Anekant Education Society's

Tuljaram Chaturchand College,

of Arts, Science & Commerce, Baramati

(Autonomous Institute)

Syllabus (CBCS) for T. Y. B. Sc. Microbiology

w.e.f.

June 2021

COURSE STRUCTURE FOR T. Y. B. SC. MICROBIOLOGY (w.e.f. June2021)

Sr. No.	Class	Semester	Code	Paper	Paper Title	Credit	Marks (I + E)
1	T.Y.B.Sc.	V	MICRO3501	Theory	MEDICAL MICROBIOLOGY-I	3	40 + 60
2	T.Y.B.Sc.	V	MICRO3502	Theory	GENETICS AND MOLECULAR BIOLOGY- I	3	40 + 60
3	T.Y.B.Sc.	V	MICRO3503	Theory	ENZYMOLOGY	3	40 + 60
4	T.Y.B.Sc.	V	MICRO3504	Theory	IMMUNOLOGY – I	3	40 + 60
5	T.Y.B.Sc.	V	MICRO3505	Theory	FERMENTATION TECHNOLOGY-I	3	40 + 60
6	T.Y.B.Sc.	V	MICRO3506	Theory	FOOD AND DAIRY MICROBIOLOGY	3	40 + 60
7	T.Y.B.Sc.	V	MICRO3507	Practical Course I	APPLIED MICROBIOLOGY	2	40 + 60
8	T.Y.B.Sc.	V	MICRO3508	Practical Course II	BIOCHEMISTRY	2	40 + 60
9	T.Y.B.Sc.	V	MICRO3509	Practical Course III	CLINICAL MICROBIOLOGY	2	40 + 60
10	T.Y.B.Sc.	V	Certificate course			2	40 + 60
					Total	**26**	
11	T.Y.B.Sc.	VI	MICRO3601	Theory	MEDICAL MICROBIOLOGY-II	3	40 + 60
12	T.Y.B.Sc.	VI	MICRO3602	Theory	GENETICS AND MOLECULAR BIOLOGY- II	3	40 + 60
13	T.Y.B.Sc.	VI	MICRO3603	Theory	METABOLISM	3	40 + 60
14	T.Y.B.Sc.	VI	MICRO3604	Theory	IMMUNOLOGY – II	3	40 + 60
15	T.Y.B.Sc.	VI	MICRO3605	Theory	FERMENTATION TECHNOLOGY-II	3	40 + 60
16	T.Y.B.Sc.	VI	MICRO3606	Theory	AGRICULTURAL AND ENVIRONMENTAL MICROBIOLOGY	3	40 + 60
17	T.Y.B.Sc.	VI	MICRO3607	Practical Course IV	BIOCHEMISTRY & MOLECULAR BIOLOGY	2	40 + 60
18	T.Y.B.Sc.	VI	MICRO3608	Practical Course V	HEMATOLOGY AND DIAGNOSTIC IMMUNOLOGY	2	40 + 60
19	T.Y.B.Sc.	VI	MICRO3609	Practical Course VI	PROJECT	2	40 + 60
					Total	**24**	
					Grand Total	**50**	

I: Internal Examination
E: External Examination

Class: T.Y.BSc (Semester-V)

Paper Code: MICRO3501

Paper: Theory Paper Title: MEDICAL MICROBIOLOGY - I

Credit: 3 Credits

Learning Objectives:-

- This course provides learning opportunities in medical microbiology
- To learn & understand basic etiology, pathogenesis, diagnosis and control measures of common diseases of human body system
- It provide conceptual knowledge of pathogenic microorganisms

Learning Outcome:-

Students will be able to-

- Build up progressive and successful career.
- Apply the knowledge to identify and diagnose pathogenic microorganisms
- Understands defense mechanism of human body system & different mechanisms of disease transmission
- Apply knowledge of various methods to control diseases

Credit	Topic	No of Lectures
I	**Introduction to infectious diseases of following human body systems:** (Common diseases, pathogens, symptoms, defense mechanisms) a. Respiratory system b. Gastrointestinal system c. Urogenital system d. Central nervous system	16
II	**Epidemiology:** a. Introduction, scope and overview of epidemiological monitoring organisationsa b. Disease distribution based on time, place and person c. Case control and cohort studies – study design and application d. Principle and methods – Clinical trials of drugs and vaccines (Randomized control trials, Concurrent parallel and cross-over trials) e. Epidemiology of infectious diseases	16

	i. Sources and reservoirs of infection ii. Modes of transmission of infections iii. Disease prevention and control measures	
III	**Study of following bacterial pathogens:** (with respect to - Classification and Biochemical characters, Antigenic structure, Viability characteristics, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis, Epidemiology, Prophylaxis and Chemotherapy): *a.* *Salmonella,* *b.* *Vibrio* *c.* *Neissserria* *d.* *Streptococcus* *e.* *Pseudomonas* *f.* *Spirochetes – Treponema, Leptospira* *g.* *Clostridium tetani* h. *Mycobacterium tuberculosis* and *M. leprae* *i.* *Rickettsia*	16

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1. Tortora, G.J., Funke, B.R., Case, C.L, 1992. Microbiology: An introduction 5th Edition, Benjamin Pub. Co. NY

2. Roitt, P.I: Mims, C.J. Medical Microbiology

3. Chakraborty, P., 2003 A textbook of Microbiology, 2nd Edition New Central Book Agency, India.

4. Medical Microbiology edited by Samuel Baron. Fourth Edition. (University of Texas Medical Branch of Galvesion)

5. Sherris, John C, Ed, Medical Microbiology: an Introduction to infectious diseases. Elsevier Publication II nd edition.

