SCHEME OF EXAMINATION

AND

COURSE OF STUDY

IN

DEPARMENT OF BOTANY & MICORBIOLOGY
GURUKULA KANGRI VISHWAVIDYALAYA, HARIDWAR – 249404
(Deemed to University u/s 3 of UGC Act 1956)

M.Sc. MICROBIOLOGY

(w. e. f. July 2019 onwards)

Schedule of Semesters

Semester	Duration	Examination
First	July-November	December
Second	January-April	April/May
Third	July-November	December
Fourth	January-April	May/June

There will be one week preparatory leave, but inter-semester breaks between theory and practical examinations shall be for 6 days including holidays.
Practical examinations in first, second and third semesters will be held for 8 hours each carrying 100 marks. In the fourth semester project work/industrial training of 3-4 months duration will be carried out in any National laboratory or Industry (entrepreneurship). Every student has to submit the **Project report** by 15th May in the same session, which will be evaluated by an external examiner through seminar and *viva voce*examination.

Revised Syllabus w. e. f. 2018-19
Gurukula Kangri Vishwavidyalaya, Hardwar (Deemed to University u/s 3 of UGC Act 1956)
M.Sc. I, II Year
M.Sc. MICROBIOLOGY

S.N	Subject Code	Subject Title	Period Per Week			Evaluation Scheme					Subject Total
							Sessional			ESE	
			L	T	P	Credit	CT	TA	Total		
M.Sc. I Year											
Semester – I											
1	MMB-C101	Fundamentals of Microbiology	3	1	-	4	20	10	30	70	100
2	MMB-C102	Virology	3	1	-	4	20	10	30	70	100
3	MMB-C103	Microbial Physiology and Biochemistry	3	1	-	4	20	10	30	70	100
4	MMB-C104	Environmental Microbiology	3	1	-	4	20	10	30	70	100
5	MMB-C151	Lab Course –I : Based on MMB-C101 & MMB-C102	-	-	8	4	20	10	30	70	100
6	MMB-C152	Lab Course –II : Based on MMB-C103 & MMB-C104			8	4	20	10	30	70	100
						24					600
Semester – II											
1	MMB-C201	Molecular Biology and Recombinant DNA Technology	3	1	-	4	20	10	30	70	100
2	MMB-C202	Microbial Genetics & Genomics	3	1	-	4	20	10	30	70	100
3	MMB-C203	Food Microbiology	3	1	-	4	20	10	30	70	100
4	MMB-C204	Industrial Microbiology	3	1	-	4	20	10	30	70	100
5	MMB-C251	Lab Course –III : Based on MMB-C 201 & MMB-C 202	-	-	8	4	20	10	30	70	100
6	MMB-C252	Lab Course –IV : Based on MMB-C 203 & MMB -C204			8	4	20	10	30	70	100
						24					600
										Total	1200
M.Sc. II Year											
Semester – III											
1	MMB-C301	Immunology	3	1	-	4	20	10	30	70	100
2	MMB-C302	Medical Microbiology	3	1	-	4	20	10	30	70	100
3	MMB-E301	Elective I Mycology*	3	1	-	4	20	10	30	70	100
4	MMB-E302	Elective II Pharmaceutical Microbiology*	3	1	-	4	20	10	30	70	100
5	MMB-E303	Elective III Cellular Microbiology*	3	1	-						
6	MMB-E304	Elective IV Agricultural Microbiology*	3	1	-						
7	MMB-E305	Elective V Microbial Ecology*	3	1	-						
8	MMB-C351	Lab Course –V: Based on MMB-C 301 & MMB -C302**			8	4	20	10	30	70	100
9	MMB-E352	Lab Course –VI: Based on any two elective papers**			8	4	20	10	30	70	100
						24					600
Semester – IV											
1	MMB-C460	Industrial Training/Project report Project Evaluation Seminar Viva-voce				20	-	-	-		 300 100 100
						20					500
										Total	1100
						92				**G Total**	2300

*- -- Select any two electives out of the five electives (MMB-E301 to MMB-E305)
**--- Practicals will be based on theory papers.

L = Lecture T = Tutorial P = Practical
CT= Cumulative Test TA= Teacher Assessment ESE= End Semester Examination

M.Sc. MICROBIOLOGY

L = Lecture T = Tutorial P = Practical
CT = Cumulative Test TA = Teacher Assessment
ESE = End Semester Examination

M.Sc. I Year **Semester – I**

MMB -C101
FUNDAMENTALS OF MICROBIOLOGY

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L T Credit Pass Marks : 40
3 1 4

NOTE: Questions of theory paper are to be set under three sections i.e., A, B, and C. **Ten objective/multiple choice questions** (MCQs) uniformly distributed from the entire syllabus are to be set for section A. In Section B, the student has to answer any five questions out of **ten short answer questions** (100 words) uniformly distributed from the entire syllabus. Eight **long answer/questions descriptive** questions uniformly distributed from the entire syllabus are to be set for section C andthe student has to answer any four questions.Section A, B, and C will be of 10, 20, and 40 marks respectively. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT – I

Emergence of Microbiology as a Discipline:-Vedic Microbiology: Agnihotra- A vedic technology for environmental purification; Origin of Earth in reference to veda, different terms used for microbes. Distribution of microorganisms, microbes and diseases, control of microbial diseases described in Vedas, Scope and application of Microbiology, Golden age of Microbiology, contributions of, Leeuwenhoek, Winogradsky, Fleming, Waksman, Landsteiner, Nicholas Appert, Joseph Lister, Louis Pasteur, Robert Koch, E. Jenner, Ivanovski, Beijerinck,, control of microorganism - physical and chemical, study of microbial structure: light, dark field, phase-contrast, fluorescence, and electron microscope, staining techniques - simple, differential, flagella, endospore, capsule. **(15 Lecture)**

