Maharaja Ganga Singh University, Bikaner

B. Sc. Microbiology Vocational

2025-2028

[Choice-Based Credit System]

1st Sem to 6th Sem

SYLLABUS AND
SCHEME OF EXAMINATION

SEMESTER - I

Paper Code	Paper Name	Code	L	T	P	Credit	Marks (External + Internal)	*Minimum Passing Marks (%)	Hours in a week
VMB 4.5DCCT- 11	Principles of Microbiology	DCC	3	1	0	4	100 (80 + 20)	36	6
VMB 4.5DCCP- 11	Practical	DCC	0	0	2	2	50 (40 + 10)	36	4
	Total					06	150		10 hrs.

**A candidate shall be required to obtain 36% marks to pass in theory, practical and internals separately. Internal Evaluation of 30 Marks shall include : 20 Marks of theory paper and 10 Marks of practical paper. (Internal assessment include assignment/seminar, logical thinking/application of knowledge and skills in internal assessment).

PRINCIPLES OF MICROBIOLOGY
Paper Code:- VMB 4.5 DCCT- 11

Course learning outcomes: At the conclusion of this course the students -

- Have developed a good knowledge of the development of the discipline of Microbiology and the contributions made by prominent scientists in this field.
- Have developed a very good understanding of the characteristics of different types of microorganisms, methods to organize/classify these into and basic tools to study these in the laboratory.
- Are able to explain the useful and harmful activities of the microorganisms.
- Are able to perform basic experiments to grow and study microorganisms in the laboratory.

Unit – 1	History of Microbiology - Contribution of Pioneers with special reference to Leeuwenhoek, Pasteur, Winogradsky, Jenner and Koch, Contribution of Indian microbiologists. Prokaryotic and Eukaryotic cell. General characteristics, occurrence, structure and importance of Cellular microorganisms - Algae, Fungi , Protozoa, Cyanobacteria and Mycoplasma.
Unit – 2	Structure and organization of Prokaryotic cell - Capsule, cell wall, cytoplasmic membrane, nucleoid, Ribosome, endospores, cytoplasmic inclusions, flagellum, pilli, protoplast and spheroplast, binary fission. Staining techniques; simple and differential. Gram positive and Gram negative bacteria. Endospore and capsule staining. Whittaker's five kingdom and Carl Woese's three kingdom classification systems. phylogenetic and phenetic classification, numerical taxonomy, Hierarchical taxa, Nomenclature and taxonomy of bacteria. Outline of Bergey's classification.
Unit – 3	General characteristics and Overview of Archaea. Introduction to Nanoarchaeota (Nanoarchaeum), Crenarchaeota (Sulfolobus) and Euryarchaeota [Methanogens (Methanobacterium, Methanocaldococcus), thermophiles (Thermococcus, Thermoplasma), and Halophiles (Halobacterium].
Unit – 4	Microbial Growth and multiplication; Growth curve and growth kinetics of bacteria, nutritional requirements, culture media, factors affecting growth; Physical and chemical measurement of Microbial growth. Pure cultures of bacteria, isolation methods; Control of growth of microorganisms: sterilization, disinfection, antisepsis; Physical and chemical methods of control: autoclave, hot air oven techniques, antibiotics etc. Preservation of microbial culture.
Unit – 5	Gram negative and Gram positive bacteria: characteristics and examples. *Bacillus*, *Clostridium*, *Staphylococcus*, *Streptococcus*, *Corynebacterium*, *Mycobacterium*, *Escherichia*, *Salmonella*, *Vibrio*, *Rickettsia* and *Chlamydia*.

Practical

Paper Code:- VMB 4.5 DCCP- 11

1. Introduction of Microbiology laboratory.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
3. Study of Microscope
4. Sterilization techniques.
5. Preparation of culture media (liquid & solid) for bacterial cultivation.
6. Isolation of bacteria using spread plate and streak plate method.
7. Culture of non-pathogenic and pathogenic bacteria.
8. Enumeration of bacterial culture by serial dilution and plating.
9. Staining Methods: Simple staining, Gram staining, Spore Staining and negative Staining.
10. Study and Identification of Fungal and Algal microbes

SCHEME OF THEORY EXAMINATION

SCHEME OF THEORY EXAMINATION

There shall be three (3) sections in the question paper. A paper/course will contain 5 units. The question paper shall contain following three sections.