6. Virulence mechanisms of bacterial pathogens (Second edition) by Roth, Bolin, Brogden Minion and Michael.

7. Davis B.D., Delbacco, 1990 Microbiology 4th edition, J.B. Lippincott Co. NY

8. Wolfgang K. Joklik, 1992, Zinsser Microbiology 20th Edition, McGraw-Hill Professional Publishing.

9. Dey, N.C and Dey, TK. 1988, Medical Bacteriology, Allied Agency, Calcutta, 17th Edition

10. Ananthnarayana, R. and C.E, Jayaram Panikar, 1996 Text book of microbiology, 5th edition, Orient Longman.

Class: T.Y.BSc (Semester-V)

Paper Code: MICRO3502

Paper: Theory **Paper Title: GENETICS AND MOLECULAR BIOLOGY- I**

Credit: 3 Credits

Learning Objectives:

Microbial Genetics is an undergraduate T.Y. B.Sc. Microbiology course that deals with both conceptual and practical tools for generating, processing and understanding biological genetic information. It develops knowledge of the underlying theories of genetics which exhibits a broad understanding of central dogma. It gives an overview of replication, transcription and translation. It also deals with genome organization of prokaryotic and eukaryotic cell. This course will help students to get the basic information regarding DNA repair mechanisms which is extension of mutation which they have learned in structure transcription, translation and genetic code that they have gained in S. Y. B.Sc.

Learning Outcomes:

Students should be able to-

1. Understand the genome organization in prokaryotic cell and eukaryotic cell
2. Learn the molecular mechanism involved in DNA replication.
3. explain the molecular mechanism involved in gene expression.
4. Discuss the different types of mutations and corresponding DNA repair mechanisms
5. Apply the Bacteriophage growth kinetics in calculation of Eclipse period, latent period and burst size

Credit	Topic	No of Lectures
I	**Genome Structure and Replication** **Chapter 1: Genome organization** 1. Viral Genome structure 2. Bacterial Genome structure Concept of Nucleoid	7

	3. Eukaryotic Genome organization Structure of nucleosome,10 nm fiber,30 nm fiber, Structure of Euchromatin and heterochromatin.	
	Chapter2: Replication 1. Ori C 2. Single replicon , Multiple Replicon 3. Bidirectional movement of replication fork. 4. Pre-priming and Priming reaction. 5. DNA polymerases, DNA synthesis of leading, lagging strand 6. Okazaki fragments. 7. Termination- Ter sequence, Tus protein	8
II	**Gene Expression** **Chapter 3: Transcription --9** 1. Structure of promoters (Prokaryotic and eukaryotic) 2. Structure and types of RNA polymerases 3. Steps of transcription : Initiation, Abortive Initiation, Elongation and Termination 4. Comparison of prokaryotic and eukaryotic transcription	9
	Chapter 4: Translation 1. Role of m-RNA, t-RNA and Ribosomes and Aminoacyl tRNA synthetase in translation 2. Initiation, elongation, translocation and termination of protein synthesis 3. Comparative account of prokaryotic and Eukaryotic translation mechanism	8
III	**DNA damage and Repair mechanisms and Bacteriophage growth kinetics** **Chapter 5: DNA damage and Repair mechanisms** 1. Overview of DNA damage by hydrolysis, deamination,	7

	alkylation, oxidation, Radiation (x rays/uv rays) and Photo reactivation 2. Mismatch repair mechanism 3. Excision repair mechanisms (BER/NER) 4. Recombination repair (NHEJ/DSB repair model) 5. Translesion DNA synthesis (SOS response)	
	Chapter 6: Bacteriophage growth kinetics 1. One step growth curve and Doerman's experiment 2. Structural organization of bacteriophage chromosome (Lambda phage) 3. Bacteriophage mutants (Plaque morphology, Conditional lethal mutants) . Concept of Deletion mapping & Benzers Spot test. 4. Concept of Genetic Complementation and Cis-trans test of genetic function. 5. Fine structure mapping of rII locus of T4 phage using Complementation analysis.	9

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1. R.J.BROOKER (2012) Genetics: Analysis and Principles , 4 th edition,McGraw-Hill publication
2. Strickberger, M.W. (1985), Genetics, 3rd Edition Macmillan Pub. Co. N

3. Gardner, Simmons and Snustad (1991)Principles of Genetics, 8 th edition John Wiley and Sons Publication

4. Russel Peter. (2009), Genetics: A Molecular Approach, 3rd Edn. Publisher Benjamin Cummings 11. Russel, Peter, (1990), Essential Genetics, 7thEdn. Blackwell Science Pub. 12

5. Lodish H. et al. (2012), Molecular Cell Biology, 7th Edn. W. H. Freeman & Company. New York.

6. Russel Peter. (2009), iGenetics: A Molecular Approach, 3rd Edn. Publisher Benjamin Cummings 11. Russel, Peter, (1990), Essential Genetics, 7thEdn. Blackwell Science Pub. 12

7. Watson J.D., Baker, T.A., Bell, S.P., Molecular Biology of the gene, 7th edition. Pearson (2013)

8. Genes IX-Benjamin Lewin

9. Russel P.J., iGenetics: A molecular Approach 3rd edition. Pearson(2010)

10. Fundamentals of Molecular Biology –By J K Pal and Saroj Ghaskadabi

11. Hyman P Abedon ST (2009). Practical methods for determining Phage growth parameters.In:Clokie M R J , Kropinski A M (eds) Bacteriophage:Methods and Protocols,Volume;Isolation ,Characterisation and Interactions,Vol.501,Humana Press, New York

12. Genetics of Bacteria and their Viruses-By William Hayes

13. Brooker, R.J., Genetics: Analysis and principles. 4th Edition. McGrow Hill (2010)

14. Principles of Genetics-By Gardner

Class: T.Y.BSc (Semester-V)

Paper Code: MICRO3503

Paper: Theory **Paper Title: ENZYMOLOGY**

Credit: 3 Credits

Learning Objectives:

- To understand the mechanism of enzyme catalysis
- To learn different methods of Enzyme purification and Enzyme assays.
- To understand the theories of enzyme kinetics and the mechanisms of enzyme regulation in the cell.

Learning Outcome:

- Students will learn about structure and function of Enzymes.
- Students will show experience with Purification, handling and characterization of proteins.

