



**NORTH MAHARASHTRA UNIVERSITY,  
JALGAON**

**Science Faculty**

**Syllabi**

**T.Y.B.Sc. BIOTECHNOLOGY**

**(With Effect From, June 2014)**

# North Maharashtra University, Jalgaon

## Syllabus for T.Y.B.Sc. Biotechnology

(With Effect From June 2014)

The revised syllabi for **T.Y.B.Sc. (Biotechnology)** applicable **with effect from June 2014** is assigned with nomenclature - **BT YSC** [Y for year, S for semester and C for course number]. The course Structure and title of the courses for T.Y.B.Sc. (Biotechnology) are given as

Course	Title	Periods	Marks	
			External	Internal
<b>THEORY COURSES SEMESTER I</b>				
BT 311	Genetics	60	40	10
BT 312	Agricultural biotechnology	60	40	10
BT 313	Animal biotechnology	60	40	10
BT 314	Industrial biotechnology	60	40	10
BT 315	Food biotechnology	60	40	10
BT 316	Environmental biotechnology	60	40	10
<b>THEORY COURSES SEMESTER II</b>				
BT 321	Gene biotechnology and bioinformatics	60	40	10
BT 322	Plant biotechnology.	60	40	10
BT 323	Immunology	60	40	10
BT 324	Advanced bioprocess technology	60	40	10
BT 325	Pharmaceutical biotechnology	60	40	10
BT 326	Biodiversity and biometry	60	40	10
<b>PRACTICAL COURSES</b>				
BT 307	Genetics and Agriculture-Plant Biotechnology and Bioinformatics	80	80	20
BT 308	Animal and Industrial Biotechnology and Immunology	80	80	20
BT 309	Food, Environment and Pharmaceutical Biotechnology	80	80	20

### Note

- 1) Each theory course is having weightage of **04** periods (45-50 min each) per week.
- 2) Each practical course is having weightage **04** periods (45-50 min each) per week.
- 3) Each Practical course will be of 100 Marks - 20 Marks for Internal and 80 Marks-For External examination.
- 4) Practical examination will be conducted ANNUALLY i.e. at the end of academic year
- 5) Study/Excursion tour is compulsory for the T.Y.B.Sc students. The students should submit their tour reports at the time of practical examination.

Chairman  
Syllabus drafting Committee

Chairman  
Board of Studies

Dean  
Science Faculty

**North Maharashtra University, Jalgaon**  
**Syllabus for T.Y.B.Sc. Biotechnology**  
**(With Effect From June 2014)**

**Semester I: BT-311 Genetics**

<b>UNIT I: Mendelian and Neo Mendelian Genetics</b>	<b>24 Lectures</b>	<b>18 Marks</b>
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- Mendel and his work
- Phenomenon of dominance (Monohybrid ratio with suitable example), mechanism of dominance
- Law of segregation, phenomenon of segregation (Dihybrid ratio with suitable example)
- Law of independent assortment - Mechanism of independent assortment : back cross and test cross
- Allelic genetic interaction.
- Incomplete dominance, co-dominance, lethal alleles, multiple alleles
- Inter allelic genetic interaction
- Quantitative inheritance (multiple genes)
- Supplementary genes and complementary genes
- Pleiotropy

<b>UNIT II: Linkage and Crossing Over.</b>	<b>19 Lectures</b>	<b>17 Marks</b>
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- Linkages - Concept and theories of linkage  
Types of linkages (complete and incomplete) and significance of linkage.
- Crossing over – Characteristics  
Types of crossing over - simple, double and multiple  
Mechanism/ theories of crossing over
- Sex linked inheritance: Types of sex linkage , X and Y linked inheritance

<b>UNIT IV: Population Genetics</b>	<b>17 Lectures</b>	<b>16 Marks</b>
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- Population, gene pool, mutation, selection
- Hardy-Weinberg law and its significance
- Disorders due to mutant genes: Causes, mechanism, diagnosis and treatment of Phenyl ketone urea, alkaptonuria and sickle cell anemia.

**References**

1. Arora M P (2003). Biotechnology, Himalaya Pub.House, Mumbai.
2. Dubey R C (2006). A Textbook of Biotechnology, S Chand and Co. New Delhi.
3. Gerald Karp (2008). Cell and Molecular Biology: Concepts and Experiments, John Wiley and Sons Inc., New York.
4. Gupta P K (2004). Biotechnology and Genomics, Rastogi Publication, Meerut.
5. Stryer L (2004). Biochemistry, W. H. Freeman and Co. New York.
6. Sundara Rajan (2000), Genetics, Anmol Publications Pvt. Ltd., New Delhi.
7. Verma P S and Agrawal V K (2004), Cell biology, Genetics, Molecular Biology, Evolution and Ecology, S Chand and Co. New Delhi.
8. Sayyed et al (2014), Text book of Biotechnology BT 311-313, Prashant publication, Jalgaon

## Semester I : BT-312: Agricultural Biotechnology

<b>UNIT I : Agriculture Biotechnology</b>	<b>24 Lectures</b>	<b>18 Marks</b>
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- Symbiotic nitrogen fixation - Legume, *Rhizobium* symbiosis, host specificity, infection, nodule development, mechanism of nitrogen fixation, Nif genes, dinitrogenase complex
- Non-symbiotic nitrogen fixation - Diazotrophy, sites of nitrogen fixation, *Cyanobacteria*, *Azotobacter*, *Azospirillum*.
- Phytohormones - Definition, classification, physiological effects, Functions of auxin, cytokinin, gibberellins.
- Assimilation of sulphur and phosphorus by plants
- Concept and types of biofertilizer.  
Microbial Inoculum - *Rhizobium* Inoculant, Blue-Green algae, *Azotobacter*, Sulphur and phosphate solubilizing biofertilizer.
- Applications of biofertilizer.