- **Section A** (10 marks) shall contain 10 questions two from each unit. Each question shall be of 1 mark. All the questions are compulsory. Section A will contain multiple-choice / fill-in-the-blank/ very short type questions.
- **Section B** (25 marks) shall contain 5 questions (two from each unit with internal choice). Each question shall be of 5 marks. The candidate is required to answer all 5 questions. The answers should not exceed 150 words.
- **Section C** (45 marks) shall contain 5 questions, one from each Unit. Each question shall be of 15 marks. The candidate is required to answer any three questions by selecting these three questions from different units. The answers should not exceed 400 words.

SCHEME OF PRACTICAL EXAMINATION

Practical Based on Theory Papers.

Time: - 4 hrs **Maximum Marks: 40** **Minimum Marks: 13**

1. Experimental Work Major	[10]
2. Experimental Work Minor	[08]
3. Spots (Five)	[10]
4. Viva-voce	[05]
5. Practical Record	[07]

Reference Books:

1. Prescot, M.J., Harley, J.P. and Klein, D.A. Microbiology. 5th Edition WCB Mc GrawHill.
2. Black J.G.Microbiology-Principles and Explorations. JohnWiley & SonsInc.NewYork(2002).
3. Pelczar, MJ Chan ECS and Krieg NR, Microbiology McGraw-Hill.
4. Jacquelyn g. Black. Microbiology principles and explorations. John wiley &sons, inc.
5. Madigan, Martinko, Bender, Buckley, Stahl. Brocks Biology of Microorganisms. Pearson
6. Text book of Microbiology D K maheshwari & R c Dubey, S Chand Publications.
7. Text book of Microbiology Sullia & Shantharaman, Oxford Publishing House
8. Modern Concept of Microbiology H D Kumar Vikas Publishing House.
9. Microbiology P D Sharma Rastogi Publications.

SEMESTER - II

Paper Code	Paper Name	Code	L	T	P	Credit	Marks (External + Internal)	*Minimum Passing Marks (%)	Hours in a week
VMB 4.5DCCT- 22	Biochemistry and Biotechniques	DCC	3	1	0	4	100 (80 + 20)	36	6
VMB 4.5DCCP- 22	Practical	DCC	0	0	2	2	50 (40 + 10)	36	4
	Total					06	150		10 hrs.

**A candidate shall be required to obtain 36% marks to pass in theory, practical and internals separately. For Internal Evaluation of 30 Marks (20 Marks theory paper, 10 Marks practical paper} (Internal assessment include assignment/seminar, Logical thinking/application of knowledge and skills in internal assessment).

BIOCHEMISTRY AND BIOTECHNIQUES
Paper Code:- VMB 4.5 DCCT- 22

Course learning outcomes: By the end of this course the students-

- Developed a very good understanding of various biomolecules which are requiredfor development and functioning of a bacterial cell.
- Have developed understanding of the structure and function of carbohydrates, lipids and proteins, and common metabolic pathways.
- Will become well conversant with multifarious function of proteins; their role in microbial structure and metabolic pathways; will be able to calculate enzyme activity and other quantitative and qualitative parameters of enzyme kinetics; will gain knowledge about lipids and nucleic acids.
- Student will learn about various techniques used to study microbial structure, their macromolecules and functions

Unit – 1	Biochemistry of Microbes: Concepts of thermodynamics; Enthalpy, Entropy, Gibb's free energy. Energy rich compounds - ATP. Molecules of living systems- Structure, classification and functions of: Carbohydrates (mono, di, and polysaccharides), Lipids (fatty acids; (saturated, unsaturated) and triglycerides). Structure, classification and functions of: - Lipids (fatty acids; (saturated, unsaturated) and glycerides.

