

**RANI DURGAVATI VISHWAVIDYALAYA, JABALPUR**  
**SYLLABUS PRESCRIBED FOR THE DEGREE OF THE MASTER OF SCIENCE IN**  
**BIOTECHNOLOGY IN UNIVERSITY TEACHING DEPARTMENT**  
**(Academic Session 2018 – 2019 & Onwards)**  
**[PROGRAMME UNDER CHOICE BASED CREDIT SYSTEM - ORDINANCE 222]**

This brochure of the programme for the M.Sc. degree in Biotechnology consists of three parts, viz., (A) Information from the relevant Ordinance (s) / Statutes, (B) Scheme of examination and (C) Courses of study.

**(A) INFORMATION FROM THE RELEVANT ORDINANCE (S)/STATUTES**

**1. DURATION OF THE COURSE**

M.Sc. Biotechnology will be a full time two-year programme to be covered in four semesters, each of six months duration. The I year of the programme will complete the I and II semesters, and the second year will complete the third and fourth semesters. The maximum duration of the programme shall be twice of the minimum duration of the programme i.e. four years.

**2. ADMISSION TO THE COURSE**

The number of seats shall be in accordance with the directives by the University. A candidate, who after having secured the B.Sc. degree with at least 50 % marks from a recognized university with a subject of Life Science, shall be eligible for admission to the course. The admission to the course will be on the basis of the merit and according to guidelines from the University and Government of Madhya Pradesh. After the term-end examination at the end of each semester, the student will be provisionally admitted to the next semester. Each semester will be followed by a break not exceeding 15 days.

**3. TUITION AND OTHER FEES**

The admitted candidate shall pay the course fee in addition to the tuition fee and such other fees as prescribed by the University.

**4. PROGRAM OF THE STUDY**

The semester will consist of 16-18 weeks of academic work. One credit is equivalent to one hour (60 minutes) of teaching (lecture or tutorial) or two hours (120 minutes) of practical work/field work per week throughout a semester. The credits associated with the courses will be valid credits, while credits associated with comprehensive viva voce will be virtual credits. In the end term examination there will be **three components, namely Core Courses, Elective Courses and Skill Development Course**, except for the 4<sup>th</sup> semester where every student will carry out and submit a **dissertation**.

The syllabus for the theory and practical examination will be prescribed by the Board of Studies in Biotechnology, R.D. University, Jabalpur.

**5. CONTINUOUS EVALUATION**

During the semester, a teacher offering the course will do the continuous evaluation of the student at three points of time by conducting three tests of 20 marks each. Of these, two must be written tests and the third may be written test/quiz/seminar/assignment for theoretical courses. Marks obtained in two best tests out of three will be awarded to the student.

**6. ATTENDANCE**

The student whose attendance is less than 75 %, will not be allowed to appear in the end semester examination and he/she will be declared fail in that semester.

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**7. END SEMESTER EXAMINATION:** There shall be end semester examination at the end of first, second & third semester. The semester examination will be held every year normally in December and June or on the dates declared in the academic calendar of the University. A student proceeding to appear in end semester examination will submit through the Head of the Department his / her application on the prescribed form along with required examination fee, etc. to the Registrar of the University. Every student will appear in four respective theory papers and two combined practical examinations in first, second, & third semesters except for the fourth semester. Each student has to appear in end semester examination, otherwise he/she shall be awarded “Ab” grade in that course. In the fourth semester, every student will be allotted dissertation work in lieu of four theory papers. Allotment of the dissertation will be done by a committee comprising of the Dean of Faculty of Life Science, Head of Department of Biological Science, one Professor and one Associate Professor of the Department by rotation according to seniority. The dissertation may be undertaken in UTD or in any of the National laboratories /Institute /Universities /Government approved companies /Industries. In such cases, there will be two supervisors, one from the parent department and another from the place where the student completes his/her dissertation work.

The dissertation will be evaluated by the external examiner who has expertise in the concerned subject. For the purpose of holding viva-voce, the supervisor will be the internal examiner along with the external examiner who has evaluated the dissertation. The scheme of marks for evaluating the various components of the dissertation will be followed as given in the syllabus.

**8. CONDITION FOR A PASS:** For each course, each student has to appear in at least two tests and end semester examination, otherwise the student will be awarded “Ab” grade. The total marks obtained in end-semester examination, and best of two tests under continuous evaluation will decide the grade in that course. The grading will be made on 10 –point scale as follows:

Letter Grade	Grade Points	Description	Range of Marks (%)
O	10	Outstanding	90-100
A+	9	Excellent	80-89
A	8	Very Good	70-79
B+	7	Good	60-69
B	6	Above Average	50-59
C	5	Average	40-49
P	4	Pass	35-39
F	0	Fail	0-34
Ab	0	Absent	Absent

For passing the examination in each semester, a candidate must have secured a minimum of 35% marks (“P” Grade: 4 Grade Points) in the course. If the marks obtained by the student in a course are less than the minimum cut-off percentage of marks, then “F” Grade will be awarded. If a student obtains “F” or “Ab” Grade in any course, he/she will be treated to have failed in the course. He/she has to reappear in the examination of the course as and when conducted or arranged by the UTD. Marks obtained earlier in continuous assessment may be carried forward and added to the marks obtained in repeat end semester examination to decide the grade in the repeat course.

The theoretical and practical courses can be repeated whenever offered or arranged by the UTD but within maximum duration of the programme. He/she can avail multiple repeat attempts to pass the course. The student will be promoted to the next semester if he/she secures at least 12 valid credits in a

semester. In case the student secures less than 12 valid credits in any semester, then the student will be asked to repeat entire semester and that semester will be treated as zero semester.

The decision of the teacher regarding the evaluation and the grade shall be final. However, a student submits in writing for review of his Marks/Grade to the Head/Director who will place the case before the board of comprehensive viva voce. The decision of the board will be final. Result of review will be declared by the concerned Head/Director. Review is effective only when grade improves. Review will be allowed only if –

- The prescribed fee is paid.
- The candidate applies within 7 days of the declaration of the grade in that course.

**There will be no provision for revaluation.** However the candidates can apply for Re-totaling in one course per semester.

**9.** In matters not covered under this Ordinance, general rules of the University shall be applicable.

**10.** In case of any dispute/ambiguity, the ruling of the Vice-Chancellor shall be final and binding.

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**(B) SCHEME OF EXAMINATION;****SEMESTER I**

<b>(A) Continuous evaluation, Theory, Practical</b>		<b>Credits</b>	<b>Maximum Marks</b>		
			<b>Continuous Evaluation</b>	<b>End Semester Exam</b>	<b>Total</b>
<b>Course Code</b>	<b>Course Title</b>				
<b>I Core courses</b>					
BTC101	Cell Biology	<b>3</b>	<b>40</b>	<b>60</b>	<b>100</b>
BTC102	Animal Cell Science and Techniques	<b>3</b>	<b>40</b>	<b>60</b>	<b>100</b>
BTC103	Microbial Physiology	<b>3</b>	<b>40</b>	<b>60</b>	<b>100</b>
BTC104	Practical based on BTC101 & BTC102	<b>4</b>	<b>40</b>	<b>60</b>	<b>100</b>
BTC105	Practical based on BTC103 & BTE101/ BTE102	<b>4</b>	<b>40</b>	<b>60</b>	<b>100</b>
<b>II Electives courses (Any one to choose)</b>					
BTE101	Biomolecules	<b>3</b>	<b>40</b>	<b>60</b>	<b>100</b>
BTE102	Bioenergetics and Intermediary Metabolism				
<b>III Skill Development course</b>					
BTS101	Skill Development module 1	<b>2</b>	<b>Grade Point will be provided by Skill Development Centre</b>		
Total valid credits		<b>22</b>			
<b>(B) Comprehensive viva voce (virtual credits)</b>		<b>4</b>			<b>50</b>