<b>UNIT II : Plant pathology</b>	<b>19 Lectures</b>	<b>17 Marks</b>
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- Concept of plant pathology.
- Classification of plant diseases based on symptoms.
- Plant diseases - Causative agent, symptoms, pathogenesis, transmission and control of  
i) Bacterial blight of cotton and ii) Whip smut of sugar cane
- Chemical and biological control methods

<b>UNIT III : Agro-Biotechnology.</b>	<b>17 Lectures</b>	<b>15 Marks</b>
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- Single cell protein and its nutritive value e.g. *Spirulina*
- Mushroom production.
- Bio-pesticides- Definition and types (microbial and botanical)
- Advantages of biopesticides over chemical pesticides.
- Bio-Processing technologies : Agricultural biotech products in the market.

### References

1. Bilgrami K.S and Dube H.G.(1994), Textbook of Modern Plant Pathology,Vikas Publications, New Delhi.
2. Gupta P.K. (1998), Genetics and Biotechnology in Crop Improvement,Rastogi Publications, Meerut.
3. Pathak V.N,Khatri N.K.,Pathak M.(1996), Fundamentals of Plant Pathology,Agrobotanical Publications,Bikaner.
4. Powar C.B., Dagainawala H.F., (1990), General Microbiology,Vol. II,Himalaya Publishing House,Mumbai.
5. Purohit S.S.(2002),Agricultural Biotechnology,Agrobios India, Jodhpur.
6. Satyanarayana U. (2007), Biotechnology, Books and Allied Pvt. Ltd. Kolkata.Vyas S. C., Vyas S., Vyas S., and Modi H. A. (1998), Biofertilizer and Organic Farming, Akta Prakashan, Nadiad, G.S, Meerut.
7. Sayyed et al (2014), Text book of Biotechnology BT 311-313, Prashant publication, Jalgaon

## Semester I : BT 313 Animal Biotechnology

<b>UNIT I : Introduction to Animal Cell and Tissue Culture.</b>	<b>24 Lectures</b>	<b>18 Marks</b>
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- History and scope of animal cell and tissue culture.
- Principle, merits and demerits of animal cell/tissue culture
- Laboratory facilities for Animal tissue culture.
- Culture media : a) Natural media b) Defined media.
- Primary and established cell lines and their characterization
- Primary culture, cultured cells and evolution of cell lines and their maintenance.
- Large scale cultivation of mammalian cell.
- Applications of animal cell culture to human health, medical and therapeutic purposes
- Pharmaceutical products of animal cell culture
- In-vitro culture of oocytes and embryo

<b>UNIT II : Transgenic Animals and Cloning</b>	<b>19 Lectures</b>	<b>17 Marks</b>
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- Cell transformation - In vitro culture of oocytes/ embryos,
- Cell/embryo cryopreservation,
- Measurement of cell death - Apoptosis,
- Animal cloning: Principle and methods with suitable example.
- Risks and safety in the animal cell culture.

<b>UNIT III: Molecular Analysis of Diseases &amp; Gene Therapy</b>	<b>17 Lectures</b>	<b>15 Marks</b>
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- Introduction to transgenic laboratory animals.
- Principles and methods of development of transgenic animals
- DNA microinjection.
- Embryogenic stem cell transfer.
- Economics aspects of transgenic animals.
- Ethical issues: Animal welfare and animal rights

### References

1. Arora M.P. (2003), Biotechnology, Himalaya Publishing House, Mumbai.
2. Freshney R. Ian (2006), Culture of Animal Cells : A Manual of Basic Techniques, John Wiley and Sons, Inc., New York.
3. Gangal Sudha (2007), Principles and Practice of Animal Tissue Culture, Universities Press India Pvt. Ltd.
4. Gupta P.K (2004), Biotechnology and Genomics, Rastogi Publication Meerut.
5. Ignacimuthu S (1995), Basic Biotechnology, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
6. Purohit S.S. (2002), Agricultural Biotechnology, Agrobios India, Jodhpur.
7. Satyanarayana U. (2007), Biotechnology, Books and Allied Pvt. Ltd. Kolkata.
8. Sayyed et al (2014), Text book of Biotechnology BT 311-313, Prashant publication, Jalgaon.

## Semester I: BT 314 - Industrial Biotechnology

<b>UNIT I : Bioprocess Technology</b>	<b>24 Lectures</b>	<b>18 Marks</b>
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- Selection of mutants -producing improved level of primary metabolites with suitable example.
  - which do not produce feedback inhibitors or repressors.
  - which do not recognize presence of inhibitors or repressors.
- Modification of permeability.
- Fermentation processes with respect to - Microorganisms involved, inoculum preparation, medium used, fermentation process, recovery of  
Enzyme - Amylase,  
Organic acid - Citric acid  
Antibiotic - Penicillin  
Vitamin - Vitamin B<sub>12</sub>

<b>UNIT II : Down stream processing.</b>	<b>19 Lectures</b>	<b>17 Marks</b>
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- Removal and recovery of cell mass (precipitation, filtration and centrifugation.)
- Cell disruption - Physical and chemical methods
- Purification of product by using  
Liquid-liquid extraction : Solvent recovery  
Chromatography : Adsorption, ion-exchange, HPLC  
Membrane processes: Ultrafiltration and reverse osmosis.  
Drying and crystallization.