Unit – 2	Amino acids and proteins (Primary, secondary and tertiary); nucleotides, nucleic acids. Brief outline of nucleotide biosynthesis. Major catabolic pathways; Embden-Meyerhof pathway, Entner-Doudoroff pathway, Krebs cycle, Electron transport chain. Gluconeogenesis. Oxidative and substrate level phosphorylation.
Unit – 3	Biochemistry of enzymes: Structure of enzyme, Apoenzyme and cofactors, prosthetic group, coenzyme, Classification of enzymes. Enzyme unit, specific activity and turnover number. Mechanism of action of enzymes: Lock and key hypothesis, and Induced Fit hypothesis. Enzyme Kinetics; Michaelis-Menten Model. Effect of pH and temperature on enzyme activity. Enzyme inhibition: Allosteric Enzymes.
Unit – 4	Microscopy- Principle and applications of bright field, Dark field, Phase contrast and Electron microscope (Scanning and Transmission). Principle and applications of Paper Chromatography, Thin layer Chromatography, Adsorption Chromatography, ion exchange Chromatography, Affinity Chromatography and HPLC.
Unit – 5	Principle and applications of centrifugation, gradient, isopycnic, ultra centrifugation. Microfiltration and Ultrafiltration. Principle and applications of Colorimetery, Spectrophotometery (UV and visible) its Components, working and applications, Electrophoretic technique (agarose and polyacrylamide gel) its Components, working and applications. Isoelectric focusing, Autoradiography.

Practical

Paper Code:- VMB 4.5 DCCP- 22

1. To study the principle and applications of important instruments (biological safety cabinets, autoclave, light microscope, electron microscope, pH meter, centrifuge, electrophoresis, chromatographic instruments) used in the microbiology laboratory.
2. Determine pH of a solution using pH meter.
3. Preparation of Buffer solutions.
4. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars.
5. Estimation of Carbohydrates (Glucose).
6. Qualitative tests of Lipids and of Proteins.
7. Separation of mixtures by paper / thin layer chromatography.
8. Preparation of Agarose gel.
9. Study and calibration of spectrophotometer.
10. Study and Separation of components of a given mixture using a laboratory scale centrifuge.

SCHEME OF THEORY EXAMINATION

SCHEME OF THEORY EXAMINATION

There shall be three (3) sections in the question paper. A paper/course will contain 5 units. The question paper shall contain following three sections.

- **Section A** (10 marks) shall contain 10 questions two from each unit. Each question shall be of 1 mark. All the questions are compulsory. Section A will contain multiple-choice / fill-in-the-blank/ very short type questions.
- **Section B** (25 marks) shall contain 5 questions (two from each unit with internal choice). Each question shall be of 5 marks. The candidate is required to answer all 5 questions. The answers should not exceed 150 words.
- **Section C** (45 marks) shall contain 5 questions, one from each Unit. Each question shall be of 15 marks. The candidate is required to answer any three questions by selecting these three questions from different units. The answers should not exceed 400 words.

SCHEME OF PRACTICAL EXAMINATION

Practical Based on Theory Papers.

Time: - 4 hrs **Maximum Marks: 40** **Minimum Marks: 13**

1. Experimental Work Major [10]
2. Experimental Work Minor [08]
3. Spots (Five) [10]
4. Viva-voce [05]
5. Practical Record [07]

Reference Books:

1. Stanbury, Biochemistry
2. Voet & Voet Fundamentals of biochemistry Wiley
3. M.M. Cox, D. L. Nelson. Lehninger's principles of biochemistry.
4. Stryer. Biochemistry W H Freeman
5. Essentials Biochemistry - Satyanarayanan & Chakraborty
6. Wilson & Walker. Principles and Techniques in Practical Biochemistry.
7. K L Ghatak. Techniques And Methods In Biology PHI Publication (2011)
8. Pranav Kumar. Fundamentals and Techniques of Biophysics and Molecular Biology (2016
9. Aurora Blair. Laboratory Techniques & Experiments In Biology.Intelliz Press
10. D.T Plummer. An Introduction to Practical Biochemistry. McGraw Hill Publication 1987.

SEMESTER - III

Paper Code	Paper Name	Code	L	T	P	Credit	Marks (External + Internal)	*Minimum Passing Marks (%)	Hours in a week
VMB 4.5DCCT- 33	Molecular Biology and Genetic Engineering	DCC	3	1	0	4	100 (80 + 20)	36	6
VMB 4.5DCCP- 33	Practical	DCC	0	0	2	2	50 (40 + 10)	36	4
	Total					06	150		10 hrs.

**A candidate shall be required to obtain 36% marks to pass in theory, practical and internals separately. Internal Evaluation of 30 Marks shall include : 20 Marks of theory paper and 10 Marks of practical paper. (Internal assessment include assignment/seminar, logical thinking/application of knowledge and skills in internal assessment).