UNIT – II

Classification of Microorganisms: Haeckel's three kingdoms, Whittaker's five kingdoms, Carl Woese classification , ribosomal RNA in microbial taxonomy, concept of microbial species; classification and salient features of bacteria on the basis of *Bergey's Manual of Determinative Bacteriology*. **(11 Lecture)**

UNIT – III

Prokaryotic cell structure and function: Morphological types –size, shape and arrangements; cytoplasmic matrix, prokaryotic cytoskeleton, plasma membrane, gas vacuole, ribosomes, inclusion bodies, nucleoid, periplasmic space, cell envelope, Gram positive and Gram negative cell wall, capsules or slime layers, fimbriae and pili, flagella, endospore,Archaeal cell wall.**(12 Lect.)**

UNIT – IV

Eukaryotic cell structure and function: Plasma membrane, cytoplasmic matrix, microfilaments, intermediate filaments and microtubules, endoplasmic reticulum, ribosomes, Golgi apparatus, lysosomes, mitochondria, chloroplasts, nucleus, nucleolus, cell wall and pellicle, cilia and flagella, vacuole. **(11 Lecture)**

UNIT – V

Non proteobacteria: General characteristics with examples, low G+C (Firmicutes), high G+C (actinobacteria), cell structure, characteristics features with examples, economic importance in agriculture and industry, cyanobacteria- occurrence, heterocyst, economic importance of cyanobacteria. **(11 Lecture)**

Suggested Reading

1. Dubey R.C**.** and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. Cappachino. Microbiology- A laboratory Manual, Pearson Education India ISBN: 978-9332535190
3. Powar and Daginawala. General Microbiology Vol1 and Vol2, Himalaya Publishing House,**ISBN-13:** 978-9350240892
4. Dubey, R.C. and Maheshwari, D.K. *Practical Microbiology*. 2nd ed., S. Chand & Co. P Ltd, New Delhi, p. 413. ISBN: 81:219-2559-2

M.Sc. I Year **Semester – I**

MMB - C102
VIROLOGY

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L T Credit Pass Marks : 40
3 1 4

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UNIT – I

General features –Discovery of viruses, nomenclature and classification, distinctive properties, morphology, ultrastructure, capsid and its arrangements, types of envelops and its composition; viral genomes; viroids– host range, genome and origin of viroids; cynophages- morphology, growth cycle, mycoviruses- types of mycoviruses, replication, example of mycoviruses (mycoviruses of mushrooms and pathogenic fungi); prions- spread of prions and diseases. **(15 Lectures)**

UNIT – II

Diagnostic microbiology – Isolation and cultivation of viruses- in embryonated eggs, cell cultures and cell lines, isolation and cultivation of bacteriophages and cyanophages; serological methods– haemagglutination, complement fixation, immunofluorescent method, ELISA and radioimmunoassay (RIA); assay of viruses- infectivity assay (plaque method, end point method); diagnostic techniques used for identification of viruses in seeds, seed stocks and diseased plants (e.g. seed symptomology, serological methods, histochemical tests and fluorescent microscopy) **(15 Lectures)**

UNIT – III

Bacteriophages- Structural organization, multiplication cycle; one step growth curve; DNA replication, eclipse phase, phage production, burst size, lysogenic cycle, bacteriophage typing, M13, Mu, T4, Φx174, phage λ;application of bacteriophages in health- bacteriophage therapy. **(10 Lectures)**

UNIT – IV

Plant Viruses– Classification and nomenclature of plant viruses; disease symptoms- histology, physiology and cytology of plants; common virus disease of paddy, tomato and sugarcane; type species of plant viruses (e.g. TMV, cauliflower mosaic virus, potato virus X, potato virus Y), transmission of plant viruses, indicator plants, prevention of crop-loss using virus-free planting material. **(10 Lectures)**

UNIT – V

Animal Viruses- Classification, nomenclature, multiplication of animal and human viruses; *RNA viruses*- picornaviruses, orthomixoviruses, paramyxoviruses, arthropod- borne viruses, rhabdoviruses, rotaviruses, HIV and other oncogenic viruses; *DNA viruses* – poxviruses, herpesviruses, adenoviruses, SV40, hepatitis B virus. **(10 Lectures)**

Suggested Reading

1. Mackie and McCartney. Practical Medical Microbiology, Elsevier
2. S. Rajan. Virology, Saras Publication.
3. CKJ Paniker. Test Book of Microbiology, Orient Longman

M.Sc. I Year **Semester – I**

MMB - C103
MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L T Credit Pass Marks : 40/
3 1 4

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UNIT – I

Carbohydrate Metabolism- Oxidation–reduction reactions; anabolism, catabolism, ATP (phosphorylation, oxidative phosphorylation, substrate level phosphorylation),metabolic pathways- glycolysis, pentose phosphate pathway, Entener Doudoroff pathway, TCA cycle, Glyoxalate cycle. **(13 Lectures)**

UNIT – II

Enzymes- Classification, enzyme components, mechanism of enzyme action, types of mechanisms, allosteric enzymes and their mechanism of action. **(8 Lectures)**

UNIT – III

Nitrogen Metabolism and Nutrient Transport: Assimilation of nitrates, ammonia assimilation; amino acid biosynthesis- glutamate family, serine family, aspartate family, histidine biosynthesis; nutrient uptakes of solutes into cells, active transport and group translocation; transport of iron. **(10 Lectures)**

UNIT – IV

Bacterial Photosynthesis: Classification of photosynthetic bacteria, oxygenic and anoxygenic photosynthetic bacteria, phytosynthetic pigments, bacteriochlorophyll, bacterirhodopsin, phycobilins; metabolism in phytosynthetic bacteria; phytosynthetic electron transport system; mechanism of photosynthesis, cyclic and non-cyclic photophosphorylation, dark reaction (Calvin–Benson cycle). **(14 Lectures)**