<b>UNIT III: Quality control, process economics and GLP.</b>	<b>17 Lectures</b>	<b>15 Marks</b>
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- Sterility testing.
- Pyrogen testing.
- Carcinogenicity testing.
- Toxicity testing
- Fermentation economics: Cost estimates, capital cost estimates, operating cost estimates.  
process design
- Good Laboratory Practices (GLP).

### References

1. Casida L.E (1991), Industrial Microbiology, Wiley Eastern, New Delhi.
2. Cruieger W and Cruieger A (2000), Biotechnology: A Textbook of Industrial Microbiology, 2nd Edi. Panima Publishing Corporation, New Delhi.
3. Patel A.H. (2004), Industrial Microbiology, Macmillan India Ltd.,New Delhi.
4. Peppler H.J and Perlman D (2006), Microbial Technology, Vol I and II,Academic Press,New York.
5. Parihar Pradeep (2007), A textbook of Biotechnology, Student edition, Jodhpur.
6. Stanbury P.F., Whitaker A. and Hall S.J (1997), Principles of Fermentation Technology, Aditya Books Pub., Ltd., New Delhi.
7. Satyanarayana U. (2007), Biotechnology, Books and Allied Pvt.Ltd. Kolkata.
8. Syyed et al (2014), Text book of Biotechnology BT 314-316, Prashant publication, Jalgaon.

## Semester I : BT 315 - Food Biotechnology

<b>UNIT I : Food and Dairy Biotechnology</b>	<b>24 Lectures</b>	<b>18 Marks</b>
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- Primary sources of microorganisms in food.
- Food borne Bacteria/ Microbes in food – Bacteria, Molds and Yeasts.
- Intrinsic and extrinsic factors affecting food microflora.
- Bacterial toxin: Botulism and Staphylococcal toxin.
- Fungal Toxin: Aflatoxin.
- Milk - Definition, composition and types.
- Fermented milk products - Yoghurt and cheese.
- Preservation of milk by heat treatment (Pasteurization and ultra high temperature)
- Physicochemical characterization of milk.
- Microbiological tests : MBRT and Resazurin test

<b>UNIT II: Aspects of Food Production.</b>	<b>19 Lectures</b>	<b>17 Marks</b>
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- Food safety - HACCP system to food protection, responsibility for food safety.
- Food additives - Definition, types and functional characteristics.
- Natural colors : Types, applications, advantages of natural colours over artificial colors.
- Sweeteners - Types and applications.
- Fermented food - Idli and Bread (process, microbiology involved, changes during fermentation and nutritive value)

<b>UNIT III: Food Spoilage and Preservation.</b>	<b>17 Lectures</b>	<b>15 Marks</b>
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- Causes of food spoilage.
- Spoilage of fruits, vegetables, meat, poultry products (eggs), dairy products (milk).
- Food preservation –
  - a) Chemical methods - Acids, salts, sugars, antibiotics, ethylene oxide, antioxidants.
  - b) Physical methods - Radiations, low and high temperature and drying.

### References :

1. Adam M.R and Moss M.O (2003), Food Microbiology, New Age International Pub.New Delhi.
2. Frazier W.C and Westhoff D.C (2005), Food Microbiology, 4<sup>th</sup> Edi., Tata Mc Graw Hill Pub Company Ltd.New Delhi.
3. Harrigan W. F (1998), Laboratory methods in Food Microbiology, 3rd Edi. Academic Press.New York.
4. Jay J.M. (1992), Modern Food Microbiology, 4<sup>th</sup> Ed. Chapman and Hall, New York ,NY, USA.
5. K.Vijaya Ramesh(2007), Food Microbiology, MJP Publishers, Chennai.
6. Powar C.B and Dagainawala H.F(2003), General Microbiology, Vol. II, Himalaya Pub.House, Mumbai.
7. Sivsankar B (2002), Food Processing and Preservation, Prentice Hall of India Pvt.Ltd. New Delhi.
8. Sayyed et al (2014), Text book of Biotechnology BT 314-316, Prashant publication, Jalgaon.

## Semester I : BT 316 - Environmental Biotechnology

<b>UNIT I: Waste Water Treatment.</b>	<b>24 Lectures</b>	<b>18 Marks</b>
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- Domestic waste water treatments - Introduction and concept
- Important microorganisms and their role in waste water treatment
- Principles of growth of micro-organisms involved in waste water treatment.
- Plasmid borne metabolic activities of microbes.
- Types of waste water treatment - Preliminary, primary, secondary and tertiary
- a) Aerobic biological treatments - Activated sludge process Rotating Biological Contactors
- b) Anaerobic biological treatments-Packed Bed Reactor(PBR), Anaerobic Contact Digester

<b>UNIT II: Biodegradation and Bioremediation Techniques</b>	<b>19 Lectures</b>	<b>17 Marks</b>
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- Biodegradation - Definition and concept, biodegradable organic pollutants.
- Measurement of biodegradation - Ready, ultimate and inherent biodegradation
- Biodegradation of hydrocarbon with suitable example
- Bioremediation –Concept
- Methods of bioremediation (*In-situ* and *Ex-situ* Methods)
- Bioremediation of soil – Bioremediation of saline and alkaline soil
- Phytoremediation - Concept and types.
- Applications of bioremediation.