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**SEMESTER II**

<b>(A) Continuous evaluation, Theory, Practical</b>		<b>Credits</b>	<b>Maximum Marks</b>		
			<b>Continuous Evaluation</b>	<b>End Semester Exam</b>	<b>Total</b>
<b>Course Code</b>	<b>Course Title</b>				
<b>I Core courses</b>					
BTC201	Molecular Biology	<b>3</b>	<b>40</b>	<b>60</b>	<b>100</b>
BTC202	Macromolecules & Basic Enzymology	<b>3</b>	<b>40</b>	<b>60</b>	<b>100</b>
BTC203	Biostatistics & Computer Application	<b>3</b>	<b>40</b>	<b>60</b>	<b>100</b>
BTC204	Practical based on BTC201 & BTC202	<b>4</b>	<b>40</b>	<b>60</b>	<b>100</b>
BTC205	Practical based on BTC203 & BTE201/ BTE202/ BTE203	<b>4</b>	<b>40</b>	<b>60</b>	<b>100</b>
<b>II Electives courses (Any one to choose)</b>					
BTE201	Biology of the Immune System	<b>3</b>	<b>40</b>	<b>60</b>	<b>100</b>
BTE202	Resource utilization and conservation				
BTE203	Microbial Metabolism				
<b>III Skill Development course</b>					
BTS201	Skill Development module 2	<b>2</b>	<b>Grade Point will be provided by Skill Development Centre</b>		
Total valid credits		<b>22</b>			
<b>(B) Comprehensive viva voce (virtual credits)</b>		<b>4</b>			<b>50</b>

**SEMESTER III**

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
			Continuous Evaluation	End Semester Exam	Total
Course Code	Course Title				
<b>I Core courses</b>					
BTC301	Environmental Biotechnology	3	40	60	100
BTC302	Genetic Engineering	3	40	60	100
BTC303	Plant Biotechnology	3	40	60	100
BTC304	Practical based on BTC301 & BTC302	4	40	60	100
BTC305	Practical based on BTC303 & BTE301/ BTE302/ BTE303/ BTE304	4	40	60	100
<b>II Electives courses (Any one to choose)</b>					
BTE301	Advanced Molecular Biology	3	40	60	100
BTE302	Agricultural Microbiology				
BTE303	Bioprocess Engineering and Technology				
BTE304	Biotechnology				
<b>III Skill Development course</b>					
BTS301	Skill Development module 3	2	Grade Point will be provided by Skill Development Centre		
Total valid credits		22			
<b>(B) Comprehensive viva voce (virtual credits)</b>		4			50

\*Both (A – Core courses; One Elective course and Skill Development modules) & (B) are compulsory components of a semester. The grades awarded in the comprehensive Viva-voce shall be shown separately in the Grade Sheet.

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**SEMESTER IV**

<b>DISSERTATION</b>	<b>Credits</b>	<b>Maximum Marks</b>
<b>A. Valuation</b> (i) Language & Presentation (ii) Review of Literature (iii) Methodology (iv) Analysis & interpretation of Result	<b>18</b>	<b>300</b>
<b>B. Viva-Voce EXTERNAL</b>		<b>50</b>
<b>C. Viva-Voce INTERNAL</b>		<b>50</b>
<b>Total</b>		<b>400</b>

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**FIRST – SEMESTER**

**Course Code BTC101: CELL BIOLOGY (Total Credits =03)**

**A: Theory**

**Unit -1**

Diversity of cell size and shape, cell theory, structure of prokaryotic and eukaryotic cells, isolation of cells, microscopic techniques for study of cells.

**Unit-II**

Sub cellular fractionation and criteria of function integrity, cellular organelles, plasma membrane, mitochondria, chloroplast, nucleus and other organelles and their structural organization; transport of nutrients, ions and macromolecules across membranes.

**Unit-III**

Cellular energy transactions- role of mitochondria and chloroplast; cell cycle- molecular events and model systems; cellular responses to environmental signals in plants and animals mechanisms of signal transduction.

**Unit-IV**

Cell motility – cilia & flagella of eukaryotes & prokaryotes; biology of cancer, metabolite pathways and their regulation.

**Unit-V**

Biosynthesis of proteins in eukaryotic cell; co and post-translational modifications, intracellular protein traffic; cellular basis of differentiation and development mitosis, gametogenesis and fertilization; development in Drosophila and Arabidopsis; spatial and temporal regulation of gene expression; brief introduction to the life cycle and molecular biology of some important pathogen of AIDS, malaria, hepatitis, tuberculosis, filaria, kalazar.

**Recommended Books**

1. Molecular Biology of Cell, Alberts, B. et al.
2. Molecular Cell Biology, Lodish et al.
3. Reproduction in Eukaryotic cells, DM Prescott, Academic Press.
4. Developmental Biology, SF Gilbert, Sinauer Associates Inc.
5. Cell in Development and Inheritance, EB Wilson, MacMilan NewYork.
6. The Coiled Spring, Ethan Bier, Cold Spring Harbor Press.
7. Fertilization, FT Longo, Chapman and Hall.
8. Molecular Biology of Steroid and Nuclear Hormone Receptors, LP Freedman, Birkhuse

**FIRST – SEMESTER**

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**Course Code BTC102: Animal Cell Science and Techniques (Total Credits =03)**

**A: Theory**

**UNIT-I**

Structure and organization of animal cell; equipments and materials for animal cell culture technology; primary and established cell lines cultures; introduction to the balanced salt solutions and simple growth medium; brief account of chemical, physical and metabolic functions of different constituents of culture medium; role of carbon dioxide, serum and supplements.

**UNIT-II**

Serum and protein free defined media and their application, measurement of viability and cytotoxicity; biology and characterization of the cultured cells, measuring parameters of growth; basic techniques of mammalian cell culture in vitro; disaggregation of tissue and primary culture; maintenance of cell culture; cell separation.

**UNIT-III**

Scaling up of animal cell culture, cell synchronization, cell cloning and micro-manipulation, cell transformation.

**UNIT-IV**

Application of animal cell cultures, stem cell cultures, embryonic stem cells and their applications, cell culture based vaccines, somatic cell genetics.

**UNIT-V**

Organ and histotypic culture, measurement of cell death, apoptosis, three dimensional culture and tissue engineering.

**Recommended Books:**

1. Culture of Animal Cells (3rd Edition), R. Ian Freshmney. Wiley-Liss.
2. Animal Cell Culture-Practical Approach, (Ed) John R.W. Masters, Oxford.
3. Cell Growth and Division' A Practical Approach. (Ed.) R. Basega, IRL Press.
4. Cell Culture Lab Fax. (Eds). M. Buller & M. Dawson, Bios Scientific Publication Ltd. Oxford.
5. Animal Cell Culture Techniques. (Ed.) Martin Clynes, Springer.
6. Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods, (Ed.) Jenni P. Mather and David Barnes,

**FIRST – SEMESTER**

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**Course Code BTC103: Microbial Physiology and Genetics (Total Credits =03)**

**A: Theory**

**UNIT-I**

The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; synchronous growth; growth as affected by environmental factors like temperature, acidity, water availability and oxygen; storage and maintenance of cultures, continuous culture.

**UNIT-II**

Metabolic diversity among microorganisms, photosynthesis in microorganisms; role of chlorophylls, carotenoids and phycobilins: Calvin cycle; chemolithotrophy; hydrogen-iron nitrite oxidizing bacteria; nitrate and sulfate reduction; Methane fermentation-diversity, syntrophy, role of anoxic decomposition, methanogenesis and acetogenesis; nitrogen fixation; hydrocarbon transformation.

**UNIT-III**

Structural diversity of bacteria: purple and green bacteria, cyanobacteria, homoacetogenic bacteria, acetic acid bacteria, budding and appendaged bacteria, spirilla, spirochaetes, gliding and sheathed bacteria, pseudomonads, lactic and propionic acid bacteria, endospore forming rods and cocci, mycobacteria, rickettsias, chlamydias and mycoplasmas methanogens; Structural diversity of viruses: bacterial, plant, animal and tumor viruses examples of herpes, pox, adenoviruses, retroviruses, viroids and prions. Prokaryotic cells structure and functions: cell walls of eubacteria; peptidoglycan and related molecules; outer-membrane of gram negative bacteria; cell membrane synthesis; cell inclusions like endospores, gas vesicles etc.

**UNIT-IV**

Host-parasite relationship: entry of pathogens into the host; colonization types of toxins: exoendo- and entero-toxins and their structures, mode of action, Chemotherapy/antibiotics: antimicrobial agents, sulfa drugs, antibiotics, penicillins and cephalosporins, broad spectrum antibiotics, mode of action, resistance to antibiotics.

**UNIT-V**

Genes, mutation and mutagenesis; UV and chemical mutagens; types of mutation; Ames test for mutagenesis, complementation test, Bacterial genetic system: transformation, conjugation, transduction, recombination, plasmids and transposons; bacterial genetics map with reference to E. coli.