Molecular Biology and Genetic Engineering
Paper Code:- VMB 4.5 DCCT- 33

Course learning outcomes: By the conclusion of this course, the students have –

- Understood genome organization of model organisms namely *E.coli* and *Saccharomyces*, and the molecular mechanisms that underlie mutations.
- Developed a fairly good knowledge about the three well known mechanisms by which genetic material is transferred among the microorganisms namely transformation, transduction and conjugation.
- Has acquired a fairly good knowledge of the tools and the methods for genetic engineering.
- Has acquired a fairly good understanding of how these tools and methods are employed in the

laboratory for manipulation of DNA so as to make it relevant for biotechnological uses. • Students can perform isolation of DNA, amplification of any gene by PCR and its analysis by gel electrophoresis.	
Unit – 1	History of Molecular Biology and Genetic engineering, Ethical issues, Structure and Properties of DNA, Salient features of double helix, Types of DNA. RNA Structure and types. Replication of DNA: Semi-conservative mechanism of DNA replication, Enzymes and proteins involved in DNA replication. Difference in Prokaryotic and eukaryotic replication.
Unit – 2	**Gene Expression:** Transcription, Translation, Genetic code, Reverse Transcription, Gene Regulation in Prokaryotes; lac operon and tryp operon.
Unit – 3	Gene mutation, types of mutations, physical and chemical mutagens; Uses of mutations, DNA damage and repair mechanisms. Restriction endonucleases: types, properties and uses. Cloning, PCR; types and functions. Taq polymerase, RFLP, RAPD.
Unit – 4	Methods of DNA sequencing, DNA finger and foot printing, Genomic libraries, Gene cloning and cloning vectors: Definition and properties plasmid vectors: pBR and pUC series, Cosmids, BACs, YACs cloning vectors. Applications of genetic engineering.
Unit – 5	Bacterial Genetics- Conjugation, transformation and transduction, Transposons, Lytic and Lysogenic development of T4 Phage and Phage λ (lambda). Property and function of plasmids, Types of plasmids.

Practical

Paper Code:- VMB 4.5 DCCP- 33

1. Preparation of Buffer solutions
2. Preparation of Agarose gel for DNA isolation.
3. Cytochemical staining of DNA–Feulgen
4. Demonstration of Isolation of genomic and plasmid DNA from *E.coli*
5. Visualization of DNA by Agarose Gel Electrophoresis.
6. Estimations of DNA and RNA using diphenylamine and orcinol reagent, and UV spectrophotometer (A260 measurement).

SCHEME OF THEORY EXAMINATION

There shall be three (3) sections in the question paper. A paper/course will contain 5 units. The question paper shall contain following three sections.

- **Section A** (10 marks) shall contain 10 questions two from each unit. Each question shall be of 1 mark. All the questions are compulsory. Section A will contain multiple-choice / fill-in-the-blank/ very short type questions.
- **Section B** (25 marks) shall contain 5 questions (two from each unit with internal choice). Each question shall be of 5 marks. The candidate is required to answer all 5 questions. The answers should not exceed 150 words.
- **Section C** (45 marks) shall contain 5 questions, one from each Unit. Each question shall be of 15 marks. The candidate is required to answer any three questions by selecting these three questions from different units. The answers should not exceed 400 words.

SCHEME OF PRACTICAL EXAMINATION

Practical Based on Theory Papers.

Time: - 4 hrs **Maximum Marks: 40** **Minimum Marks: 13**

1. Experimental Work Major [10]
2. Experimental Work Minor [08]
3. Spots (Five) [10]
4. Viva-voce [05]
5. Practical Record [07]

Reference Books:

1. Benjamin Lewin, GeneVII, Oxford University Press, (2000).
2. Bruce Alberts, Alexander Johnson,J ulian Lewis,Martin Raff, Keith Roberts, Peter Walter, Molecular biology of the Cell, 4th Edition. Garland publishing Inc. (2002).
3. Lodish and Baltimore, Molecular Cell Biology, Scientific American PublishingInc. (2000).
4. Watson. J .D, Baker. T. A, Bell.S .P,Gann. A. Levine. M.Losick. R, Molecular Biology of Gene, 5th Edition. The Benjamin/Cumming Pub.Co.Inc. (2003).
5. Brown T.A., Gene Cloning and DNA analysis. 2nd Edition, ASMpress. (2004).
6. Sandy Primrose. Principles of Gene Manipulation and Genomics. 7th Ed., Blackwell Publishers. (2006). 7. Glick BR and Pasternak JJ , Molecular Biotechnology, ASM press.
7. Cell and Molecular Biology, S C Rastogi, New Age International Publisher.
8. Essentials of Molecular Biology Sahu, kalyani Publishers
9. Russel P J, Essential genetics, Blackwell Science Inc, 2 sub edition, (1987).