<b>UNIT III: Xenobiotics</b>	<b>17 Lectures</b>	<b>15 Marks</b>
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- Xenobiotics and recalcitrants – Definitions and characteristics
- Xenobiotics degradation - Pesticide degradation (Principle with suitable example)
- Herbicide degradation (principle with suitable example)
- Metabolism of xenobiotics - Cytochrome P<sub>450</sub> system, phase I, phase II,
- Metabolic reactions

### References

1. Asthana D.K. and Asthana M.(2001),Environment : Problems and Solutions, S.Chand and Company Ltd, New Delhi.
2. Mohapatra P. K. (2006), Textbook of environmental Biotechnology, IK international, New Delhi
3. Chatterji A.K.(2002),Introduction to Environmental Biotechnology, Prentice Hall of India Pvt. Ltd, New Delhi.
4. Evan G.M.and Furlong J.C (2003), Environmental Biotechnology: Theory and Applications, John Wiley and Sons Ltd., England.
5. Gupta P.K. (2004), Biotechnology and Genomics, RastogiPublication, Meerut.
6. Jogdand S.N.(2006), Environmental Biotechnology,3<sup>rd</sup> Edi., Himalaya Publishing House, Mumbai
7. Kalaichelvan P.T., I Arul Pandi (2007), Bioprocess Technology, MJP Publishers, Chennai.
8. Murugesan A. G.andRajakumari C (2005), Environmental Science and Biotechnology: Theory and Techniques, MJP Publishers, Chennai.
9. Rittmann B. E. And McCarty P. L. (2001), Environmental Biotechnology Principles And Applications, McGraw Hill, USA.
10. Sayyed et al (2014), Text book of Biotechnology BT 314-316, Prashant publication, Jalgaon.



## Semester II : BT 321. Gene Biotechnology and Bioinformatics

### Unit – I Genetic code

24 Lectures

18 Marks

- Gene regulation – Tryptophan operon
- Mutation: Definition, types – Random and directed mutation
- Genetic suppression: Intergenic and Intragenic
- The decoding system: aminoacyl synthetases, brief structure of tRNA, the adaptor hypothesis, attachment of amino acids to t-RNA.
- Codon-anticodon interaction - the wobble hypothesis. Selection of initiation codon - Shine and Dalgarno sequence and the 16S rRNA.

### Unit – II Gene Biotechnology and rDNA Technology

19 Lectures

17 Marks

- Techniques in rDNA technology – DNA sequencing by Maxam and Gilbert method
- Blotting techniques – Southern, Northern and Dot blotting
- a) Tools of genetic engineering a) PCR – Types and applications b) RFLP, RAPD, SNPs
- DNA fingerprinting – Methods and applications
- DNA cloning: Basics of genetic engineering, restriction endonucleases, other enzymes of DNA manipulation.
- Vectors: Plasmid vectors (pBR322 and pUC 18/19)
- Phage vector: Lambda replacement and insertion vectors Cosmids, phagmids.
- Cutting and joining DNA (cohesive end ligation, methods of blunt end ligation).

### UNIT III: Bioinformatics.

17 Lectures

15 Marks

- Bioinformatics – Definition, history and scope of bioinformatics
- Definition and classification of databases (primary and secondary)
- Bioinformatics and internet.
- Searching for gene and amino acid sequence on Internet -BLAST.
- DNA sequence databases (Gene Bank, EMBL, DDBJ), NCBI

### References

1. Arora M.P (2003), Biotechnology, Himalaya Publishing House, Mumbai.
2. Clavene J.M and Notredame C (2003), Bioinformatics: A Beginner's Guide, Wiley-Dreamtech India Pvt.ltd., New Delhi.
3. Jogdand S.N (2006), Gene Biotechnology, Himalaya Publishing House, Mumbai.
4. Joshi P (2002), Genetic Engineering and its applications, Agrobios Pub, Jodhpur.
5. Mitra Sandhya (2006), genetic Engineering, MacMillan India Ltd, Delhi.
6. Rashidi H.H and Buahler L.K (2000), Bioinformatics : Applications in Biological Science and Medicine, CRC Press, USA.
7. Satyanarayana U. (2007), Biotechnology, Books and Allied Pvt. Ltd. Kolkata.
8. Dubey R.C (2006), A Text Book of Biotechnology, S. Chand and Co. Ltd, New Delhi.
9. Sayyed et al (2014), Text book of Biotechnology BT 321-323, Prashant publication, Jalgaon.

## Semester II : BT 322 - Plant Biotechnology

<b>UNIT I: Introduction to Plant Tissue Culture and Techniques.</b>	<b>24 Lectures</b>	<b>18 Marks</b>
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- Totipotency- Definition and concept.
- Laboratory organization of PTC.
- Designing of culture media for PTC.
- Aseptic techniques of PTC.
- Principle, methodology and application of callus and meristem culture.
- Organ Culture: Root culture, anther culture and pollen culture.
- Somatic embryogenesis, protoplast culture.

