SARVAJANIK UNIVERSITY

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Faculty of Science

SHREE RAMKRISHNA INSTITUTE OF COMPUTER EDUCATION AND APPLIED SCIENCES, SURAT

M.Sc. Industrial Microbiology

Syllabus

(Effective from 2021)

M.T.B Collge Campus, B/h P.T.Science College, Opp. Chowpati,
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M.Sc. Industrial Microbiology	
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A. About M.Sc. Industrial Microbiology Programme

The M.Sc. Industrial Microbiology programme offered by Sarvajanik University is of two years' duration and is divided into four semesters. The various courses of the programme are designed to include classroom teaching and lectures, laboratory work, project work, viva, seminars, assignments and field trips. Three categories of courses are being offered in this programme: Core courses, Skill enhancement courses and Elective course. A separate research-based course that leads to a dissertation is also one of the Core Courses offer in the final semester. The student presents his/ her research orally at the end of the semester, and this is coupled to a *viva-voce*. This not only equips the student for a career in research/ industry, but also fosters self-confidence and self-reliance in the student as he/she learns to work and think independently. Thirty percent of the total marks for each course will be awarded through Internal Assessment. Particular emphasis is laid on the practical aspects of the field. Students are taught how to plan experiments, perform them carefully, analyze the data accurately, and present the results both, qualitatively and quantitatively.

B. Programme Objective

- Through the stimulus of scholarly progression and intellectual development the programme aims to equip students with excellence in education and skills, thus enabling the student to pursue a career of his/her choice.
- By cultivating talents and promoting all round personality development through multi-dimensional education a spirit of self-confidence and self-reliance will be infused in the student.
- The student will be instilled with values of professional ethics and be made ready to contribute to society as responsible individuals.

C. Eligibility

- A candidate must have passed Bachelor's degree in Microbiology / Medical Technology/Biotechnology/Environmental Science / Industrial Microbiology /Bioscience / General Science/ Life-Science / Botany/Plant Science/Zoology/Animal Science/ Biology /Agriculture/Fisheries/Forestry /others.

- The candidate who has passed equivalent exam from other subjects or boards need to avail eligibility certificate for this programme from the Board of Equivalence (BoE) of the Sarvajanik University.

D. M.Sc. Industrial Microbiology Course Structure

Sem	Course Type	Course Code	Paper Title	Hours/Week		Credit
				Th	Pr	
1	Core course	DSC-1	Principles of Industrial Microbiology	4	4	4+2
		DSC-2	Fermentation Technology	4	4	4+2
	SEC	SEC-1	Molecular biology & Genetic Engineering	4	4	4+2
	Elective	DSE-1		4	4	4+2
2	Core course	DSC-3	Microbial Physiology & Metabolism	4	4	4+2
		DSC-4	Principles of Biochemical Engineering & Bioseparation	4	4	4+2
	SEC	SEC-2	Instrumentation and analytical techniques	4	4	4+2
	Elective	DSE-2		4	4	4+2
3	Core course	DSC-5	Microbial products	4	4	4+2
		DSC-6	Enzyme & Immuno Technology	4	4	4+2
	SEC	SEC-3	cGMP & Quality Assurance	4	4	4+2
	Elective	DSE-3		4	4	4+2
4	Core course	DSC-7	Dissertation	32		16
		DSC-8	Seminar Presentation			4
		DSC-9	Review of published research paper/Article			4
					Total Credit	96
Note: DSC – Discipline Specific Core, DSE - – Discipline Specific Elective, SEC - Skill Enhancement Course						

Semester	DSE (Any one to be opt)
1	1. Food Chemistry 2. Energy and Environment 3. Laboratory safety and management 4. Bioethics & Biosafety
2	1. Forensic Chemistry & Toxicology 2. Bioinformatics & Other “OMICS” 3. IPR 4. Biostatistics.
3	1. Forensic biology and DNA typing 2. Research Methodology 3. Bio-entrepreneurship 4. Application of Green Chemistry

E. Evaluation Scheme

M.Sc. Industrial Microbiology					
Evaluation	**Criteria**	**Theory**	**Practical**	**Dissertation**	**Seminar/ Review of published research paper**
Internal	Continuous & Comprehensive Evaluation (CCE)	40	60	140	60
	Attendance	10	10	10	10
	Assignment	20	----	----	----
	Internal Practical Test and Viva – Voce /	----	70	----	----
	Internal assessment	----	----	50	30
External	External Evaluation	30	60	100	50
	Total	100	200	300	150

F. Syllabus

Semester 2

Microbial Physiology & Metabolism

Name of faculty: Science	**Department:** Microbiology
Program: M.Sc. Industrial Microbiology Sem-II	**Type:** DSC-3
Subject: Microbial Physiology & Metabolism	
Credit: 4+2	**Total learning hours:** 60
Course description: Microbial Physiology is a concentrated course with the goal of integrating microbial biochemistry and physiology to enhance the understanding of the microbial cell and the diverse nature of various life processes, which provides opportunity to re-address the learning about general scientific conceptions. This course will attempt learning to provide a balance central metabolism, energy conservation and integration of metabolic events.	
Student learning outcome: • Students will learn about various events in the subject of microbial physiology and metabolism. Along with microbial transport of molecules and various metabolic pathways • They will also learn working of metabolic potential of micro-organisms • After completing this course, students will have the clear understanding about microbial physiology and metabolism with enhance ability to solve metabolic and physiological issues.	