Credit	Topic	Number of Lectures
I	**Enzymes** a. Methods to determine amino acid residues at active site (Physical and chemical methods). b. Role of cofactors in metabolism: Occurrence, Structure and Biochemical functions of the following: i. Nicotinic Acid (Niacin) and the Pyrimidine nucleotides. ii. Riboflavin (Vitamin B2) and the Flavin nucleotides iii. Thiamine (Vitamin B1) and Thiamine Pyrophosphate iv. Pantothenic acid and coenzyme- A v. Pyridoxal phosphate (Vitamin B6) vi. Metal ions	6 6
II	**Enzyme assays and Principles and Methods of Enzyme purification.** a. Principles of enzyme assays: Sampling methods and continuous assay, Enzymes assays with examples by: i. Spectrophotometric methods ii. Spectroflurometric methods	5

	iii. Radioisotope assay. b. Principles and Methods of Enzyme purification: Methods of cell fractionation, Principles and methods of enzyme purification: i. Based on molecular size ii. Based on charge iii. Based on solubility differences iv. Based on specific binding property and selective adsorption, Characterization of enzymes: Determination of Molecular weight based on: Ultracentrifugation, SDS-PAGE, gel filtration.	13
III	**Enzyme Kinetics and Metabolic Regulations** a. Concept and use of initial velocity, Michaelis Menton equation for the initial velocity of single substrate enzyme catalyzed reaction. Brigg's Haldane modification of Michaelis Menton equation. Michaelis Menton plot. Definition with significance of Km, Ks, Vmax, Different plots for plotting Kinetic data: i. Lineweaver and Burk plot ii. Hanes plot iii. Eadie Hofstee plot iv. Eisanthal, Cornish-Bowden plot, Concepts and types of Enzyme Inhibitions. b. Metabolic Regulations: Enzyme compartmentalization at cellular level, Allosteric enzymes, Feedback mechanisms, covalently modified regulatory enzymes (e.g. Glycogen phosphorylase), Proteolytic activation of zymogens, Isozymes - concept and examples vii. Multienzyme complex e.g. Pyruvate dehydrogenase complex (PDH). c. Immobilization of enzymes: Concept, methods of immobilization and applications.	8 8 2

References:

1. Nelson D. L. and Cox M. M. (2002) *Lehninger's Principles of Biochemistry*, Mac Millan Worth Pub. Co. New Delhi

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

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

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

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7. David A. Hall & Krishna Rao (1999) Photosynthesis (Studies in Biology) 6th Edition, Cambridge University Press, London

Class: T.Y.B.Sc (Semester-V)

Paper Code: MICRO3504

Paper: Theory **Paper Title: IMMUNOLOGY- I**

Credit: 3 Credits

A. Learning Objectives:

1.To enrich the students knowledge about immunity and infections.

2. To develop expertise in immunological processes.

3. To enrich student's knowledge and train them in immunology.

4. To understand the general and scientific responsibilities while working in medical field.

5. To develop opportunities in entrepreneurships

Learning outcome:

1. Theoretical understanding of basic immunological processes.
2. Each student would be able to understand immune mechanism of our body.
3. Students would be able to apply his knowledge to society for human welfare.
4. Establishment and development as an entrepreneur.

Credit	Topic	No. of Lectures
I	**Immunity:** Definition and Classification	**2**
	Formation of blood cells: Erythrocytic, myelocytic, monocytic and lymphocytic lineages and differentiation process, lymphocyte types and subsets	**2**
	Innate immunity: Non specific mechanisms of defense a. **First line of defense** – Physical, chemical barriers b. **Second line of defense**: i. Humoral components: Defensins, pattern recognition proteins (PRP) and pathogen associated molecular patterns (PAMPs), complement, kinins, acute phase reactants.	**2** **2**

	ii. Cellular components: Phagocytic cells – PMNL, macrophages (reticulo-endothelial cell system) and dendritic cells	**2**
	iii. Functions: Phagocytosis (oxygen dependent and independent systems), Complement activation (Classical, Alternative and lectin pathway), Inflammation	**6**
II	**Organs of immune system:** a. Primary lymphoid organs (Thymus,bone marrow and Bursa): Thymus – structure, thymic education (positive and negative selection)	**3**
	b. Secondary lymphoid organs – structure and function of spleen and lymph node, mucous associated lymphoid tissue; response of secondary lymphoid organs to antigen, lymphatic system and lymph circulation	**3**
	Antigen: a. Concepts and factors affecting 2mmunogenicity	**2**
	b. Antigenic determinants, haptens and cross-reactivity, Carriers, Adjuvants	**2**
	c. Types of antigens: Thymus-dependent and thymus-independent antigens, Synthetic antigens, Soluble and particulate antigens, Autoantigens, Isoantigens	**2**
	Immunoglobulins: a. Structure and types of Immunoglobulin's, chemical and biological properties	**2**
	b. Characteristic of domain structure, functions of light and heavy chain domains	**1**
	c. Antigenic nature of immunoglobulin molecules	**1**
III	**Adaptive / Acquired Immunity (Third line of defense):** **1. Humoral Immune Response** a. Primary and secondary response kinetics, significance in vaccination programs	**3**
	b. Antigen processing and presentation (MHC class I and class II	**6**

	restriction pathways), activation and differentiation of B-cells	
	2. Cell Mediated Immune Response a. Activation and differentiation of T cells b. Mechanism of CTL mediated cytotoxicity, ADCC c. Significance of CMI	**4**
	Transplantation and Immunity a. Types of Grafts, b. Allograft rejection mechanisms c. Prevention of allograft rejection	**3**

References:

1. Abul K. Abbas and Andrew H. Lichtman. *Basic Immunology- Functions and Disorders of Immune System.* 2nd Ed. 2004. Saunders. Elsevier Inc. PA. USA.

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*histatins***.** *Biotechnol. Lett.* 2005, **27**:1337–1347.

9. Ganz, T.: *Defensins: antimicrobial peptides of innate immunity***.** *Nat. Rev. Immunol.* 2003, **3**:710–720.

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21. Zeev Pancer and Max D. Cooper, (2006), *The Evolution of Adaptive Immunity*, Ann. Rev. Immunol., **24:** 497–518

22. kubey, *Immunology*, 5th edition.