<b>UNIT II: Transgenic plants</b>	<b>19 Lectures</b>	<b>17 Marks</b>
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- Transgenic plants - History and concept
- Methods of developing transgenic plants - Electroporation, microinjection, particle bombardment, liposome mediated gene transfer.
- *Agrobacterium* mediated gene transfer vectors- Ti plasmid, transformation technique.
- Analysis of transgenic plant material - Marker Gene Selectable method
- Applications of transgenic Plants -
  - a) Herbicide resistance (Glyphosphate and Atrazine)
  - b) Resistance against insects and pests (Bt endotoxin and protease inhibitor)

<b>UNIT III: Horticulture and floriculture biotechnology</b>	<b>17 Lectures</b>	<b>15 Marks</b>
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- Concept of horticulture.
- Use of biotechnology in horticulture and floriculture.
- Techniques in horticulture
- Green house management.

### References

1. Bhojwani S. S. and Razdan M.K. (1983) Plant tissue culture theory and practice, Elsevier Science Pub., Amsterdam.
2. De K.K.,(1998) An introduction to Plant Tissue Culture, New central book agency Pvt.Ltd.,Calcutta.
3. Gupta P.K. (1998), Genetics and Biotechnology in Crop Improvement, Rastogi Publications, Meerut.
4. Laurie A and Ries V.H. (2004),Floriculture-Fundamentals and Practices, Agrobios India, Jodhpur.
5. Purohit S.S. (2002),Agricultural Biotechnology, Agrobios India, Jodhpur.
6. Ramawat K.G (2004), Plant Biotechnology, S. Chand and Company Ltd., New Delhi.
7. Satyanarayana U. (2007), Biotechnology, Books and Allied Pvt. Ltd. Kolkata.
8. Sayyed R.Z and Patil A.S. (2009), Biotechnology: Emerging Trends, Scientific Publishers, Jodhpur.
9. Sayyed et al (2014), Text book of Biotechnology BT 321-323, Prashant publication, Jalgaon.

## Semester II: BT 323 -Immunology

<b>UNIT I: Immune system and immune response.</b>	<b>24 Lectures</b>	<b>18 Marks</b>
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- Blood cells - Morphology, formation and functions.
- Primary and secondary lymphoid organs – Morphology and functions.
- Concept of immunity – Innate and acquired immunity
- MHC restriction
- Immune response – Primary and secondary
- Humoral immune response / Ab mediated immunity (AMI) – Mechanism
- Cellular immune response / Cell mediated immunity (CMI) - Mechanism
- Other protective mechanisms –
  - a) Complement System: Classical and alternative pathway.
  - b) Inflammation – Mechanism and types – Acute and chronic
  - c) INF and TNF

<b>UNIT II: Immunological techniques.</b>	<b>19 Lectures</b>	<b>17 Marks</b>
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- Ag-Ab interactions – Stages in Ag-Ab reaction, Ab specificity, cross reaction, precipitation, agglutination
- Ag-Ab techniques – Principles, methods and applications of following RIA, ELISA, Immunofluorescence, and Fluorescence activated cell sorter technique. immunoelectrophoresis
- Monoclonal Antibodies: Production (Hybridoma Technology) and applications

<b>UNIT III: Immuno-prophylaxis.</b>	<b>17 Lectures</b>	<b>15 Marks</b>
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- Immunosuppression – General and specific immunosuppressive therapy.
- Active immunization – Vaccines - Types – One example, genetically engineered vaccines.
- Passive immunization - Immune-sera., antitoxin sera : Types and one example.
- Immunization Schedule.
- Immunodeficiency disorder: Cancer of immune system such as Leukemia.
- Immune pharmacology: Nonsteroidal anti-inflammatory drugs and glucocorticoids.

### References

1. Ananthnarayan P., Paniker C.K.J (1990), Textbook of Microbiology, Orient Longman Pub., Madras.
2. Arora M. P. (2003), Biotechnology, Himalaya Publishing House Mumbai.
3. Coleman R.M., Lombard M.F., Sicard R.E.(1989), Fundamental Immunology, 2<sup>nd</sup> edi., W. C. Brown Publishers, USA.
4. Glazier A.M., Nikaido H (1995), Microbial Biotechnology, W. H. Freeman & Co., New York.
5. Kimball J.W.(1990), Introduction to Immunology, Macmillan Publishing Co. New York.
6. Roitt E.M.(1988), Essential Immunology, ELBS, Blackwell Sci. Publ., Oxford, London.
7. Kuby J.W.H.(1994), Immunology, W.H. Freeman and Co., New York.
8. Satyanarayana U. (2007), Biotechnology, Books and Allied Pvt. Ltd. Kolkata.
9. Gerd-Rudiger Burmester and Antonio Pezzutto, (2003), Color Atlas of Immunology, Thieme Stuttgart, New York.
10. Sayyed et al (2014), Text book of Biotechnology BT 321-323, Prashant publication, Jalgaon.