**Recommended Books:**

1. General Microbiology, Stanier, R.Y. Ingraham, J.L. Wheelis, M.L. and Painter, P.R. The Macmillan press Ltd.
2. Brock Biology of Microorganisms, Madigan M.T. Martinko, J.M. and Parker, J. Prentice- Hall.
3. Microbiology, Pelczar, M.J. Jr. Chan E.C.S. and Kreig, N.R. Tata McGraw Hill.
4. Microbial Genetics Maloy, S.R.C Cronan, J.E.Jr. and Frelfelder, D. Johnos Bartlett Publishers.
5. Microbiology- A Laboratory Manual, Cappuccino, J.G. and Sherman N. Addison Wesley.
6. Microbiological Application: A Laboratory Manual in General Microbiology Benson, H.J, WCB: Wm C. Brown publishers.

**COURSE Code BTC104: Practical based on Course Code BTC101 & Course Code BTC102 (Total Credits = 04)**

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**Suggested list of Practicals (Course BTC101)**

1. To determine the bleeding time of human blood by using blotting paper.
2. To perform agglutination reaction for identification of blood group.
3. To determine the clotting time of human blood by using capillary tube.
4. To determine the hemoglobin contain in blood sample.
5. To prepare a blood smear.

**Suggested list of Practicals (Course BTC102)**

1. To clean and re-sterilize glass wares.
2. To perform agglutination reaction for identification of blood groups.
3. To determine the differential count of leucocytes.
4. Isolation of DNA from animal tissue.
5. To count erythrocytes in a given blood samples.
6. To count total leucocytes in given blood samples.

**COURSE BTC105:** Practical based on Course Code BTC103 & Course Code BTE101 / BTE102  
(Total Credits = 04)

**Suggested List of Practicals (Course BTC103)**

1. To prepare liquid and solid media for the growth of microorganisms.
2. To isolate and identify micro-organisms by serial dilution agar plating method.
3. To isolate bacteria from water sample on XLD, TCBS, MacConkey, EMB selective agar medium.
4. To examine bacteria microscopically by Gram' staining.
5. To determine MPN of different water sample.
6. To isolate bacteria from soil sample on XLD, TCBS, MacConkey, EMB selective media by using pore plate & spread plate method.
7. To confirm the presence of coliforms in water samples by using 24 hrs old positive lactose broth culture.
8. Microscopic identification of different cyanobacterial & algal cultures.

**List of Elective Papers**

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FIRST – SEMESTER

Course Code BTE101: Biomolecules (Total Credits =03)

**UNIT I**

Structure of water and its solvent properties, Acid- bases, pH and buffer, Bi and polyprotic buffer. Free energy and spontaneity of reactions, ATP and other phosphorylated compound with their free energy of hydrolysis, Phosphoryl group transfer, Biological oxidation reductions reaction, Coupled reaction and oxidative phosphorylation, Inhibitors and uncouplers.

**UNIT II**

Enzyme classification, Specificity, Active site, Enzyme kinetics, Michealis Menton equation, Determination of kinetic parameters, Bi-substrate reaction and their kinetics, Enzyme inhibition and kinetics, Allosteric enzyme. Kinetics and Allosteric regulation of phosphofructo kinase

**UNIT III**

Structure and chemistry of macromolecules, Proteins, Carbohydrates and Lipids, Protein folding, Structure and chemistry of biomolecules such as antibiotics, Pigments, Vitamins as coenzymes, Lipid analysis by GLC and Mass Spectrometry, Oligosaccharide and Polysaccharide analysis.

**UNIT IV**

Biosignaling molecular mechanism of signal transduction, Gated ion channels, Nicotinic acetyl choline receptor, Receptor enzyme, The insulin receptor, G- proteins and cyclic AMP membrane transport, Biomembrane, Nutrient transport across membranes, Active and passive diffusion, Symport, Antiport and uniport, Na<sup>+</sup> K<sup>+</sup> pumps and their metabolic significance.

**UNIT V**

Chromatographic technique, Paper and TLC , Gel filtration, Ion exchange, Affinity, HPLC, SDS, PAGE, Isoelectric focusing, Western blotting, Protein sequencing, Mass spectrometry, MALDI , TOF, MS.

**Books Recommended**

J. L., Jain, Sanjay, and Jain Nitin, (1979) Fundamentals of Biochemistry (6th revised Edition). S. Chand & Co. Ltd. New Delhi.

Buchanan . B.B. Gruissem, W. and Jones .R.L. (2000) Biochemistry and Molecular Biology of Plants , American Society of Plant Physiologists, Maryland ,USA.

Albert L. Lehninger, Davis L. Nelson, Michael M. Cox. (2004) Lehninger Principles of Biochemistry.

Lea P.J. and Leegood ,R.C. (1999) Plant Biochemistry and Molecular Biology (2 nd Edition ) John Wiley and Sons. Chichester, England

Berg Jeremy, Tymoczko John, Stryer Lubert (2001) Biochemistry 4th Ed, W. H. Freeman, New York.

Conn Eric, Stumpf Paul K., Bruening George, Doi Roy H., (1987) Outlines of Biochemistry 5th Ed , John Wiley and Sons, New Delhi.

Dawes Edwin A. (1972) Quantitative Problems in Biochemistry, Churchill Livingstone, Edinburgh.

Hall D. D. and Rao K. K. (1996) Photosynthesis 5th Ed., Cambridge University Press. 5. Mandelstam

Joel and McQuillen Kenneth (1976) Biochemistry of Bacterial Growth, Blackwell Scientific Publication London.

Metzler David E. (2001) Biochemistry: The chemical Reactions of Living Cells, Volume 1&2, Academic Press California.

Moat Albert G. and Foster John W. (1988) Microbial Physiology 2nd Ed. John Wiley and Sons New York.

Nelson D. L. and Cox M. M. (2005) Lehninger's Principles of Biochemistry, Fourth edition, W. H. Freeman & Co. New York.

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Palmer Trevor (2001) Enzymes: Biochemistry, Biotechnology and Clinical chemistry, Horwood Pub. Co. Chinchester, England.

Segel Irvin H. (1997) Biochemical Calculations 2nd Ed., John Wiley and Sons, New York.

Voet Donald and Voet Judith G. (1995) Biochemistry, 2nd Ed.. John Wiley and sons New York.

White Abraham, Handler Philip, Smith Emil, Hill Rober, Lehman J. (1983) Principles of Biochemistry, Edition 6, Tata Mc-Graw Hill Companies, Inc.

White David (2000) Physiology and Biochemistry of Prokaryotes. 2nd Ed. Oxford University Press, New York.

Zubay Geoffrey (1998) Biochemistry, 4th Ed., W. C. Brown, New York.

**Suggested list of practicals (Course Code BTE101)**

1. To study working of weighing balance.
2. To study the working of pH meter.
3. To determine the pKa value of acetic acid by pH titration method.
4. Preparation of acetate buffer at pH=5.
5. Prepare Phosphate buffer at pH=8.
6. To prepare tris buffer at pH=9.
7. Estimation of protein by Lowry method.
8. Chromatographic separation by paper and thin layer Chromatography.
9. To determine pKa value of glycine.
10. Determine the absorption maxima of Potassium dichromate.
11. To prove the validity of Beer-Lambert's law.
12. Qualitative assessment of carbohydrate.
13. Qualitative assessment of lipids.
14. Qualitative assessment of proteins.
15. To prepare standard curve of glucose by anthrone method.
16. To determine the Km and Vmax of amylase enzymes.
17. To study the effect of substrate concentration on enzyme activity.
18. To study the effect of temperature on enzyme activity.

**Course Code BTE102: Bioenergetics and Intermediary Metabolism (Total Credits = 03)**

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### UNIT I

Bioenergetics: energy transformation, biological oxidations, oxygenases, hydroxylases, dehydrogenases and energy transducing membranes; free energy changes and redox potentials, phosphate potential, ion and proton electrochemical potentials, membrane potentials, chemo-osmotic theory; ion transport across energy transducing membranes, influx and efflux mechanisms, transport and distribution of cations, anions and ionophores. Uniport, antiport and symport mechanisms, shuttle systems.

### UNIT- II

The mitochondrial respiratory chain, order and organization of carriers, proton gradient, iron sulphur proteins, cytochromes and their characterization; the Q cycle and the stoichiometry of proton extrusion and uptake. Oxidative phosphorylation, uncouplers and inhibitors of energy transfer. Fractionation and reconstitution of respiratory chain complexes. ATP synthetase complex, microsomal electron transport.

### UNIT- III

Carbohydrates: glycolysis, citric acid cycle- its function in energy generation and biosynthesis of energy rich bonds, pentose phosphate pathway, alternate pathways of carbohydrate metabolism, gluconeogenesis, inter-conversions of sugars, biosynthesis of glycogen, starch and oligosaccharides.