Class: T.Y.BSc (Semester-V)

Paper Code: MICRO3505

Paper: Theory Paper Title: FERMENTATION TECHNOLOGY - I

Credit: 3 Credits

A. Learning Objectives:

1. To cater the needs of students for building up their careers in industries such as pharmaceutical, food, dairy and fermentation.
2. To develop expertise in industrial microbiological testings and processes.
3. To enrich student's knowledge and train them in industrial microbiology.
4. To understand the general and scientific responsibilities while working in industrial sector.
5. To understand the opportunities towards entrepreneurship.

B. Learning outcome:

1. Theoretical understanding of principles and basic protocols of industrial processes.
2. Laboratory exercises shall help the students to directly work in different divisions of industries.
3. Acquaintance to the several quality control tests that results into well-trained and skilled man power.
4. Establishment and development as an entrepreneur.

Credit No.	Topic	Lectures
I	**Unit 1: Strain Improvement** a. Concept & objective of strain improvement, properties other than strains' productivity, feedback control mechanisms of biosynthesis of metabolites b. Principle and methods for strain improvement: **i.** Mutation and selection: Modification of cellular permeability, isolation of auxotrophic mutants, isolation of analogue resistant mutants and revertants. **ii.** Recombinant techniques: Application of recombinant DNA technology (improvement of strains to produce heterologous and native microbial products (self cloning)	**9**

	Unit 2: Medium optimization: a. Nutritional, non-nutritional factors and responses b. Methods of medium optimization : i. Classical approach – One factor at a time, Full factorial design (with example) ii. Plackett-Burman design (with example) iii. Response Surface Methodology (RSM) *Merits and demerits of each method with comparison*	**4**
	Unit 3: Sterilization of Medium a. Methods of industrial sterilization b. Batch sterilization and Continuous sterilization c. Concept and derivation of Del factor	**3**
II	**Unit 1: Scale-up and Scale-down** a. Objectives of scale-up b. Levels of fermentation (laboratory, pilot-plant and production level) c. Criteria of scale-up for critical parameters (aeration, agitation, broth rheology and sterilization) d. Scale-down	**4**
	Unit 2: Principles and methods of downstream processing a. Cell disruption b. Filtration c. Centrifugation d. Liquid-liquid extraction e. Distillation f. Ion exchange chromatography g. Drying	**10**
	Unit 3: Quality assurance (QA) of fermentation products a. Sterility testing b. Pyrogen testing: Endotoxin detection (LAL test)	**2**
III	**Unit 1: Quality assurance (QA) of fermentation products** a. Ames test and modified Ames test b. Toxicity testing c. Shelf-life determination	**4**
	Unit 2: Quality assurance (QA) of fermentation products Detection and quantification of the product by Physicochemical, Biological and Enzymatic assays	**7**
	Unit 3: Fermentation economics a. Contribution of various expense heads to a process (Recurring and nonrecurring expenditures) citing any	**3**

	suitable example. b. Introduction to Intellectual Property Rights (IPR) - Types of IPR (patenting in fermentation industry)	**2**

References:

1. A. H. Patel. (1985), *Industrial Microbiology*, Macmillan India Ltd.
2. *Bioreactor Design and Product Yield (*1992*)*, BIOTOL series, Butterworths Heinemann.
3. Casida, L. E., (1984), *Industrial Microbiology*, Wiley Easterbs, New Delhi
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Class: T.Y.B.Sc. (Semester-V)

Paper Code: MICRO3506

Paper: Theory **Paper Title: FOOD AND DAIRY MICROBIOLOGY**

Credit: 3 Credits

Learning objectives:

- ✓ To enrich student's knowledge regarding dairy and food science
- ✓ To introduce the concepts of Applied microbiology
- ✓ To educate students about the microorganisms and their significance associated with different dairy products
- ✓ To help students build-up a progressive and successful career

Learning outcomes:

- ✓ Students will learn about various methods regarding milk and milk product as well as food sanitation and regulation
- ✓ Students will learn the concepts of applied microbiology

Credit	Topic	No of Lectures
I	**DAIRY MICROBIOLOGY**	
	Milk chemistry and constituents: • Definition and composition of milk • Types of milk (skimmed ,toned and homogenized) • Concept of clean milk • Factors affecting quality and quantity of milk • Nutritive value of milk • Physico-chemical properties of milk	**05**
	Microbiology of milk: • Common micro-organisms found in milk	**06**

	• Fermentation and spoilage of milk • Milk borne diseases	
	Preservation of milk by pasteurization and its storage: • Methods of Pasteurization – LTH, HTST, UHT • Storage specifications after pasteurization • Phosphatase test and its significance	**03**
	Microbial analysis of milk • Dye reduction test (using methylene blue and resazurin) • Total bacterial count • Brucella ring test and tests for mastitis • Somatic cell count	**04**
II	**FOOD MICROBIOLOGY**	
	Introduction to properties of food and spoilage of food **Definition of food and Classification of food** (Perishable, non-perishable, and stable). **Sensory characters of food-** • Sensory or organoleptic factors- appearance factors-(size, shape, color, gloss, consistency, wholeness,) • Textural factors-texture changes, Flavor factors (taste, smell, mouthfeel, temperature)	**04**
	Factors affecting Microbial growth in food- • Intrinsic factors- pH, water activity, O-R potential, nutrient content, biological structure of food, inhibitory substances in food. • Extrinsic factors-Temperature of storage, Relative humidity, concentration of gases.	**03**
	Sources of food spoilage microorganisms. • Contamination and spoilage of perishable foods- vegetables and	**08**

	fruits, Meat and meat products, Fish and other sea food, Egg and poultry products. • Contamination and spoilage of canned foods • Contamination and spoilage of cereals, sugars and miscellaneous foods- cereals and cereal products, sugar and sugar products, fatty acids, salad dressings, spices and condiments.	
III	**Food Preservation and food in relation to disease.**	
	Principles of food preservation • Importance of TDP, TDT, D, F, Z values • Use of low and high temperature for food preservation. • Use of chemicals and antibiotics in food preservation, • Canning • Dehydration • Use of radiation • Tetra pack technology Food grade bio preservatives	**06**
	Microbial food poisoning and food infection • Food poisoning -*Clostridium botulinum, Staph aureus, Aspergillus flavus* Food infection -*Salmonella typhimurium, Vibrio parahaemolyticus*	**04**
	Concept of Prebiotic and Probiotic and fermented food- definition, Health effects, Quality assurance, Safety, side effects and risk. Potential applications of Prebiotic, Probiotic and fermented food	**03**
	Food sanitation and regulatory authorities (ISO, FDA, WHO)	**02**

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1. William C. Frazier, Dennis C.Westhoff , N.M. Vanitha (2013) Food Microbiology, 5th edition, McGraw Hill education, India.