Unit-1: Energy Metabolism and Transport of Molecules **(Duration: 08 Hrs)**

1.1 Properties of biomolecules and foundations of life
1.2 Thermodynamics
1.3 Transport of molecules
1.4 Role of ATP & ATP Synthase complex

Unit-2: Metabolism of Carbohydrate **(Duration: 08 Hrs)**

2.1 Glycolysis & Gluconeogenesis
2.2 Pentose Phosphate pathway
2.3 Citric acid cycle
2.4 Glyoxylate cycle
2.5 Photorespiration and C4& CAM pathways

Unit-3: Metabolism of Lipids **(Duration: 08 Hrs)**

3.1 Lipid digestion, Absorption and Transport
3.2 Fatty acid oxidation and Ketone Bodies
3.3 Biosynthesis of Fatty Acid

3.4 Regulation of Fatty acid Metabolism

Unit-4: Metabolism of Amino acid and Protein **(Duration: 08 Hrs)**

4.1 Metabolic fate of amino group
4.2 Nitrogen Excretion and Urea cycle
4.3 Catabolism of amino acids
4.4 Protein metabolism

Unit-5: Metabolism of Nucleotide **(Duration: 08 Hrs)**

5.1 De novo pathway
5.2 Salvage pathway degradation of Nucleotide
5.3 Ribonucleotide reductase

Unit-6: Oxidative Phosphorylation **(Duration: 08 Hrs)**

6.1 Electron Transfer reaction in mitochondria
6.2 ATP synthesis
6.3 Regulation of oxidative Phosphorylation

Unit-7: Photosynthesis **(Duration: 08 Hrs)**

7.1 General features of photophosphorylation
7.2 Light driven electron flow
7.3 ATP Synthesis by photophosphorylation
7.4 The evolution of oxygenic photosynthesis

Unit-8: Integration of Metabolism **(Duration: 04 Hrs)**

8.1 Metabolism in starvation
8.2 Hemoglobin metabolism

Reference Book:

- Berg, Jeremy M, Tymoczko, JohnL., Stever, Lubert Biochemistry 6th edition Published by W.H Freemaan. (2006) ISBN 0716787245
- Donald J Voet Judith G Voet, Charlotte W. Pratt. Principles of Biochemistry 3rd Edition John Wiley & Sons, Inc (2008).ISBN-13 978-0470-23396-2S
- Michael M.Cox,David L. Nelson. Lehninger Principles of Biochemistry 5th Edition .W.H. Freeman and Company (2008) ISBN 978-0-230-22699-9
- Pankaja Naik Biochemistry 4th edition Jaypee The Health Sciences publisher (2016) ISBN 978-93-5152-989-7
- Robert K Murray,Daryl K Granner, Victor W Rodwekk Harpers Illustrated Biochemistry. 27th Edition Mc Graw Hill (2006). ISBN 007-125301-7(India)

Further Reading:

- Denise R Ferrier Lippincott Illustrated Reviews Biochemistry Wolters Kluwer India Pvt Ltd (2020). ISBN 978-9389859751

- J.L.Jain , Sunjay Jain, Nitin Jain Fundamentals of Biochemistry S.Chand Publishing (1979). 9788121924535
- U. Satyanarayana, U Chakrapani Biochemistry 5th edition Elesvier (2020) ISBN 978-8131262535

List of Practical

1) Estimation of DNA by DPA and RNA by orcinol method.
2) Estimation of lipid by Bligh and Dyer's/ van Handel's method.
3) Electrophoretic separation of protein by PAGE: SDS & Native
4) Isolation of respiratory deficient mutant by UV radiation in yeast cell.
5) Study of chemical mutagenesis in *E. coli.*

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Biochemical engineering & Bioseparation

Name of faculty: Sciences	**Department: Microbiology**
Program: M. Sc. Industrial Microbiology Sem-II	**Type:** DSC-4
Subject: Principles of Biochemical engineering & Bioseparation	
Credit: 4+2	**Total learning hours:** 60

Course description:

The course aimed to give technical insight of various operations carried out during microbial fermentation. It also covers downstream processing of fermentation broths. These includes various cell separation technologies.

Student learning outcome: By the end of this course students will;

- Get technical detail of fluid, fluid mechanics and its behaviour during fermentation.
- Acquire knowledge about mixing operations of fermentation broths
- Get detailed technical insight of transfer of mass and heat.
- Acquire thorough knowledge of underlying principles of cell separation from fermentation broth.
- Able to plan and execute the separation strategies for microbial products.

Unit-1: Material Balances and Energy Balances. **(Duration: 07 Hrs)**

1.1 Thermodynamic Preliminaries.
1.2 Law of conservation of mass.
1.3 Stoichiometry of microbial growth and product formation
1.4 Electron Balances.
1.5 Biomass Yield.
1.6 Product stoichiometry.
1.7 Theoretical oxygen demand.
1.8 Basics energy concepts.
1.9 Thermodynamics of microbial growth

Unit-2: Fluid Flow **(Duration: 08 Hrs)**

2.1 Classification of fluids and Fluids in motion
2.2 Viscosity & it's measurement
2.3 Non-newtonian fluids
2.4 Rheological properties of fermentation broth and Factors affecting it

Unit-3: Mixing Operation **(Duration: 08 Hrs)**

3.1 Mixing Operation, mechanism and mixing equipment
3.2 Flow patterns in agitated tanks
3.3 Assessment of effectiveness of mixing
3.4 Power requirement for mixing of Ungassed and gassed fluids
3.5 Effect of rheological properties on mixing