### UNIT- IV

Lipids: fatty acid biosynthesis: acetyl CoA carboxylase, fatty acid synthase; fatty acid oxidation:  $\alpha$ ,  $\beta$ , oxidation and lipoxidation; lipid biosynthesis: of triacylglycerols, phosphoglycerides and sphingolipids, biosynthetic pathways for terpenes and steroids.

### UNIT- V

Amino acids and nucleic acids: biosynthesis and degradation of amino acids and their regulation, specific aspects of amino acid metabolism, urea cycle and its regulation, in-born errors of amino acid metabolism; Nucleic acids: degradation of purines and pyrimidines, regulation of purine and pyrimidine biosynthesis, structure and regulation of ribonucleotide biosynthesis, biosynthesis of ribonucleotides, deoxyribonucleotides and polynucleotides, inhibitors of nucleic acid biosynthesis.

### Books recommended

M.M. Cox and D.L. Nelson (2008) Lehninger Principals of Biochemistry W.H. Freeman & Company  
Otto Hoffmann-Ostenhof (2008) Intermediary metabolism; *Van Nostrand Reinhold (USA)*.

[P.H. Clarke](#) (1978) Intermediary metabolism; *John Wiley & Sons Ltd Hoboken, New Jersey (United States)*.

[Alexander Lowen](#) (1994) Bioenergetics; *Penguin/Arkana Books USA*.

[David G. Nicholls](#) and [Stuart Ferguson](#) (2013) Bioenergetics; *Academic Press Elsevier United States*.

### Suggested list of practicals (Course Code BTE102)

1. To prepare acetate buffer of pH4.7.
2. To perform carbohydrate tests of manosaccharides, polysaccharides, disaccharides.
3. To determine protein of unknown sample by Lowry method.
4. To perform the detection of lipid in the given sample

**Course Code BTS101: SKILL DEVELOPMENT MODULES 1 (Total Credits = 02)**

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**PERSONALITY DEVELOPMENT- MODULE- 1 (Semester-1)****Hrs.-30**

S. No.	Subject	Classroom Activity	Hrs.
01	Orientation , Personality Development	Worksheet	1
02	Role and Impact of Personality	Group Activity	1
03	Pre Self-Assessment (Psychometric Analysis)	PDP Assessment Sheet	2
04	Listening and Caring	Group Activity	1
05	The Art of Communication	Worksheet	1
06	Different level of Effective Communication	Worksheet	1
07	Professional Communication P-A-C	Worksheet	1
08	Rules of Professional Communication	Group Activity	1
09	Body Language - 1	Worksheet	1
10	Language Lab	Worksheet	1
11	Thought Process - 1	Worksheet	1
12	Interpersonal Skills	Worksheet	1
13	Observation & Imagination Power	Group activity	1
14	Creativity	Group Activity	1
15	Extempore - 1	Group activity	1
16	Extempore - 2	Group Activity	1
17	Presentation Skills	Worksheet	2
18	How to Draw the Attention of Audience	Worksheet	1
19	Steps of Effective Presentation	Worksheet	1

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## M.SC. BIOTECHNOLOGY 2018-2019 ONWARDS

20	Prioritizing Matrix	Worksheet	1
21	Leadership Quality	Group activity	1
22	SWOT Analysis	Worksheet	1
23	Interview Skills	Lecture	2
24	Group Discussion	Group Activity	2
25	Resume Preparation	Group Activity	1

### SECOND – SEMESTER

Course Code BTC201: Molecular Biology (Total Credits =03)

#### A: Theory

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**UNIT-I**

DNA replication: prokaryotic and eukaryotic DNA replication, mechanics of DNA replication enzymes and accessory proteins involved in DNA replication.

**UNIT-II**

DNA repair and recombination – methyl directed mismatch repair, very short patch repair nucleotide and base excision repair, SOS system. Holliday junction, gene targeting and gene knock-outs, FLP/ FRT Cre/Lox recombination, RecA and other recombinases.

**UNIT-III**

Transcription and modification in RNA/ protein; prokaryotic and eukaryotic transcription, RNA polymerases, general and specific transcription factors, regulatory elements and mechanisms of transcription regulation, 5- Cap formation transcription termination, 3' – end processing and polyadenylation, splicing, editing, stability and nuclear export of mRNA; post- transcriptional gene silencing, Protein localization; synthesis of secretory and membrane proteins.

**UNIT-IV**

Oncogenes and tumor suppressor genes: viral and cellular oncogenes, tumor suppressor genes from humans; structure function and mechanism of action of pRB and p53 tumor suppressor proteins. Antisense and ribozyme technology, molecular mechanism of anti- sense molecules, disruption of RNA structure. Biochemistry of ribozyme; hammerhead, hairpin and other ribozymes, strategies for designing ribozymes, applications of antisense and ribozyme technologies.

**UNIT-V**

Molecular mapping of genome: genetic and physical maps, physical mapping and map- based cloning. Southern and fluorescence in situ hybridization for genome analysis; chromosome micro-cloning; molecular markers in genome analysis: RFLP and RAPD analysis, application of RFLP in forensic, disease prognosis, genetic counseling, pedigree, varietal and germplasm maintenance. Genome sequencing and genomic libraries, YAC, BAC libraries, strategies for sequencing genome, packaging, transfection and recovery of clones

**Recommended Books:**

1. Molecular cloning : A Laboratory Manual , J. Sambrook ; Fritsch and T. Maniatis Cold Spring Harbor Laboratory Press, New York, 2000.
2. Introduction to practical molecular biology P.D. Dabre, John Wiley & sons Ltd. N York 1988
3. Molecular Biology LabFax, T.A. Brown (Ed) Bios Scientific Publishers Ltd. Oxford, 1991
4. Molecular Biology of the Gene (4th edition ), J.D. Watson N.H. Hopkins, J.W. Roberts J.A. Steitz and A.M. Weiner, The Benjamin/ Cummlngs Publ Co. Inc. California, 1987.
5. Molecular Cell Biology (2nd Edition) J. Darnell, H. Lodish and D. Baltimore, Scientist American Books, Inc., USA, 1994.
6. Molecular Biology of the Cell (2nd Edition) B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J. D. Watson, Garland Publishing, Inc., New York, 1994.
7. Gene VI (6th Edition) Benjamin Lewin, Oxford University press, U.K., 1998.
8. Molecular Biology and biotechnology; a comprehensive desk reference, R.A. Meyers (Ed.) VCH Publishers, Inc, New York, 1995
9. Genomes, T.S. Brown

**SECOND – SEMESTER**

**Course Code BTC202: Macromolecules & Basic Enzymology (Total Credits =03)**

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**Unit-1**

- Review of uni-substrate enzyme kinetics and factors affecting the rates of enzyme catalyzed reactions, Micheali's pH function and their significance
- Kinetics of Bisubstrate reactions
- Enzyme catalysis in solution- kinetics and thermodynamic analysis
- Effect of organic solvents on enzyme catalysis and structre consequence

**Unit-2**

- Concept of convergent and divergent evolution of enzymes
- Methods of examining enzyme-substrate complex, flexibility and conformationalmobility of the enzyme
- Protein-protein and protein ligand interactions
- Cooperative phenomenon Hill and Scatchard plot, symmetric and sequential mode for action of allosteric enzymes and their significance

**Unit-3**

- Detailed mechanism of catalysis of serine proteases, ribonuclease and triose phosphate isomerase
- General mechanism of enzyme regulation, Feedback inhibition and feed forward stimulation, Reversible and irreversible covalant modifications of enzymes
- Mono-cyclic and multi-cyclic cascade system with specific amino-acid
- Functional protein-enzymes and recaption

**Unit-4**

- Macromolecule and supra molecule assemblies, glyco-lipid proteins, extracellular matrix, membrane chromatin, Ribosomes
- Conformational properties of polynucleotide and polysaccharide
- Protein denaturation and denaturants
- Nanoparticles

**Unit-5**

- Physical techniques in proteins, Nucleic acid and Polysaccharide; Structural analysis- UV, IR, NMR, Fluorscence spectroscopy; Ultracentrifugation; Electron microscopy, Freeze fracture technique, Cryo Scanning electron microscopy.

**SECOND – SEMESTER**

**Course Code BTC203: Biostatistics & Computer Applications (Total Credits =03)**

**A: Theory**

**UNIT-I**

Importance and scope of statistics in biochemical experimentation; Elements of Probability-Mathematical and Statistical definitions; Addition and Multiplication theorems; Probability Distribution Functions – Binomial, Poisson and Normal; Area under normal distribution curve.

