

THIRUVALLUVAR UNIVERSITY

BACHELOR OF SCIENCE

B.Sc. MICROBIOLOGY DEGREE COURSE

(With effect from 2020 - 2021)

The Course of Study and the Scheme of Examinations

S. No.	Part	Study Components		Ins. Hrs / week	Credit	Title of the Paper	Maximum Marks		
		Course Title					CIA	Uni. Exam	Total
SEMESTER I									
1.	I	Language	Paper-1	6	4	Tamil/Other Languages	25	75	100
2.	II	English (CE)	Paper-1	6	4	Communicative English I	25	75	100
3.	III	Core Theory	Paper-1	6	4	Fundamentals of Microbiology	25	75	100
	III	Core Practical	Practical-1	4	0	Experiments in Basic Microbiology	0	0	0
4.	III	Allied -1	Paper-1	4	3	Biochemistry - I	25	75	100
	III	Allied- 1	Practical-1	2	0	Biochemistry	0	0	0
5.	III	PE	Paper 1	6	3	Professional English I	25	75	100
6.	IV	Environmental Studies		2	2	Environmental studies	25	75	100
		Sem. Total		36	20		150	450	600
SEMESTER II									
7.	I	Language	Paper-2	6	4	Tamil/Other Languages	25	75	100
8.	II	English (CE)	Paper-2	6	4	Communicative English II	25	75	100
9.	III	Core Theory	Paper-2	5	4	Microbial Physiology	25	75	100
10.	III	Core Practical	Practical-1	3	2	Experiments in Basic Microbiology (Contd.)	25	75	100
11.	III	Allied-1	Paper-2	4	3	Biochemistry - II	25	75	100
12.	III	Allied Practical - 1	Practical-1	2	2	Biochemistry (Contd.)	25	75	100
13.	III	PE	Paper 1	6	3	Professional English II	25	75	100
14.	IV	Value Education		2	2	Value Education	25	75	100
15.	IV	Soft Skill		2	1	Soft Skill	25	75	100
		Sem. Total		36	25		225	675	900
SEMESTER III									
16.	I	Language	Paper-3	6	4	Tamil/Other Languages	25	75	100
17.	II	English	Paper-3	6	4	English	25	75	100
18.	III	Core Theory	Paper-3	4	4	Immunology	25	75	100

	III	Core Practical	Practical-2	3	-	Experiments in Immunology and Microbial Genetics	0	0	0
19.	III	Allied-3	Paper-3	4	3	Bioinstrumentation	25	75	100
		Allied Practical - 2	Practical-2	3	-	Bioinstrumentation and Biostatistics	0	0	0
20.	IV	Skill Based Subject	Paper-1	2	2	Haematology and Blood Banking	25	75	100
21.	IV	Non-Major Elective	Paper-1	2	2	Microbes in Human Welfare	25	75	100
		Sem. Total		30	19		150	450	600
SEMESTER IV									
22.	I	Language	Paper-4	6	4	Tamil/Other Languages	25	75	100
23.	II	English	Paper-4	6	4	English	25	75	100
24.	III	Core Theory	Paper-4	4	4	Microbial Genetics	25	75	100
25.	III	Core Practical	Practical-2 (Contd.)	3	3	Experiments in Immunology and Microbial Genetics (Contd.)	25	75	100
26.	III	Allied-4	Paper-4	4	3	Biostatistics	25	75	100
27.	III	Allied Practical - 2	Practical-2 (Contd.)	3	2	Bioinstrumentation and Biostatistics (Contd.)	25	75	100
28.	IV	Skill Based Subject	Paper-2	2	2	Mushroom Cultivation	25	75	100
29.	IV	Non-Major Elective	Paper-2	2	2	Emerging Microbial Diseases	25	75	100
		Sem. Total		30	24		200	600	800
SEMESTER V									
30.	III	Core Theory	Paper-5	6	6	Medical Bacteriology and Mycology	25	75	100
31.	III	Core Theory	Paper-6	6	5	Agricultural and Environmental Microbiology	25	75	100
32.	III	Core Theory	Paper-7	5	5	Food Microbiology	25	75	100
	III	Core Practical	Practical-3	4	-	Experiments in Medical Microbiology	0	0	0
	III	Core Practical	Practical-4	4	-	Experiments in Applied Microbiology	0	0	0
33.	III	Internal Elective	Paper-1	3	3	(to choose one out of 3) A. Immunotechnology B. Human anatomy and physiology C. Cell Biology	25	75	100
34.	IV	Skill Based Subject	Paper-3	2	2	Bioinformatics	25	75	100
		Sem. Total		30	21		125	375	500
SEMESTER VI									
35.	III	Core Theory	Paper-8	6	6	Medical Virology and Parasitology	25	75	100
36.	III	Core Theory	Paper-9	5	5	Industrial Microbiology	25	75	100
37.	III	Core Practical	Practical-3	3	3	Experiments in Medical Microbiology (Contd.)	25	75	100
38.	III	Core Practical	Practical-4	3	3	Experiments in Applied Microbiology (Contd.)	25	75	100
39.	III	Compulsory Project	Paper-10	5	5	Group/Individual Project	25	75	100

40.	III	Internal Elective	Paper-2	3	3	(to choose one out of 3) A. Biotechnology B. Herbal Technology C. Genetic Engineering	25	75	100
41.	III	Internal Elective	Paper-3	3	3	(to choose one out of 3) A. Bioinoculants Technology B. Clinical Microbiology C. Food analysis and quality control	25	75	100
42.	IV	Skill based Subject	Paper-4	2	2	Medical Laboratory Techniques	25	75	100
43.	V	Extension Activities		-	1	-	100	0	100
		Sem. Total		30	31		300	600	900
									4300

Part	Subject	Papers	Credit	Total Credits	Marks	Total Marks
Part I	Languages	4	4	16	100	400
Part II	Communicative English & English	4	4	16	100	400
Part III	Allied (Odd Semester)	2	3	6	100	200
	Allied (Even Semester)	2	3	10	100	200
	Allied Practical	2	2		100	200
	Electives	3	3	9	100	300
	Core	9	(3-5)	43	100	900
	Core practical	4	(2-3)	11	100	400
	Professional English	2	3	6	100	200
	Compulsory Project (Group/Individual Project)	1	5	5	100	100
Part IV	Environmental Science	1	2	2	100	100
	Soft skill	1	1	1	100	100
	Value Education	1	2	2	100	100
	Lang. & Others /NME	2	2	4	100	200
	Skill Based	4	2	8	100	400
Part V	Extension Activities	1	1	1	100	100
	Total	43		140		4300

THIRUVALLUVAR UNIVERSITY

BACHELOR OF SCIENCE B.Sc. MICROBIOLOGY

(With effect from 2020 - 2021)

SYLLABUS

SEMESTER III CORE PAPER - 3 IMMUNOLOGY

Course Objective: To enable students to understand immune system, immunity and their implication on health and disease

Course Outcomes:

At the end of the course, the student will be able to

1. Outline the history and scope of Immunology.
2. Explain the structure, functions and properties of immune cells.
3. Compare the different types of antibodies and relate them to antigens.
4. Comprehend on the complement system and Major histocompatibility complex.
5. Familiarize with immunohaematology and hypersensitivity reaction.

UNIT - I

History and scope of Immunology. Types of Immunity - Innate and Acquired immunity - Active, Passive, Humoral and Cell Mediated Immunity.

UNIT - II

Structure, Functions and Properties of Immune Cells - Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs - Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT.

UNIT - III

Antigens - Types, Characteristics of antigen, Haptens, Epitopes (T & B cell epitopes), Factors influencing antigenicity. T-dependent and T-independent antigens; Adjuvants. Antibodies - Structure, types, properties and functions of immunoglobulins.

UNIT - IV

Complement system - Structure, Components, Properties and Functions, Pathways of Complement activation. Major Histocompatibility complex proteins (MHC) – Definition, Types, physiological role, Antigen processing and presentation.

UNIT - V

Immunohaematology - Blood cell components, ABO blood grouping, RH typing, Pre-transfusion testing, Antibody detection, Cross matching, Investigation of immune hemolysis, Perinatal screening blood test. Hypersensitivity and Allergic reactions - Immediate and Delayed type, Methods to detect hypersensitivity.

Text Books

1. Immunology. 6th edition. Kuby J, Richard A. Goldsby, Thomas J. Kindt (2006). W.H. Freeman and company, New York.
2. Immunology. 3rd edition. Richard M. Hyde (2011). Williams & Wilkins, Philadelphia.
3. Immunology. An Introduction. 1st edition. Tizard K (1995). Saunders college publishing, Philadelphia.

Reference books

1. Roitts Essential Immunology. 13th edition. Peter J. delves, Seamus J. Martin, Dennis R. Burton & Ivan M. Roitt (2017). Wiley- Blackwell publishers, United States.
2. Cellular and Molecular Immunology. 9th edition. Abbas Abut K, Lightman Andrew K. and Pober Jordan S. (2017). Elsevier, Netherlands.
3. Fundamental Immunology, 7th edition. William E. Paul. (2012). Lippincott Williams and Wilkins, Philadelphia.
4. Immunology, 10th edition. Weir D.M and Stewart, J. (2000). Churchill Livingstone, New York 2000.
5. Text Book of Immunology. 1st edition. Bashir S.F (2011). PHI Learning Private limited, New Delhi.