Unit-4: Heat Transfer **(Duration: 08 Hrs)**

4.1 Concept of heat transfer
4.2 Heat transfer equipment
4.3 Mechanism of Heat transfer
4.4 Heat Conduction
4.5 Heat transfer between fluids
4.6 Design equation for heat transfer systems
4.7 Application of design equation

Unit-5: Mass transfer **(Duration: 08 Hrs)**

5.1 Concept of Mass transfer
5.2 Molecular diffusion and its role in bioprocessing
5.3 Film theory and Convective mass transfer
5.4 Oxygen uptake in cell culture
5.5 Oxygen transfer in fermenter and factors affecting oxygen transfer
5.6 Mass transfer correlation
5.7 Measurement of K_La

Unit-6: Cell Separation Techniques **(Duration: 07 Hrs)**

6.1 Filtration: Principle, Modes of filtration
6.2 Batch Filters and Continuous filters
6.3 Microfiltration, Ultrafiltration, Nanofiltration & High-performance tangential flow filtration
6.4 Reverse Osmosis: Mechanism
6.5 Centrifugation: Principle & Types of Centrifugal Separations
6.6 Solid bowl, Tubular-bowl, Continuous decanter, Disk centrifuges Centrifuge

Unit-7: Cell Disintegration and Extraction **(Duration: 07 Hrs)**

7.1 Introduction to Cell disruption techniques
7.2 Mechanical, Physical, Chemical and Enzymatic Methods for cell Disruption
7.3 Introduction to Liquid-liquid Separation and conventional technologies
7.4 Liquid Biphasic Partitioning System (LBPS) and Liquid Biphasic Flotation System (LBFS): Principle and Mechanism
7.5 Comparison of Conventional Liquid-Liquid Separation, LBPS, and LBFS

Unit-8: Product Finishing Technologies **(Duration: 07 Hrs)**

8.1 Drying

8.2 Crystallization
8.3 Evaporation and Precipitation

Reference Book:

- Doran, Pauline M. Bioprocess engineering principles. Elsevier, 2008, ISBN: 9788131200018
- Kristiansen Bjorn and Ratledge Colin, Basic Biotechnology. Cambridge University Press, 2007. ISBN: 9780521708029
- Show, Pau Loke, Chien Wei Ooi, and Tau Chuan Ling, eds. Bioprocess engineering: downstream processing. CRC Press, 2019. ISBN: 9781138605756
- Stanbury, Peter F., Allan Whitaker, and Stephen J. Hall. Principles of fermentation technology. Second Edition, Elsevier, 2013. ISBN: 9788181478085
- Todaro, Celeste M., and Henry C. Vogel, eds. Fermentation and biochemical engineering handbook. William Andrew, 2014. ISBN: 9781455725533

Further Reading:

- Kargi, Fikret., Shuler, Michael L.., DeLisa, Matthew. Bioprocess Engineering: Basic Concepts, 3rd Edition, Brazil: Prentice Hall, 2017. ISBN: 9780137062706
- Yoshida, Fumitake., Katoh, Shigeo., Horiuchi, Jun-ichi. Biochemical Engineering: A Textbook for Engineers, Chemists and Biologists, 2nd Edition, Germany: John Wiley & Sons, Incorporated, 2015. ISBN: 9783527684984

List of Practical

1) Determination of K_La.
2) To concentrate and purify the protein using column chromatography technique.
3) Rheological study of culture broth by Brookfield viscometer.
4) Partial purification of amylase by ammonium sulphate purification and dialysis. Calculate specific activity and fold purification.

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Instrumentation and Analytical Techniques

Name of faculty: Science	**Department:** Chemistry
Program: M.Sc. Sem-II	**Type:** SEC-2
Subject: Instrumentation and Analytical Techniques	
Credit: 4+2	**Total learning hours:** 60
Course description: This Course Paper proposes to teach about Principle, Instrumentation and Applications of various spectroscopy and chromatographic techniques, advanced instrumentation techniques, chemical sensors and biosensors.	
Student learning outcome: At the end of the course students will be able to... Learn • The History, origin, laws, principles, theories, instrumental set up, its' working mechanism, various components and it's working pattern, procedure of analysis and applications in the various field of analysis about: • Visible Spectroscopy • Atomic Absorption Spectrometry • Optical Emission Spectrometry • Advanced Instrumentation Techniques • Gas Chromatography • High Performance Liquid Chromatography • Ion Exchange and Ion Exclusion Chromatography • Chemical Sensors and Biosensors	

Unit-1: Visible Spectroscopy **(Duration: 06 Hrs)**

1.1 Characteristics of electromagnetic spectrum
1.2 Origin of spectra and electronics transitions
1.3 Laws of absorption of radiation - Lambert & Beer's law and its deviation
1.4 The architecture of a spectrophotometer
1.5 Calibration curve and standard addition method - multi component analysis
1.6 Applications of UV-visible spectroscopy

Unit-2: Atomic Absorption Spectrometry **(Duration: 08 Hrs)**

2.1 The history & principle of atomic absorption spectroscopy
2.2 AAS – Instrumentation
  2.2.1 Radiation sources: line & continuum
  2.2.2 Atomization techniques: FAAS & GFAAS
  2.2.3 Wavelength selector: monochromator
  2.2.4 Detectors: PMT
  2.2.5 Single & double beam AAS
2.5 Applications of atomic absorption spectrometry