UNIT – V

Nitrogen Fixation: Symbiotic nitrogen fixation systems- root nodulating symbiotic bacteria, process of root nodule formation, leghemoglobulin; free-living and associative N_2 fixing bacteria, metabolism of N_2 fixation, (anaerobic microorganisms, cyanobacteria, free-living aerobic and symbiotic microorganisms); genetics of nitrogen fixing bacteria, *nif* genes and their regulation, nitrogen fixation mechanisms, nitrogenase types– structure and function; alternative nitrogenase, substrates for nitrogenase, actinorhizal nodules, oxygen protection in nodules. **(15 Lectures)**

Suggested Reading

1. Roger Y. Stanier, John L. Ingraham. General Micobiology, Palgrave Macmillan, **ISBN-13:** 978-0333763643
2. Dubey R.C**.** and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
3. Powar and Daginawala. General Microbiology Vol1 and Vol2, Himalaya Publishing House,**ISBN-13:** 978-9350240892
4. M.T.Madigan, J.M.Mahinko Jack Parkar Brock: Biology of Microorganisms, Pearson Education ISBN 978-9332586864

MMB - C104
ENVIRONMENTAL MICROBIOLOGY

Sessional : 30

MM : 100
Time : 3 hrs ESE : 70
L T Credits Pass Marks : 40
3 1 4

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UNIT - 1

Aeromicrobiology : Adaption of microorganism to the air environment, Bioaerosol: Sources, survival and spread, Biological aerosol as a source of human diseases**,** Droplet nuclei, aerosol, assessment of air quality, brief account of air-borne microbes-bacteria, fungi, viruses, their diseases and preventive measures; phylloplane and phyllosphere microflora. Detection of microbes in air by microscopic and culture methods. **(10 Lectures)**

UNIT – II

Soil Microbiology: Soil-physical and chemical characteristics, soil as a habitat for microorganisms, microflora of various soil types, rhizosphere and rhizoplane microflora and its estimation, root exudates, its composition and effects on plants; actinorrhiza; mycorrhizal fungi and its effect on plants; molecular markers for ecological study of soil microorganisms.

(13 Lectures)

UNIT – III

Aquatic Microbiology : Water ecosystems- types, fresh water, (pond, lakes), marine habitats (estuaries, deep sea, hydrothermal vents); eutrophication, food chain; potability of water, microbial assessment for water quality, water purification, physical, chemical, microbiological characteristics of sewage. **(10 Lectures)**

UNIT – IV

Waste Treatment – Types of wastes–, characterization of solid and liquid wastes, physical, chemical and biological (aerobic, anaerobic- primary, secondary, tertiary) treatment; solid waste treatment; fuel (methanol, methane), fertilizer (composting); liquid waste treatment- trickling filter, activated sludge, oxidation ponds.

(15 Lectures)

UNIT – V

Bioremediation: *In situ* bioremediation and *Ex-situ* bioremediation, use of genetic engineered microorganisms, Bioremediation of heavy metals, Bioaugmentation: principle of bioaugmentation, bioremediation in paper and pulp industry, degradation of hydrocarbons and xenobiotics e.g. pesticides. Biomagnification. **(10 Lectures)**

Suggested Reading

1. N.S. SubbhaRao, Soil Microbiology, Science Publisher, ISBN: 9781578080700
2. Dubey, R.C**.** *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
3. P.D. Sharma, Microbiology, Rastogi Publication ISBN:978-8171339358.
4. Dubey R.C**.** and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3

MMB - C201
MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L T Credits Pass Marks : 40
3 1 4

NOTE: Questions of theory paper are to be set under three sections i.e., A, B, and C. **Ten objective/multiple choice questions** (MCQs) uniformly distributed from the entire syllabus are to be set for section A. In Section B, the student has to answer any five questions out of **ten short answer questions** (100 words) uniformly distributed from the entire syllabus. Eight **long answer/questions descriptive** questions uniformly distributed from the entire syllabus are to be set for section C and the student has to answer any four questions. Section A, B, and C will be of 10, 20, and 40 marks respectively. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT - I

Nature of Nucleic acids- Nucleic acids as genetic material (evidences from bacteria, bacteriophages, bacterial conjugation, RNA viruses); DNA structure- historical aspects and current concepts, organization of DNA in eukaryotic cell, DNA torsion angles and sugar puckering; types of RNA- rRNA, mRNA (the 5' cap, non-coding region, initiation codon, coding region, termination codon, poly-adenylation); tRNA (structure of tRNA-clover leaf model). **(10 Lectures)**

UNIT – II

DNA Replication, Damages and Repair Systems- Watson and Crick's model of DNA replication (experimental evidence), enzyme involved in DNA replication (DNA polymerase I, Pol II, Pol III, DNA ligase); mechanism of DNA replication; DNA damage and repair systems- types of damage (deamination, oxidative damage, alkylation, pyrimidine dimers); repair pathways- methylation -directed mismatch repair, very short patch repair, nucleotide excision repair, base excision repair, recombination repair, SOS repair. **(15 Lectures)**

UNIT – III

Gene Expression and Regulation- Gene expression- RNA polymerase, site of transcription; transcription- chain initiation, chain elongation, chain termination; post-transcriptional processing of RNAs- methylation, polyadenylation and splicing of mRNA; translation– charging of tRNA, initiation of polypeptide synthesis, elongation of polypeptide chain, termination of polypeptide chain; gene regulation- negative regulation- *lac* operon of *E. coli* promoter, repressor and operator genes, structural gene.
(15 Lectures)