2. James J M, Loessner MJ, Modern Food Microbiology, 7th edition, Springer

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International Thompson publishing.

5. Early R, 2012, Guide to quality management for the food Industry, Blackie Academic and Professional2006,

6. Gupta V. 2017, The food safety and standards act 9th edition, Commercial law publishers (India) pvt. Ltd.

7. Mahindru S N,2010, Encyclopedia of food analysis.

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Class : T.Y.B.Sc. (Semester - V)

Paper Code: MICRO 3507

Paper: Practical Course – I Title: APPLIED MICROBIOLOGY

Credits: 2 Credits (Each credit = 6 Practicals)

Credit No.	Topic	Number of Practicals
I	**a.** Tests for Milk and Dairy products i. Phosphatase test ii. MBRT test iii. Test for mastitis iv. Milk fat estimation v. Standard Plate Count vi. Direct Microscopic Count/ Somatic cell count vii. Spray drying of milk (Demonstration)	**4**
	b. Laboratory scale fermentation, estimation, product recovery and yield calculation of ethanol / organic acid (any one**)**	**2**
II	a. Quality assurance tests: i. Antibiotic/ growth factor assay (agar gel diffusion technique) ii. Sterility testing of non-biocidal injectables	**2** **1**
	b. Antifungal activity of Lactic acid bacteria	**1**
	c. Isolation and identification of *Aspergillus* spp. from onions infected with black mold	**1**
	d. Isolation and identification of *Xanthomonas* spp. from infected sample	**1**

Class : T.Y.B.Sc. (Semester - V)

Paper Code: MICRO 3508

Paper: Practical Course – II Title: BIOCHEMISTRY

Credits: 2 Credits (Each credit = 6 Practicals)

Credit No.	Topic	Number of Practicals
I & II	a. Determination of absorption spectra and molar extinction co-efficient (By colorimetry/ spectrophotometry).	**1**
	b. Clinical Biochemistry - Estimations of: blood sugar, blood urea, serum cholesterol, serum proteins and albumin.	**4**
	c. Qualitative analytical tests for proteins and carbohydrates.	**2**
	d. Preparation of buffer	**1**
	e. Paper chromatography	**1**
	f. Quantitative biochemical techniques: Estimation of total carbohydrates in Flour of Different Types of Grain by Phenol-sulfuric acid method, Estimation of reducing sugar in Milk sample by DNSA method and Estimation of proteins from natural sample by Folin Lowry method.	**3**

Class : T.Y.B.Sc. (Semester - V)

Paper Code: MICRO 3509

Paper: Practical Course – III Title: CLINICAL MICROBIOLOGY

Credits: 2 Credits (Each credit = 6 Practicals)

Credit No.	Topic	Number of Practicals
I & II	a. Physical, Chemical and Microscopic examination of Clinical samples – urine, stool, pus	**3**
	b. Isolation, identification of following pathogens from clinical samples (any one pathogen from each sample) *E. coli*, *Salmonella* spp., *Pseudomonas spp.*, *Proteus* spp., *Klebsiella* spp., *Shigella* spp., *Staphylococcus spp*, *Streptococcus* spp.(for identification use of keys as well as Bergey's Manual is recommended) Antibiotic sensitivity testing of the isolates (for Gram negative and Gram Positive)	**8**
	c. Study of growth characters of isolated pathogens on following media: Mannitol Salt Agar, Wilson Blair agar, Salmonella Shigella agar, Glucose azide medium, Cetrimide agar, TSI agar	**1**

Class: T. Y. B. Sc. (Semester-VI)

Paper Code: MICRO3601

Paper: Theory Paper Title: MEDICAL MICROBIOLOGY - II

Credit: 3 Credits

Learning Objectives:-

- This course provides learning opportunities in medical microbiology.
- To learn & understand basic etiology, pathogenesis, diagnosis and control measures of diseases of human body.
- It provide conceptual knowledge of different viral, protozoan & fungal pathogenic microorganisms.

Learning Outcome:-

Students will be able to-

- Build up progressive and successful career.
- Apply the knowledge to identify and diagnose pathogenic microorganisms
- Understands different mechanisms of chemotherapeutic agents to control diseases & pathogens

Credit No.	Topic	Number of lectures
I	**Chemotherapy**	**16**
	Unit 1. Introduction to Chemotherapy: a. Desirable parameters of good chemotherapeutic agent (Selective toxicity, Bioavailibility of Drug, MIC, MBC, LD-50 value) b. Routes of drug administration	 2 1
	Unit 2. Mode of action of following antimicrobial agents on: a. Bacterial: i) Cell wall (Beta lactams, Cycloserine, Bacitracin) ii) Cell membrane (Polymyxin, Monensin) iii) Protein synthesis (Streptomycin, Tetracyclin) iv) Nucleic Acids (Nalidixic acid, Rifamycin) v) Enzyme inhibitors (Trimethoprim, Sulfa drugs) b. Fungi (Griseofulvin, Amphotericin B, Nystatin) c. Viruses (Acyclovir, Remdesivir, Zidovudine) d. Protozoa (Metronidazole, Mepacrine)	 6 2 2 1
	Unit 3. Mechanism and reasons of drug resistance	2