Unit-3: Optical Emission Spectrometry **(Duration: 08 Hrs)**

3.1 Introduction and principle
3.2 Atomic spectroscopic sources
3.3 Inductively coupled plasma - the discharge
3.4 ICP-OES Instrumentation
  3.4.1 Nebulizers
  3.4.2 Spray Chambers
  3.4.3 Sample introduction systems
  3.4.4 Optics and the spectrometer
  3.4.5 Emission detectors
3.5 Applications of ICP-OES

Unit-4: Advanced Instrumentation Techniques **(Duration: 06 Hrs)**

Principle, Instrumental set up & Applications of
4.1 Non dispersive IR (gas analyzer)
4.2 Modern elemental analyzer
4.3 Total organic carbon analyzer
4.4 Mossbauer Spectroscopy
4.5 Turbidimetry
4.6 Naphelometry

Unit-5: Gas Chromatography **(Duration: 08 Hrs)**

5.1 Introduction of chromatography and principle of separation
5.2 Classification -GSC and GLC & its applications
5.3 Components of instruments: carrier gas, sample injection system, stationary and mobile phase
5.4 Columns - packed column and capillary column - WCOT, SCOT, PLOT
5.5 Detectors - FID, TCD, ECD, ASD
5.6 Principle and applications of GC-HS, GC-MS

Unit-6: High Performance Liquid Chromatography **(Duration: 08 Hrs)**

6.1 Introduction, principle and types of HPLC
6.2 Components of instruments: pumps high pressure, pneumatic, syringe, reciprocating, hydraulic
6.3 Sample injection system
6.4 Column
6.5 Detector: ultra violet light absorption, refractive index, evaporative light scattering
6.6 Selective applications in separation and estimations
6.7 Principle and applications of LC-MS

Unit-7: Ion Exchange and Ion Exclusion Chromatography **(Duration: 08 Hrs)**

7.1 Ion exchangers – types, characteristics and properties
7.2 Ion exchange equilibrium and factors affecting it
7.3 Instrumental set up of IEC- columns and detector
7.4 Principle, procedure and applications of IEC
7.5 Principle, working procedure and applications of Ion Exclusion Chromatography:
7.5.1 Gel Permeation Chromatography
7.5.2 Ion Exclusion Technique
7.5.3 Inorganic Molecular Sieves

Unit-8: Chemical Sensors and Biosensors (Duration: 08 Hrs)

8.1 Definition and classification of sensors, Signal and noise
8.2 Efficiency of sensors, sensitivity and limit of detection
8.3 Principle and applications of
8.3.1 Electrochemical sensors
8.3.1.1 Coulometry & Potentiometry
8.3.1.2 Conductimetry & Amperometry
8.3.1.3 Polarography & Voltammetry
8.3.2 Solid state electrode & Mass sensitive sensors
8.3.3 Optical sensors & Thermal sensors
8.3.4 Biosensors & Biocatalytic biosensors

Reference Book:

- Engineering Chemistry, P.C. Jain & Monica Jain, 17th Edition, Reprint 2011, Dhanpatrai Publishing Company (P) Ltd., ISBN: 9789352167203.
- Handbook of Analytical Instrument, R.S. Khandpur,2nd Edition, Reprint 2009, Tata McGraw Hill Publishers.,ISBN: 9780070604605.
- Instrumental Methods of Chemical Analysis(Analytical Chemistry) , H. Kaur, 8th Edition, 2012, Pragati Prakashan, ISBN: 9789387151673.
- Basic Concepts of Analytical Chemistry, S.M. Khopkar, 3rd Edition, Reprint 2009, New Age International (P) Limited, Publishers, ISBN: 9781906574000.
- Analytical Instrumentation Handbook, Ewing's , Edited by Jack Cazes, 3rd Edition, 2005, Marcel Dekker Publisher. ISBN : 9780429121432.
- Instrumental Methods of Analysis, H.H.Willard, L.L.Meritt, J.A. Dean and F.A. Settle, 7th Edition,1986, CBS Publishers. ISBN : 9788123909431.
- Instrumental methods of analysis, B.K. Sharma, 24th Edition, 2005, Go Publishing House, ISBN : 9788182836730.
- Instrumental Analysis, D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch,11th Edition, Reprint 2012, Cengage Learning, ISBN- 9781305577213.
- BIOS-Instant Notes-Analytical Chemistry, D. Kealey, P.J. Haines, 2002, Viva Books (P) Ltd., ISBN-9781859961896.
- Analytical Instrumentation, Bela G. Liptak, 1st Edition,1994, 1st Indian Reprint, 2012, Chilton Book Company, ISBN-9780801983979.

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List of Practical

1) Determination of Phenol in water sample by Spectrophotometer.
2) Determination of COD in water sample by Spectrophotometer.
3) Estimation of Sugar in natural sample by Spectrophotometer.

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Forensic Chemistry & Toxicology

Name of faculty: Science	**Department:** Chemistry
Program: M.Sc. Sem-II	**Type:** DSE-2
Subject: Forensic Chemistry & Toxicology	
Credit: 04(T) + 02 (P)	**Total learning hours:** 60
Course description: This course paper intends to deal about the Forensic Toxicology, the branch of science that applies the principles and knowledge of toxicology to issues and problems in the field of law. To achieve this, techniques of analytical chemistry are combined with principles of toxicology to address issues related to the toxic effects of substances on humans that are germane to judicial proceedings. Analytical chemistry deals with the techniques and methods for determining the identity and relative amounts of unknown components in a sample of matter.	
Student learning outcome: At the end of the course students will be able to learn... • Forensic chemistry and its scope, • Examination of petroleum products, fires, explosives, • Types of forensic toxicology, analysis, extraction, isolation and clean up procedures, • Forensic examination of metallic poison and various organic-toxic compounds.	