UNIT – IV

Cloning Enzymes and ` Vectors– Essential enzymes used in rDNA technology: nucleases, restriction endonucleases, alkaline phosphatases, DNA polymerase, terminal transferases, ligase, reverse transcriptase; restriction digestion, ligation; cloning vectors - plasmids cosmids, Ti plasmids, BAC vectors, YAC vectors; cloning strategies, gene libraries- cDNA and genomic libraries.
(10 Lectures)

UNIT – V

Blotting Methods and Gene Sequencing– PCR- working principle and applications; electrophoresis; blotting techniques- Southern blotting, northern blotting, western blotting; nucleic acid hybridization; gene sequencing methods: Maxam-Gilbert methods, Sanger & Nicolson method, automated gene sequencing. **(10 Lectures)**

Suggested Reading

1. Bruce Alberts. Molecular Biology of the Cells, W.W. Norton and Company, ISBN: 9780815344643
2. Dubey, R.C. *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
3. Harvey, Lodish. Molecular Cell Biology, W.H.Freeman
4. Dubey, R.C. and Maheshwari, D.K. *Practical Microbiology*. 2nd ed., S. Chand & Co. P Ltd, New Delhi, p. 413. ISBN: 81:219-2559-2

M.Sc. I Year **Semester – II**

MMB - C202
MICROBIAL GENETICS AND GENOMICS

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L T Credits Pass Marks : 40
3 1 4

NOTE: Questions of theory paper are to be set under three sections i.e., A, B, and C. **Ten objective/multiple choice questions** (MCQs) uniformly distributed from the entire syllabus are to be set for section A. In Section B, the student has to answer any five questions out of **ten short answer questions** (100 words) uniformly distributed from the entire syllabus. Eight **long answer/questions descriptive** questions uniformly distributed from the entire syllabus are to be set for section C and the student has to answer any four questions. Section A, B, and C will be of 10, 20, and 40 marks respectively. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT - I

Essentials of Genetics: Genetic notations- prototrophs, auxotrophs, diploid, and electroporation. Gene as unit of mutation and recombination, molecular nature of mutation, origin of resistance due to spontaneous mutation.Model organisms and genetic analysis of bacteria and yeast.Locating a gene on a 'small DNA molecule' and a 'large DNA molecule. **(14 Lectures)**

UNIT - II

Gene transfer mechanisms-Bacterial transformation (detection of transformation, development of competence, mechanism of transformation, transfection); conjugation- and compatibility, the F-factor, the conjugal transfer process; high frequency recombination (Hfr) strains; the order of chromosome transfer; formation of F prime (F'); transduction - generalized transduction; abortive transduction; specialized transduction, sexduction. **(14 Lectures)**

UNIT - III

Genetic recombination– Mechanism of recombination, Holliday model for general recombination; non-reciprocal general recombination; site specific recombination; transposable elements – classes of transposable elements; nomenclature of transposable elements, insertion sequence (IS elements), transposon family (structure, mechanism of transposition)**(12 Lectures)**.

UNIT - IV

Microbial genomics- Introduction - functional and comparative genomics, proteomics, environmental genomics, genome evolution in microbes, phylogenetic trees.**,** whole genome shotgun sequencing **,,** library construction **(10 Lectures)**

UNIT - V

Bioinformatics - -Introduction, gene anotation, random sequencing, fragment alignment and gap closure, editing;databases, database similarity search BLAST, FASTA, metagenomics: basic concepts, application, bioinformatics. **(10 Lectures)**

Suggested Reading

1. David Friefelder, Microbial Genetics, Narosa Publishing House.
2. Gardner, Principle of Genetics, Wiley
3. Dubey, R.C**.** *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
4. Lehninger, Nelson and Cox. Principles of Biochemistry, WH Freeman; 7th ed, ISBN:978-1319108243

M.Sc. I Year **Semester – II**

MMB - C203
FOOD AND DAIRY MICROBIOLOGY

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L T Credits Pass Marks : 40
3 1 4

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UNIT – I

Food substrates, its spoilage and preservation– Microorganisms and their importance in food microbiology - food-borne molds, yeast, bacteria, general features, principles of food preservation; asepsis- removal of microorganisms (anaerobic conditions, high temperature, low temperature, drying), Mechanism of chemical preservation, chemicals used as preservative, and food additives, concept of modified atmosphere packaging (MAP). **(13 Lectures)**

UNIT – II

Contamination and Spoilage –Factors influencing microbial growth in food– extrinsic and intrinsic factors; Cereals, sugar products, vegetables, fruits, meat and meat products; milk and milk products, fish and sea food, poultry; spoilage of canned food; detection of spoilage and characterization. Contamination and spoilage of **c**ereals, sugar products, fruits, meat products, milk and milk products, fish and sea food; detection of spoilage and characterization. **(13 Lectures)**

UNIT – III

Food-borne infections and intoxications – Bacterial and non- bacterial intoxication (with examples of infective and toxic types) – *Brucella, Bacillus, Clostridium, Escherichia, Shigella, Staphylococcus, Vibrio, Yersinia;* Protozoa, algae, fungi and viruses; food borne outbreaks – laboratory testing procedures, preventive measures, food sanitation in manufacturer and retail trade; Food control agencies and its regulations; Employee's health standards, waste treatment, disposal and quality control.**(11 Lectures)**

UNIT – IV

Indicators of microbial food quality – brief account of microbes (coliform group, enterobacteriaceae group, enterococcus group) and microbial products that correlate with food quality, control of microbiological quality of foods – training, facilities and operation, equipments, cleaning and disinfection, HACCP concept, hazard analysis, identification of CCPs and establishment of CCP limits . **(10 Lectures)**

UNIT – V

Dairy microbiology: Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese, Probiotics:concept of probiotics, prebiotics, and synbiotics, health benefits, types of microorganisms used, probiotic foods available in market.