**UNIT-II**

Measures of central tendency: Arithmetic, geometric & harmonic means; Measures of dispersion: range, quartile deviation, variance, standard deviation, coefficient of variation, confidence limits of population mean. Tests of significance hypotheses and errors; student t statistics- population mean equals a specified value; equality of 2 independent means ( equal & unequal variance), equality of 2 means ( paired samples).

**UNIT-III**

Analysis of variance: one-way analysis (sample sizes equal and unequal), completely randomized design; two-way analysis (one observation per cell), randomized block design; multiple comparisons: least significant difference, Duncan's new multiple range test.

**UNIT-IV**

Linear regression: regression diagram and equation, regression coefficient, standard error, significant tests, prediction of dependent variable from the independent variable; linear correlation- scatter diagram, correlation coefficient, standard error, significance tests; relationship between regression and correlation coefficients; Non parametric tests: Chi-square statistics, test of goodness of fit, test of independence of attributes; standard line interpolation.

**UNIT-V**

Introduction to Computers: Basic architecture, generations of computer hardware and software; operating systems-WINDOWS and UNIX; system and application software; introduction to internet-LAN, MAN, WAN, Concept of bioinformatics; application of bioinformatics in microbiology.

**Course BTC204: Practical based on Course Code BTC201 & Course Code BTC202 (Total Credits = 04)**

**Suggested list of practicals (Course Code BTC201)**

1. Establishment of *E.coli* in EMB media.
2. Establishment of *E.coli* in Luria-Barthetti Broth.
3. To Perform Protein electrophoresis by SDS-PAGE.
4. Isolation of Plasmid DNA from *E. coli*.
5. Isolation of genomic DNA from higher plants.
6. To perform Agarose gel electrophoresis for isolated DNA sample.

**Suggested list of practicals (Course Code BTC202)**

1. To estimate glucose or fructose concentration by DNS method.

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2. To study the effect of temperature on activity of invertase enzyme.
3. To study product inhibition by sucrose and calculation of  $K_m$ .
4. To study the substrate inhibition and calculation of  $K_m$  of the enzyme invertase.
5. To study the effect of pH on activity of invertase enzyme.

**Course BTC205:** Practical based on Course Code BTC203 & BTE201 / BTE202 / BTE203 (**Total Credits = 04**)

**Suggested list of practicals (Course Code BTC203)**

1. To test the statistical definition of probability.
2. To test the hypothesis that binomial distribution can be normal distribution at small n if  $n=q$ .
3. To measure the central tendency and dispersion of the length of leaves.
4. Determine the confidence interval by t-statistics.
5. To test the hypothesis by mean pulse rate of M.Sc. student is statistically equal to 72 beats/min.
6. To test that mean pulse of student is similar by F-test.
7. Find out the coefficient of co-relation between length and weight of mango leaves.

**List of Elective Papers**

**SECOND – SEMESTER**

**Course Code BTE201: Biology of the Immune System (Total Credits =03)**

**A: Theory**

**UNIT-I**

Introduction: phylogeny of immune system, innate and acquired immunity, clonal nature of immune response; organization and structure of lymphoid organs, nature and biology of antigens and super antigens.

**UNIT-II**

Antibody structure and function; antigen-antibody interactions, major histocompatibility complex, BCR & TCR, generation of diversity, complement system.

**UNIT-III**

Cells of the immune system; hematopoiesis and differentiation, lymphocyte trafficking. B lymphocytes, T-lymphocytes, macrophages, dendritic cells, natural killer and lymphokine activated killer cells, eosinophils, neutrophils and mast cells. Regulation of immune response: antigen processing and presentation, generation of humoral and cell mediated immune responses, activation of B-and T-lymphocytes, cytokines and their role in immune regulation; T-cell regulation, MHC restriction, immunological tolerance.

**UNIT-IV**

Cell- mediated cytotoxicity; mechanism of T cell and NK cell mediated lysis; antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity; hypersensitivity autoimmunity, transplantation.

**UNIT- V**

Immunity to infectious agents (intracellular parasites, helminthes & viruses); tumor immunology; AIDS and other immunodeficiencies, hybridoma technology and monoclonal antibodies.

**Recommended Books:**

1. Kuby immunology, 4th Edition, R.A. Goldsby, Thomas J. Kindt, Barbara, A. Osbarne. (Freedom)
2. Immunology-A short Course, 4th Edition- Ell Benjamin, Richard Coico, Geoffrey Sunshine (Wiley-Liss).
3. Fundamentals of immunology, William Paul.
4. Immunology, Roitt and others.

**Suggested list of practicals (Course Code BTE201)**

1. To perform test for antibiotics sensitivity by disc method.
2. To determine the minimum inhibitory concentration of given antibiotics.
3. Preparation of blood smear.
4. To isolate serum from blood plasma.
5. To perform agglutination reaction to identification of blood group.

**Course Code BTE202: Resource Utilization and Conservation (Total Credits = 03)**

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**UNIT – I**

Major Biomes of the world, Tropical rain & Seasonal Forests, Temperate rain & Seasonal forests, Boreal forests, Grasslands, Deserts, Aquatic Ecosystems wetlands, Lakes & Ponds Streams & Rivers, Marine & Estuarine habitats.

**UNIT – II**

Resource utilization, Status & Utilization of Biodiversity, Sustainable development resources from forest, Grassland and aquatic habitats, Food forage, Fodder, Timber & Non-wood forest products, Threats to quality & quantity of Resources due to overexploitation.

**UNIT –III**

Strategies for conservation of resources: Classifications of resources, Principles of conservation, *In-situ* conservation sanctuaries, National parks, Biosphere reserves for wildlife conservation, Habitat conservation practices of conservation for forests ranges, Soil and water.

**UNIT – IV**

Air, Water and Soil pollution, Kinds, Sources, Quality parameters, Effects on structure & function of ecosystems, Management of pollution, Bioremediation, Climate changes sources, Trends & role of greenhouse gases, Effect of global warming on climate, Ecosystem processes & Biodiversity, Ozone layer & Ozone hole.

**UNIT – V**

Resource monitoring, Remote sensing concepts & Tools, Satellite remote sensing basics sensors, Visual & digital interpretation, EMR bands and their applications, Indian remote sensing program, Thematic mapping of resources, Application of remote sensing in Ecology & Forestry.

**Books recommended**

- Chopra R. N. (1933) Indigenous Drugs of India.
- Hayes W. B. (1953) Fruit Growing in India.
- Atkinson E. T. (1980) Economic Botany of Himalayan Regions.

**Suggested list of practicals: Course Code BTE202 (Resource Utilization and Conservation)**

1. To find the pH of the various sample of soil by pH meter.
2. To determine the presence of carbonate in different soil mixtures.
3. To determine the presence of phosphate in soil and water sample.
4. To determine the presence of nitrate in mixture sample.
5. To determine the presence of nitrite in mixture sample.
6. To determine frequency, density and abundance of herbaceous species from local garden.
7. To determine the biomass of plant vegetation.
8. To determine leaf area, dry weight and moisture content of few species of plant from grassland.

**Course Code BTE203: Microbial Metabolism (Total credits: 3)**

**Theory**

**UNIT-I**

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Microbial growth: mathematical expression of growth, growth measurement, efficient growth curve, synchronous growth and continuous culture, effect of environmental factors on microbial growth, nutrients diffusion, active transport, group translocation, solutes, temperature, oxygen relations.

**UNIT-II**

Chemolithotrophy: Sulphur, iron, hydrogen, carbon monoxide, nitrogen oxidations. Methanogenesis, luminescence. Brief account of photosynthetic and accessory pigments chlorophyll, bacteriochlorophyll, carotenoids, oxygenic, anoxygenic photosynthesis. Electron transport-photoautotrophic generation of ATP, fixation of CO<sub>2</sub>- Calvin cycle, reverse TCA, carbohydrate anabolism.

**UNIT-III**

Respiratory metabolism: Embden Mayer Hoff pathway, Entner Doudroff pathway, glyoxalate pathway, Krebs cycle, oxidative and substrate level phosphorylation, Pasteur effect, fermentation of carbohydrates-homo and heterolactic fermentations. Synthesis of polysaccharides- gluconeogenesis and other pathways.

**UNIT-IV**

Assimilation of nitrogen: Dinitrogen - nitrate nitrogen-ammonia- denitrification, synthesis of major amino-acids, polyamines; peptidoglycan-biopolymers as cell components.