Unit 1: Forensic Chemistry and its Scope **(16 hrs)**

1.1 Analysis of beverages:
Alcohol and Non- alcoholic, country made liquor, illicit liquor

1.2 Drugs of abuse: Introduction, Classification, Narcotic drugs & Psychotropic substances, drugs of abuse in sports.

1.3 Brief Introduction to Drugs and cosmetic act, Excise Act, NDPS Act

1.4 Analysis of Gold and Other metals in cheating cases.

Unit 2: Examination of Petroleum Products **(14 hrs)**

2.1 Distillation & Fractionation, various fraction and their commercial uses.

2.2 Standard methods of analysis of petroleum products for adulteration

2.3 Trap cases: purpose, examination of chemicals used in trap case

2.4 Cement: Composition, types and Forensic analysis, Mortar & Concrete

Unit 3: Fires **(13 hrs)**

1.1.1 Nature and Chemistry of fire, Classification

1.2 Igniters of fires, Phases of fires, Main types of fires

1.3 Examination of scene of fires

1.4 Arson: Relevant IPC sections, Motives, Analysis of Accelerants

Unit 4: Explosives **(14 hrs)**

4.1 Classification, Comparison & characterization of explosives

4.2 Military & Commercial explosives

4.3 Qualitative determination: Detection of Explosophores (anions), Detection of Black powder, Nitrocellulose and Dynamite,

4.4 Quantitative determination

Unit 5: Forensic Toxicology **(14 hrs)**

5.1 Introduction, concept and Significance

5.2 Poisons: Definition, Classification of poisons

5.3 Types of poisoning sign and symptoms of poisoning

5.4 Mode of action, factors modifying the action of poisons

5.5 Toxicological exhibits in fatal and survival cases

5.6 Preservation Treatment in cases of poisoning

5.7 Analysis report

Unit 6: Extraction, Isolation and Clean-up procedures **(15 hrs)**

6.1 Non-volatile organic poison

6.2 Stas-otto, Dovbriey Nickolls (Ammonium sulphate) method, acid digest and Valov(Tungstate) methods, Solid phase micro extraction techniques, Solvent extraction methods

6.3 Volatile Poisons: Industrial solvent acid and basic Distillation

6.4 Toxic Cations: Dry Ashing and Wet digestion process

6.5 Toxic Anions: Dialysis method total alcoholic extract

Unit 7: General Study and Analysis **(13 hrs)**

7.1 Barbiturates, methaqualone, Hydro morphine, Methadone, Meprobamate, Mescaline, Amphetamines, LDS, Heroin, Cannabinoids, Phinothiazines

7.2 Insecticides: Types, General methods for their analysis

7.3 Alkaloids: Definition, classification, Isolation and General characterization.

7.4 Analysis of Ethyl Alcohol in blood and urine, illicit liquor, Methanol, Acetone, Chloroform, Phenol

7.5 Snake venoms and Poisons, Irrespirable gases

7.6 Vegetable poisons, Opium, Abrus, Cynanogenetic glycosides, Dhatura, Marking nuts, Nux-vomica, Oleander and Aconite

7.7 Forensic Pharmacological studies:
Absorption, Distribution, Metabolism, Pathways of drug metabolism

Unit 8: Forensic Examination of Metallic Poisons (14 hrs)

8.1 Absorption, Distribution, Metabolism, Pathways of metallic poison metabolism: Arsenic, Mercury, Lead, Bismuth, Copper, Aluminium, Iron, Barium, Zinc.

References:

1. Vogel's Textbook of Quantitative Chemical Analysis, Maudham Bassett et.al; 6th Edition, 2004, Longman Essex.
2. Organic Chemistry Vol. II, I. L. Finar, Pearson Education, Singapore.
3. Organic Chemistry, R.T. Morrison, R.N. Boyd; 6th Edition., 2003, Prentice Hall, New Delhi.
4. Vogel Textbook of Practical Organic Chemistry, Brean S. Furniss et. al; 1998, Addison Wesley Longman, Edinburg.
5. Medicinal Chemistry, A. Burger, Vol. II, 1970, Wiley Interscience, NY.
6. D. A. Skoog, D.M. West, F.J. Holler; Analytical Chemistry – An Introduction, 7th Edition, 2000, Saunders College Pub. Philadelphia, USA.
7. Working Procedure Manual – Chemistry, Explosives and Narcotics, 2000, BPR&D Pub. 11. Official and standardized Methods of Analysis, C.A. Watson, 1994, Royal Society of Chemistry, UK.
8. Modi's Medical Jurisprudence & Toxicology, 1988, M. M. Trirathi Press Ltd. Allahabd.
9. Forensic Science Hand Book, Vol I, II and III, Saferstein, R., 1982, Pretince Hall, NI.
10. Analytical Methods in Human Toxicology, Part II, Curry, 1986.
11. Poison Detection in Human Organs Curry, A.S., 1976.
12. Forensic Science, Handbook, Vol. I, II & III, Saferstien, Prentice Hall Inc, USA.