ALLIED - 2
PAPER - 3
BIOINSTRUMENTATION

Course Outcomes:

On completion of the course, the student will be able to

1. appreciate the importance of instrumentation in Biology labs
2. illustrate the design of the instruments
3. compare different instruments
4. make use of different instruments for analysis
5. apply the knowledge of instruments in biological analysis

UNIT-I

Centrifuge - Basic principles of sedimentation; relative centrifugal force, Types of centrifuges (clinical, high speed, refrigerated and ultra); Applications.

UNIT-II

Colorimetry - Principle, Beer-Lambert's law; Applications. Spectrophotometry – UV & Visible, IR, NMR and Atomic absorption spectrophotometry; Applications.

UNIT-III

Chromatography – Principle; Paper, TLC, Column, Adsorption, Ion exchange, GC and HPLC; Applications.

UNIT-IV

Electrophoresis techniques - Principle; Types of electrophoresis - Paper, Gel, proteins and nucleic acids; Immunoelectrophoresis; Applications.

UNIT-V

Radioisotopic techniques – Radioisotopes; Detection and measurement of radioactivity; GM counter, Scintillation counter, Autoradiography; Applications. Biosensors and their types and Applications.

Text book:

Bioinstrumentation. L. Veerakumari. 2019. MJP Publisher, Chennai.

Reference Books:

1. Bioinstrumentation. John G. Webster. 2007. Wiley Publications.
2. Practical Biochemistry – Principles and techniques. Keith Wilson and John Walker. 1994. Cambridge Press, New York.
3. Principles of Applied Biomedical Instrumentation. L.A. Geddes and L.E. Baker. 2008. John Wiley & Sons.

SKILL BASED SUBJECT

PAPER - 1

HAEMATOLOGY AND BLOOD BANKING

Course Outcomes:

At the end of the course, the student will be able to

1. Discuss in detail the collection and processing of blood.
2. Understand the appropriate methods of diagnosis and management of disorders.
3. Understand how to diagnose and manage hematological disorders and blood parasites.
4. Appreciate the various types of blood group systems.
5. Know the methods of preservation, storage and transportation of blood to distant places.

UNIT - I

COLLECTION OF BLOOD CELLS - Blood: Definition, Characters, Composition. Collection of Blood - Capillary Blood from Adults/Infants, Examinations employed, Advantages/Disadvantages - venous blood from Adults/Infants, Examinations employed, Advantages/Disadvantage. Anticoagulants: Definition - Type: Wintrob's /EDTA /Heparin /Citrate, Concentration, Examinations, Advantages /Disadvantage.

UNIT - II

COUNTING OF BLOOD CELLS: Neubauer counting chamber - Total RBC count : diluting fluids, Macro dilution / Micro dilution technique, Falsely Low and High Counts, Normal values - Total WBC count: diluting fluids, Macro dilution / Micro dilution technique, Falsely Low and High Counts, Normal values - correction for TWBC - Absolute Eosinophil count - Differential Leucocyte count: Granulocyte / Agranulocytes, Morphology / Function, Staining Technique - Platelet Count: Morphological characters / Functions, Direct /Indirect method - Reticulocyte count, Dry/ Wet smear technique. Haemoglobin: Composition /Normal Values: Determinations.

UNIT - III

COAGULATION MECHANISM: Factors: Bleeding time, Clotting time. Hematological indices: - Packed cell volume: Wintrob's / Micro HCT method - Mean corpuscular Volume - Mean corpuscular haemoglobin - Mean Corpuscular haemoglobin concentration - Volume index - volume thickness index - Mean corpuscular diameter - saturation index. Erythrocyte sedimentation etc, Principle-Determination: wintrob's / Westergren Method - advantages / disadvantages.

UNIT - IV

PREPARATIONS OF STAINS AND STAINING TECHNIQUES OF BLOOD SMEAR: Wright stain - Leishmans stain - Giemsa's stain - Jaswanthsingh and Bhattarcharji stain - Fields stain - Peroxidase stain: Examination of Blood smear:- Peripheral smear report: Size/ colour/ shapes/ inclusions - Blood parasites: Malarial parasite/Microfilaria.

UNIT - V

BLOOD BANKING: ABO Grouping; History/Discovery - slide / Tube technique - Rh. Typing: Slide / Tube technique, Bovine replacement technique - Coombs test: Direct /Indirect - Donor screening - Cross matching: Major / Minor - Blood bank practices - Collection of blood / preservation /storage.

Text Books

1. Medical Laboratory Technologies Vol I - III. Mukerjee, K.L. (1988). Tata McGraw Hill. Publishers, New Delhi.
2. Basic & Applied Concepts of Blood Banking and Transfusion Practices. 4th edition, Paula R. Howard (2016). Mosby publishers, United States

Reference Books

1. A text book of Practical Physiology, 4th Edition. Pal, G.K and Pravathi Pal (2016). Universities Press (India) Pvt Ltd.
2. Laboratory Procedures in Haematology, 1st edition. Mehdi S.R (2006). Jaypee Publishers.
3. Textbook of Medical Laboratory Technology 2 Volume Set, 3rd Edition. 2014. Gadkar P.B and Gadkar D.P. Bhalani Publishing House, Mumbai India.

NON-MAJOR ELECTIVE

PAPER - 1

Microbes in Human Welfare

Course Outcomes:

At the end of the course, the student will be able to

1. Understand the scope and relevance of Microbiology in daily life
2. Gain knowledge on the various types of microorganisms
3. Understand the potential of microorganisms
4. Appreciate the beneficial aspects of microorganisms
5. Get acquainted with various ways of using microorganisms

UNIT - I

Definition and Scope of Microbiology - The five major groups of microorganisms - Brief history of Microbiology - Theory of Spontaneous generation - Microscopy and staining - Concepts like Pure culture, culture media, fermentation - Bacterial growth, exponential multiplication, nutrients required for microbial growth - Photosynthetic microorganisms - bacteria, algae, cyanobacteria

UNIT - II

Household fermented foods - Idly, Pickles; Fermented milk products - Single Cell Proteins - Mushrooms

UNIT - III

Microbial production of organic acids, alcohols, enzymes, antibiotics, pigments, Biopolymers

UNIT - IV

Biofertilizers and biopesticides; Seaweeds and their uses; Microalgae and their uses - *Spirulina*; Biodegradation of Organic pollutants, Heavy metals, Plastic Degradation

UNIT - V

Concept of immunization and Vaccines, Immunoglobulins as therapeutic agents - Microorganisms as model organisms in genetic studies; Probiotics

Text books

1. Microbiology. 6th Edition. vMcGraw Hill Inc., New York.
2. x A Text of Microbiology. Revised edition. Pelczar Jr. M.J., Chan E.C.S and Kreig, N.R. (2006). S. Chand & Company Ltd., New Delhi.

Reference books

1. Microbiology. 5th edition. David B.D., Delbeco R., Eisen, H.N. and Ginsburg, H.S (1990). Harper and Row, New York.
2. Industrial Microbiology. 3rd edition. Patel A.H (2001). Mac Millan India ltd, New Delhi.
3. Industrial Microbiology. 2nd edition. Casida J.E (2005). Wiley Blackwell publishers, UK

**SEMESTER IV
CORE PAPER - 4
MICROBIAL GENETICS**

Course Objective: To provide an insight on the genomic structure, its organization and regulation, methods of gene transfer in bacteria and to familiarize on the concept of mutation.

Course Outcomes:

At the end of the course, the student will be able to

1. Outline the structure, replication and function of DNA
2. Explain about mutation, types of mutation and DNA repair mechanism.
3. Elaborate the different gene transfer methods in bacteria.
4. Compile the gene regulation in prokaryotes and eukaryotes.
5. Describe transposons and gene mapping.

UNIT - I

Discovery of DNA as genetic material, Griffith's experiment, Hershey and Chase Warring blender experiment; Structure of DNA; Plasmids - types and significance; Replication of DNA - Messelson and Stahl's Experiment - Types of replication - DNA polymerases; Triplet nature of the Genetic code.

UNIT - II

Mutation - Spontaneous mutation - missense, nonsense and frame shift mutation; Induced mutation - Mutagens - UV, X-Rays - Chemical agents - NTG and Base Analogues, Reversion - AMES Test, DNA damage - SOS response - DNA repair.

UNIT - III

Transcription, Translation; Concept of Gene and operon; Gene transfer Mechanisms - Transformation, Conjugation, Transduction - Generalized and specialized.

UNIT - IV

Gene regulation in prokaryotes and eukaryotes, positive regulation, negative regulation, attenuation - Gene expression system - Lactose and tryptophan operon. RNA structure and RNA processing - post transcriptional regulation. Transcriptional and translational regulation. Post translational modification and protein stability.

UNIT - V

Transposable genetic elements and Gene Mapping - Introduction - Discovery, insertion sequences, complex and compound transposons - T10, T5, and retroposon. Genetic mapping - *E. coli* - Virus T4 phage - using r II system.

Text Books

1. Microbial Genetics. Stanley R Maloy, John E Cronan and David Freifelder. 2nd Edition 1994. Jones and Bartlett Publishers, Boston.
2. Principles of Genetics. 7th edition. Robert H Tamarin (2002). Tata McGraw Hill P. Ltd., New Delhi.
3. Instant Notes in Molecular Biology, 2001, (2nd Edition). Turner P. C., Mc Lennan A. G., Bates A. D and White M. R. H. Published by arrangement with Bios Scientific Publishers Ltd., Oxford.

