6. Embryology of Angiosperms, (2009), S.S. Bhojwani and S.P. Bhatnagar, Vikas Publ House, India.
7. Ashwani Kumar, Shekhawat NS (2009) – Plant tissue culture and molecular markers: their role in improving crop productivity (IK International)
8. Biotechnology, 4th edition, (2010), H K Das, Wiley India Pvt. Limited, India

BT310: Scientific Research and Communication (4C)

Sr. No.	Topic	Lectures (Total 60)
1.	History and Philosophy of science	08
	History of Science- Origin of modern science, Trends in Natural Sciences (Physics, Chemistry and Biology)	2
	Methods of Science, Importance of inquiry in Science, Assumptions and limitations in science	3
	Philosophy of Science- General introduction to Philosophy of Science, The differences in discipline specific philosophies (e.g. how philosophy of biology might differ from that of the physics etc.)	3
2.	Phases of Scientific Enquiry	07
	Problem identification/ beginning of scientific approach Asking the right question, review of literature and referencing	2
	Choosing an appropriate system/s, Design of a study, Observational Studies, Experimental Studies	3
	Data Collection, Data Analysis	2
3.	Types of research methodologies	10
	Formation of a query Methodology of observations Advantages & shortcomings and - explanation with examples	5
	Hypothesis based- Deriving the hypothesis from the study question Intricacies of experimental design Importance of controls in designing an experiment Different types of controls (Positive, negative and internal) Lab based experiments and field based experiments Manipulative & Non manipulative experiments	5

4.	Sampling & Biostatistics	14
	Importance of sampling in research Role of the study design in the choice of sampling technique	4
	Sampling effort in context of statistical analysis, Sampling distributions, Statistical tests for comparison of sample means and sample variance- t-test, non parametric tests, Correlation and Regression, Introduction to multivariate analysis	6
	Mathematical models Simulation as a tool to test these models	4
5.	Research Ethics	7
	Social implications of research, bio-safety issues Animal experimentation ethics, wild-life ethics and human experimentation ethics	5
	Data fudging and plagiarism	2
6.	Scientific Communication	10
	Importance of scientific communication Types of scientific communications Logical organization of scientific data and documentation	2
	Different modes of scientific communication Details of – Proposal writing, Research paper writing, Thesis writing	4
	Oral forms of scientific communication- Popular and Scientific talks, Poster presentations	4
7.	Legal forms of communication of science	4
	Ethics in scientific communication IPR, patent submissions	4

References:

1. **Anthony M. Graziano, Michael L. Raulin**, Research Methods: A Process Of Inquiry (2012) 8th Edition, , *Pearson Publication, Delhi*
2. **Barass Robert**, Scientists Must Write: A Guide to Better Writing for Scientists, Engineers and Students (2002), *Routledge Publication, UK*
3. **Barrow And Tipler**, The Anthropic Principle (1988), *Oxford University Press, Oxford*
4. **David B. Resnik**, The Ethics of Science: An Introduction (1998), *Routledge Publication, UK*
5. **Fisher R A**, The Design of Scientific Experiment (1971) 9th edition, *Collier Macmillan Publishers, London*
6. **Ganguli Prabuddh**, Intellectual Property Rights (2001), *Tata McGraw-Hill Publishing Company Ltd., Delhi*

7. **Jacob Bronowski And Bruce Mazlish**, *The Western Intellectual Tradition* (1960), *Harper & Row, New York*
8. **John D'Angelo**, *Ethics in Science: Ethical Misconduct in Scientific Research* (2012), *CRC Press, USA*
9. **Kuhn Thomas**, *The Structure of Scientific Revolution* (2012) 50th anniversary edition, *Chicago University Press, USA*
10. **Martha Davis**, *Scientific Papers And Presentations* 2nd edition (2004), *Academic Press*
Maynard Smith, J. *The Problems Of Biology* (1986), *Oxford University Press, Oxford*
Maynard Smith, J., *Current Controversies in Evolutionary Biology* (1983), *Cambridge University Press, USA*
11. **Medawar, P. B. And Medawar, J. S.**, *The Life Science: Current Ideas Of Biology* (1977), *Wildwood House, London*
12. **Peter Raven et al**, *Biology* 9th edition (2010), *McGraw-Hill Education, Singapore*
13. **Popper Karl**, *The Logic of Scientific Discovery* (2004), *Routledge Publication, UK*
14. **Richard P. Feynman**, *The Meaning Of It All: Thoughts Of A Citizen-Scientist* (2005), *Basic Books, New York*
15. **Richard P. Feynman**, *The Pleasure Of Finding Things Out: The Best Short Works Of Richard P. Feynman* (1999), Edited By Jeffrey Robbins, *Perseus Books, USA*
16. **Robert A. Day, Barbara Gastel**, *How to Write and Publish a Scientific Paper* 7th edition (2011), *ABC-CLIO, USA*
17. **Robert R. Sokal and F. James Rohlf**, *Introduction to Biostatistics* 2nd edition (2009), *Dover Publication, New York*
18. **Scott, E. C.** *Evolution Vs. Creationism: An Introduction.* (2004), *University of California press, USA*
19. **Smith, Roger**, *The Norton History Of The Human Sciences*, New York: W.W. Norton, 1997. **Strunk, Jr., W. And White, E.B.**, *The Elements of Style* 5th Edition (2003), *Pearson Publication, Delhi*
20. **Wolpert, L.**, *The Unnatural Nature of Science* (1992), *Faber & Faber, London*