## Semester II - BT 324 - Advanced Bioprocess Technology

<b>UNIT I: Biotransformation, bioleaching and enzyme technology.</b>	<b>24 Lectures</b>	<b>18 Marks</b>
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- Biotransformation: Concept and types of biotransformation reactions.
- Steroid and antibiotic biotransformation : Applications in pharmaceutical industry.
- Biosorption: Definition, mechanism, bio-sorbent, applications of biosorption.
- Bioleaching of metal: Concept, microorganisms involved ,
- Mechanism of leaching and methods of leaching.
- Advantages and limitations of microbial leaching.
- Commercial leaching process using bacteria- Copper leaching
- Immobilization of enzyme: Methods of immobilization.
- Commercial applications of immobilized enzyme.

<b>UNIT III: Biofuels</b>	<b>19 Lectures</b>	<b>17 Marks</b>
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- Production of biofuels :
  - a) Biogas : Interactions between various microbial groups, biogas plant design, biogas production mechanism.
  - b) Hydrogen: Biohydrogen, fermentative production of hydrogen, photo fermentation, biophotolysis.
  - c) Methane: Methanogens, mechanism of methane production
  - d) Ethanol- Microbes, production and recovery
- Conversion of agricultural biomass to biofuels

<b>UNIT III: Patenting Biotechnology and Intellectual property rights.</b>	<b>17 Lectures</b>	<b>15 Marks</b>
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- Intellectual Property Rights (IPR).
- Introduction to Patent, steps involved in filling, trade secret,
- Copy rights and trade mark.
- Introduction to - GATT (General Agreement of Tariff and Trades) and TRIP (Trade Related Intellectual Property)
- Patenting of microorganisms, transgenic organisms, higher plants and higher animals.

### References

1. Bu'llock J and Kristiansen B.(1987),Basic Biotechnology, Academic Press, London.
2. Dubey R.C (2006), A Text Book of Biotechnology, S. Chand and Co. Ltd, New Delhi.
3. Gupta P. K. (2004) Biotechnology and Genomics, Meerut Publication.
4. Jogdand S.N (2006), Industrial Biotechnology, Himalaya Pub House, Mumbai.
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7. Satyanarayana U. (2007), Biotechnology, Books and Allied Pvt. Ltd. Kolkata.
8. Vyas S. P. and Kohli D.V.(2002), Methods in Biotechnology, Bioengineering CBS Pub and Distributors, New Delhi.
9. Sayyed et al (2014), Text book of Biotechnology BT 324-326, Prashant publication, Jalgaon.

## Semester II : BT 325 - Pharmaceutical Biotechnology

<b>UNIT I : Secondary Metabolites of Plants &amp; antimicrobial therapy</b>	<b>24 Lectures</b>	<b>18 Marks</b>
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- Introduction and types of secondary metabolites.
- Production of secondary metabolites in plants through hairy root culture.
- Factors affecting secondary metabolite production (precursors, growth factors, and nutrients)
- Types of antibiotics based on their mode of action (example of each class)
- Mechanism of action of antimicrobial agent (General account)
- Bacterial resistance to antibiotics (Types and mechanism)
- Application of antibiotics in various fields.
- Assaying antimicrobial activity: Principle and methods of microbial assay - MIC, MFC and different types of agar diffusion

<b>UNIT II: Protein Engineering and Chemotherapeutics Agents.</b>	<b>19 Lectures</b>	<b>17 Marks</b>
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- Structure, mechanism of action and applications of -
  - a) Antibacterial drug: Sulfonamides and aminoglycosides
  - b) Antiviral drug: Amantadine and azidothymidine.
  - c) Antifungal drug: Nystatin and griseofulvin.
  - d) Antiprotozoal drug: Quinolones

<b>UNIT IV: Drug Discovery, Designing and Delivery</b>	<b>17 Lectures</b>	<b>15 Marks</b>
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- Protein engineering: Principles and applications.
- Introduction to Indian and international pharmacopoeia.
- Drug Discovery: Molecular biology and combinatorial drug discovery.
- Drug designing: Introduction, computer aided drug designing, approaches for rational designing of drug.
- Drug delivery: Advantages, disadvantages and applications of liposome drug delivery system.

### References

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3. Jogdand S.N (2004), Medical Biotechnology, Himalaya Publishing House, Mumbai.
4. Jogdand S.N (2008), Biopharmaceuticals, Himalaya Publishing House, Mumbai.
5. Parihar Pradeep (2007), A textbook of Biotechnology, Student edition, Jodhpur.
6. Purohit S. S. (1999), Agricultural Biotechnology 2<sup>nd</sup> edi. Agrobios India Pvt. Ltd. Jodhpur. botanica Bikaner.
7. Ramawat K.G;Merillon J.M (2003) Biotechnology: Secondary Metabolites, Oxford and IBH Pub.Co. Pvt. Ltd, New Delhi.
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## Semester II BT 326- Biodiversity and Biometry

<b>Unit I: Taxonomy and Biodiversity</b>	<b>24 Lectures</b>	<b>18 Marks</b>
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- Evolutionary classification, taxonomic hierarchy, concept of species
- Numerical taxonomy: Dendrogram and Cladogram.
- Chemotaxonomy: Nomenclature with respect to animals, plants and prokaryotes (with suitable example)
- Molecular taxonomy
- Biodiversity: Concept and significance
- Species diversity, Genetic diversity and ecosystem diversity
- Hot spots of biodiversity
- Red data book and endangered species
- Conservation of biodiversity (In-situ and ex-situ methods, principle and applications)

<b>UNIT II: Bioprospecting</b>	<b>19 Lectures</b>	<b>17 Marks</b>
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- Concept and examples of bio-indicators (plant, microbes, protozoa and earthworm)
- Concept of Biomonitoring.
  - a) Biomonitoring of aquatic environment.
  - b) Biomonitoring of air quality.
- Principles and applications of biosensors in environment analysis
- Vermitechnology and use of bio-plastic

<b>UNIT IV: Biostatistics and Biometry.</b>	<b>17 Lectures</b>	<b>15 Marks</b>
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- Samples and population, techniques of sampling
- Measures of central tendency : Arithmetic, Harmonic, Geometric Mean, Mode and Median.
- Measures of dispersion : Definition, Range, Variance, Standard Deviation, Coefficient of Variation,
- Skewness and Kurtosis, correlation and regression.