Reference books

1. Modern Microbial Genetics, 2002 (2nd Edition). Streips, U. N. and R. E. Yasbin. Wiley-Liss, Inc., New York.
2. Principles of Genetics. 8th edition. Gardner Simion Snustad (2005). John Wiley and Sons Inc, New York.
3. Gene VII, 7th Edition, 2000. Benjamin Lewin. Oxford University Press.
4. Genetics: A Conceptual Approach. Benjamin A. Pierce (2002). W.H.Freeman and Company, United States.
5. Advanced Molecular Biology - A concise Reference. Twyman, R M. 1998, Viva Books Private Ltd., New Delhi.

CORE PRACTICAL - 2

EXPERIMENTS IN IMMUNOLOGY AND MICROBIAL GENETICS

LIST OF EXPERIMENTS

Separation of Serum and Plasma

Demonstration of buffy coat

Blood grouping

ASO test

RPR test

Widal slide test

Preparation of blood smear and observation of WBC

Differential Count – Blood smear

Single radial immune diffusion

Double immuno diffusion

Isolation of antibiotic resistant bacteria by induced mutation

Reference Manuals

1. District Laboratory Practice in Tropical Countries - Part I and II 2nd Edition. Monica Cheesbrough. Cambridge University Press, New Delhi. 2006.
2. Practical Medical Microbiology. Mackie and McCartney. South Asia Edition. 14th edition. 2006.
3. Laboratory Exercises in Microbiology. Harley and Prescott (1996). McGraw Hill Higher Education, 3rd Edition

**ALLIED - 2
PAPER - 4**

BIOSTATISTICS

Course Outcomes:

On completion of the course, the student will be able to

1. appreciate the importance of statistics
2. differentiate the basic terms and formulae in statistics
3. relate the formulae with the applications
4. plan analysis with statistical tools
5. apply statistical tools in biological subjects

UNIT-I

Introduction – Scope and limitations of Statistics. Classification and tabulation of statistical data. Frequency distribution: Simple and Cumulative.

UNIT-II

Measures of central tendency: Arithmetic Mean, Median and Mode. Measures of Dispersion: Standard Deviation and Coefficient of Variation.

UNIT-III

Correlation analysis: Karl Pearson's, Spearman's rank and Concurrent deviation methods. Regression Analysis: Simple regression equations.

UNIT-IV

Small sample: test of significance based on t, F and Chi-Square distributions with respect of mean, variance and correlation coefficients.

UNIT-V

Basic principles of design of experiments: Randomization, Replication and Local Control. Analysis of Variance - One way and two way classifications.

Text Book:

An Introduction to Biostatistics. Gurumani N. 2005. MJP Publishers, Chennai.

Reference Books:

1. Biostatistics- A Foundation for Analysis in the Health Sciences. Daniel, W. W. 2007. Wiley.
2. An Introduction to Probability and Statistics. Rohatgi, V.K. and Saleh, A.K. Md. 2001. John Wiley & Sons.
3. Medical Statistics - Principles and Methods. Sundaram, K.R. 2010. BI Publications, New Delhi.
4. Introductory Biological Statistics. John E. Havel, Raymond E. Hampton, Scott J. Meiners. 2019. Waveland Press, Inc.

5. Fundamentals of Biostatistics. Dutta, N. K. 2004. Kanishka Publishers, New Delhi.

ALLIED PRACTICAL - 2

BIOINSTRUMENTATION PRACTICAL

Course outcomes:

On completion of the course, the student will be able to

- understand the basic principles instruments
- care and maintain the instruments in Biology labs
- use different instruments for analysis

1. Centrifuge a mixture of solution and observe sedimentation
2. Observe the Optical density and Transmission of a coloured solution
3. Prepare OD Vs. Conc. graph for a coloured solution
4. Perform paper chromatography
5. Prepare agarose gel and cast
6. Perform DNA electrophoresis

Biostatistics Practical

Course outcomes:

On completion of the course, the student will be able to

- understand the basic principles biostatistics
- perform simple calculations
- make use of statistical applications

1. Construction of Univariate and Bivariate frequency distributions with samples of size not exceeding 50.
2. Frequency distribution: Simple and Cumulative.
3. Measures of central tendency: Arithmetic Mean, Median and Mode.
4. Measures of Dispersion: Standard Deviation and Coefficient of Variation.
5. Correlation analysis: Karl Pearson's, Spearman's rank and Concurrent deviation methods.
6. Regression Analysis: Simple regression equations.
7. Small sample: test of significance based on t, F and Chi-Square distributions with respect of mean, variance and correlation coefficients.
8. Analysis of Variance - One way and two way classifications.

SKILL BASED SUBJECT
PAPER-2
MUSHROOM CULTIVATION

Course Objective: To provide the necessary skills in Mushroom cultivation.

Course Outcomes:

At the end of the course, the student will be able to

1. Outline the structure, cultivation of mushroom
2. Explain about Spawn preparation.
3. Elaborate the Cultivation of important Mushroom varieties.
4. Appreciate the nutritional value of mushrooms.
5. Describe the economic aspects of mushroom cultivation.

UNIT - I

Introduction, History of Mushroom Cultivation- Morphology and life Cycle of Mushroom - Edible and Non-Edible Mushroom (Most commonly cultivated Mushrooms in the World, Distribution and Production in various Countries).

UNIT - II

Spawn; Types Spawn, Preparation of Spawn, Mushroom Bed Preparation and factors affecting Mushroom bed preparation, Compost: Materials used for Compost preparation , Compost Technology in Mushroom production- Casing; Raw material used for casing, preparation of Casing Material. Important Sanitation during various stages of Mushroom cultivation.

UNIT - III

Cultivation of important Mushroom: General process for the cultivation of *Agaricus bisporus* (White button Mushroom), *Pleurotus flabellatus* (Oyster Mushroom), *Volvariella volvaceae* (Paddy Straw Mushroom).

UNIT - IV

Mushroom nutritional value; (Proteins, Amino acids, Vitamins, Minerals, Carbohydrates) - Pests and diseases of Edible Mushrooms (Environmental, Fungal, Bacterial, Viral, Insect Pests and Nematode diseases and competitor Moulds).

UNIT - V

Economics of mushroom cultivation (fixed assets, recurring expenditure, labour, economics of cultivation throughout the year and seasonal growing formulation of project report for getting finance from funding agencies). Precautions in mushroom cultivation (precaution to be taken while selecting the area, spawn preparation, spawn run, during

cropping harvesting etc.). Mushroom recipes (Western and Indian recipes, pickles, powders, jams etc)

Text Books

1. Mushroom production and processing Technology, Pathak Yadav Gour (2010) Published by Agrobios (India).
2. Mushroom - the art of cultivation, Harander Sing (1991). Sterling Publishers.
3. Biology and conservation of mushroom, Kaul T N (2001). Oxford and IBH Publishing Company, New Delhi.

Reference books

1. Changs Biology and cultivation of Mushrooms. . T.W.A. Hanyanes. 1978. Acad press. N.Y.
2. Edible Mushroom, Biotechnology. Vol. 3. Zadrazil. F & K. Grabbe. 1983. Weinheim: verlag Chemie, Berlin.
3. Handbook of Edible Mushrooms. Kannaiyan. 2001. TNAU Publication.

**NON-MAJOR ELECTIVE
PAPER - 2
EMERGING MICROBIAL DISEASES**

Course Outcomes:

At the end of the course, the student will be able to

1. Understand the role of Microbiology in diseases
2. Get acquainted with various diseases caused by microorganisms
3. Gain knowledge on the various types of pathogenic microorganisms
4. Understand the mode of disease spread
5. Appreciate the methods of preventing diseases

UNIT - I

Diseases Vs Infections; Communicable versus Non-communicable diseases; Microbiology; Microorganisms - Pathogens; Transmission; Sources of infection - air, water, food, animals, hospitals; Diagnosis; Treatment - Antibiotics; Prevention - hygiene, vaccines

UNIT - II

Bacterial diseases - Symptoms, causative agent, diagnosis, treatment, prevention methods of tuberculosis, cholera, diarrhea, dysentery, typhoid, pertussis, diphtheria, tetanus, syphilis, gonorrhoea, leptospirosis, plague, scrub typhus

UNIT - III

Fungal diseases - Symptoms, causative agent, diagnosis, treatment, prevention methods of candidiasis, aspergillosis, mycetoma, fungal eye infection, ringworm, athlete's foot, jock itch, fungal nail infections

UNIT - IV

Parasitic diseases - Symptoms, causative agent, diagnosis, treatment, prevention methods of Malaria, Amoebic dysentery, leishmaniasis, filariasis

UNIT - V

Viral diseases - Symptoms, causative agent, diagnosis, treatment, prevention methods of Polio, Jaundice, Mumps, Measles, Chicken pox, Rabies, Dengue fever, Chikungunya, Japanese encephalitis, Influenza, SARS, Covid19, AIDS

Text books

1. Text Book of Microbiology. 9th edition. Ananthanarayan R and Paniker C.K.J. (2013). Universities Press, Hyderabad.
2. A Text of Microbiology. Revised edition. Dubey R.C and Maheswari D.K. (2012). S. Chand & Company Ltd., New Delhi.

Reference books

1. District Laboratory Practice in Tropical Countries - Part I and II. 2nd edition. Monica Cheesbrough. (2005). Cambridge University Press, New Delhi.
2. Microbiology. 6th Edition. Pelczar Jr. M.J., Chan E.C.S and Kreig, N.R. (2006). McGraw Hill Inc., New York.