13. Encyclopedia of Forensic Sciences Vol. I, II and III, J. A. Siegel, P.J Saukko, 2000, Acad. Press.

Laboratory Practical

1. Estimation of mixture (Acid + Amide)
2. Estimation of mixture (Acid + Ester)
3. Organic synthesis of Paracetamol.
4. Organic synthesis of 6 - methyluracil.
5. Organic synthesis of Acridone.
6. Organic synthesis of Methyl Orange.
7. Determination of Phenol in water sample by Spectrophotometer.
8. Determination of COD in water sample by Spectrophotometer.
9. Estimation of Sugar in natural sample by Spectrophotometer.
10. Identification of salts and metals by simple colour test and group analysis.
11. Identification of different vegetable poison by colour test, chromatography etc.
12. Identification of insecticides and pesticides by TLC/ colour test.

References:

1. Standard Methods for Examination of Water & Wastewater, Andrew D. Eaton, Lenore S. Clesceri, Eugene W. Rice, Arnold Greenberg, 23rd Edition, 2017, published by APHA, AWWA, WEF.
2. Official Methods of Analysis, Dr. William Harwitz, Dr. George W Latimer, 18th Edition, 2005, published by Association of Officiating Analytical Chemists (AOAC).
3. Analytical Techniques in Agriculture, Biotechnology and Environmental Engineerin; A. Nag; 1st Edition, 2006, Prentice Hall of India.
4. Laboratory Manual in Biochemistry – J. Jayaraman, 2011, New Age Publication.
5. Analytical Chemistry, H. Kaur, 1st Edition, 2013, Pragati Prakashan.

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Bioinformatics & Other "OMICS"

Name of faculty: Science	**Department:** Microbiology
Program: M.Sc. Microbiology Sem-II	**Type:** DSE-2
Subject: Bioinformatics & Other "OMICS"	
Credit: 04+02	**Total learning hours:** 60

Course description: The paper mainly emphasizes on study concept development and application of omics and Bioinformatics. The objective of the paper is to introduce students to the rapidly evolving field of bioinformatics. Explain the different NGS study designs, outline the application areas of comparative genomics and proteomics. Describe some relevant databases, sequence alignment methods and various bioinformatics application.

Student learning outcome: After learning this course students will be able to understand.

- Concept, Mechanism and application genomics, Proteomics and metagenomics
- Student will be utilized the available biological database, online resources and tools.
- Student will be able to understand and perform the bimolecular structure visualization, sequences alignment, modelling and drug discovery.

Unit-1: Genomics (Duration: 08 Hrs)

1.1 Introduction to Genomics: Structural, Functional and Comparative

1.2 Next Generation Sequencing Technologies

1.3 Genome Mapping

1.4 Genome Assembling and annotation

Unit-2: Proteomics (Duration:08 Hrs)

2.1 Genomics to Proteomics: the way forward

2.2 Interaction Proteomics: Methods of Protein-Protein Interaction

2.3 Wet lab Techniques for proteomics data generation: 2-D Differencial gel electrophoresis, Protein Microarray and its Application, Types and Manufacture of protein chip, MALDI-ToF.

2.4 Application of Proteomics.

Unit-3: System Biology (Duration: 07 Hrs)

3.1 Systems biology: Understanding of Biological Systems

3.2 Microbial Metabolomics

3.3 Mass Spectrometry-Based Microbial Metabolomics: Techniques, Analysis, and Applications.

3.4 Concept of Synthetic biology

Unit-4: Other omics (Duration: 07 Hrs)

4.1 Metagenomics: Fundamental concepts, library construction and screening methods

4.2 Mining Metagenomes for Novel Bioactive Molecules

4.3 Transcriptomics: RNA level Gene Expression: DNA Micro array Technology and its Application, Printing Technologies

4.4 Concepts of Culturomics, Metatranscriptomics and Metaproteomics

Unit-5: Major Bioinformatics Resources (Duration:08 Hrs)

5.1 Databases in Bioinformatics

5.2 Sequence databases: NCBI, DDBJ, EMBL, PIR, Swissprot

5.3 3D Structure and classification Database : PDB, MMDB, CDD, E-MSD, 3-D Genomics, CATH, SCOP,InterPro, Prosite, Pfam, ProDom.

5.4 Database Searches: Keyword-based searches using tools like ENTREZ and SRS

5.5 Sequence-based searches: BLAST and FASTA

Unit-6: Sequence Alignment (Duration:08 Hrs)

6.1 Sequence Analysis, Basic concepts: Sequence similarity, identity and Homology, Scoring Matrix.

6.2 Pairwise and Multiple sequence alignments

6.3 Molecular Phylogenetics

6.4 Phylogenetic Tree Construction Methods and Programs

Unit-7: Comparison of protein 3D structures (Duration: 07 Hrs)

7.1 Protein primary structure analysis and prediction.

7.2 Secondary structure prediction: Algorithms viz. Chou Fasman, GOR methods

7.3 Tertiary Structure prediction: Fundamentals of the methods for 3D structure prediction

7.4 Homology/comparative Modeling, fold recognition, threading approaches, and *ab initio* structure prediction methods

Unit-8: Bioinformatics Application (Duration:07 Hrs)

1.1 Bioinformatics Application in drug design: Chemical databases like NCI /PUBCHEM.

1.2 Fundamentals of Receptor-ligand interactions.

1.3 Structure-based drug design:

1.4 Ligand based drug design: Structure Activity Relationship – QSARs &Pharmacophore etc.

1.5 *In silico* predictions of drug activity and ADMET.