	Alteration in target site, Blockage of transport of drug, Inactivation of drug, Metabolic bypass	
II	**Study of protozoan and fungal parasites :**	**16**
	Unit 1. Study of following groups of parasites (with respect to – Classification, life cycle, Morphological characteristics, Viability characteristics, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis (serological diagnosis wherever applicable), Epidemiology, Prophylaxis and Chemotherapy): *a. Plasmodium* *b. Entamoeba*	5 4
	Unit 2 : Study of following groups of fungal pathogens (with respect to – Morphological and cultural characteristics, Classification, Pathogenecity, Pathogenesis, Symptoms, Laboratory diagnosis, Epidemiology, Prophylaxis and Chemotherapy): *a. Candida,* *b. Aspergillus*	4 3
III	**Study of human and animal viral pathogens**	**16**
	Unit 1: Study of human pathogenic viruses: **(with respect to – Virion characteristics, Viability characteristics, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis including serological diagnosis, Epidemiology, Prophylaxis and Chemotherapy):** a. HIV b. COVID-19 (SARS-CoV-2) virus c. Dengue virus d. Influenza virus e. Polio virus f. Rabies virus g. Hepatitis A & B virus	2 2 2 2 2 2 2
	Unit 2: Study of animal virus : **FMD** (with respect to – Virion characteristics, Viability characteristics, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis including serological diagnosis, Epidemiology, Prophylaxis and Chemotherapy):	2

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Class: T.Y.B.Sc. **Semester: VI**

Paper Code: MICRO3602 **Theory Paper Title: Genetics and Molecular Biology II**

Credits: 3 Credits (Each credits = 16 Lectures) =Total no. of Lectures 48

A. Learning Objectives:

Microbial Genetics is an undergraduate T.Y. B.Sc. Microbiology course that deals with both conceptual and practical tools for generating, processing, and understanding biological genetic information. It develops knowledge of the underlying theories of genetics which exhibits a broad understanding of genetic exchange among prokaryotes. It gives an overview of recombinant DNA technology and biotechnology applications utilising genetic manipulation.

B. Learning outcome:

1. Understand the different mode of gene transfer in prokaryotic cell
2. Understand the concept of recombination
3. use the recombination for gene mapping.
4. Solve problems based on mapping
5. Apply the recombinant DNA technology for generation of engineered DNA

Credits	Unit	Topic	No. of Lectures
I	1	**Gene Transfer** **Transformation** a) Discovery of natural transformation b) Natural transformation in gram positive bacteria (*Streptococcus pneumoniae*) c) Natural transformation in gram negative bacteria (*Haemophilus influenzae*) d) Artificial transformation	5
	2	**Transduction** a) Discovery of transduction b) Generalized transduction (P22) c) Specialized transduction (Lambda phage)	5

	3	**Conjugation** a) Discovery of conjugation b) F plasmid c) Cross $F^+ \times F^-$ d) Formation of HFr cell e) Cross HFr × F^- f) Formation of F’	6
II	**4**	**Recombination mapping** a) Definition of Recombination b) Recombination mapping: Map unit and Recombination frequency c) Mapping by co-transformation d) Mapping by co-transduction e) Mapping by conjugation (Interrupted mating experiment) f) Mapping by Tetrad analysis: 1. Mendel’s laws 2. Eukaryotic cell cycle 3. Mitosis 4. Meiosis 5. Gene mapping by Tetrad analysis in *Neurospora crassa*	1 1 2 2 2 8
III	**5**	**Recombinant DNA Technology** a. Types of restriction enzyme b. Nomenclature of restriction enzyme c. Cutting of DNA using restriction enzyme d. Vectors: Plasmid, lambda phage, Cosmid and Phagemid e. Joining of DNA: ligase, linker, adapter, Homopolymer tailing f. Transfer of recombinant DNA in to host cell: g. Screening of recombinant DNA: Insertional inactivation and Blue white assay	1 1 1 6 4 1 2

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Class: T.Y.B.Sc. **Semester: VI**

Paper Code: MICRO3603 **Theory Paper Title: Metabolism**

Credits: 3 Credits (Each credits = 16 Lectures) =Total no. of Lectures 48

- **Learning Objectives:**

1. To explaining the role of catabolic and anabolic pathways in cellular Metabolism
2. To understand the functions and transport mechanisms in cell membrane
3. To understand how organisms convert solar energy into chemical energy

- **Learning Outcome:**

1. Students will learn about Structure and function of cell membrane
2. To understand function of specific anabolic and catabolic pathways

Credit	Topics	No. of Lectures
I	**Unit 1: Membrane transport mechanisms:**	
	i. Composition and Architecture of cell Membrane	**1**
	ii. Passive transport - Diffusion, Osmosis, Facilitated transport	**3**
	iii. Active transport - Active transport systems in bacteria	**2**
	iv. Group translocation of sugars in bacteria	**1**
	v. Ionophores: Mechanism and examples	**1**
	Unit 2: Bacterial Photosynthesis:	
	i. Habitat and examples of photosynthetic bacteria	**2**
	ii. Photosynthetic apparatus	**2**
	iii. Oxygenic and Anoxygenic mechanisms	**2**
	iv. Calvin cycle and its regulation	**2**
II	**Unit 1: Bioenergetics:**	
	i. Laws of thermodynamics	**1**
	ii. Concepts of free energy, entropy	**2**
	iii. High energy compounds: Pyrophosphate, enolic phosphates, acyl phosphates, thioester compounds, and guanidinium compounds	**5**
	Unit 2: Mitochondrial electron transport chain:	
	i. Components of ETC	**1**
	ii. Arrangement of different components in the inner membrane	**2**
	iii. Structure and function of ATP synthase	**1**
	iv. Inhibitors and uncouplers of ETC	**1**
	v. Oxidative phosphorylation	**2**
	vi. Energetics of electron transport chain	**1**

III	**Biosynthesis and Degradation:** **Unit1: Chemistry, concept of polymerization of Macromolecules**: i. Polysaccharides. (Starch, Glycogen) ii. Lipids(Fatty acids, triglycerides and phospholipids)	 **4** **4**
	Unit 2: Degradation of macromolecules: i. Polysaccharides (starch, glycogen) ii. Lipids (fatty acids oxidation) iii. Proteins (urea cycle)	 **4** **2** **2**

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Class: T.Y.B.Sc. **Semester: VI**

Paper Code: MICRO3604 **Theory Paper Title: Immunology – II**

Credits: 3 Credits (Each credits = 16 Lectures) =Total no. of Lectures 48

A. Learning Objectives:

1. To enrich the students knowledge about immunity and infections.
2. To develop expertise in immunological processes.
3. To enrich student's knowledge and train them in immunology.
4. To understand the general and scientific responsibilities while working in medical field.
5. To develop opportunities in entrepreneurships.