Suggested Reading

1. Doyle et al., Food Microbiology: Fundamentals and Frontier, American Society of Microbiology
2. William C Frazier, Food Microbiology, MacGraw Hills Education.
3. Adam and Moss, Food Microbiology, Royal Society of Chemistry

M.Sc. I Year **Semester – II**

MMB - C204
INDUSTRIAL MICROBIOLOGY

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L T Credits Pass Marks : 40
3 1 4

NOTE: Questions of theory paper are to be set under three sections i.e., A, B, and C. **Ten objective/multiple choice questions** (MCQs) uniformly distributed from the entire syllabus are to be set for section A. In Section B, the student has to answer any five questions out of **ten short answer questions** (100 words) uniformly distributed from the entire syllabus. Eight **long answer/questions descriptive** questions uniformly distributed from the entire syllabus are to be set for section C and the student has to answer any four questions. Section A, B, and C will be of 10, 20, and 40 marks respectively. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT – I

Introduction: Scope, strategies for selection and improvement of industrial strains; preservation of gene pool in industrial organisms; industrial media and nutrition of industrial organisms; metabolic pathways for the biosynthesis of industrial microbiology products, IPR: Intellectual property right and protection (IPP), forms of protection- patents; copyrights; trade secrets; Trademarks; European Patent convention (EPC), Budapest treaty and Paris convention. **(12 lectures)**

UNIT – II

Fermentors, fermentordesigning &operation: Basic functions of fermentors, types of fermentor and construction, , fermentor configurations, fed-batch cultivation; design of fermentor on the basis of physiology of organisms-air lift fermentors;pilot plant, surface or solid state fermentors, batch, fed-batch, and continuous fermentation;measurement and control of fermentation parameters, pH, temperature, dissolved oxygen, foaming and aeration. **(13 lectures)**

UNIT – III

Downstream processing of microbial products: Solids (insolubles) removal– filtration, centrifugation, coagulation and flocculation, foam fractionation, whole broth treatment;primary product isolation–cell disruption, liquid extraction, dissociation extraction, ion-exchange adsorption, precipitation;purification– chromatography, carbon decolorization, crystallization;product isolation– crystalline processing, drying. **(12 lectures)**

UNIT – IV

Sterility in industrial microbiology. Basis of loss by contaminants, physical and chemical methods of achieving sterility, sterilization of fermentor and its accessories, media sterilization;viruses (phages) in industrial microbiology – morphological grouping of bacteriophages, lysis of hosts by phages, prevention of phage contamination, use of phage resistant mutants, inhibition of phage with chemicals, use of adequate media conditions. **(12 lectures)**

UNIT – V

Fermentation products: Production of beer, wine, organic acids – citric & lactic, amino acids –glutamic acid, yeast – baker's, food, feed, ethyl alcohol, antibiotics– penicillin & cephalosporin,methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase). **(11 lectures)**

Suggested Reading

1. Dubey, R.C**.** *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
2. Casida, L.E.J.R. Industrial Microbiology, New Age International Publisher,
3. A.H.Patel, Industrial Microbiology, Laxmi Publication, **ISBN-10:** 9385750267
4. Prescott and Dunns.Industrial Microbiology, CBS Publishers and Distributers, ISBN-10**:** 8123910010

M.Sc. II Year **Semester – III**

MMB - C301
IMMUNOLOGY

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L T Credits Pass Marks : 40
3 1 4

NOTE: Questions of theory paper are to be set under three sections i.e., A, B, and C. **Ten objective/multiple choice questions** (MCQs) uniformly distributed from the entire syllabus are to be set for section A. In Section B, the student has to answer any five questions out of **ten short answer questions** (100 words) uniformly distributed from the entire syllabus. Eight **long answer/questions descriptive** questions uniformly distributed from the entire syllabus are to be set for section C and the student has to answer any four questions. Section A, B, and C will be of 10, 20, and 40 marks respectively. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT – I

Immune system and Immunity: History of immunology, structure, composition and function of cells and organs involved in immune system; Host-parasite relationships; microbial infection; virulence and host resistance; immune response – naturally acquired immunity; artificially acquired immunity; immunohaematology- blood groups, blood transfusion and Rh incompatibility. **(11 Lectures)**

UNIT – II

Antigens and Antibodies- Antigens- structure and properties (types, iso and allo- haptens, adjuvants); antigen specificity; Immunoglobulins (antibodies)- structure, heterogeneity – types and subtypes, properties (physico-chemical and biological); theories of antibody production; complement pathways and biological consequences of complement activation; hybridoma technology- monoclonal antibodies, methods of production; application of monoclonal antibodies;immunotoxins; vaccines and toxoids. **(13 Lectures)**

UNIT - III

Antigen-Antibody reactions –*In vitro* methods- agglutination, Widal test, haemagglutination, precipitation, complement fixation, immunofluorescence; enzyme linked immunosorbent assay (ELISA), radioimmunoassay; *in vivo* methods – skin test and immune complex tissue demonstrations; application of these methods in diagnosis of microbial diseases. **(12 lectures)**

UNIT – IV

Major hisocompatibility complex (MHC) and tumour immunology- Structure and functions of MHC and HLA system; gene regulation and Ir-genes; HLA and tissue transplantation; tissue typing methods for organ and tissue transplantation in humans; graft versus host reaction and rejection; autoimmunity- theories, mechanisms and diseases with its diagnosis; tumour immunology- tumour specific antigens, immune response to tumour, immunodiagnosis of tumour- detection of tumour markers- alpha foetal proteins, carcinoembryonic antigens, etc. **(13 Lectures)**

UNIT – V

Hypersensitivity reactions- Antibody-mediated Type I; anaphylaxis: Type II; antibody dependent cell toxicity, Type III; immune complex mediated reactions; Type IV; cell mediated hypersensitivity reactions and the respective disease, immunological methods of their diagnosis; lymphokines and cytokines- its assay methods. **(11 Lectures)**