**UNIT-V**

Microbial development, sporulation and morphogenesis, hyphae vs. yeast forms and their significance. Multicellular organization of selected microbes. Dormancy. Endospore-structure, properties and germination.

**List of Recommended Books**

1. Doelle H.W. 1969. Bacterial Metabolism. Academic Press.
2. Gottschalk G. 1979. Bacterial Metabolism. Springer Verlag. Moat AG. 1979. Microbial Physiology. John Wiley & Sons.
3. Sokatch JR. 1969. Bacterial Physiology and Metabolism. Academic Press.
4. Moat A G., Foster J W., Spector M P. Microbial Physiology, 4th Ed: Wiley India Pvt Ltd 2009.

**Suggested list of Practicals (Course CODE BTE203: Microbial Metabolism)**

1. Determination of Bacterial growth by turbidity measurements (spectrophotometric method).
2. Study of effect of temperature on growth of bacteria.
3. Study of effect of pH on growth of Bacteria.
4. Isolation of rhizobia from root nodules.
5. Slide culture technique for studying morphology and molds.

## Course Code BTS201: SKILL DEVELOPMENT MODULES 2 (Total Credits = 02)

**SOFT SKILLS DEVELOPMENT MODULE-2 (Semester- 2) Hrs. 30**

S. No.	Subject	Classroom Activity	Hrs.
01	Orientation , Personality Development	Worksheet/ lecture	02
02	Role and Impact of Personality	Group Activity/ lecture	01
03	Pre Self-Assessment (Psychometric Analysis)	PDP Assessment Sheet	02
04	Importance of characteristics and Traits	lecture/Group Activity	02
05	Empowerment of Internal and external traits	lecture	02
06	Definition of Personality	Lecture	02
07	Power of Self	Lecture	03
08	Path to Improve Personality	lecture/Group Activity	03
09	Body Language - 1	Worksheet	02
10	Grooming Yourself	Lecture	02
11	IQ / EQ / MQ / SQ	lecture	02
12	Disposition of Body in various aspects	Group Activity	03
13	Getting desired output	Group Activity	02
14	Post Assessment of Personality	Group Activity	02

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**THIRD – SEMESTER**

**Course Code BTC301: Environmental Biotechnology (Total Credits =03)**

**A: Theory**

**UNIT-I**

Environment: Basic concepts and issues; environmental pollution: types and methods for the measurement; methodology of environmental management-problem solving approach, its limitations; air pollution and its control through biotechnology, air sampling techniques; biodiversity: conservation and management.

**UNIT-II**

Water pollution and its control: Water as a scarce natural resource, need for water management, sources and measurement of water pollution, waste water treatment-physical, chemical and biological treatment processes; algal blooms and human health.

**UNIT-III**

Microbiology of waste water treatment: Aerobic process-activated sludge, oxidation ditches, trickling filter, towers, rotating discs, rotating drums, oxidation ponds; anaerobic processes anaerobic digestion, anaerobic filters, upflow anaerobic sludge blanket reactors; treatment schemes for waste waters of dairy, distillery, tannery industries; biotechnological application of microbes from extreme environment.

**UNIT-IV**

Microbial degradation of xenobiotics in the environment- ecological considerations, decay behaviour & degradative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides; bioaccumulation of metals and radio-nucleids and detoxification; bioremediation.

**UNIT-V**

Biological N<sub>2</sub> fixation, H<sub>2</sub> production, biofertilizers and biopesticides; solid wastes; sources and management (composting, vermiculture and methane production). Single cell protein (Spirulina, yeast, mushroom); global environmental problems-ozone depletion, UV-B green house effect and acid rain, their impact and biotechnology approaches for management

**Recommended Books :**

1. Wastewater Engineering- Treatment, disposal and Reuse. Metcalf and Eddy, Inc., Tata McGraw Hill, New Delhi.
2. Comprehensive Biotechnology. Vol. 4, M. Moo-young (Ed-in-chief), Pergamon Press, Oxford.
3. Environmental Chemistry, A.K. De. Wiley Eastern Ltd. New Delhi.
4. Introduction to Biodeterioration. D. Allsopp and K.J. Seal, ELBS/Edward Arnold

**THIRD – SEMESTER**

**Course Code BTC302: Genetic Engineering (Total Credits =03)**

**A: Theory**

**UNIT-I:** Scope of genetic engineering, milestones in genetic engineering; isolation of enzymes, DNA sequencing, synthesis and mutation, detection and separations, cloning, gene expression; cloning and patenting of life forms; genetic engineering guidelines; molecular tools and their applications; restriction enzymes, modification enzymes, DNA and RNA markers; nucleic acid purification, yield analysis.

**UNIT-II:** Nucleic acid amplification and its applications, gene cloning vectors-plasmids, bacteriophages, phagemids, cosmids, artificial chromosomes; restriction mapping of DNA fragments and map construction; nucleic acid sequencing; cDNA synthesis and cloning; mRNA enrichment, reverse transcription, DNA primers, linkers, adaptors and their chemical synthesis; library construction and screening.

**UNIT-III:** Alternative strategies of gene cloning; cloning interacting genes-two-and three hybrid systems, cloning differentially expressed genes, nucleic acid micro array; site-directed mutagenesis and protein engineering; gene regulation-DNA transfection, Northern blot, primer extension, S1 mapping, RNase protection assay, reporter assays.

**UNIT-IV:** Expression strategies for heterologous genes; vector engineering and codon optimization, host engineering; in vitro transcription and translation, expression in bacteria, yeast, insects and insect cells, mammalian cells, plants; processing of recombinant proteins-purification and refolding, characterization of recombinant proteins, stabilization of proteins; phage display.

**UNIT-V:** T-DNA and transposon tagging; role of gene tagging in gene analysis, identification and isolation of genes through T-DNA or transposon; transgenic and gene knockout technologies targeted gene replacement, chromosome engineering; gene therapy-vector engineering, strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing.

**Recommended Books:**

1. Molecular cloning: A Laboratory Manual, J. Sambrook , E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
2. DNA Cloning: A practical Approach, D.M. Glover and B.D. Hames, IRL Press, Oxford, 1995.
3. Molecular and Cellular Methods in Biology and Medicine, P.B. Kaufman, W. Wu. D. Kim and L.J. Cseke, CRC Press, Florida, 1995.
4. Methods in Enzymology Vol. 152, Guide to Molecular Cloning Techniques, S.L. Berger and A.R. Kimmel, Academic Press, Inc. San Diego,1998.
5. Methods in Enzymology Vol.185 Gene Expression Technology, D.V. Goeddel, Academic Press, Inc. San Diego, 1990.
6. DNA Science. A First Course In Recombinant Technology, D.A. Mickloss and G.A. Freyer, Cold Spring Harbor Laboratory Press, New York,1990.
7. Molecular Biotechnology (2nd Edn.) S.B. Primrose, Blackwell Scientific Publishers, Oxford, 1994.
8. Milestones in Biotechnology, Classic Papers in Genetic Engineering, J.A. Davies and W.S. Reznikoff, Butterworth-Heinemann, Boston, 1992.
9. Route Maps in Gene Technology, M.R. Walker and R. Rapley, Blackwell Science Ltd. Oxford, 1997.
10. Genetic Engineering; An Introduction to gene analysis and exploitation in eukaryotes, S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford, 1998.
11. Molecular Biotechnology-Glick

**THIRD – SEMESTER**

**Course Code BTC303: Plant Biotechnology (Total Credits =03)**

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**A: Theory**

**UNIT-I:** Introduction to plant cell and tissue culture: tissue culture media (composition and preparation), initiation and maintenance of callus and suspension culture. Regeneration through organogenesis and somatic embryo genesis; transfer and establishment of whole plant in soil; embryo culture and embryo rescue; anther, pollen and ovary culture for production of haploid plants and homozygous diploid lines; cryopreservation for germplasm conservation; protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plant; symmetric and asymmetric cybrids; germplasm conservation, virus free plants.

**UNIT-II** Cloning vector for higher plant transformation: *Agrobacterium tumefaciens* Ti and Ri plasmids, basis of tumor formation, hairy root, mechanisms of DNA transfer, role of virulence genes. Viral vectors and their application: direct gene transfer: particle bombardment, electro oration, microinjection: transformation of monocots; transgene stability and gene silencing, selection of clones. Expression of cloned genes: genetic markers, reporter genes, Gus assay.