SEMESTER - IV

Paper Code	Paper Name	Code	L	T	P	Credit	Marks (External + Internal)	*Minimum Passing Marks (%)	Hours in a week
VMB 4.5DCCT- 44	Soil, Agriculture and Environmental Microbiology	DCC	3	1	0	4	100 (80 + 20)	36	6
VMB 4.5DCCP- 44	Practical	DCC	0	0	2	2	50 (40 + 10)	36	4
	Total					06	150		10 hrs.

**A candidate shall be required to obtain 36% marks to pass in theory, practical and internals separately. Internal Evaluation of 30 Marks shall include: 20 Marks of theory paper and 10 Marks of practical paper. (Internal assessment include assignment/seminar, Logical thinking/application of knowledge and skills in internal assessment).

Soil, Agriculture and Environmental Microbiology
Paper Code:- VMB 4.5 DCCT- 44

- **Course learning outcomes:** By the completion of this course, the students –
- Have developed a fairly good knowledge and understanding of different types of environments and habitats where microorganisms grow including the microbiomes of the human gut and animal gut.
- Are able to identify the important role microorganisms play in maintaining healthy environment by degradation of solid/liquid wastes; how these activities of microorganisms are used in sewage treatment plants, production of activated sludge and functioning of septic tanks Have understood the significance of BOD/COD and various tests involving use of enumerating fecal *E.coli* for assessing

quality of water. • Have developed the practical skills for conducting experiments to assess the BOD/COD of wastewaters and their interpretation; practically assess the portability of drinking water by the use of standard microbiological tests.	
Unit – 1	Physical and chemical characteristics of soil, Microflora of soil, Rhizosphere, Phyllosphere, Microflora of fresh water and marine habitats, Aeromicroflora. Microbial interactions- Symbiosis, Mutualism, Commensalism, Competition, Amensalism, Synergism, Parasitism, Predation.
Unit – 2	Biological nitrogen fixation, Nitrogen fixing organism, symbiotic and non -symbiotic nitrogen fixation, Bio-fertilizers, Mycorrhiza. Rumen Microbiology. Organic matter decomposition, Microbial decomposition of plant material: Cellulose and lignin.
Unit – 3	Major biogeochemical cycles and microorganism involved - Carbon, Nitrogen, Phosphorus and Sulphur. A brief account of Biodegradation, Xenobiotics, Bioaccumulation, Bio -deterioration, Bioremediation and Biomagnification.
Unit – 4	Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and Biogas production). Liquid waste management: BOD and COD, Primary, secondary (oxidation ponds, trickling filter, activated sludge process) and tertiary sewage treatment.
Unit – 5	Plant disease management: Casual agent, Symptoms and control measures of the diseases. TMV, Citrus canker, Green ear, Tikka and mycoplasmal diseases. Microorganisms as biocontrol agents. Microbial pesticides herbicides and weedicides, GM crops: Bt crops, golden rice.

Practical

Paper Code:- VMB 4.5 DCCP- 44

1. Analysis of soil pH, moisture content, water holding capacity.
2. Isolation of Microorganisms from soil.
3. Enumeration of microorganisms in soil by serial dilution method.
4. Isolation of Rhizosphere microflora.
5. Study of Phylloplane microflora (leaf impression method).
6. Preparation of slides of N-fixing bacteria from root nodules.
7. Assessment of microbiological quality of water.
8. Determination of BOD of wastewater sample.

SCHEME OF THEORY EXAMINATION

There shall be three (3) sections in the question paper.A paper/course will contain 5 units. The question paper shall contain following three sections.