Suggested Reading

1. Janis Kubey, Immunology, W.H.Freeman
2. Peter J Delves, S.J. Martins, D.R. Burtons, Roitts Essential Immunology, Wiley Blackwell
3. C.V.Rao , An Introduction to Immunology, Alpha Science International Ltd , **ISBN** 978-1842650356

MMB - C302
MEDICAL MICROBIOLOGY

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L T Credits Pass Marks : 40
3 1 4

NOTE: Questions of theory paper are to be set under three sections i.e., A, B, and C. **Ten objective/multiple choice questions** (MCQs) uniformly distributed from the entire syllabus are to be set for section A. In Section B, the student has to answer any five questions out of **ten short answer questions** (100 words) uniformly distributed from the entire syllabus. Eight **long answer/questions descriptive** questions uniformly distributed from the entire syllabus are to be set for section C and the student has to answer any four questions. Section A, B, and C will be of 10, 20, and 40 marks respectively. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT – I

Basics of medical microbiology- Early discovery of pathogenic microorganisms, development of bacteriology as scientific discipline, contribution of early microbiologists; classification of medically important microorganisms; normal microflora of human body, role of resident flora on human health; infection- types of infection, pathogenicity; characteristics of infectious diseases - disease cycle (sources of disease, reservoirs, carriers); transmission of pathogens. **(13 Lectures)**

UNIT – II

Bacterial Diseases: Characteristics of a successful pathogen, virulence factors- entry, adherence, invasiveness, iron sequestering, antiphagocytic factors, host-mediated pathogenesis, antigenic variation, bacterial diseases-characteristic features of causal organisms, symptoms, epidemiology, prophylaxis and treatment of diseases caused by *Salmonella*, *Vibrio, Mycobacterium*, *Neisseria, Corynebacterium, Staphylococcus.* **(16 Lectures)**

UNIT – III

Viral diseases- Classification, epidemiology, symptoms, pathogenesis, diagnosis and treatment of diseases caused by adenovirus, poxvirus, herpesvirus, hepatitis B virus, influenza virus, paramyxovirus (mumps, measles and rubella viruses), rabdoviruses, retrovirus (HIV) and ebola virus. **(13 Lectures)**

UNIT – IV

Fungal diseases- Significance of fungi in human health, mycoses and mycotoxicoses, superficial mycoses (Tineanigra), subcutaneous mycoses (chromoblastomycosis, basidiobolomycosis), dermatophytoses (Tineacapitis, Tineabarbae, Tineacorporis, tineacruris, Tineaunguium, Tineapedis), systemic mycoses (histoplasmosis, candidiasis, aspergillosis**). (13 Lectures)**

UNIT – V

Diagnosis and antimicrobial therapy-Methods of specimen collection, transportation and storage;laboratory diagnosis-identification of pathogens through microscopy, culture, serology and molecular biology; antimicrobial chemotherapy - development of chemotherapy, antimicrobial drugs and their mode of actions, drug resistance, various methods of drug susceptibility testing and its significance, MICs and MBCs, antibiotic assay in body fluids; vaccines- vaccination schedules,
(15 Lectures)

Suggested Reading

1. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. Mackie and McCartney. Practical Medical Microbiology, Elsevier
3. CKJ Paniker. Test Book of Microbiology, Orient Longman
4. D.R.Arora. Medical Mycology, CBS Publisher and Distributors

MMB - E301
ELECTIVE - I MYCOLOGY

MM : 100	Sessional : 30
Time : 3 hrs	ESE : 70
L T Credits	Pass Marks : 40
3 1 4	

NOTE: Questions of theory paper are to be set under three sections i.e., A, B, and C. **Ten objective/multiple choice questions** (MCQs) uniformly distributed from the entire syllabus are to be set for section A. In Section B, the student has to answer any five questions out of **ten short answer questions** (100 words) uniformly distributed from the entire syllabus. Eight **long answer/questions descriptive** questions uniformly distributed from the entire syllabus are to be set for section C and the student has to answer any four questions. Section A, B, and C will be of 10, 20, and 40 marks respectively. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT – I

Introduction – History and development of mycology, structure and criteria used in classification/identification of fungi, various fungal classification system; *Myxomycota* – general account only; brief account of Chytridiomycetes, Oomycetes; Zygomycotina-Evolution of conidium. **(12 Lectures)**

UNIT – II

General Features of Fungal Classes: Ascomycotia – Hemiascomycetes, Plectomycetes, Pyrenomycetes, Discomycetes, Laboulbeniomycetes, Laculoascomycetes; Basidiomycotia- Teliomycetes, Hymenomycetes, Gasteromycetes; Deuteromycotia-Hyphomycetes, Coelomycetes, Blastomycetes. **(12 Lectures)**

UNIT – III

Fungi in ecosystem: contribution of fungi to ecosystems, breakdown of hemicellulose, cellulose, pectins, chitin, starch and glycogen, lignin degradation; flow of nutrients-transport and translocation, secretion of colonizers on a substrate. **(12 Lectures)**

UNIT – IV

Fungalplant pathogens: occurrence, classification, morphology, characteristics features and life cycle of *Sclerotium rolfsii*, *Melamspora lini,, Erysiphe graminis, Fusarium oxysporum, Alternaria solani*, *Phytophthora infestans*, *Taphrina deformans*, *Venturiani aegualis.* **(12 Lectures)**

UNIT – V

Fungal metabolites of industrial importance–industrial alcoholic beverages and organic acids; Fungi as bioinoculant agents, mycotoxins- Aflatoxins, rubratoxin, ochratoxin; fungal enzymes of commercial importance-amylases and cellulases, mycoprotein (quorn). **(12 Lectures)**