BT311: Food Technology and Nutrigenomics (T+P : 3C: 2C + 1C)

Sr. No.	Topic	Lectures (Total 30)
1	Classification of food: Health food, ethnic food, organic food, functional food, nutraceuticals, fabricated foods, convenience foods, GM foods, space foods	2
2	Food Chemistry, Biochemistry and Nutrition: Overview of biomolecules in food products. Carbohydrates: Structure and functional properties of mono- oligo-polysaccharides including starch, cellulose, pectic substances and dietary fibre; Proteins: Classification and structure of proteins in food; Lipids: Classification and structure of lipids, Rancidity of fats, Polymerization and polymorphism; Pigments: Carotenoids, chlorophylls, anthocyanins, tannins and myoglobin; Food flavours: Terpenes, esters, ketones and quinones; Enzymes, Enzymatic and non-enzymatic browning; Nutrition: Balanced diet, Essential amino acids and fatty acids, PER, Water soluble and fat soluble vitamins, Role of minerals in nutrition, Antinutrients, Nutrition deficiency diseases.	5
3	Food Microbiology: Microbial flora of food products Microbial growth in food: Intrinsic and extrinsic factors (in brief). Food spoilage: Contributing factors, Spoilage bacteria, Microbial spoilage of milk and milk products, meat and meat products; Foodborne disease: Toxins produced by Staphylococcus, Clostridium and Aspergillus; Bacterial pathogens: <i>Salmonella</i> , <i>Bacillus</i> , <i>Listeria</i> , <i>Escherichia coli</i> , <i>Shigella</i> , <i>Campylobacter</i> ; Fermented food: Buttermilk, yoghurt, cheese, alcoholic beverage, vinegar, sauerkraut and soya sauce	4
4	Food Products Technology: Processing principles: Canning, chilling, freezing, dehydration, control of water activity, fermentation, hurdle technology, addition of preservatives and food additives, Food packaging, cleaning in place and food laws.; Grain products processing: Milling of rice, wheat, and maize, parboiling of paddy, production of bread, biscuits, extruded products and breakfast cereals, refining and hydrogenation of oil, Extraction, clarification concentration and packaging of fruit juice, Production of jam, jelly, marmalade, squash, candies, and pickles, pectin from fruit waste, tea, coffee, chocolate and essential oils from spices; Milk and milk products processing: Pasteurized and sterilized milk, cream, butter, ghee, ice-cream, cheese and milk powder; Animal products processing: Drying and canning of fish, post mortem changes, tenderization and freezing of meat, egg powder. Food additives Definitions, uses and functions of Acid, Base, Buffer systems, Salts and chelating/sequestering agents, Masticatory substances. Low calorie and non nutritive sweeteners, Polyols. Antioxidants, Emulsifying and stabilizing agents, Anti-caking agents, thickeners, Firming agents. Flour bleaching agents and Bread improvers.	8