- **Section A** (10 marks) shall contain 10 questions two from each unit. Each question shall be of 1 mark. All the questions are compulsory. Section A will contain multiple-choice / fill-in-the-blank/ very short type questions.
- **Section B** (25 marks) shall contain 5 questions (two from each unit with internal choice). Each question shall be of 5 marks. The candidate is required to answer all 5 questions. The answers should not exceed 150 words.
- **Section C** (45 marks) shall contain 5 questions, one from each Unit. Each question shall be of 15 marks. The candidate is required to answer any three questions by selecting these three questions from different units. The answers should not exceed 400 words.

SCHEME OF PRACTICAL EXAMINATION

Practical Based on Theory Papers.

Time: - 4 hrs **Maximum Marks: 40** **Minimum Marks: 13**

1. Experimental Work Major [10]
2. Experimental Work Minor [08]
3. Spots (Five) [10]
4. Viva-voce [05]
5. Practical Record [07]

Reference Books:

1. Medigan, M.T., Martinko, J. M. and Parker, J. Brock Biology of Microorganisms. Pearson Education Inc. , New York
2. Alexander, M John. Microbial ecology. Wiley & Sons, Inc., New York.
3. Alexander, M John. Introduction to soil microbiology.Wiley & Sons Inc., New York.
4. Barker, KH, and Herson, D.S. Bioremediation. Mc Craw Hill Inc., New York.
5. Pelczar, MJ Chan ECS and Krieg NR, Microbiology McGraw-Hill.
6. Willey, Sherwood, Woolverton. Prescott, Harley, and Klein's Microbiology McGraw-Hill publication
7. Tortora, Funke, Case. Microbiology. Pearson Benjamin Cummings.
8. Jacquelyn Black. Microbiology Principles and explorations. JOHN WILEY & SONS, INC.
9. Madigan, Martinko, Bender, Buckley, Stahl. Brock Biology of Microorganisms. Pearson
10. Mehrotra R S and Ashok Agrawal. Plant Pathology. Tata Mc Graw Hill ,6th reprint (2006).
11. K. S. Bilgrami, H. C. Dube. A textbook of modern pathology. 6th Eds ,Vani Educational.

SEMESTER - V

Paper Code	Paper Name	Code	L	T	P	Credit	Marks (External + Internal)	*Minimum Passing Marks (%)	Hours in a week
VMB 4.5DCCT- 55	Industrial and Applied Microbiology	DCC	3	1	0	4	100 (80 + 20)	36	6
VMB 4.5DCCP- 55	Practical	DCC	0	0	2	2	50 (40 + 10)	36	4
	Total					06	150		10 hrs.

**A candidate shall be required to obtain 36% marks to pass in theory, practical and internals separately. Internal Evaluation of 30 Marks shall include:20 Marks of theory paper and 10 Marks of practical paper} (Internal assessment include assignment/seminar, Logical thinking/application of knowledge and skills in internal assessment).

Industrial and Applied Microbiology
Paper Code:- VMB 4.5 DCCT- 55

Course learning outcomes: By the conclusion of this course, the students –

- Will be capable to understand the industrial fermentation processes.
- Would have developed an understanding of different types of reactors or fermenters which are used

for laboratory, pilot and industrial scale fermentations and their processes parameters. • Would have acquired a fairly good knowledge of how microbes are used in the fermentative production of organic acids, alcohols, enzymes, antibiotics and various foods in the industry. • Would have acquired knowledge of various physical parameters which affect production of industrial products by the microorganisms and the safety aspects of the production and use of these products. • Would have developed laboratory skills in producing alcohol and enzymes by fermentative process using bacteria/yeast; Laboratory skills of testing microbial load in milk.	
Unit – 1	Brief history and developments in industrial microbiology. Industrial strains, their sources, strategies for selection, improvement, preservation and maintenance, types of fermentation: Solid-state and submerged; batch, fed-batch , and continuous fermentations. Fermentation media.
Unit – 2	Design and Components of a typical bio-reactor, Operation and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration Types of bioreactors- constantly stirred tank and air-lift fermenters. Down-stream processing; Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying.
Unit – 3	Industrial production of organic acid (Succinic, Lactic acid), Enzymes (Amylase, Protease, Cellulase), Alcohol (Ethanol, Butanol), Antibiotics (Penicillin, Streptomycin), Microbial production of vitamins-Riboflavin, Niacin and Vitamin-C. Microbiology of milk, Preservation of milk and milk products, Production of fermented dairy Products-Acidophilus milk, cheese, yogurt.
Unit – 4	Food microbiology-, Preservation of food, Sources of food spoilage, Food infection and intoxication, control of food borne microorganism, Role of microbes in preparation of Sauerkraut, bread and pickles, Single cell protein, Mushroom production. Alcoholic beverages (beer and wine).
Unit – 5	Microbes in production of Vaccines: genetic and recombinant vaccines, Bio-gums, Bio-chips and Bio-plastics. Bioinformatics: Introduction, Primary and Secondary databases, Sequence elucidation for proteins and DNA by software. BLAST AND FASTA.