Suggested Reading

1. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. CKJ Paniker. Test Book of Microbiology, Orient Longman
3. D.R.Arora. Medical Mycology, CBS Publisher and Distributors

MMB - E302
ELECTIVE - II PHARMACEUTICAL MICROBIOLOGY

MM : 100	Sessional : 30
Time : 3 hrs	ESE : 70
L T Credits	Pass Marks : 40
3 1 4	

NOTE: Questions of theory paper are to be set under three sections i.e., A, B, and C. **Ten objective/multiple choice questions** (MCQs) uniformly distributed from the entire syllabus are to be set for section A. In Section B, the student has to answer any five questions out of **ten short answer questions** (100 words) uniformly distributed from the entire syllabus. Eight **long answer/questions descriptive** questions uniformly distributed from the entire syllabus are to be set for section C and the student has to answer any four questions. Section A, B, and C will be of 10, 20, and 40 marks respectively. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT – I

Non-medicinal antimicrobial agents:- Bacteriostatic and bactericidal agents, factors affecting antimicrobial activity;non medicinal antimicrobial chemicals - sanitizers, disinfectants, antiseptics, antimicrobial action of phenols and phenolic compounds, alcohols, halogens, heavy metals, dyes, aldehydes, detergents. **(11 Lectures)**

UNIT – II

Medicinal antimicrobial agents: History of chemotherapy – plants and arsenicals as therapeutics, Paul Ehrlich and his contributions, selective toxicity and target sites of drug action in microbes. Development of synthetic drugs – Sulphanamides, antitubercular compounds, nitrofurons, nalidixic acid, metronidazole group of drugs. Antibiotics - The origin, development and definition of antibiotics as drugs, types of antibiotics and their classification. Non-medical uses of antibiotics **(11 Lectures)**

UNIT – III

The ecology of microorganisms affecting pharmaceutical industry – The atmosphere, water, skin & respiratory flora of personnel, raw-materials, packing, equipments, building, utensils; types of microorganisms occurring in pharmaceutical products;microbial contamination and spoilage of pharmaceutical products (sterile injectibles, non injectibles, ophthalmic preparations and implants) and their sterilization,manufacturing procedures and in process control of pharmaceuticals.; other pharmaceuticals produced by microbial fermentations (streptokinase, streptodornase) **(13 Lectures)**

UNIT – IV

The drug resistance – The phenomenon, clinical basis of drug resistance, biochemistry of drug resistance, genetics of drug resistance in bacteria,microbiological assays: assays for growth promoting substances, nutritional mutants and their importance, vitamin assay, amino acid assay,assay for growth inhibiting substances – assay for non-medicinal antimicrobials (phenol coefficient/RWC);drug sensitivity testing methods and their importance;assay for antibiotics – determination of MIC, the liquid tube assay, solid agar tube assay, agar plate assay (disc diffusion, agar well and cylinders cup method); Introduction to pharmacokinetics. **(13 Lectures)**

UNIT – V

Quality control, quality assurance and validation: good manufacturing practices (GMP) and good laboratory practices (GLP) in pharmaceutical industry;regulatory aspects of quality control;quality assurance and quality management in pharmaceuticals ISO, WHO and US certification;sterilization control and chemical and biological indicators;design and layout of sterile product manufacturing unit; (designing of microbiology laboratory), safety in microbiology laboratory, MLT , Endotoxin test (LAL test), pyrogen test.

(12 Lectures)

Suggested Reading

1. S.S.Purohit, Pharmaceutical Microbiology, AGROBIOS
2. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
3. Chandrakant Kokare. Pharmaceutical Microbiology, Nirali Publisher

MMB - E303
ELECTIVE - III CELLULAR MICROBIOLOGY

MM : 100	Sessional : 30
Time : 3 hrs	ESE : 70
L T Credits	Pass Marks : 40
3 1 4	

NOTE: Questions of theory paper are to be set under three sections i.e., A, B, and C. **Ten objective/multiple choice questions** (MCQs) uniformly distributed from the entire syllabus are to be set for section A. In Section B, the student has to answer any five questions out of **ten short answer questions** (100 words) uniformly distributed from the entire syllabus. Eight **long answer/questions descriptive** questions uniformly distributed from the entire syllabus are to be set for section C and the student has to answer any four questions. Section A, B, and C will be of 10, 20, and 40 marks respectively. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT – I

Introduction – Bacterial diseases - mutualism, commensalism, and parasitism, bacteria and idiopathic diseases; emergence of cellular microbiology, cellular biology underlying prokaryotic and eukaryotic interactions- ultrasturucture, cytoskeleton, vesicular transport pathways, exocytosis, endocytosis, genomic expression, pathogenecity island, cell cycle and apoptosis.**(12 Lectures)**

UNIT – II

Prokaryotic and eukaryotic signalling mechanism – Eukaryotic cell to cell signalling, endocrine signalling, cytokines signalling, prokaryotic cell to cell signalling; quorum sensing and bacterial pheromones; intracellular signalling-prokaryotic signalling mechanisms and eukaryotic signalling pathways, outcomes of activation of signalling pathways. **(12 Lectures)**

UNIT – III

Infection and cell-cell interaction – Bacterial adherence, basic principles, molecular mechanisms of adhesion, bacterial strustures involved, bacterial adhesins, effect of adhesion on bacteria, effect of adhesion on host cells, bacterial invasion of host cells – mechanism, consequences of invasion, survival and growth after invasion. **(13 Lectures)**

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UNIT – IV

Bacterial protein toxins: classification of toxins on the basis of activity, biological effects of toxin action- cell death, nerve transmission, signal transduction, interaction with cytokines; origin and evolution of toxin genes, therapeutic uses of toxins. **(11 Lectures)**