B. Learning outcome:

1. Theoretical understanding of basic immunological processes.
2. Each student would be able to understand immune mechanism of our body.
3. Students would be able to apply his knowledge to society for human welfare.
4. Establishment and development as an entrepreneur.

Credit	Topic	No. of Lectures
I	**Unit 1: Antigen-Antibody Interactions** **Principles of interactions:** Antibody affinity and avidity, ratio of antigen antibody, lattice hypothesis and two stage theory, antigen-antibody reaction kinetics (dialysis equilibrium experiment) **Visualization of antigen antibody complexes:** a. Precipitation reactions: in fluid and in gel, immunoelectrophoresis b. Agglutination reactions: hemagglutination, bacterial agglutination, passive agglutination and agglutination-inhibition c. Immunofluorescence techniques: direct and indirect, FACS d. ELISA, biotin-avidin system e. RIA f. Jerne's hemolytic plaque assay	8
	Unit 2: Major Histocompatibility Complex a. Structure of MHC in man and mouse b.Structure and functions of MHC class–I and class–II molecules c. Polymorphism of MHC molecules d. MHC antigen typing (microcytoxicity and mixed lymphocyte reaction)	5
	Unit 3: Cytokines Types, General characters and role in immune activation, Interferons, Interleukins and TNFs	3

II	**Unit 1: Immunohematology** a. Systems of blood group antigens b. ABO system - Biochemistry of blood group substances, Bombay blood group, Inheritance of ABH antigens c. Rh system d. Laboratory methods of blood group typing, Coomb's test e. Medico-legal applications of blood groups f. Blood banking practices, transfusion reactions	10
	Unit 2: Public Health Immunology a. Types of vaccines and Antisera b. Current perspective of vaccines. c. Immunization schedules: principles, schedules in developing and developed countries	6
III	**Unit 1: Hypersensitivity** a. Immediate and delayed type hypersensitivity b. Gell and Coomb's classification of hypersensitivity – mechanism with examples for type I, II, III and IV	6
	Unit 2: Autoimmunity and Autoimmune diseases a. Immunological tolerance b. Types of autoimmune diseases c. Factors contributing development of autoimmune diseases d. Immunopathological mechanisms e. Diagnosis and treatment of autoimmune diseases: Myasthenia gravis and Rheumatoid arthritis f. Therapeutic immunosuppression for autoimmunity	7
	Unit 3: Hybridoma Technology a. Preparation, HAT selection and propagation of hybridomas secreting monoclonal antibodies b. Applications of monoclonal antibodies	3

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Class: T. Y. B. Sc. **Semester: VI**

Paper Code: MICRO3605 **Theory Paper Title: FERMENTATION TECHNOLOGY - II**

Credits: 3 Credits (Each credits = 16 Lectures) =Total no. of Lectures 48

A. Learning Objectives:

1. To cater the needs of students for building up their careers in industries such as pharmaceutical, food, dairy and fermentation.
2. To develop expertise in industrial production processes.
3. To enrich student's knowledge and train them in industrial microbiology.
4. To understand the general and scientific responsibilities while working in industrial sector.
5. To understand the opportunities towards entrepreneurship.

B. Learning outcome:

1. Theoretical understanding of principles and basic protocols of large-scale industrial production processes.
2. Laboratory exercises shall help the students to directly work in different divisions of industries.
3. Acquaintance to the several industrial production processes that results into well-trained and skilled man-power.
4. Establishment and development as an entrepreneur.

Credit No.	Topic	Lectures
I	**Unit 1: Introduction to Solid state fermentation and Submerged fermentation**	**2**
	Unit 2: Uses of following primary metabolites and their large scale production (with respect to microbial producers, production process & recovery, and flowsheet): a. Vitamins (B12 & Riboflavin) b. Amino acids (Glutamic acid & Lysine) c. Organic acids (Citric acid, Acetic acid & Lactic acid)	**4** **4** **6**
II	**Unit 1: Uses of following secondary metabolites and their large scale production (with respect to microbial producers, production process & recovery, and flowsheet):** a. Ethanol b. Alcoholic beverages (Beer & Wine) c. Antibiotics (Penicillin & Streptomycin)	**2** **4** **5**

	Unit 2: Uses of the following enzymes and their large scale production (with respect to microbial producers, production process & recovery, and flowsheet):	
	a. Amylase	**2**
	b. Protease	**2**
	c. Esterase	**1**
III	**Unit 1: Uses of the following fermentation products and their large scale production (with respect to microbes involved, production process, and flowsheet):**	
	a. Baker's and Distiller's yeast	**2**
	b. Edible mushroom	**2**
	c. Dairy products:	
	i. Cheese (Cheddar & Swiss)	**2**
	ii. Yoghurt	**1**
	Unit 2: Large scale production of the following:	
	a. Viral vaccines (Polio, Rabies)	**3**
	b. Bacterial vaccine (Tetanus toxoid)	**1**
	c. Immune Sera	**2**
	Unit 3: Steroid transformation by microbes	**3**

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Class: T. Y. B. Sc. **Semester: VI**

Paper Code: MICRO3606 **Theory Paper Title: AGRICULTURAL AND ENVIRONMENTAL MICROBIOLOGY**

Credits: 3 Credits (Each credits = 16 Lectures) =Total no. of Lectures 48

A. Learning objectives:

1. To enrich student knowledge about plants disease resistance mechanism.
2. To focus on mechanism of biological Nitrogen fixation.
3. To define biofertilizers and biopesticides along with their classes and importance with suitable examples.
4. To introduce students with different environmental terms.

B. Learning outcomes:

1. Acquaintance about plants mechanism for disease resistance will improve.
2. Understanding different techniques in agriculture to control diseases in plant.
3. Students will become familiar with different concepts of environmental microbiology
4. Application of different biofertilizers and biopesticides in field their importance over chemical fertilizer and pesticides will be understood by students.