SEMESTER V
Core Paper - 5
Medical Bacteriology and Mycology

Course Objective: To enable student to understand medically important bacteria and fungi that cause diseases in humans

Course Outcomes:

At the end of the course, the learners will be able to:

1. Outline the importance of Normal microbial flora of human body and Host-Parasite relationships.
2. Explain about the diseases caused by the bacterial pathogens, prevention and treatment.
3. Discuss the different modes of transmission of bacterial diseases and the preventive measures.
4. Compare the morphological classification of fungi, and perform isolation of fungi from clinical specimen.
5. Compile the common mycotic diseases, their pathogenicity and various antifungal agents used for treatment.

UNIT - I

Normal Microbial flora of human body. Host parasite relationship - Infection and types of infection (Primary, Secondary, Reinfection, cross infection, Nosocomial and Iatrogenic infection) - Virulence factors of bacteria causing infection. Specimen collection, Transport and storage; Specimen processing (Blood, Urine, CSF, Sputum and other body fluids).

UNIT - II

Morphology, classification, antigenic structure, cultural characteristics, pathogenicity, laboratory diagnosis, preventive measures and treatment of Human pathogens - *Staphylococcus aureus*, *Streptococcus pyogenes*, *Streptococcus pneumoniae*, *Neisseriae meningitides* and *Neisseriae gonorrhoeae*, *Corynebacterium diphtheriae*, *Mycobacterium tuberculosis* and *Mycobacterium leprae*, *Clostridium botulinum*, *Clostridium tetani* and *Clostridium perfringens*, *Bacillus anthracis*. Family - Enterobacteriaceae (*Escherichia coli*, *Klebsiella*, *Salmonella*, *Shigella* and *Proteus*).

UNIT - III

Morphology, classification, antigenic structure, cultural characteristics, pathogenicity, laboratory diagnosis, preventive measures and treatment of *Vibrio cholerae* and *Vibrio parahaemolyticus*, *Pseudomonas aeruginosa*, *Brucella abortus*, *Bordetella pertussis*, *Haemophilus influenzae*, *Treponema pallidum*, Chlamydiae and Rickettsiae - Hospital waste disposal.

UNIT - IV

General introduction, Morphology and classification of fungi of medical importance - Detection and recovery of fungi from clinical specimens. Yeasts of medical importance - *Candida albicans*, *Cryptococcus neoformans*.

UNIT - V

Dermatophytes and agents of superficial mycosis - *Trichophyton*, *Epidermophyton* and *Microsporum* - Dimorphic fungi causing systemic mycoses - Histoplasmosis, Coccidioidomycosis, Blastomycosis - Mycetoma - Antifungal agents.

Text Books

1. Text Book of Microbiology, 9th edition. Ananthanarayan R & Paniker C.K.J. (2013). Universities Press, Hyderabad.
2. Medical Microbiology. 26th edition. Jawetz, Melnick, & Adelberg's. (2013). McGraw-Hill, New York.
3. An Introduction to Mycology. 1st edition. Mehrotra RS and Aneja KR. (2006). New age international publishers, Chennai.

Reference books

1. Diagnostic Microbiology, 13th edition. Tille P. Bailey and Scott (2013). Mosby Publishers, United States.
2. Medical Microbiology. 1st edition. Rajan S (2009). MJP Publishers, Chennai.
3. Essentials of Medical Microbiology. 3rd edition. Rajesh Bhatia and Ratan Lallchhpujani (2004). Jaypee Brothers, Medical Publishers (P) Ltd., New Delhi.
4. District Laboratory Practice in Tropical Countries. Part 1 & 2, Monica Cheesbrough (2003). Cambridge University Press.
5. Jagadish Chander (1996). A text book of Medical Mycology. 1st edition. Interprint, New Delhi.

Core Paper - 6

Agricultural and Environmental Microbiology

Course Objective: To enable students to understand the impact of microbial association in the field of Agriculture and the Environment.

Course Outcomes:

At the end of the course, the learners will be able to;

1. Outline the physical, chemical properties and microflora of soil.
2. Explain the role of microorganisms in biogeochemical cycles.
3. Compile the significance of microbial interactions and phytopathogens.
4. Demonstrate the air sampling techniques and summarize on air borne pathogens.
5. Apply the processes involved in the treatment of municipal water supplies

UNIT - I

Soil - Physical properties of soil - Soil color, Soil moisture, Soil temperature, Soil structure, Bulk density of soil- Types of soil. Chemical properties of soil- pH, Electrical conductivity, Nitrogen, Phosphate, Potash - Microflora of soil.

UNIT - II

Role of Microorganism in Biogeochemical cycles - Carbon, Nitrogen, Phosphorus, Sulphur and Iron. Organic matter decomposition - Composting (aerobic and anaerobic) - Vermicompost production - Biopesticides (Bacterial, Viral and Fungal).

UNIT - III

Microbial interaction-Symbiosis, Mutualism, Commensalism, Ammensalism, Parasitism-Rhizosphere; Phyllosphere - Plant pathogens- Bacteria (*Xanthomonas* sp.), Fungus (*Fusarium* sp.), Virus (Tobacco Mosaic Virus)

UNIT - IV

Microbiology of air - Sources of Microorganisms in air - Assessment of air quality-Air sampling techniques - Enumeration of airborne organisms - Air borne diseases - Air sanitation.

UNIT - V

Aquatic Microbiology - Ecosystems - Fresh water (River, Ponds, Lakes, Streams) Marine, Estuaries. Microbial assessment of water quality - Water purification. Water borne diseases. Waste Water treatment- Municipal waste water treatment primary, Secondary (Biological) and Tertiary.

Text Books

1. Microbial Ecology, Fundamental and Application, 3rd edition. Atlas R.M. and Bartha R (1992). Bengamin and Cummings. United States.
2. Environmental Aspects of Microbiology. Joseph C. Daniel. Brightsun Publications. Chennai
3. Soil Microbiology. 4th edition. Subba Rao N.S (2004). Oxford and BH Publishing Co.Pvt. Ltd., New Delhi.

Reference books

1. Environmental Microbiology. 1st edition. Raina M. Maier, Ian L. Pepper, Charles, P. Gerba (2006). Academic press, United States.
2. Environmental Science and Biotechnology. 1st edition. Murugesan A.G and Rajakumari C (2005). MJP Publishers, Chennai.
3. Soil Microbiology. 1st edition. Mishra R.R (2004). CBS Publishers and distributors, New Delhi.
4. Disease of Crop Plants in India. 4th edition. Rangaswami G and Mahadevan A (2002). PHI Learning (P) Ltd., New Delhi.
5. Soil Microbiology. 1st edition. Robert L Tate (1995). John Wiley and Sons, Inc. New York.

CORE PAPER- 7

FOOD MICROBIOLOGY

Course Objective: To enable students to understand the beneficial and harmful association of microbes on food

Course Outcomes:

At the end of the course, the learners will be able to;

1. Outline the important microorganisms present in food.
2. Elaborate the principles and methods of food preservation.
3. Compile the contamination, spoilage and spoilage of various foods.
4. Demonstrate and prepare fermented foods.
5. Summarize bacterial and non-bacterial food borne diseases.

UNIT - I

Food as a substrate for microorganisms - important microorganisms associated with food (bacteria, mold and yeast). Factors affecting the growth of microorganisms in food -pH, moisture, oxidation - reduction potential , nutrient content and inhibitory substances and biological structure.

UNIT - II

Contamination and Spoilage of food - microorganisms involved in the spoilage of cereals, vegetables and fruits, egg, meat and meat products, poultry, sea foods and milk - canned foods; prevention of spoilage.

UNIT - III

Principles of food preservation - Methods of food preservation - Asepsis -techniques involved in removal of microorganisms from food - use of temperature - low temperature & high temperature - canning, drying, radiation and food additives.

UNIT - IV

Fermented foods -pickled cucumber, sauerkraut, soy sauce, bread, idli & Dosa; Fermented dairy products - kefir, yoghurt and cheese; health benefits of fermented foods.

UNIT - V

Food borne illness - Foodborne infections -Bacterial - food intoxication - bacterial toxins - Mycotoxins- investigation of food poisoning outbreaks. Food quality control measures - food standards & quality control. HACCP, FDA, WHO, FSSAI.

Text Books

1. Food Microbiology. 4th edition. Frazier W.C. and West Hoff D.C (2008). McGraw Hill, New York.
2. Food Microbiology. 2nd edition. Adam M.R. and Moss M.O (2004). New international pvt. Ltd., publishers. UK.

3. Food Microbiology. 1st edition. Vijaya Ramesh K (2007). MJP Publishers, Chennai.

Reference books

1. Food Processing and Preservation. 8th edition. Sivashankar B and Mosses (2011). PHI Learning P. Ltd., New Delhi.
2. Basic Food Microbiology. 2nd edition. Banwart G. J (2004). CBS Publishers and Distributors, New Delhi.
3. Modern Food Microbiology. 4th edition. James M. Jay (2003). CBS Publishers, New Delhi.
4. Dairy Microbiology. Robinson R.K,(1990). Elseveir Applied science, London.
5. Principles of Fermentation technology. 1st edition. Stanbury P.F., Whitaker A and Hall S.J (1995). Pergamon, UK.

**INTERNAL ELECTIVE
PAPER - 1
(to choose one out of 3)**

A. IMMUNOTECHNOLOGY

At the end of the course, the learners will be able to;

1. understand basic concepts of Immunotechnology
2. demonstrate Antigen - Antibody reactions
3. express the concept of Autoimmunity
4. explain the role of Cytokines
5. discuss the role of vaccines in preventing diseases

UNIT - I

Introduction and scope of Immunotechnology; Preparation and purification of antigens, Extraction of antigens from pathogens, Preparation of synthetic antigens, Recombinant antigens; Production, purification and characterization of antibodies, Purification of Immunoglobulin, Characterization of Immunoglobulin.