UNIT – V

Cellular microbiology future directions –prokaryotic and eukaryotic interactions in bacterial growth, effect of bacteria on eukaryotic growth and survival, bacterial control of eukaryotic cell cycle and apoptosis, commensal microflora in cellular conversation, application of cellular microbiology to the generation of novel therapeutics, cellular microbiology and idiopathic diseases. **(13 Lectures)**

Suggested Reading

1. CKJ Paniker. Test Book of Microbiology, Orient Longman
2. Henderson. Cellular Microbiolgy, Wiley
3. Warran Levinson .Medical Microbiology and Immunology, Appleton & Lange;**ISBN** 978-0071382175

MMB - E304
ELECTIVE - IV AGRICULTURAL MICROBIOLOGY

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L T Credits Pass Marks : 40
3 1 4

NOTE: Questions of theory paper are to be set under three sections i.e., A, B, and C. **Ten objective/multiple choice questions** (MCQs) uniformly distributed from the entire syllabus are to be set for section A. In Section B, the student has to answer any five questions out of **ten short answer questions** (100 words) uniformly distributed from the entire syllabus. Eight **long answer/questions descriptive** questions uniformly distributed from the entire syllabus are to be set for section C and the student has to answer any four questions. Section A, B, and C will be of 10, 20, and 40 marks respectively. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT – I

Soil- Physico-chemical properties, soil fertility, Soil genesis: formation of soil and soil factors: climate, bed rock, temperature, vegetation and precipitation; factors affecting soil properties., soil enzymatic activity, Distribution of soil microorganisms in soil., factors influencing the soil microflora., Interactions among microorganisms- antibiosis, mutualisms, commensalism, competition, amensalism, parasitism, predation.

(10 Lectures)

UNIT – II

Interactions between microbes and plants,microflora of rhizosphere and phyllosphere, microbes in composting; characteristics features of the following beneficial organisms in agriculture- Bacteria-*Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium and Frankia, Cyanobacteria-Anabaena, Nostoc, Hapalosiphon*. Fungi: *Glomus*. **(13 Lectures)**

UNIT – III

Microbial biomass, Microbial transformations of carbon, nitrogen, phosphorus and sulphur. Biological nitrogen fixation, mechanism, ammonification, nitrification, denitrification and microorganisms involved in such processes. **(11 Lectures)**

UNIT – IV

Biofertilizer- bacterial , cyanobacterial and mycorrhizal (Ecto and endomycorrhiza) , production methods of biofertilizers – significance, storage, shelf life, quality control of biofertilizers, Isolation and Purification of phosphate solubilizers. Mass multiplication and field applications of phosphate solubilizer. Algal and other biofertilizers, endophytic biofertilizers**.**

(13 Lectures)

UNIT – V

Biological control- microbial agents for control of plant disease, production of microbial insecticides, Pseudomonads and bacillus (*B. thuringiensis*, toxin production etc.), Entomopathogenic fungi, biological control of nematodes and fungal pathogens.

(13 lectures)

Suggested Reading

1. N.S. SubbhaRao, Soil Microbiology, Science Publishers.
2. M.K.Rai, Handbook of Microbial Fertilizers, Internation Book Distributing Co.
3. Dubey, R.C**.** *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
4. Rangaswami,G. Agriculture Microbiolgy, Prentice Hall Indian Learning Ltd

MMB - E305
ELECTIVE - V MICROBIAL ECOLOGY

MM : 100	Sessional : 30
Time : 3 hrs	ESE : 70
L T Credits	Pass Marks : 40
3 1 4	

NOTE: Questions of theory paper are to be set under three sections i.e., A, B, and C. **Ten objective/multiple choice questions** (MCQs) uniformly distributed from the entire syllabus are to be set for section A. In Section B, the student has to answer any five questions out of **ten short answer questions** (100 words) uniformly distributed from the entire syllabus. Eight **long answer/questions descriptive** questions uniformly distributed from the entire syllabus are to be set for section C and the student has to answer any four questions. Section A, B, and C will be of 10, 20, and 40 marks respectively. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT - I

Ecological groups of microorganisms: Based on O_2 requirement (Aerophile, Microaerophiles, Anaerobic bacteria) requirement, based on C sources (Methanotrophs, Methylotrophs) , temperature, and habitat, Microbial diversity- distribution, ecological niche: plant-microbe interactions **(12 Lectures)**

UNIT – II

Population interaction- population within biofilm; positive and negative interaction- neutralism, commensalisms, synergism, mutualism, competition, antagonism, parasitism, and predation. **(10 Lectures)**

UNIT – III

Extremophiles- Psychrophiles, acidophiles, alkaliphiles, thermophiles, barophiles and osmophiles, halophiles- membrane variation, electron transport; Application of extremophiles; methanogens and biogas production; *Rumen microbiology*- rumen anatomy, rumen microorganisms and action. **(14 Lectures)**

UNIT – IV

Stress Microbiology: Environmental stress (density-dependent and density-independent) stress, stress sequestration by bacteria and other organisms, heavy metal detoxicants (metal-microbe interaction, biosorption, bioaccumulation and metal scavenging by microbes). **(12 Lectures)**

UNIT – V

Chemolithotrophs: Methylotrophs; microbial leaching (bioleaching) - microbes and mechanism of bioleaching of iron, copper and uranium; oxidative transformation of metals- sulphur oxidation, iron oxidation, ammonia oxidation, hydrogen oxidation.
(12 Lectures)

Suggested Reading

1. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. Singh and Purohot, Microbial Ecology, AGROBIOS
3. Atlas. Microbial Ecology, Pearson Education ISBN13: 9788129707710

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M.Sc. II Year **Semester – IV**

MMB – C460
INDUSTRIAL TRAINING/ PROJECT REPORT
PROJECT EVALUATION
SEMINAR
VIVA-VOCE

MM : 500
Credits: 20

Project evaluation : 300
Seminar : 100
Viva-voce : 100