**UNIT-III** Application of plant transformation for productivity and performance: herbicide resistance (phosphinothricin, glyphosate, sulfonyleurea, atrazine), insect resistance (Bt. Endotoxin genes, Non-Bt like proteinase inhibitors alpha amylase inhibitor), virus resistance (Coat protein mediated protection (CPMP), nucleocapsid gene), disease resistance (anti fungal proteins chitinase, 1-3 beta glucanase, ribosome inactivating proteins (RIP), thionins, pathogenesis related (PR) proteins, nematode resistance, abiotic stress (salt tolerance); post harvest losses, long shelf life of fruits and flowers, use of ACC synthase. polygalacturanase. ACC oxidase, carbohydrate composition and concentration during storage. ADP glucose pyrophosphatase.

**UNIT-IV** Chloroplast transformation: advantages, vectors, success with tobacco and potato; metabolic engineering and industrial products; plant secondary metabolites, control mechanism and manipulation of phenyl propanoid pathway, Shikimate pathway, alkaloids, industrial enzymes; biodegradable plastics. Polyhydroxybutyrate, therapeutic proteins; lysosomal enzymes, antibodies, edible vaccines purification strategies, oleosin partitioning technology.

**UNIT-V** Molecular marker- aided breeding RFLP maps. Linkage analysis. RAPD markers. STS, microsatellites, SCAR (sequence characterized amplified region), AFLP, QTL. Molecular assisted selection; arid and semi- arid plant biotechnology, green house and green- home technology.

**Recomonded Books:**

1. J. Hammond, P. McGarvey and V. Yusibov (Eds.): Plant Biotechnology. Springer Verlag, 2000.
2. T, J. Fu, G. Singh and W.R. Curtis (Eds): Plant Cell and Tissue Culture for the Production of Food Ingredients. Kluwer Academic/Plenum Press. 1999.
3. H.S. Chawla: Biotechnology in Group Improvement, International Book Distributing Company. 1998.
4. R.J. Henry: Practical Application of Plant Molecular Biotechnology. Chapman and Hall. 1997.
5. P.K. Gupta Elements of Biotechnology. Rastogi and Co. Meerut. 1996.

**THIRD – SEMESTER**

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**Course Code BTC304:** Practical based on Course Code BTC301 & Course Code BTC302 (**Total Credits = 04**)

**Suggested list of practicals (Course Code BTC301)**

1. Isolation of *Cyanobacteria* (blue green algae).
2. Estimation of nitrate.
3. Estimation of nitrite.
4. Estimation of ammonia.
5. Determination of biological oxygen demand (BOD) of water sample.
6. Determination of chemical oxygen demand (COD) of water sample.
7. To study air born microbes by agar plate technique.
8. To study pollution stress by chlorophyll and carotenoid ratio from algae sample.
9. To study of effect of heavy metal on growth of bacteria.
10. To study of effect of pesticides on the growth of bacteria.

**Suggested list of practicals (Course Code BTC302)**

1. Isolation of bacterial DNA by quick preparation.
2. To isolate fungal DNA.
3. To perform Agarose gel electrophoresis of isolated DNA.
4. Comments on Electrophoresis.
5. Comments on Gel documentation system.
6. Comments on PCR.

**Course Code BTC305:** Practical based on Course Code BTC303 & BTE301 / BTE302 / BTE303 /BTE 304 (**Total Credits = 04**)

**Suggested list of Practical (Course Code BTC303)**

- 1.To sterilize the equipments required for plant tissue culture.
- 2.Preparation of media of plant tissue culture and its sterilization.
- 3.To culture zygotic embryo from *Arachis hypogaea in vitro*.
- 4.To induce Callus from given ex plants leaf on MS-Media.
- 5.To study the effect of herbicide on groundnut.
- 6.To study the effect of salt concentration on embryo culture of Maize.
- 7.Encapsulation of *Vinca rosea* by sodium alginate.
- 8.To isolate genomic DNA from leaves of *Vinca rosea*.
- 9.To confirm the presence of genomic DNA in the sample by agarose gel electrophoresis.

**List of Elective Papers**

**THIRD SEMESTER**

**Course Code BTE301: Advanced Molecular Biology (Total Credits = 03)**

**UNIT I**

Recombinant DNA technology I: methods of creating recombinant DNA molecule, properties of restriction endonucleases and their mode of action, selection screening construction of DNA library.

**UNIT II**

Recombinant DNA Technology II: Use of cloned gene, sub-cloning; recombinant proteins production in bacteria, site-directed mutagenesis, RFLP, PCR, DNA-fingerprinting, antisense-RNA technology, chromosomal walking.

**UNIT III**

Hybridoma technology: monoclonal antibodies mycelium cell infusion selection of hybridomas, protoplast fusion and HAT-medium screening assay purification and application of monoclonal antibodies.

**UNIT IV**

Cell and tissue culture: micropropagation, somatic cell culture, somoclonal variations, somatic cell hybridization, protoplast isolation, protoplast fusion, protoplast culture, genetic transformation, various methods of gene transfer (all vector and methods), production of transgenic plant and animal; production of secondary metabolites, primary and transferred cell culture, differentiated cells in culture application.

**UNIT V**

Fermentation technology: continuous and batch type culture techniques, principle types of Fermenters, general design of fermentors. Fermentation processes, brewing manufacture of antibiotics, production of single cell protein. Application of genetic and molecular biology procedures in strain improvement.

**Books recommended**

1. Molecular cloning : A Laboratory Manual , J. Sambrook ; Fritsch and T. Maniatis Cold Spring Harbor Laboratory Press, New York, 2000.
2. Introduction to practical molecular biology P.D. Dabre, John Wiley & sons Ltd. N York 1988
3. Molecular Biology LabFax, T.A. Brown (Ed) Bios Scientific Publishers Ltd. Oxford, 1991
4. Molecular Biology of the Gene (4th edition ), J.D. Watson N.H. Hopkins, J.W. Roberts J.A. Steitz and A.M. Weiner, The Benjamin/ Cummlngs Publ Co. Inc. California, 1987.
5. Molecular Cell Biology (2nd Edition) J. Darnell, H. Lodish and D. Baltimore, Scientist American Books, Inc., USA, 1994.
6. Molecular Biology of the Cell (2nd Edition) B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J. D. Watson, Garland Publishing, Inc., New York, 1994.
7. Gene VI (6th Edition) Benjamin Lewin, Oxford University press, U.K., 1998.
8. Molecular Biology and biotechnology; a comprehensive desk reference, R.A. Meyers (Ed.) VCH Publishers, Inc, New York, 1995
9. Genomes, T.S. Brown

**Suggested list of practicals (Course CODE BTE301)**

1. To isolate genomic DNA from fungi by LETS methods.

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2. To determine the quantity and quality of the isolated fungal DNA.
3. To determine the agarose gel electrophoresis of the isolated fungal DNA.
4. To isolate plasmid DNA from bacteria by quick method.
5. To purify the DNA from agarose gel.
6. To study the Thermal cycler.
7. To study the gel documentation system.

**Course code BTE302: Agricultural Microbiology (Course credit: 3)**

**Theory**

**UNIT – I**

History, scope and development of agricultural microbiology, rhizosphere and phyllosphere: concept, importance, factors affecting microbial diversity.

**UNIT – II**

Soil health: crop residues, humus, mineralization, immobilization, soil-sickness, composting, vermicomposting, green manure. Effect of crop residues on plant growth; biodegradation of pesticides and pollutants; biodegradation fate, bioavailability, acceleration, bioremediation. Biofertilizers: types, production, formulation and constraints.

**UNIT – III**

General idea about major agricultural pests: Plant diseases- late blight potato. downy mildew of pea, stem gall of coriander, powdery mildew / rust / smut, rust of linseed, Ergot of bajara, Anthracnose of soybean, Tikka disease of groundnut, wilt of arhar, bacterial blight of paddy, citrus canker, leaf curl of papaya, little leaf of brinjal. Insects: gram, soybean. Weeds: parthenium, xanthium, waterhyacinth, cyperus, phalaris

**UNIT – IV**

Post harvest losses of agricultural products: causes, problems and management recent trends in pest management: strategies, mass production, formulation and application technology, achievements, constraints

**UNIT – V**

Biotechnology in agriculture: the new green revolution, transgenic crops, gene protection technology, frost control technology, resistant varieties. Bioconversion futurology: exploitation of agricultural wastes for food / feed and fuel.

**List of Recommended Books**

1. Soil microbiology by Subba Rao
2. Soil and microbes by Waksman and Starkey.
3. Plant pathology by Mehrotra.
4. Alexander, M. Introduction to Soil Microbiology, 3rd Edition. Wiley Eastern Ltd., New Delhi
5. Microbiology by S.S. Purohit.