UNIT - II

Antigen - Antibody reactions - Agglutination, Precipitation, Passive agglutination, Complement fixation test, neutralization tests, Immunofluorescence, ELISA, RIA, Western blot analysis, Immunoelectrophoresis, Flow cytometry, Chemiluminescence assay, Fluorescence activated cell sorting (FACS) analysis.

UNIT - III

Autoimmunity- Autoimmune diseases- Hashimoto's disease, Systemic lupus erythematosus, Multiple sclerosis, Myasthenia gravis and their treatment. Transplantation Immunology - Tissue transplantation - Tissue typing methods for tissue and organ transplantations. Graft versus host reaction and rejection, xenotransplantation.

UNIT - IV

Cytokines: Interferons, Interleukins and TNF - Production, Properties, biological functions and assay methods. Therapeutic uses of cytokines. Hybridoma technology - Production of monoclonal antibodies and their applications, chimeric antibodies.

UNIT - V

Principle of Immunization - Active and Passive Immunization; Kinds of vaccines - live, killed, attenuated, Toxoids, Purified Macromolecules as Vaccines, subunit vaccines, recombinant vector vaccines, DNA vaccines, peptide vaccines, conjugate vaccines; Recommended childhood immunization schedule.

Text Books

1. Immunology. 6th edition. Kuby J., Richard A. Goldsby, Thomas J. Kindt (2006). W.H. Freeman and company, New York.
2. Immunology. 3rd edition. Richard M. Hyde (2011). Williams & Wilkins, *Philadelphia*.
3. Immunology - An Introduction. 1st edition. Tizard K (1995). Saunders College Publishing, Philadelphia.

Reference books

1. Roitt's Essential Immunology. 13th edition. Peter J. delves, Seamus J. Martin, Dennis R. Burton & Ivan M. Roitt (2017). Wiley- Blackwell publishers, United States.
2. Cellular and Molecular Immunology. 9th edition. Abbas Abut K, Lightman Andrew K. and Pober Jordan S. (2017). Elsevier, Netherlands.
3. Fundamental Immunology, 7th edition. William E. Paul. (2012). Lippincott Williams and Wilkins, Philadelphia.
4. Immunology, 10th edition. Weir D.M & Stewart, J. (2000) Churchill Livingstone, New York 2000.
5. Text Book of Immunology. 1st edition. Bashir S.F (2011). PHI Learning Private limited, New Delhi.

**INTERNAL ELECTIVE
PAPER - 1
B. HUMAN ANATOMY AND PHYSIOLOGY**

Course Outcomes:

At the end of the course, the learners will be able to;

1. Explain the organs and functions of Respiratory System.
2. Outline the structure of organs of Gastro Intestinal System.
3. Discuss about the Musculoskeletal and Nervous System.
4. Describe the features of Circulatory system and Endocrine System.
5. Compile the information on Reproductive and urinary System.

UNIT - I

Introduction to applied human anatomy and physiology; **Respiratory System:** Different organs of the Respiratory System. Functions of the different organs of the Respiratory System. **Special Sensory Organs:** Introduction to special sensory organs. Function and functions of eye, ear, nose, tongue, and skin.

UNIT - II

Gastro Intestinal System: Different organs associated with the Gastro Intestinal system: (Salivary glands, Pancreas, Liver and Gall bladder and others).

UNIT - III

Musculoskeletal and skin: Introduction of musculo-skeleton system. Different parts of involved in skeleton system. Function of skeleton. Parts and function of skin. **Nervous System:** Introduction to nervous system. Different organs and function of central nervous system (CNS) and peripheral nervous system PNS and related to infection

UNIT - IV

Circulatory system: Blood - Site of formation, composition, functions of blood cells, Different parts of the circulatory system and its function. **Endocrine System:** Introduction to endocrine system.

UNIT - V

Reproductive System: Introduction Male reproductive system - physiological anatomy, spermatogenesis and its regulation, testicular hormones, composition of semen Female reproductive system - menstrual cycle, pregnancy and parturition, lactation and family planning. **Urinary System:** Different organs and Functions of Urinary System. Mechanism of urine formation and composition of urine.

Text Books

1. Manipal Manual of Anatomy, 3rd Edition. Sampath Madhyastha, (2016) CBS Publishers and Distributors Pvt Ltd. Chennai.
2. Handbook of Human anatomy 3rd Edition. Chaurasia, B.D, (2005). CBS Publishers and Distributors Pvt Ltd. Chennai.
3. Human physiology, 2nd edition- BJ Mejer, HS Meij, AC Meyer, AITBs publishers and distributors.

Reference Books

1. Text book of Anatomy. Srivastava, (2013). Books and Allied (P) Ltd, Kolkatha.
2. Anatomy and physiology in Health and illness. Cathleen JW Wilson OBE Anne Wangh. Churchill Livingstone Publication, UK, NK, 1996.
3. A Ross and Wilson's Anatomy and Physiology in Health and Illness, 9th Edition. Waugh A., Grant. Churchill Livingston, London.2001.
4. Guyton. Human Physiology and Mechanisms of Disease. Guyton AC and Hall JE. 1996. Hartcourt Publishers, Limited.
5. Gray's Anatomy. Williams PL (Ed). Churchill Livingstone, London.

INTERNAL ELECTIVE

PAPER - 1 C. CELL BIOLOGY

Course Outcomes:

On completion of the course the student is expected to be able to:

1. understand the structures and purposes of basic components of prokaryotic and eukaryotic cells
2. explain how the cellular components are used to generate and utilize energy in cells
3. understand the cellular components underlying mitotic cell division.
4. summarize the structure and function of the different cell components
5. outline how cell ultra structure is related to cell function

UNIT - I

INTRODUCTION TO CELL BIOLOGY - origin and evolution of cells, Diversity of cell size and shape Cell theory, cell as basic unit of life. Structure and organization of prokaryotic and eukaryotic cells. Comparison between plant and animal cells, General structure of cytoskeleton - structure, composition and functions of microfilaments , microtubules and intranuclear filaments.

UNIT - II

SUBCELLULAR ORGANELLES - The ultrastructure of cell wall, plasma membrane, nucleus, mitochondria, rough and smooth endoplasmic reticulum, Golgi apparatus structure and function lysosome structure and function, peroxisome, ribosomes, chloroplast and glyoxisome and their function. Organization of cells into tissue. Types of tissue. Cell - cell adhesion, cell matrix adhesion. Extracellular matrix- components and their biological role.

UNIT - III

BIOMEMBRANE - plasma structure, organization and basic functions, fluid mosaic model of structure, membrane proteins and their properties, membrane carbohydrates and their role. Transport across cell membrane - uniport, symport and antiport. Passive and active transport and water channel. Organization of cells into tissue. Types of tissue. Cell - cell adhesion, cell matrix adhesion. Extracellular matrix- components and their biological role.

UNIT - IV

ORGANIZATION OF GENOME - Organisation of prokaryotic, eukaryotic genome and chromosomes, types, structure and function. Cell division, mitosis, meiosis, their significance; Cell cycle - phases of cell cycle, comparison of mitosis and meiosis cell growth, kinetics of cell growth;

UNIT - V

CELL SIGNALING - Cell - to - Cell Signaling; Hormones and Receptors, Intracellular signaling in Development and Disease, Transport across Cell Membranes Protein Sorting: Organelle Biogenesis and Protein secretion, Stem Cell Biology, Cancer, Regulation of Cell Death; Apoptosis Circadian Rhythms.

Text Books

1. Cell and Molecular Biology: Concepts and Experiments (6th ed). Karp, G. (2010). John Wiley & Sons. Inc.
2. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology (14th ed). P.S.Verma and V.K.Agarwal. (2004). S. Chand and Company Ltd.
3. Essential Cell Biology (4th ed). Bruce Alberts and Dennis Bray (2013). Garland Science.

Reference Books

1. Cell and Molecular Biology.(8th ed). De Robertis, E.D.P. and De Robertis, E.M.F. (2010). Lippincott Williams and Wilkins, Philadelphia.
2. The Cell: A Molecular Approach. (5th ed). Cooper, G.M. and Hausman, R.E. (2009). Sunderland, Mass. Sinauer Associates, Inc.
3. The World of the Cell. (7th ed). Wayne M. Baker (2008). Pearson Benjamin Cummings Publishing, San Francisco.
4. Molecular Cell Biology 5th Edition. Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris Kaiser, Monty Krieger, Matthew Scott, Lawrence Zipursky and James Darnell. W.H Freeman and Company.

**SKILL BASED SUBJECT
PAPER-3
BIOINFORMATICS**

Course Objective: To make students aware of Bioinformatic concepts and their applications.

Course Outcomes:

At the end of the course, the learners will be able to;

1. Explain Databases and Sequence analysis.
2. Outline the process of BLAST and Gene prediction.
3. Discuss about the concept of Comparative Genomics.
4. Describe the Genome projects and Model Organisms.
5. Compile the information on Proteomics.

UNIT - I

Historical introduction and overview - Databases - Formats - Sequence analysis - Alignment of pairs of sequences - Multiple sequence alignments - Phylogenetic tree.

UNIT - II

Database searching for similar sequences - Scoring matrices; BLAST; Gene prediction - Methods - Protein structure prediction.