Reference Book:

- Low, L. W. Y., & Tammi, M. T. (Eds.). (2017). Bioinformatics: A Practical Handbook of Next Generation Sequencing and Its Applications. # N/A.
- Primrose, S. B., & Twyman, R. (2013). Principles of gene manipulation and genomics. John Wiley & Sons.
- Twyman, R., & George, A. (2013). Principles of proteomics. Garland Science.
- Baidoo, E. E. (Ed.). (2019). Microbial Metabolomics: Methods and Protocols. Humana Press.
- Xiong, J. (2006). Essential bioinformatics. Cambridge University Press.
- Kitano, H. (2001). Foundations of systems biology. The MIT Press Cambridge, Massachusetts London, England.
- Camilla Benedetti, (2014) Metagenomics methods, applications and perspectives, Nova Publisher.
- Kalia, V. C., Shouche, Y., Purohit, H. J., & Rahi, P. (Eds.). (2017). Mining of microbial wealth and metagenomics. Springer Singapore.
- Ghosh, Z., & Mallick, B. (2008). Bioinformatics: principles and applications. Oxford University Press.
- Rastogi, S. C., Rastogi, P., & Mendiratta, N. (2008). Bioinformatics Methods And Applications: Genomics Proteomics And Drug Discovery 3Rd Ed. PHI Learning Pvt. Ltd.

Further Reading:

- Ouellette, B. F., & Baxevanis, A. (Eds.). (2001). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. John Wiley.
- Pevsner, J. (2015). Bioinformatics and functional genomics. John Wiley & Sons.
- Humphery-Smith, I., & Hecker, M. (Eds.). (2006). Microbial proteomics: functional biology of whole organisms (Vol. 48). John Wiley & Sons.
- Orengo, C., Jones, D., & Thornton, J. (Eds.). (2003). Bioinformatics: genes, proteins and computers. Taylor & Francis.
- Lesk, A. M. (2017). Introduction to genomics. Oxford University Press.
- Mount, D. W., & Mount, D. W. (2001). Bioinformatics: sequence and genome analysis (Vol. 1). Cold Spring Harbor, NY: Cold spring harbor laboratory press.
- Janitz, M. (Ed.). (2011). Next-generation genome sequencing: towards personalized medicine. John Wiley & Sons.

List of Practical

1) Biological databases search and Retrieval of Data.
2) Pair-wise and multiple sequence alignment
3) Perform the phylogenetic analysis using Clustal Omega
4) ORF Finding
5) Primer designing
6) Protein structure prediction
7) Homology Modeling

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Intellectual Property Rights

Name of Faculty: Science	**Department:** Environmental Science
Program: M. Sc. Sem-II	**Type of Subject:** Theory
Subject: Intellectual Property Rights	
Semester: 3	

Student Learning Outcomes (SLOs):

- The course is designed to provide comprehensive knowledge to the students regarding principles of IPR, concept and theories.
- The course is designed to provide knowledge regarding historical development, procedure for granting patent, infringement.
- The course is designed to provide comprehensive knowledge to the students regarding the effect of IPR especially of patents on emerging issues like public health, climate, Domain Name Disputes and Cyber-squatting, Bio piracy etc. and the ways to tackle this problem,

References and Textbooks: (With Author, Edition, Publishers, ISBN)

1. D.P. Mittal (Taxman Publication), Indian Patents Law and Procedure
2. B.L. Wadera, Patents, trademarks, copyright, Designs and Geographical Judications.
3. P. Narayanan (Eastern Law House), Intellectual Property Law
4. N.S. Gopalakrishnan & T.G. Agitha, Principles of Intellectual Property (2009), Eastern Book Company, Lucknow
5. Ganguli (Tata Megraw), Intellectual Property Rights
6. Brinkhof (Edited), Patent Cases, Wolters Kluwer
7. Prof. Willem Hoyng & Frank Eijsvogels, Global Patent Litigation, Strategy
8. Hilarry Pearson and Clifford Miller, Commercial Exploitation of INtellectual Property

Unit-1: Introduction to IPR (7 Lecture)

1.1 Introduction, concept and theories

1.2 Kinds of IPR

1.3 Need for private rights versus public interests

1.4 Advantages and disadvantages of IPR

UNIT-2: Criticism and world Scenario (7 Lecture)

2.1 Criticisms of IPR

2.2 Politics of IPR

2.3 Third World Criticisms and Marxist Criticisms

2.4 International Regime relating to IPR, TRIPs and other triaties (WIPO,WTO,GATTS)

UNIT-3 Patent law-1 (7 Lecture)

3.1 Research exemption and historical development in IPR law

3.2 Concepts in IPR: novelty, utility, inventiveness/non-obviousness

3.3 Patent protection: software patent, product, process and microorganisms

3.4 Patent Act-1970-amendments of 1999,2000,2002 and 2005

UNIT-4 Paten law-2 (7 Lecture)

4.1 Rights of patentee

4.2 Procedure for granting a patent and obtaining patent

4.3 grounds for opposition

4.4 Working of patents, compulsory license, acquisition, surrender, revocation and restoration

4.5 Transfer of patent rights.

UNIT-5 Infringement of IPR (7 Lecture)

5.1 Introduction to direct, contributory and induced

5.2 Ingringer and determined

5.3 Official machinery, controller, powers and functions

5.4 Defenses to infringement

UNIT-6 Copyright and law (7 Lecture)

6.1 Copyright and neighboring right : Concept and principles

6.2 Copyright: registrar, procedure, ownership, licence and translation of copyright

6.3 Copyright Act, 1957 and International copyright law

6.4 copyright in computer program, dramatic-musical, literary,special rights, broadcasting and performers.