### References

1. Agrawal K. C. (1996), Biodiversity, Agro. Botanica, Bikaner.
2. Arora M. P. (2003). Biotechnology, Himalaya Publishing House, Mumbai
3. Arora P. N. and Malhan P. K. (2006) Biostatistics, Himalaya Publishing House, Mumbai.
4. ChakrobortySupriyo, (2006) Biodiversity, Pointer Publishers, India.
5. Dubey R.C. (2005) A textbook Of Biotechnology, S. Chand and Co. Ltd. New Delhi.
6. Gurumani N. (2005), An Introduction to Biostatistics 2<sup>nd</sup> Edi.MJP Publishers, Chennai
7. Jogdand S. N.(2006) Environmental biotechnology (Industrial Pollution Management), 3<sup>rd</sup> Edition, Himalaya Publishing House, Mumbai.
8. Modi H.A., (1996), Elementary Microbiology, Vol. II, Akta Prakashan, Nadiad.
9. Ratledge C. and Kristiansen B. (2001), Basic Biotechnology, 2<sup>nd</sup> Edition, Cambridge, University Press.
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## Practical Courses

### BT 307 – Genetics, Plant Biotechnology and Bioinformatics

Sr. No.	Title of practical
1	Monohybrid and Dihybrid crosses in <i>Pea/Drosophila</i> demonstrating Mendel's law of inheritance.
2	Problems set in Mendelian inheritance, single point, two point crosses and gene mapping in bacteria
3	Study of conjugation in bacteria
4	Development of competent cell system and study of transformation in bacteria
5	Isolation of DNA from <i>E. coli</i>
6	Study of stomatal physiology
7	Isolation and identification of <i>Xanthomonas citri</i> from infected citrus fruit or leaf.
8	Isolation of <i>Rhizobium sp.</i> from root nodule of leguminous plant.
9	Preparation and applications of biofertilizer
10	Determination of IAA oxidase activity
11	Demonstration of various domains (search engines) for bioinformatics through internet
12	Concept of databases: Accessing database
13	Searching for gene and protein sequences and accessing information from web
14	Preparation of plant tissue culture explant and its sterilization
15	Preparation of stock solutions of plant tissue culture media
16	Preparation of plant tissue culture media
17	Shoot tip culture in banana OR Any one plant of medicinal importance.
18	Visit to cell culture facilities /production / biofertilizer industry

## BT 308. Animal and Industrial Biotechnology and Immunology

Sr. No.	Title of practical
1	Animal cell culture media preparation, sterilization, washing and packing
2	Observation and identification of different cell types in peripheral blood
3	Preparation, sterilization, washing and packing of animal cell culture
4	Fermentative production of antibiotics/ vitamins
5	Fermentative production of enzyme (Amylase)
6	Fermentative production of alcohol using <i>Sacharomyces cerevisiae</i>
7	Fermentative production of organic acid (Citric acid)
8	Estimation of fermentative product (Acetic acid from vinegar)
9	Estimation of ascorbic acid from given food sample/fermented broth by titrimetric method
10	Estimation of penicillin/streptomycin by chemical assay
11	Estimation of penicillin/streptomycin by biological assay
12	Preparation of Saurkaut by microorganisms
13	Survival curve of bacteria against UV radiations and chemical mutagens
13	Study of nucleic acid separation by Agarose Gel Electrophoresis
14	Study of Immuno-Diffusion by Ouchterlony Double Diffusion technique
15	Detection of antigen, antibody reaction by ELISA tests
16	Study of agglutination reaction and its significance performing Widal test
17	Immobilization of whole cell (yeast) in calcium alginate
18	Visit to Animal/plant tissue culture laboratory/fermentation industry/Diagnostic laboratory



## BT 309 : Food, Environment and Pharmaceutical Biotechnology

Sr.No	Title of practical
1	Isolation and characterization of food fermenting organism from idli batter
2	Analysis of mycotoxin (Aflatoxin) in fungus contaminated food material
3	Microscopic examination of food/milk by breed method
4	Estimation of lactose from milk
5	Quality checking of milk - MBRT method
6	Evaluation of Pasteurization of milk - Phosphatase test
7	Detection of microbial count in milk by SPC method
8	Sterility testing of pharmaceutical products (Ophthalmic solution)
8	Determination of Biological Oxygen Demand (BOD) of polluted water
9	Determination of Chemical Oxygen Demand (COD) of polluted water
10	Estimation of cellulose from composting/plant wood material
11	Detection of potability of water - MPN test
12	Determination of alkalinity and hardness of water
13	Determination of total carbohydrates and phosphorus of soil
14	Demonstration of total nitrogen estimation by Kjeldahl's method
15	Sterility testing of injectable as per IP
16	Determination of Minimum Inhibitory Concentration (MIC) of Antibiotic
17	Evaluation of antimicrobial activity of chemical agent
18	Visit to food/fermentation /pharmaceutical industry