UNIT - III

Comparative Genomics: Purpose and Methods of comparison, Tools for genomic comparison: Applications of Comparative Genomics.

UNIT - IV

Genome projects and Model Organism research - Human Genome Project - Yeast; *Drosophila*; *C. elegans*; and Mouse - a comparative analysis.

UNIT - V

Proteomics - Gene expression analysis by cDNA micro arrays - Experimental techniques (2D Electrophoresis, Mass Spectrophotometry, Protein Micro arrays) - Ligand Screening.

Text Books

1. Bioinformatics - Methods and Applications, Third edition, 2008. S.C. Rastogi, N. Mendiratta and P. Rastogi PHI Learning Private Limited, New Delhi.
2. Fundamental Concepts of Bioinformatics. Dan E. Krane and Michael L. Razmer. 2003. Pearson Education Inc. UK.

Reference Books

1. Bioinformatics. David W. Mount. 2001. CBS Publishers & Distributors, New Delhi - Bangalore.
2. Microarrays for an Integrative Genomics. Ed. I.S. Kohane, A.T. Kho and A.J. Buttle. 2004. Ane Books, New Delhi.
3. Biological Sequence Analysis: Probabilistic Models of Proteins. Anders Krogh, Richard M. Durbin, and Sean Eddy. 1998. Cambridge University Press.
4. Bioinformatics Data Skills: Reproducible and Robust Research with Open Source Tools. Vince Buffalo. 2015. O'Reilly Media Inc., USA.

SEMESTER VI

CORE PAPER- 8

MEDICAL VIROLOGY AND PARASITOLOGY

Course Objective: To provide an in depth knowledge on diseases caused by viruses and parasites, their epidemiology and control measures.

Course Outcomes:

At the end of the course, the learners will be able to;

1. Explain the properties, classification and cultivation of viruses.
2. Outline the zoonotic and arthropod borne diseases.
3. Discuss about the oncogenic viruses.
4. Describe the classification of parasites and demonstrate the laboratory diagnosis of parasitic diseases.
5. Compile the information on common parasites, protozoan and metazoan diseases.

UNIT - I

General properties of virus - Classification; Structure and properties of viroids, prions; Detection of viruses and antigens in clinical specimens - Serological diagnosis of virus infections, cultivation of viruses.

UNIT - II

Arthropod borne virus (Chickungunya virus, Dengue, Japanese Encephalitis, West Nile fever, Yellow fever) and rodent borne viral diseases (Lassa, Hanta and Ebola virus) - Picorna viruses (Polio, Rhino Virus) , Hepatitis viruses (Type A, B and C) , Rabies virus, Orthomyxo (H1N1 Influenza) and Paramyxo viruses (Measles, Mumps) - SARS and MERS.

UNIT - III

Pox viruses, Adeno viruses, Herpes Simplex virus, Reo virus, Rota virus and Human immunodeficiency virus - Oncogenic virus (Papilloma virus and Polyoma virus) - Antiviral drugs, Interferon, Viral vaccines.

UNIT - IV

Introduction to Medical Parasitology - Classification of parasites - Laboratory diagnosis of common parasitic diseases. Common protozoan diseases - Amoebiasis, Giardiasis, Trypanosomiasis, Malaria, Toxoplasmosis, Leishmaniasis.

UNIT - V

Morphology of common metazoans - Pathogenicity, clinical manifestation and diagnosis of Ascariasis, Hook worm infection, Filariasis, Hydatidosis, Fasciolopsis, Schistosomiasis and Taenia infection.

Text Books

1. Text Book of Microbiology, 9th edition. Ananthanarayan R & Paniker C.K.J. (2013). Universities Press, Hyderabad.
2. Introduction to modern virology 4th edition. Dimmok N.J and Primrose S.B (1994). Blackwell scientific company publications, United States.
3. Text book of Medical Parasitology. 4th edition. Subhash Chandra Parija (2013). All India Publishers and Distributors (Medical Books Publishers), New Delhi.

Reference books

1. Medical Microbiology. 26th edition. Jawetz, Melnick & Adelberg (2013). McGraw-Hill. New York.
2. Parasitology, Protozoology & Helminthology. 13th edition. Chatterjee K.D (2016). Joe media Publishers. Calcutta.
3. General virology. 3rd edition. Luria S.E, Darnell J.E, Baltimore D and Compare A (1978). John Wiley and Sons, New York.
4. Text book of Medical Parasitology. 5th edition. Jayaram Paniker C.K (2004). Jaypee Brothers Publishers (P) Ltd., New Delhi.
5. Medical Parasitology. Revised edition. Karyakarte R.P and Damle AS (2005). Books and Allied (P) Ltd., Kolkata.

CORE PAPER - 9

INDUSTRIAL MICROBIOLOGY

Course Objective: To familiarize the learners on the basic microbial processes carried out in Industries and its significance.

Course Outcomes:

At the end of the course, the learners will be able to;

1. Outline the history and scope of Industrial Microbiology.
2. Explain about the methods involved in screening and development of production strains.
3. Elaborate on the principles, design and types of bioreactors.
4. Compile on the fermentation process and downstream processing.
5. Discuss on the industrial production of various products using microorganisms.

UNIT - I

General concept of Industrial Microbiology; History and scope of Industrial Microbiology; Industrially important Microorganisms and their products; screening and strain development strategies; Preservation techniques of the production strains.

UNIT - II

Bioreactor - Principle, Design, mode of operation and types; Fermentation- types of fermentation process (Batch and Continuous fermentation); Fermentation media, Sterilization of media; Down Stream processing.

UNIT - III

Foods produced by Microbes - Fermented foods - Bread, Pickles; Fermented Beverages - Beer and Wine; Dairy products - Yoghurt, Cheese; Microbial cell as food - Single Cell Proteins.

UNIT - IV

Microbial production of Organic acids - Citric acid, Lactic acid, Acetic acid; Amino acid production - glutamic acid and lysine; Steroid transformations

UNIT - V

Production of enzymes - Amylase, Protease; Ethanol production; Antibiotics - Penicillin, Streptomycin; Vitamin - B12.

Text Books

1. Industrial Microbiology. 3rd edition. Patel A.H (2001). Mac Millan India ltd, New Delhi.
2. Industrial Microbiology. 2nd edition. Casida J.E (2005). Wiley Blackwell publishers, UK.

3. Pharmaceutical Microbiology. 4th edition. Hugo W.B and Russell A.D (2002). Blackwell scientific publications / oxford, London

Reference books

1. Principles of Fermentation technology. 1st edition. Stanbury P.F., Whitaker A and Hall S.J (1995). Pergamon, UK.
2. Principles and Applications of Fermentation Technology. 1st edition. Arindam Kuila & Vinay Sharma (2018). Scrivener Publishing LLC, Beverly.
3. Industrial Microbiology: An Introduction. 1st edition. Michael J. Waites, Neil L. Morgan, John S. Rockey, Gary Higton (2001). Blackwell publishers, USA
4. Industrial Microbiology. 1st edition. Prescott and Dunn (1982). AVI Publishing co., west port, Connecticut, USA.
5. The Complete Book of Tanning Skins & Furs. 1st edition. James Churchill (1983). Stackpole Books, UK.

CORE PRACTICAL -3

EXPERIMENTS IN MEDICAL MICROBIOLOGY

LIST OF EXPERIMENTS

Acid fast staining for *M. tuberculosis*

LPCB mounting of fungal pathogens

Examination of stool samples for parasites

Type study of the following bacteria - *Staphylococcus aureus*, *Streptococcus pyogenes*, *Escherichia coli*, *Klebsiella* sp., *Salmonella* sp., *Shigella* sp., *Proteus* sp., *Pseudomonas aeruginosa*.

Coagulase test for Staphylococci

Isolation of pathogenic bacteria from sputum

Isolation of pathogenic bacteria from urine

Isolation of pathogenic bacteria from faeces

Blood culture

Antibiotic susceptibility test

Reference Manuals

1. Monica Cheesbrough. District Laboratory Practice in Tropical Countries - Part I and II 2nd edition. Cambridge University Press, New Delhi. 2006.
2. Mackie and McCartney. Practical Medical Microbiology, South Asia Edition. 14th edition. 2006.

CORE PRACTICAL - 4

EXPERIMENTS IN APPLIED MICROBIOLOGY

LIST OF EXPERIMENTS

- Microscopic observation of curd
- Microscopic observation of spoiled food and vegetables
- Methylene Blue Reduction test
- Enumeration of microorganisms from air by Open plate method
- Enumeration of bacteria from water sample
- Enumeration of bacteria and fungi from soil sample
- Test for coliforms in water by MPN method
- Test for coliforms in water by Presence - Absence method
- Demonstration of amylase producing bacteria
- Demonstration of lipase producing bacteria
- Demonstration of protease producing bacteria
- Cross section of root nodules
- Isolation of *Rhizobium* from root nodules

Reference Manuals

1. Rajan. S and Selvi Christy (2015). Experimental Procedures in Life Sciences, Anjanaa Book House Publishers, Chennai.
2. Cappuccino and Sherman. Microbiology: A Laboratory manual by (7th edition) Benjamin Cummings Publications, 2004.

**INTERNAL ELECTIVE
PAPER - 2
(to choose one out of 3)**

A. BIOTECHNOLOGY

Course Outcomes:

At the end of the course, the learners will be able to;

1. understand basic concepts of Biotechnology
2. demonstrate the uses of enzymes
3. express the importance of plant biotechnology
4. explain the role of animal biotechnology
5. discuss the role of microorganisms in environment

UNIT - I

Concept of Biotechnology - Definition and history of Biotechnology - Major areas of Biotechnology - Indian scenario in Biotechnology - centers, activities achievements and bio-industries in India.