6.5 Infringement: criteria and importance

Unit-7 Trade mark and TRIPS (7 Lecture)

7.1 Introduction: trade mark and TRIPS

7.2 Registration and procedure of trademark.

7.3 TRIPS Flexibilities and access to medicine

7.4 Infringement of trademark

Unit-8 Emerging Issues and challenges (7 Lecture)

8.1 Public health, Climate change and IPR

8.2 Patents and biotechnology

8.3 Bio piracy

8.4 Domain name disputes and cyber squatting

Practical

1. Searching of chemical/biological process patent.
2. Searching of trademark in computer/instrumentation.
3. Review the case study of Beyer pharmaceutical/Novartis pharmaceutical.
4. Review the case study of Beyer pharmaceutical/Novartis pharmaceutical.

Biostatistics

Name of faculty: Sciences	**Department: Microbiology**
Program: M.Sc. Microbiology Sem-II	**Type:** DSE-2
Subject: Biostatistics	
Credit: 04+02	**Total learning hours:** 60

Course description:

The course deals with the application of statistical principles to uncover biological phenomena. It also deals with statistical concepts and terminology and basic analytic techniques. The course also explain the use of computer tools and software to solve statistical data.

Student learning outcome: By the end of the course, student will;

- Recognize the importance of data, data collection methods
- Able to express data by suitable type of graphs and diagram
- Able to perform various statistical tests to get inference from data sets.
- Able to calculate measures of central tendency and dispersion of data.
- Able to perform students t-test, chi-square test, and ANOVA
- Understand about software packages and computer tool to analyse data.

Unit-1: Introduction to Biostatistics and Data collection (Duration: 08 Hrs)

3.1 Biostatistics: Definition, Role and Application

1.2 Biological variations and uncertainties and role of statistics

1.3 Data: Definition

1.4 Primary and secondary data

1.5 Data Collection

1.6 Classification and tabulation of data

1.7 Frequency Distribution

Unit-2: Diagrammatic and Graphical Representation of Data (Duration: 07Hrs)

2.1 Diagrammatic representation of data and its Limitation

2.2 Diagrammatic representation of data and its Limitation

2.3 Graphical representation of data: Significance and limitation

Unit-3: Basic Concepts of Population, samples and variables (Duration: 07 Hrs)

3.1 Population and Samples: Introduction

3.2 Methods of Sampling

3.3 Sampling errors

3.4 Variables: Introduction, Definition, Types, Measurement and scale of measurements

Unit-4: Measures of Central Tendency (Duration: 08 Hrs)

4.1 Average, its function and desirable properties of good measure of tendency

4.2 Arithmetic mean, Median, Mode, Geometric & Harmonic Mean- Calculation techniques, merits and demerits

4.3 Relationship between Mean, Median and Mode

4.4 Comparison of the mean, median and mode: Advantage and Disadvantages

4.5 Partition Values: Quartiles, Deciles and Percentiles

Unit-5: Measures of Dispersion (Duration: 07 Hrs)

5.1 Dispersion: Definition and Need for Measures of Dispersion

5.2 Range, Mean deviation, Variance and the standard deviation

5.3 Introduction to Skewness

5.4 Introduction to Kurtosis

Unit-6: Correlation and regression analysis (Duration: 08 Hrs)

6.1 Introduction to Correlation, Correlation and Causation

6.2 Types and Methods to study Correlation

6.3 Introduction to Regression

6.4 Difference between Correlation and regression

6.5 Linear regression analysis: Regression line and Equation

6.6 Non-Linear and multiple regression

Unit-7: Tests of significance and ANOVA (Duration: 08 Hrs)

7.1 Statistical Hypotheses

7.2 Tests of Significance: General procedure and steps, Significance of test, p value

7.3 Normal Curve test, Chi-square test, Students t-test

7.4 Analysis of Variance (ANOVA)

Unit-8: Computers in Biostatistics **(Duration: 07 Hrs)**

8.1 Computer Software for Statistical operation

8.2 MS Excel for statistical analysis: Descriptive statistics, t-test, ANOVA

8.3 R in Biostatistics

Reference Book:

- Arora, P. N., and P. K. Malhan. Biostatistics. Himalaya Publishing House, 2011. ISBN: 978-93-5024-718-1
- Gurumani, N. An introduction to Biostatistics. 2nd Edition, MJP publisher, 2002. ISBN: 978-81-9094-006-4
- Khan, Irfan A., and Atiya Khanum. Fundamentals of biostatistics. Ukaaz, Third revised edition 2012. ISBN: 81-900441-0-9
- Rao, K. Visweswara. Biostatistics: a manual of statistical methods for use in health, nutrition and anthropology. Jaypee Brothers Medical Publishers (P) Ltd, 2nd edition, 2007. ISBN; 81-8448-055-5
- Rao, PSS Sundar, and J. Richard. Introduction to biostatistics and research methods. 5th Edition, PHI Learning Pvt. Ltd., 2018. ISBN: 978-81-203-4520-1

Further Reading:

- Schmuller, Joseph. Statistical Analysis with Excel For Dummies United Kingdom: Wiley, 2016.

List of Practical

6) Making plain tables in Microsoft Excel
7) Preparation of basic chart in Microsoft Excel
8) Finding mean, median and mode by Microsoft Excel.
9) Performance of ANNOVA by Microsoft Excel
10) Performance of students t-test.
11) Performance of chi-square test.
12) Calculation of standard deviation.

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