	<p>Anti microbial agents / Class I and Class II preservatives as per PFA Act. Colorants, Flavoring agents and related substances, Clarifying agents. Gases and Propellants.</p> <p>Tracers and other additives. Concept of QA,QC,HACCP,ISO. Sensory analysis of food.</p>	
5	<p>Food Engineering: Structure of food and its products. Changes in food structure during preservation and ripening. Texturial Property analysis of food. Rheology and viscosity, pasting properties of wheat and other flour (TPA and RVA analysis). Mixographical study of food. Effect of heat on food (Differential scanning calorimetry). Introduction to concepts of Mass and energy balance, Heat transfer, calorific value. Humidification and dehumidification operations.</p>	3
6	<p>Specialty foods: nutraceuticals, functional foods, neutrigenomics</p> <p>Scope, importance and renewed emphasis on speciality foods, health foods, functional foods.</p> <p>Nutraceuticals, infant and baby foods, adolescent/ teen age foods, foods for pregnant ladies and nursing mothers, geriatric foods. Concept of neutrigenomics</p> <p>Food recommended and restricted in metabolic disorders and disturbances, gastrointestinal disorders; fever and infection; liver, gall, bladder and pancreatic disturbances; blood, circulatory and cardiac diseases; urinary and musculoskeletal diseases; allergies.</p> <p>Nutritional deficiencies and its correction trough fortification and supplementation of foods.Beneficial effect of spices, honey, spirulina etc.</p> <p>Health benefits/ mode of action of PUFA/ gamma linolenic acids, antioxidants, dietary fiber,oligosaccharides, sugar alcohols, peptides and proteins, glycosides, alcohols, iso-prenoides and vitamins, choline, LAB, phenolics, flavonols, minerals and other miner food constitutes asreported in literature. Transgenic plant foods with health claims. Prebiotics and Probiotics.</p>	6
7	<p>Food Engineering: Structure of food and its products. Changes in food structure during preservation and ripening. Texturial Property analysis of food. Rheology and viscosity, pasting properties of wheat and other flour (TPA and RVA analysis). Mixographical study of food. Effect of heat on food (Differential scanning calorimetry). Introduction to concepts of Mass and energy balance, Heat transfer, calorific value. Humidification and dehumidification operations.</p>	3
8	<p>Specialty foods: nutraceuticals, functional foods, neutrigenomics</p> <p>Scope, importance and renewed emphasis on speciality foods, health foods, functional foods.</p> <p>Nutraceuticals, infant and baby foods, adolescent/ teen age foods, foods for pregnant ladies and nursing mothers, geriatric foods. Concept of neutrigenomics</p>	6

	<p>Food recommended and restricted in metabolic disorders and disturbances, gastrointestinal disorders; fever and infection; liver, gall, bladder and pancreatic disturbances; blood, circulatory and cardiac diseases; urinary and musculoskeletal diseases; allergies.</p> <p>Nutritional deficiencies and its correction through fortification and supplementation of foods. Beneficial effect of spices, honey, spirulina etc.</p> <p>Health benefits/ mode of action of PUFA/ gamma linolenic acids, antioxidants, dietary fiber, oligosaccharides, sugar alcohols, peptides and proteins, glycosides, alcohols, iso-prenoids and vitamins, choline, LAB, phenolics, flavonols, minerals and other minor food constituents as reported in literature. Transgenic plant foods with health claims. Prebiotics and Probiotics.</p>	
9	<p>Food legislation and economics: Food standards and Specifications: Compulsory and voluntary trade and Company standards. FDA, US FDA, FPO. Consumer Protection Act (1986) and relevant Food Legislation (Act, orders, standards): PFA(1954), FPI(1955), SWMA, MPO(1977), VCO(1978), AgMark, BIS, US, Canadian, EU, ISO and Codex Food Standards, Export Quality Control and Inspection act (1963), Environment Protection Act (1986), WTO & GATT. Overview of Current status, growth rate and economics of food industry in India.</p>	2

References:

1. **Anthony M. Graziano, Michael L. Raulin**, Research Methods: A Process Of Inquiry (2012) 8th Edition, , *Pearson Publication, Delhi*
2. **Barass Robert**, Scientists Must Write: A Guide to Better Writing for Scientists, Engineers and Students (2002), *Routledge Publication, UK*
3. **Barrow And Tipler**, The Anthropic Principle (1988), *Oxford University Press, Oxford*
4. **David B. Resnik**, The Ethics of Science: An Introduction (1998), *Routledge Publication, UK*
5. **Fisher R A**, The Design of Scientific Experiment (1971) 9th edition, *Collier Macmillan Publishers, London*
6. **Ganguli Prabuddh**, Intellectual Property Rights (2001), *Tata McGraw-Hill Publishing Company Ltd., Delhi*
7. **Jacob Bronowski And Bruce Mazlish**, The Western Intellectual Tradition (1960), *Harper & Row, New York*
8. **John D'Angelo**, Ethics in Science: Ethical Misconduct in Scientific Research (2012), *CRC Press, USA*
9. **Kuhn Thomas**, The Structure of Scientific Revolution (2012) 50th anniversary edition, *Chicago University Press, USA*
10. **Martha Davis**, Scientific Papers And Presentations 2nd edition (2004), *Academic Press*
Maynard Smith, J. The Problems Of Biology (1986), *Oxford University Press, Oxford*
Maynard Smith, J., Current Controversies in Evolutionary Biology (1983), *Cambridge University Press, USA*