UNIT - II

Enzyme technology - Enzyme immobilisation, Products, Applications - Biotechnological potentials of Seaweeds, Microalgae - Biofuel - Hydrogen gas as fuel from Microorganisms - Biosensors-different types, applications - medical and non medical

UNIT - III

Genetic engineering of plants - Electroporation - Gene gun - Particle bombardment - Ti plasmid vectors - Applications - Transgenic plants - Insect resistant, Stress tolerant, Virus resistant plants, genetically modified foods - Terminator gene technology - concept and basics

UNIT - IV

Transgenic animals - Retroviral vector method, DNA micro injection method - Applications of rDNA technology - Recombinant products - insulin, tPA, vaccines - Gene therapy - Patents - IPR

UNIT - V

Bioremediation - Clean-up Biotechnology - Microbial removal of metal ions - Soil Bioremediation - Removal of oil spill - Biodegradation of hydrocarbons - Genetically modified organisms.

Text Books

1. Biotechnology. Singh B.D. 2006. Kalyani Publishers, New Delhi.
2. Genetics - A Molecular approach. 3rd edition. Brown J.A. 2001. Nelson Tormes.

Reference books

1. Text Book of Biotechnology. Pandian, T.T. and Kandavel, D.2008. I.K International Publishing House, New Delhi.
2. Essentials of Biotechnology. Ane Books Pvt. Ltd. New Delhi.
3. Text book of Biotechnology. Das, H.K. 2007. Wiley India Pvt. Ltd. New Delhi

**INTERNAL ELECTIVE
PAPER - 2**

B. HERBAL TECHNOLOGY

Course Outcomes:

At the end of the course, the student will be able to

1. Get acquainted with the basics of Pharmacognosy
2. Gain knowledge of medicinal plants
3. Understand the use of various medicinal plants
4. Appreciate the Herbal medicines used to treat human ailments
5. Understand the Propagation methods of medicinal plants

UNIT - I

Pharmacognosy: Pharmacology - Definition and history; Indian systems of medicine - Siddha, ayurvedha, and Unani systems; Classification of Crude drugs; Chemistry of Drugs; Future of pharmacognosy.

UNIT - II

Classification of medicinal plants; locally available medicinal plants - Vernacular name and family - Geographical Distribution; Crude drugs - chemical composition - pharmaceutical uses - processing and marketing.

UNIT - III

Medicinal plant parts as herbal medicines: Leaves - Adathoda, Eucalyptus; Flower - Clove; fruits seeds - Nux vomica Nutmegs, Gooseberry - unorganized drugs; Gum - Acacia - Resin - Turpentine, fixed oil - castor oil. Underground stem - ginger, Alpinia; Roots - Rauolfia, Belladonna; Aerial parts - Bark - Cinchona.

UNIT - IV

Herbal medicines for Human ailments - Drugs acting on Blood pressure, cardiac diseases, cerebral diseases, Respiratory diseases - Drugs acting on Nervous system - Depressants. - stimulants - Urogenital system - Psychoactive plants; Drug adulteration - methods of Drug evaluation.

UNIT - V

Propagation of medicinal plants - cultivation of medicinal and aromatic plants - Micro and macro propagation - conservation of rare medicinal plants - seed banks - Role of biotechnology in medicinal plants - Herbal food - Food processing - packaging - Herbal sale and Export of medicinal plants - marketing - Intellectual property rights - Export laws.

Text Books

1. Herbal Drug Technology, 2nd Edition. Agarwal, S.S and Paridhavi, M (2012). Universities Press (India) Private Ltd.
2. Herbal Plants and their Applications in Cosmeceuticals. Kuntal Das (2014). CBS publishers and distributors Pvt. Ltd., Chennai.

Reference books

1. Pharmacognosy 12th edition. George Edward Trease and W.C. Evans. English Language Books Society, Baelliere Tindall.
2. Pharamcognosy by 2nd Edition. Handa, S.S. and Kapoor, V.K. Vallabh Prakashan Publishers, New Delhi.
3. Indian Medicinal plants. Jain, S.K (1980).
4. Pharmacognosy by 12th edition. Kokate, C.K., Durohit, A.P. and Gokhale, S.R. Nirali Prakasham Publishers, Pune.
5. Introduction to Medical Botany and Pharmacognosy. Kumar N.C. (1993).

INTERNAL ELECTIVE

PAPER - 2

C. GENETIC ENGINEERING

Course Outcomes:

At the end of the course, the student will be able to

1. Get acquainted with the basics of Genetic Engineering
2. Understand the role of various enzymes acting on DNA
3. Gain knowledge of Cloning vectors
4. Understand the Gene / DNA transfer techniques
5. Appreciate the applications of rDNA technology

UNIT - I

Milestones in Genetic Engineering - Definition of gene manipulation - Major steps involved in gene cloning - Isolation and Purification of Chromosomal and Plasmid DNA, Isolation and Purification of RNA - Chemical Synthesis of DNA, Genomic Library and cDNA Library - applications.

UNIT - II

Restriction endonucleases: Discovery, Type I, II and III and Mode of action, Applications of type II restriction endonucleases, Ligases, DNA polymerases, DNA modifying enzymes and topoisomerases.

UNIT - III

Cloning vectors: Definition and properties - Plasmid based vectors: Natural vectors (pSC101, pSF2124, pMB1), Artificial vectors (pBR322 and pUC) - Phage based vectors - Lamda) phage vectors and its derivatives - Hybrid Vectors; Phagemid and Cosmid, BAC and YAC - Expression systems - *E. coli*.

UNIT - IV

Gene/ DNA transfer techniques: Physical - Biolistic Method (Gene gun), Chemical- Calcium chloride and DEAE Methods, Biological in vitro packaging method in viruses - Selection and Screening of recombinants: Direct Method: Selection by Complementation, Marker inactivation methods - Indirect methods: Immunological and Genetic methods.

UNIT - V

Blotting (Southern, Western, Northern and North- eastern) techniques - PCR - basic steps in DNA amplification, RAPD, RFLP and their applications - DNA finger printing - DNA microarray analysis - Applications of recombinant DNA technology.

Text Books

1. An introduction to Gene Cloning, 3rd edition. Brown TA. 1995. Chapman and Hall.
2. Gene Cloning and DNA Analysis, 7th edition. Brown TA. 2015. Wiley Blackwell.
3. Principles of Gene Manipulation and Genomics. Primrose SB and Twyman RM. 2006. Wiley Blackwell, 7th edition.

Reference Books

1. Principle of Gene Manipulation, 5th edition. Old RW and Primrose SB. 1995. Blackwell Scientific Publication, Boston.
2. Gene Cloning - Principles and Applications. Julia Lodge, Peter Lund and Steve Minchin. 2006. Taylor and Francis, UK.
3. From gene to clones, Introduction to Gene Technology. Winnecker ED. 1987. VCH Publication, FRG.
4. Molecular Biotechnology. Principles and Application of recombinant DNA, Glick BR and Pasternak JJ. 1994. ASM Press. Washington.

INTERNAL ELECTIVES
PAPER - 3
(to choose one out of 3)

A.BIOINOCULANTS TECHNOLOGY

Course Outcomes:

At the end of the course, the student will be able to

1. Understand the role of Plant Growth Promoting Rhizobacteria
2. Get acquainted with production and field application of *Rhizobium* and *Frankia*
3. Gain knowledge of Cyanobacteria as N₂ fixers
4. Understand the Phosphate solubilizing microbes
5. Appreciate the role of Mycorrhiza in plant growth promotion

UNIT - I

Biofertilizers, Plant Growth Promoting Rhizobacteria; Bioinoculants; General account of the microbes used as biofertilizers for crop plants and their advantages. Non - Symbiotic N₂ fixers - *Azospirillum* - *Azotobacter* - Taxonomic characters, isolation, characterization, mass production and field application.

UNIT - II

Symbiotic N₂ fixers: *Rhizobium* - Isolation, characterization, identification, Classification, inoculum production and field application. *Frankia* - Isolation, characterization - actinorrhizal nodules - non-leguminous crop symbiosis.

UNIT - III

Symbiotic N₂ fixers - Cyanobacteria, *Azolla* - *Anabaena* - Isolation, characterization, mass multiplication - Role in rice cultivation - Crop response - field application - immobilization.

UNIT - IV

Phosphate solubilizers - Phosphate solubilizing microbes - Isolation, characterization, mass inoculum production, field application - Phosphate solubilization mechanism.

UNIT - V

Mycorrhizal bioinoculants - Taxonomy of mycorrhizae - importance of mycorrhizal Ectomycorrhizae - Endomycorrhizae - Ectendo mycorrhizae - Isolation of VA mycorrhizae - Quantification and assessment of VAM in roots - Mass inoculum production of VAM - field applications of Ectomycorrhizae and VAM.

Text Books

1. Bioethnology of Biofertilizers. Kannaiyan, S. (2003). CHIPS, Texas.
2. Hand book of Microbial biofertilizers. Mahendra K. Rai (2005). The Haworth Press, Inc. New York.