Practical

Paper Code:- VMB 4.5 DCCP- 55

1. Study different parts of fermenter.
2. Isolation of common microorganisms their standard plate count from milk.
3. MBRT of milk samples.
4. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
5. Isolation of any foodborne bacteria from food products.
6. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
7. Isolation of spoilage microorganisms from bread.
8. Preparation of Yogurt.

SCHEME OF THEORY EXAMINATION

There shall be three (3) sections in the question paper.A paper/course will contain 5 units. The question paper shall contain following three sections.

- **Section A** (10 marks) shall contain 10 questions two from each unit. Each question shall be of 1 mark. All the questions are compulsory. Section A will contain multiple-choice / fill-in-the-blank/ very short type questions.

- **Section B** (25 marks) shall contain 5 questions (two from each unit with internal choice). Each question shall be of 5 marks. The candidate is required to answer all 5 questions. The answers should not exceed 150 words.
- **Section C** (45 marks) shall contain 5 questions, one from each Unit. Each question shall be of 15 marks. The candidate is required to answer any three questions by selecting these three questions from different units. The answers should not exceed 400 words.

SCHEME OF PRACTICAL EXAMINATION

Practical Based on Theory Papers.

Time: - 4 hrs **Maximum Marks: 40** **Minimum Marks: 13**

1. Experimental Work Major	[10]
2. Experimental Work Minor	[08]
3. Spots (Five)	[10]
4. Viva-voce	[05]
5. Practical Record	[07]

Reference Books:

1. Richard H. Baltz. Julian E Davies and Arnold L. Demain Manual of Industrial Microbiology and Biotechnology. 3rd edition, ASM Press (2010).
2. Daniel Forciniti. Industrial Bioseperation: Principles and practice. 1st edition, Wiley Blackwell (2008).
3. Reed. G. Prescott and Dunn's Industrial Microbiology. CBS Publishers. (1999).
4. Demain, A. L. Industrial Microbiology and Biotechnology. 2nd Edition. (2001).
5. EL Mansi. E.M.T. Fermentation Microbiology and Biotechnology. 2ndEdition,CRC Taylor & Francis (2007).
6. Waites,M.J.,Morgan, N.L.,Rockey, J.S.and Higton,G. Industrial Microbiology: An lntroduction. Blackwell Science Publishers (2002).
7. Casida LE, Industrial Microbiology, J. Wiley, (1968).
8. Pelczar, MJ Chan ECS and Krieg NR, Microbiology McGraw-Hill.
9. Willey, Sherwood, Woolverton. Prescott, Harley, and Klein's Microbiology McGraw-Hill Publications.
10. Tortora, Funke, Case. Microbiology. Pearson Benjamin Cummings.

SEMESTER - VI

Paper Code	Paper Name	Code	L	T	P	Credit	Marks (External + Internal)	*Minimum Passing Marks (%)	Hours in a week
VMB 4.5DCCT- 66	Virology and Immunology	DCC	3	1	0	4	100 (80 + 20)	36	6
VMB 4.5DCCP - 66	Practical	DCC	0	0	2	2	50 (40 + 10)	36	4
	Total					06	150		10 hrs.

**A candidate shall be required to obtain 36% marks to pass in theory, practical and internals separately. Internal Evaluation of 30 Marks shall include: 20 Marks of theory paper and 10 Marks of practical paper} (Internal assessment include assignment/seminar, Logical thinking/application of knowledge and skills in internal assessment).

Virology and Immunology
Paper Code:- VMB 4.5 DCCT- 66

Course learning outcomes: By the completion of this course, the students would –

- Understood what are viruses and the chemical nature of viruses, different types of viruses infecting animals, plants and bacteria (bacteriophages).
- Gain knowledge of a variety of plant viruses and animal viruses.
- Acquire a fairly good understanding of normal microflora of human body, common diseases caused by bacteria, viruses and other microbes.
- Understood the basic components of the immune system and how this system serve to protect the host against disease-causing microbes.