11. **Medawar, P. B. And Medawar, J. S.**, The Life Science: Current Ideas Of Biology (1977), *Wildwood House, London*
12. **Peter Raven et al**, Biology 9th edition (2010), *McGraw-Hill Education, Singapore*
13. **Popper Karl**, The Logic of Scientific Discovery (2004), *Routledge Publication, UK*
14. **Richard P. Feynman**, The Meaning Of It All: Thoughts Of A Citizen-Scientist (2005), *Basic Books, New York*
15. **Richard P. Feynman**, The Pleasure Of Finding Things Out: The Best Short Works Of Richard P. Feynman (1999), Edited By Jeffrey Robbins, *Perseus Books, USA*
16. **Robert A. Day, Barbara Gastel**, How to Write and Publish a Scientific Paper 7th edition (2011), *ABC-CLIO, USA*
17. **Robert R. Sokal and F. James Rohlf**, Introduction to Biostatistics 2nd edition (2009), *Dover Publication, New York*
18. **Scott, E. C.** Evolution Vs. Creationism: An Introduction. (2004), *University of California press, USA*
19. **Smith, Roger**, The Norton History Of The Human Sciences, New York: W.W. Norton, 1997. **Strunk, Jr., W. And White, E.B.**, The Elements of Style 5th Edition (2003), *Pearson Publication, Delhi*
20. **Wolpert, L.**, The Unnatural Nature of Science (1992), *Faber & Faber, London*

Practical course:

Sr. No.	Topic	1 Credit (5P X 3H)
1	Food Chemistry, Biochemistry and Nutrition Estimation of ascorbic acid in beverage/juices Determination of water activity of different food materials Determination of adulterant (NaHCO ₃) in wheat flour/ Maida Determination of Gluten content in wheat flour samples	2
2	Food Products Technology: Preparation of pickles/ jam/jelly/marmalades/ confectionary/breads/candies and its preservation and sensory analysis. Enzymatic browning of fruits and vegetables and its control.	1
3	Food Microbiology: Determination of microbiological quality (TPC/SPC) of any food sample: pasteurized and sterilized/ flavored milk/cheese/butter/veg/fruit/bread/meat samples.	1
4	Food Engineering: Study the Texture profile analysis or rheology (TPA/ RVA) of different samples using Texture Analyses (DEMO/ VISIT	1

BT408: Bio-entrepreneurship (2C)

Sr. No.	Topic	Lectures (Total 30)
1	Entrepreneurship in Biotechnology	10
	Integration of Science, technology and business	1
	Basic principles and practices of management- Definition, concepts and application; Organization types, coordination, control and decision making in management	3
	Conceptual framework and characteristics for being an entrepreneur in biotechnology. Case studies of successful and unsuccessful bio-entrepreneurs	3
	Biotechnology: emerging industries with examples from Transgenics, Environmental biotechnology, New drug development, DNA chip technology, Stem cell research, Tissue engineering. Contract Research Organization, marketing consultancy, bio-learning module	3
2	Business development in biotechnology	10
	Factors affecting biotech business: (finance, infrastructure, equipment, manpower , resources , project location, end product, quality issues, etc)	4
	Core concept of Market: Identification and evaluation of market potential of various bio-entrepreneur sectors. Marketing, Marketing research- concept and techniques	3
	Role of government and schemes, financial institutions in fostering bio-entrepreneurship	3
3	Skills in bio-entrepreneurship	6
	Personality and attitude, Organizational behaviour, Leadership	2
	Principles of effective communication- Body language, public speaking, presentations, business proposal writing.	3
	Communication aid and application of technology	1
4	Ethics and IPR in biotech-industries	4
	Fundamentals of ethics in business, Ethical dilemmas in biotech industry	2
	IPR- Introduction, Forms of IPR.	2

References:

1. Commercializing Successful Biomedical Technologies, 2008, Shreefal S. Mehta, Cambridge University Press
2. Handbook Of Bioentrepreneurship, 2008 , Patzelt, Holger; Brenner, Thomas, Springer

3. Entrepreneurship And Business Of Biotechnology, [Prof S N Jogdand](#), Himalaya Publisher
4. Entrepreneurship Development, 2003, S Anil Kumar, New Age International (P) Ltd. Publishers
5. Entrepreneurship For Everyone: A Student Textbook, 2009, Robert Mellor, Sage Publication Ltd1.
6. Exploring Entrepreneurship: Practices and Perspective, 1/e, 27 Jul 2011
Author(s): Richard Blundel & Nigel Lockett **Oxford University Pres**
7. Entrepreneurial Development: Text and Cases,1992- Entrepreneurship Sultan Chand & Sons,