**Suggested list of Practicals (Course Code BTE302: Agricultural Microbiology)**

1. Isolation and Enumeration of the microorganism from soil by serial dilution agar plate method.
2. Isolation of fungi from soil by warcup's method.
3. Isolation of azotobacter species from soil.
4. Isolation of microorganism from rhizosphere.
5. Isolation of microorganism from phyllosphere (phyloplane) by serial dilution, agar plate method or leaf impression method.
6. Plant diseases – leaf curl of papaya, rust of wheat, citrus canker, red rot of sugarcane. Study of weeds- Parthenium, water hyacinth.

**Course Code BTE303: Bioprocess Engineering and Technology (Total Credits =03)**

**A: Theory**

**UNIT-I**

Biofermentation: designing and application, principles of biofermentation, monitoring and control of parameters (pH, oxygen, agitation, temperature, foam etc.), batch & continuous; production medium, raw materials, isolations; maintenance, preservation & improvement of industrial strains, computer control of fermentation processes.

**UNIT-II**

Downstream processing: Filtration of fermentation broths, ultra-centrifugation, recovery of biological products by distillation, superficial fluid extraction.

**UNIT-III**

Industrial production of solvents: Ethyl alcohol, citric and acetic acids; enzymes; amylases, proteases, cellulases; vitamins: vitamin B12, vitamin C, antibiotics (penicillin, streptomycin, tetracycline and griseofulvin). Microbes in petroleum industry (oil recovery); immobilized cells & enzymes.

**UNIT-IV**

Microbiology of food: sources and types of microorganisms in food, food borne pathogens, microbiological examination of food, spoilage of food, food preservation, fermented foods, microbial proteins.

**UNIT-V**

Dairy microbiology: sources and types of microorganisms in milk, microbial examination of milk, pasteurization and phosphatase test, sterilization of milk, grades of milk, dairy products, fermented milk, butter & cheese.

**Recommended Books:**

1. Biochemical Engineering, Aiba, S., Humphrey, A.E. and Millis, N.F. Univ of Tokyo Press, Tokyo.
2. Biochemical Reactors, Atkinson, B: Pion Ltd. London.
3. Biochemical Engineering Fundamentals, Baily, J.E. and Ollis, D.F. McGraw-Hill Book Co. New York.
4. Bioprocess Technology: Fundamental and Application, KTH, Stockholm.
5. Process Engineering in Biotechnology, Jackson, A.T., Prentice Hall, Engelwood Cliffs.
6. Bioprocess Engineering: Basic Concepts, Shuler, M.L. and Kargi, F., Prentice Hall, Engelwood Cliffs.
7. Principles of Fermentation Technology, Stanbury, P.F. and Whitaker, A. Pergamon Press, Oxford.
8. Bioreaction Engineering principles, Nielson, J. and Billadsen, J. Plenum Press.
9. Chemical Engineering Problems in Biotechnology, Shuler, M.L. (Ed.) AICHE.
10. Biochemical Engineering, Lee, J.M. Prentice Hall Inc.
11. Bioprocess Engineering-kinetics, Mass Transport, Reactors and Gene Expression, Viet; W.F., John Wiley & Sons, Inc.

**Suggested list of Practicals (Course Code BTE303)**

1. Isolation of micro-organism from canned food.
2. Isolation of bacteria and fungi from spoiled bread.
3. Quantitative test of milk by resazurin test.
4. Quantitative estimation of Amylase production.
5. Isolation of lipase producing bacteria from soil.

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6. Isolation of phosphate solubilizing/producing bacteria from soil.
7. Estimation of antibiotic property of bacteria.

**Course Code BTE304: Biotechnology (Total Credits = 03)**

**UNIT I**

Biotechnology an Overview, Definition, Perspective and scope of biotechnological processes and products, Biotechnology and Ethics, Introduction, Medical and chemical Biotechnology, Agriculture and Food, Energy and environment and human, Bioethics, Facing problem and finding solutions, Regulating the use of biotechnology, Patenting biotechnology inventions.

**UNIT II**

Genetic Engineering and gene cloning, Introduction of genetic engineering procedure, restriction endonuclease, cloning vehicle, Vectors for animals and plants, Insertion of DNA molecule in to a vector, Direct transformation, Isolation and cloning, Transformation and growth of cells, Selection and screening of particular recombinants, Genomic library, sequencing of DNA, Gene identification and mapping, Analysis of expression of cloned genes, Polymerase chain reaction, Monoclonal Antibodies.

**UNIT III**

Plant cell and tissue cultures, Culture techniques, Protoplast fusion, Direct gene transfer, Microinjections, Nuclear transplantation, Plastid and mitochondrial genes, production of secondary metabolites by immobilized plant cell, Development of disease resistant, herbicide resistant, Salt & drought resistant plant varieties, Microbial Toxins, Introduction, Toxins gene isolation, Genetic engineering of *B. thuringiensis* strains, *Baculovirus* as biocontrol agents.

**UNIT IV**

Culturing microorganisms for the production of biomass, Production of microbial (Bacterial, Cyanobacterial and Fungal) products, Batch culture, Continuous culture, Fed-batch culture, Mass culture, Use of culture system for the production of microbial products, Production of cyanobacterial biomass for food, Feed and health care products, Improvement of microbial strains for industry, Agriculture, Immobilization of microbial cells and enzyme and its applications.

**UNIT V**

Strain improvement, bioreactor design, Reactor types, Application of immobilized cells and enzyme, improvement in bioreactor to control environment of process organism. use of microorganisms in pollution control, Waste treatment, Bioremediation, Biological removal of eutrophic nutrients, Heavy metals, Toxic chemicals (Herbicide, Insecticide and Fungicide and Other Toxicants) from waste water and industrial effluents, Utilization of waste water for the production of food and feed, Biodegradation, Biobleaching of metals, Application of microorganisms from environment

**Books recommended**

- Haekett P. B., Fuchs J. A. and Mesing J. W. (1988) An Introduction to Recombinant DNA techniques – basic experiments in gene manipulation.
- Glck B. R. and Thompson J. E. (1993) Methods in Plant Molecular Biology and Biotechnology.
- Bjorn Kristiansen, (2012) Basic Biotechnology third Edition.

**Suggested list of practicals (Course Code BTE304)**

1. Demonstration:-

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PCR  
Spectrophotometer  
pH meter  
Centrifuse  
Photomicrographic Camera

2. To prepare the media for plant tissue culture.
3. Isolation of pathogenic fungi from infected plants/Disease plants (Leaf/ Stem/ root)
4. Identification of unknown microorganism from given plates.
5. Preparation of tissue culture media.

Course Code BTS301: SKILL DEVELOPMENT MODULES 3 (Total Credits = 02)

**ENTREPRENEURSHIP DEVELOPMENT PROGRAMME AGENDA (Semester-3) TIME - 30**  
**Hrs**

1. **ORIENTATION PROGRAM FOR ENTREPRENEURSHIP**
2. **WHAT IS ENTREPRENEURSHIP**
  - Definition of Entrepreneurship
  - Be a Successful Entrepreneurship
3. **TYPE OF ENTREPRENEURSHIP**
  - Manufacturing
  - Trading
  - Service Provider
4. **NEED TO BE SUCCESSFUL ENTREPRENEURSHIP**
  - Knowledge - About work and Concern
  - Information - About sources/ market/ Customer's
  - Assets - About Technology, Place, Man power and money
5. **CHOOSING A BUSINESS -**
  - Micro Scale Unit      Small Scale Unit
  - Large Scale Unit      Mega Scale Unit
6. **MARKETING and DISTRIBUTION**
  - Definition and Type of Marketing
  - About Sales and Marketing
  - Distribution channels
7. **PRODUCT DESIGNING / BRANDING / MERCHANDIZING**
  - Research and Development
8. **FINANCIAL FLUENCY, PLANNING AND LEGAL ASPECTS**
  - Taxation
  - Rules and norms of the Govt. to run a business

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**9. GOVERNMENT SCHEMES AND ASSISTENCE**

**About financial loan / Place/ Training / Subsidy.....etc**

**10. INDUSTRY VISITS.**

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FOURTH- SEMESTER (TOTAL CREDITS = 18)

<b>DISSERTATION</b>
<b>A. Valuation</b>
1.Language & Presentation
2.Review of Literature
3.Methodology
4.Analysis & Interpretation of Results
<b>B.Viva –Voce</b>