Unit – 1	Virology: general properties and discovery of viruses, concept of viroids, virusoids and Prions. Structure and chemical nature of Viruses. Classification and nomenclature of different groups of viruses. Replication of viruses, T4 phage, lytic and lysogenic phages (lambda phage.)
Unit – 2	Cultivation of viruses, Haemagglutination and plaque assay. Viral transmission. Salient features of Influenza and Hepatitis B virus, HIV, polio virus, retro-viruses, TMV, Cauliflower Mosaic Virus. Oncogenic viruses.
Unit – 3	Historical background of immunology, innate and acquired immunity, humoral and cell mediated immunity, Lymphoid Organs, cells of immune system. Immune response (primary and secondary), Cytokines.
Unit – 4	MHC, Antigens- Types and characteristics. Immunoglobulin structure and properties, Monoclonal antibodies, antigen-antibody reactions, complement fixation, complement system.
Unit – 5	Immunofluorescence methods, ELISA and radioimmunoassay, Hypersensitivity and its types, mechanism. Autoimmune diseases. Immunodeficiency diseases.

Practical
Paper Code:- VMB 4.5 DCCP- 66

1. Study of the structure of important viruses (influenza, retroviruses, caulimosac, tobacco, ϕX174) using electron micrographs.
2. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample. using double agar layer technique.
3. Study of cytopathic effects of viruses using photographs.
4. Determination of antibiotic sensitivity test of bacteria.
5. Blood cell counting by Haemocytometer.
6. Determine the blood group of Human blood sample.
7. Demonstration of antigen-antibody interactions.
8. Demonstration of Enzyme linked immunoassay.

SCHEME OF THEORY EXAMINATION

There shall be three (3) sections in the question paper.A paper/course will contain 5 units. The question paper shall contain following three sections.

- **Section A** (10 marks) shall contain 10 questions two from each unit. Each question shall be of 1 mark. All the questions are compulsory. Section A will contain multiple-choice / fill-in-the-blank/ very short type questions.

- **Section B** (25 marks) shall contain 5 questions (two from each unit with internal choice). Each question shall be of 5 marks. The candidate is required to answer all 5 questions. The answers should not exceed 150 words.
- **Section C** (45 marks) shall contain 5 questions, one from each Unit. Each question shall be of 15 marks. The candidate is required to answer any three questions by selecting these three questions from different units. The answers should not exceed 400 words.

SCHEME OF PRACTICAL EXAMINATION

Practical Based on Theory Papers.

Time: - 4 hrs	**Maximum Marks: 40**	**Minimum Marks: 13**
1. Experimental Work Major	[10]	
2. Experimental Work Minor	[08]	
3. Spots (Five)	[10]	
4. Viva-voce	[05]	
5. Practical Record	[07]	

Reference Books:

1. Bernard, Davis B. Dulbecco, Eisen and Ginsberg. Microbiology including immunology and molecular Genetics. 3rd Edition
2. Roitt I. Essential Immunology. 10th Ed. Blackwell Science.
3. Kuby. Immunology. 4th edition. W. H. Free man & company.
4. Ananthanarayan and Paniker. Text book of microbiology. University press. 8th edition
5. Pelczar, MJ Chan ECS and Krieg NR, Microbiology McGraw-Hill.
6. Willey,Sherwood,Woolverton. Prescott,Harley, and Klein's Microbiology McGraw-Hill Tortora,Funke,Case. Microbiology.Pearson Benjamin Cummings.
7. JACQUELYN G. BLACK. Microbiology Principles and explorations. JOHN WILEY & SONS,
8. Madigan,Martinko, Bender,Buckley,Stahl.Brock Biology of Microorganisms. Pearson
9. Tom Besty, D.C Jim Koegh. Microbiology Demystified McGRAW-HILL.
10. Stainier R.V., Ingraham, J.L., Wheelis, M.L. and Painter P.R. The Microbial World. Printice-Hall of India (Pvt.) Ltd., New Delhi
11. Ellen Strauss, James Strauss.Viruses and Human Disease 2nd Edition. Academic Press.