### References

- 1) Aneja K.R. (1998), Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom cultivation, Vishwa Prakashan, New age international (p) Ltd., New Delhi.
- 2) Dubey R.C. and Maheshwari D.K. 2004, Practical Microbiology, S.Chand and Co. Delhi.
- 3) Gaud R.S. (2000), Practical biotechnology, Nirali Prakashan.
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- 5) Jayararnan, I (1981) Laboratory Manual in Biochemistry, Wiley Eastern Ltd., New Delhi.
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- 2) Sadashivam S. and Manickam A. (1996), Biochemical Methods, 2<sup>nd</sup> Edi. New Age International, N. Delhi.
- 3) Schmauder Hans Peter (1997), Methods in Biotechnology, Taylor and Francis, London.
- 4) Schuler M. A. and Zielinski R. E. (1989), method in plant molecular biology
- 5) Sharma Kanika, Manual of Microbiology Tools & techniques, 2nd Ed. (2007), Ane's Book India
- 6) Sharma P.K and Dandiya P.C (2004), Pharmaceutical Biochemistry: Theory & Practical, Vallabh Prakashan, Delhi
- 7) Thimmaiah S.K (2006), Standard Methods of Biochemical Analysis, Kalyani Publishers, New Delhi.
- 8) Vyas S.P. and Kohli D.V. (2002), Methods in Biotechnology and Bioengineering, CBS Publishers and Distributors, New Delhi.

## Skills to be acquired

During study of this course a student is expected to acquire/learn skills related to following aspects of biotechnology

- 1) **Molecular biology skills** – like conjugation, transformation, isolation of DNA and protein and nucleic acid separation by electrophoresis
- 2) **Immuno-biotechnology skills** – like Immuno-diffusion, qualitative and quantitative estimation of antigen/antibody
- 3) **Microbiological skills** – like isolation, enumeration and identification of bacteria, biological assay of antibiotics and chemicals
- 4) **Health biotechnology skills** – like detection of potability of water - MPN test, determination of BOD.
- 5) **Applied and agriculture skills** – like isolation and identification of plant pathogens and useful soil microbes and preparation of biofertilizers.
- 6) **Food and dairy biotechnology skills** – like Isolation of idli and other food fermenting, detection of mycotoxin, microscopic examination of food/milk, Quality checking of milk
- 7) **Tissue culture skills** – like techniques for preparation of animal and plant cell culture, microscopic examination of cell types and cell culture propagation of important and medicinal plant.
- 8) **Biochemistry and fermentation skills** – like determination / estimation of MIC of Antibiotic/chemical, concentration of antibiotic and organic acid, microbiological checking of pharmaceutical products. Skill to design the laboratory process for fermentative production of organic acids, antibiotics, vitamins, alcohol etc.
- 9) **Soil Science skills** - Determination of soil pH, alkalinity and hardness of water and total organic carbon, total carbohydrates, phosphorus and nitrogen.
- 10) **Bioinformatics** – Skill of accessing database and searching for gene and protein sequences

## Job prospectus after completing this course

**Employment** - A Biotechnology graduate can get has ample opportunities in various fields can get positions as Technologist, Scientist, Executive, Officer, Assistant manager, Deputy Manager and Manage, Head in Production units, Quality control Units, Research and development Units in following sectors -

- 1) **Food and dairy Sector** –for checking the quality of food/milk, for developing the process for consumer needed products or their quality.
- 2) **Industrial Biotechnology Sector-** For monitoring, regulating and developing, quality controlling of fermentation process for enzymes, amino acids, vitamins, antibiotics, organic acids, and alcohols production
- 3) **Pharmaceutical biotechnology sector-** For microbial testing and validation of drug, prevention of risks of contamination, toxins, pyrogens etc. Quality assurance, environmental monitoring, sterility test, antibiotic assay, microbial limit test.
- 4) **Medical Biotechnology** – for studying the cause, transmission, treatment, control and prevention of various diseases. For implementation and awareness of hygiene, prophylaxis, immunization etc.
- 5) **Microbial Ecology field** –For examining biotransformations of inorganic matter, plant-microbe interaction, biogeochemical cycles.
- 6) **Agricultural Biotechnologists** – For studying various plant diseases their prevention and control by using suitable control measures. Preparation and development of region specific biofertilizers, biogas production and compositing

### Self Employment -as small scale entrepreneur

- 1) Dairy unit – For manufacturing of curd, pro-biotics, cheese, fermented milk etc
- 2) Agriculture units - For manufacturing of biofertilizers, biopesticides, plant growth regulators, consultancy for soil analysis and examination of plant diseases and their control.
- 3) Solid waste management unit– For compositing of solid waste and preparation of compost
- 4) Pathology/Diagnostic laboratory – Histological/pathological/microbiological/ biochemical examination of blood, urine, sputum, serum and other types of samples.
- 5) Mushroom cultivation unit
- 6) Tissue culture unit – Preparation if tissue culture of cash crop plant, hardening of plantlets
- 7) Consultant microbiologist/pathologist/biochemist
- 8) Consultant plant pathologist