3. Bioinoculants for sustainable agriculture and forestry. Reddy, S.M. et. al. (2002). Scientific Publishers.

Reference Books

1. Soil microorganisms and plant growth. Subba Rao N.S (1995) Oxford and IBH publishing co. Pvt. Ltd. New Delhi.

2. Biofertilizers in Agriculture and forestry. Subba Rao N.S. (1988) Oxford and IBH Publishing Co., Ltd., New Delhi.

**INTERNAL ELECTIVES
PAPER - 3**

B. CLINICAL MICROBIOLOGY

Objective: To familiarize students on clinical laboratory guidelines, infections of organs and organ systems, transmission and detection of diseases.

Course outcomes:

At the completion of the course, the learners will be able to

1. Collect various clinical specimens for microbiological examination.
2. Gain knowledge on infections of different organ and organ system.
3. Comprehend the different modes of transmission of infection, prevention and its control.
4. outline the importance of immunoprophylaxis, genetic disorders and gene therapy.
5. Perform laboratory tests to detect infection and diseases.

UNIT - I

Philosophy and General Approaches to clinical specimens - clinical laboratory standard guidelines - Collection and transportation of specimens for microbiological examination (Pus, Urine, blood, CSF, body fluids etc.). Collection of data and maintenance of laboratory records.

UNIT - II

Normal microbial flora of human body .Infection and infectious diseases- types of infection. Pathogenic/parasitic organisms: Bacterial, viral and protozoan infections of the gastrointestinal system, nervous system, lung, liver and eye- Transmission and spread of diseases - Disease epidemiology.

UNIT - III

Sexually transmitted diseases, arthropod borne diseases, skin infections and zoonosis. Control and prevention of infections - drugs and antibiotics - drug resistance; Immunodeficiency, Autoimmunity and hypersensitivity.

UNIT - IV

Blood parasites (Malaria, Filaria) - importance, lifecycle, spread and Control of vectors - Mosquito control. Laboratory control of antimicrobial therapy, Immunoprophylaxis. Vaccines - types and methods of action. Genetic disorders and Gene therapy.

UNIT - V

Biochemical changes due to different infections - Blood tests - blood smear preparation - thick and thin - Leishman and Giemsa staining ; tissue analysis. Isolation and identification of organisms from tissue samples. Disease detection - conventional and molecular techniques.

Text Books

1. Diagnostic Microbiology, 13th Edition. Bailey and Scott, (2013). Elsevier Health Sciences publishers.
2. Mackie, Mc Cartney's Practical Medical Microbiology, 14th Edition. Collee, J.C. Dugrid, J.P., A.C., Marimion, B.P (2007). Churchill Livingstone.
3. Medical Microbiology. 14th edition. David Greenwood, Richard CD, Slack, John Forrest Peutherer. (2010). ELBS with Churchill Livingstone.

Reference Books

1. Essential Immunology. Ivan M. Roit. (2010). Wiley India Pvt. Ltd, New Delhi.
2. Topley & Wilson's. (1990) Principles of Bacteriology, Virology and Immunity, VIII edition, Vol. III Bacterial Diseases, Edward Arnold, London.
3. Medical Microbiology. 26th edition. Jawetz, Melnick, & Adelberg's. (2013). McGraw-Hill, New York.
4. Text book of Medical Parasitology. 4th edition. Subhash Chandra Parija (2013). All India Publishers and Distributors (Medical Books Publishers), New Delhi.

**INTERNAL ELECTIVES
PAPER - 3**

C. FOOD ANALYSIS AND QUALITY CONTROL

Objectives: The paper focuses on analysis of food, concepts of quality control and quality management

Course Outcomes:

At the end of the course, the student will be able to

1. Understand the Techniques used in food analysis
2. Get acquainted with various food analysis methods
3. Gain knowledge on the various methods of food quality assessment
4. Understand the Food quality management procedures
5. Appreciate the role of Food Safety organizations

UNIT - I

Sampling - Sampling techniques and preparation of food samples. **Techniques used in food analysis** - Chromatography, Electrophoresis, Electrometric determinations, Refractometry and Polarimetry Spectrophotometry, Fluorimetry, Radio - active tracer techniques, Atomic absorption

UNIT - II

Physico chemical methods for food analysis - Moisture and Total solids, Carbohydrates, Proteins, Fats, Fiber, Ash and its types, Minerals, Vitamins. Enzymatic methods **Biological methods of food analysis** - Standard plate count; Plate loop method; Spiral plate; Droplet technique; Dye reduction; Catalase test and ELISA. Testing of food for organisms such as *B. cereus*, *C. botulinum*, *E. coli*, *L. monocytogenes*, *S.aureus*, *Salmonella* and *Shigella*.

UNIT - III

Sensory assessment of food quality - Appearance of food, Flavor of food, Texture of food. **Sensory Tests** - Difference, Rating and Sensitivity tests. Types of panels, Testing area and schedule. **Quality control of following food products** - Milk and milk products, Oils and Fats, Cereal grains and flours, Fruits and vegetable products, Canned foods, Egg and egg products, Meat and Meat products

UNIT - IV

Food quality management - Objectives, Importance and Functions of quality control. Total quality, management, Good manufacturing practices, seven principles of HACCP and codex in food. Quality control, methods of - a. raw materials, b. manufacturing process and c. finished products.

UNIT - V

Food Safety - Role of voluntary agencies and legal aspects of consumer protection. National and International food laws - PFA, FDA, BIS, AGMARK, Essential Commodity Act, Export (quality and inspection act, Consumer protection act), Nutritional labeling requirements of foods, Food adulteration.

Text Books

1. Food Analysis - Theory & Practice. Pomeranz.Y, Meloan.C.E, 1996. CBS Publiishers, New Delhi.
2. Food microbiology, 4th edition. Frazier, W.C and Westhoff, D.C (1988). Tata Mac Graw Hill, New Delhi.

Reference books

1. Chemical Analysis of Food & Food Products. Jacobs.M.B., 1999. CBS Publiishers, New Delhi.
2. Introduction to chemical Analysis of foods. Nielsen, S.S, 2004. CBS Publishers, New Delhi.
3. Handbook of Analysis & Quality control for Fruit & Vegetable Products. Ranganna. S., 2001. Tata McGraw Hill, New Delhi.

**SKILL BASED SUBJECT
PAPER-4
MEDICAL LABORATORY TECHNIQUES**

Course objective: To provide students an effective background on Medical Laboratory techniques.

Course outcomes:

At the completion of the course, the learners will be able to;

1. Outline the general laboratory procedures for collection of various specimens.
2. Explain the mechanism of coagulation and procedures carried out in estimation of blood cells.
3. Describe about chemical and microbiological examination of CSF, Urine, semen, stool and vaginal fluids.
4. Elaborate on the collection and testing of amniotic fluid, gastric juice, lymph, sputum and synovial fluid.
5. Apply the theoretical knowledge in practice.

UNIT - I

Medical laboratory practices; General Laboratory apparatus, procedures, glassware's, safety measures, first aid in lab- sterilization and disinfection procedures. Blood-components of blood (plasma and cellular elements) and their functions.

UNIT - II

Hematopoietic system of the body (Erythropoiesis, Leucopoiesis and Thrombopoiesis)- Abnormalities in blood cell morphology- types of Anaemia and Leukemia. Blood grouping, Blood bank, Blood transfusion (Coomb's test, cross matching).

UNIT - III

Coagulation system: Clotting time, bleeding time. Estimation of PCV, ESR, RBC count, WBC count, Differential count, Platelet count. Mechanism of coagulation and Platelet disorders.

UNIT - IV

Body fluids- Physical properties, compartments, solutes and movements. CSF- physical examination, functions of CSF, chemical analysis, microbiological examination. Urine analysis, semen analysis, stool and vaginal fluid analysis and Pap smear.

UNIT - V

Amniotic fluid- chemical composition, functions and collection. Testing -Alpha-fetoproteins, Acetylcholinesterase, Neural tube defects. Collection of lymph, gastric juice, sputum, synovial fluid and testing.

Text Books

1. Textbook of Medical Laboratory Technology. 1st edition. Mrinalini Sant M D. (2020). CBS Publishers& Distributors.
2. Textbook of Medical Laboratory Technology. 1st edition. Praful B. Godkar and Darshan P. Godkar. (2014). Bhalani Publishing House.
3. District Laboratory Practice in Tropical Countries - Part I and II. 2nd edition. Monica Cheesbrough. (2005). Cambridge University Press, New Delhi.

Reference books

1. Concise note on Medical Laboratory Technology. Maiti. C.R. (2002). New central book agency. New Delhi A
2. Basic Clinical Laboratory Techniques. 6th edition. Barbara H. Estridge and Anna P. Reynolds (2011). Cengage learning publishers, United States B
3. Concise Book of Medical Laboratory Technology Methods and Interpretations. 2nd edition. Ramnik Sood. (2015). Jaypee Health Science publishers. C
4. Laboratory Procedures in Haematology, 1st edition. Mehdi S.R (2006). Jaypee Publishers. L

QUESTION PAPER PATTERN (Practical)

Internal Examination - Maximum = 25 Marks

External Examination - Maximum = 75 Marks

Total - Maximum = 100 Marks

External Examination - Maximum 75 Marks

(Will be conducted on two consecutive days of three hours each)

Question	Description	Marks
1	<ul style="list-style-type: none">• Minor Experiment (to be reported on the same day)	1 x 20 Marks = 20 Marks
2	<ul style="list-style-type: none">• Major Experiment (to be reported on the second day)	1 x 30 Marks = 30 Marks
3	<ul style="list-style-type: none">• Spotters	5 x 3 Marks = 15 Marks
4	<ul style="list-style-type: none">• Record Notebook	10 Marks
	Total	75 Marks