Credit No.	Topic	Lectures
I	**Plant Pathology and Agricultural Technology**	
	UNIT 1. Plant growth improvement with respect to: a. Disease resistance b. Environmental tolerance	**4**
	UNIT 2. Methods of plant disease control a. Chemical control b. Eradication c. Biological control (employing bacterial and fungal cultures) d. Integrated pest management e. Application of viral proteins in controlling plant viral diseases f. Mycoviruses acting against fungal plant pathogens	**6**
	UNIT 3. Tools and techniques: a. Development of insect resistant plants (BT crops) b. Antisense RNA technology in plant disease control c. RNA interference (RNAi) technology in controlling plant pathogens	**6**

II	**Biofertilizers and Biopesticides**	
	UNIT 1. Mechanism of: a. Nitrogen Fixation b. Phosphate solubilization c. Potassium mobilization d. Iron chelation	**8**
	UNIT 2. Production, Methods of application and Uses of following biofertilizers: a. *Azotobacter* b. *Rhizobium* c. *Azospirillum* d. Blue green algae e. Phosphate solubilizing microorganisms	**5**
	UNIT 3. Biopesticides a. Introduction b. Types of biopesticide c. Advantages	**3**
III	**Environmental microbiology**	
	UNIT 1. Bioremediation and Bioaugmentation: **1. Bioremediation:** a. Definition b. Role of plants & Microbes in Bioremediation of: Xenobiotics and Hydrocarbons c. Genetically Modified Microorganisms in Bioremediation **2. Bioaugmentation:** a. Definition b. Use of microbial cultures and enzymes for bioaugmentation c. Applications	**6**
	UNIT 2. Bioleaching: a. Microorganisms used b. Bioleaching process c. Bioleaching of – Copper & Gold d. Advantages of Bioleaching	**4**
	UNIT 3. Nanotechnology: a. Introduction and application b. Environmental concerns of nanotechnology	**3**
	UNIT 4. Microbial Biosensors and Biochips in Environmental Monitoring: a. Definition, components, types, advantages & limitations b. Application of Biosensors and Biochips	**3**

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22. William C. Frazier, Dennis C. Westhoff, N. M. Vanitha (2013). Food Microbiology,5thEdn.McGraw-Hill Education (India).

Class: T.Y.BSc (semester-VI)
Paper code : MICRO3607
Title of Paper : Practical Course IV: Biochemistry and Molecular Biology
Credit : 2 (Each credit=6 Practicals)

Learning Objective:

1. Aim to develop expertise in practical skills in enzymology
2. Aim to provide the knowledge and practical skills in Molecular biology

Learning Outcome:

1. Students will learn about different techniques in Molecular biology & Biochemistry

Credit No.	Topic	Number of Practicals
I & II	a. Enzyme Purification:	
	i. Precipitation of amylase from fermentation broth	**1**
	ii. Dialysis	**1**
	iii. Determination of specific activity of crude and purified amylase and establishment of Purification chart	**2**
	iv. Immobilization of Invertase	**1**
	b. Isolation and enumeration of bacteriophages and study of phage morphology	**2**
	c. Genomic (bacterial) DNA isolation and estimation.	**2**
	d. Transformation of *E. coli* and selection of recombinants	**2**
	e. Visit to Research laboratory/Industry	**1**

Class: T. Y. B. Sc. **Semester: VI**

Paper Code: MICRO3608 **Paper Title: Practical Course – V Hematology and Diagnostic Immunology**

Credits: 2 Credits (Each credits = 6 Practicals) =Total no. of Practicals 12

Credits	Sr. No.	Practical Titles	No. of Practicals
I and II	**1**	**Study of permanent slides of following microbial pathogens:** *a. Entamoeba histolytica* b. *Giardia* spp. c. *Plasmodium* spp. d. *Mycobacterium* (tuberculosis and leprae)	1
	2	**Immunohematology**: a. Peripheral Blood Smear (differential WBC count) b. Blood Grouping c. Cross-matching (Major and Minor) d. Estimation of Hemoglobin by acid hematin and cyanmethaemoglobin method	1 1 1 2
	3	**Immunochromatographic tests** a. The qualitative differential detection of IgM and IgG antibodies to Dengue virus in Human serum /Plasma. b. Qualitative detection of Hepatitis B surface Antigen (Rapid card test)	2
	4	**Antigen-Antibody Interaction:** **a.** Immunoprecipitation: Double Diffusion (Ouchterlony) Technique. **b.** Agglutination: Widal Test (Rapid) **c.** Indirect Coomb's Test	1 1 1
	5	**Blood Bank / Diagnostic lab visit**	1

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2. Abbas A. K. and Litchman A. H. (2004), Basic Immunology, Functions and Disorders of Immune System, 2nd Ed., Elsevier Inc.
3. Gabriel Virella, (2001), Medical Immunology, 5th Ed., Marcel Dekker, Inc.

4. William E., Md. Paul, (2003), *Fundamental Immunology*, 5th Ed, Lippincott Williams & Wilkins Publishers.

5. Dubey R.C. and Maheshwari D.K. (2017) Practical Microbiology. 3rd Revised edition Reprint. S. Chand and Company Publishing, New Delhi.

6. Maheshwari N. (2017). Clinical Pathology Hematology and Blood Banking (For Dmlt Students). 3rd edition. Jaypee Brothers Medical Publishers. ISBN-13: 978-9386261182

7. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology, Volume I: Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education

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9. Talib V. H. (2019). Handbook Medical Laboratory Technology. 2nd edition. CBS, Publishers and Distributors Pvt. Ltd. ISBN-13: 978-8123906775

Class: T. Y. B. Sc. **Semester: VI**

Paper Code: MICRO3609 **Paper Title: Practical Course – VI Project**

Credits: 2 Credits

- The students must complete a project/dissertation work.
- Students may undertake the projects with maximum three to four objectives.
- A group of maximum four students may undertake one project.
- Each group will be supervised by a Guide.
- There will be continuous evaluation of the project during the tenure of semester VI.
- Evaluation will be done at the end of the semester VI for which students must submit a project report.
- Survey reports shall not be considered for this credit.