University of Mumbai

No. UG/ 104 of 2019-20

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges, the Head of the University Department and Directors of the recognized Institutions in Science & Technology Faculty is invited to this office Circular No. UG/22 of 2013-14, dated 9th May, 2013 relating to the revised syllabus as per the (CBSGS) for Sem. I & II of M.Sc. degree programme in the course of Microbiology.

They are hereby informed that the recommendations made by the Board of Studies in Microbiology at its meeting held on 22nd May, 2019 have been accepted by the Academic Council at its meeting held on 26th July, 2019 **vide** item No.4.11 and that in accordance therewith, the revised syllabus as per the (CBCS) for the M.Sc. Part- I (Sem. -I & II) (PSMB) in Microbiology has been brought into force with effect from the academic year 2019-20, accordingly. (The same is available on the University's website www.mu.ac.in).

(Dr. Ajay Deshmukh)
REGISTRAR

MUMBAI – 400 032
11th September, 2019

To

The Principals of the affiliated Colleges, the Head of the University Department and Directors of the recognized Institutions in Science & Technology Faculty. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C/4.11/26/07/2019

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No. UG/104 -A of 2019-20 MUMBAI-400 032 11th September, 2019

Copy forwarded with Compliments for information to:-

1) The I/c Dean, Faculty of Science & Technology,
2) The Chairman, Board of Studies in Microbiology,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Co-ordinator, University Computerization Centre,

(Dr. Ajay Deshmukh)
REGISTRAR

Cover Page

AC 26/7/19
Item No. 4.11

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	MSc Part I in Microbiology
2	Eligibility for Admission	B Sc in Microbiology
3	Passing Marks	40 | 100
4	Ordinances / Regulations (if any)	Ord 0.6002. Cir No. UG/9 of 2012 dt 21 Feb 2012.
5	No. of Years / Semesters	2 yrs 4 Semesters
6	Level	P.G. / ~~U.G./ Diploma / Certificate~~ **(Strike out which is not applicable)**
7	Pattern	~~Yearly~~ / Semester **(Strike out which is not applicable)**
8	Status	~~New~~ / Revised **(Strike out which is not applicable)**
9	To be implemented from Academic Year	From Academic Year 2019-20

Date:

Signature : Bhatheja Dr Z P Bhatheja

Name of BOS Chairperson / Dean : Dr Z P Bhatheja

UNIVERSITY OF MUMBAI

Revised Syllabus for MSc (Part1)
In Microbiology
SEM I and SEM II
Program: M.Sc.
Course: MICROBIOLOGY
(PSMB)

Choice Based Credit System with effect from the academic year **2019–2020**

MSc Microbiology Syllabus Semester 1 and II

Revised for Choice Based Credit System (CBCS) from academic year 2019-20

INDEX
Semester 1
THEORY

Course Code	Unit	Topic Headings	Credits	Lec/topic
PSMB101 Molecular Genetics -1	I	Genetic Exchange among bacteria and Recombination	04	15
	II	Eukaryotic Transposable elements, DNA repair and Genetics of Cancer		15
	III	Regulation of gene expression in prokaryotes		15
	IV	Global regulation in bacteria		15
PSMB 102 Environmental Microbiology & sustainability	I	Theories of evolution and astrobiology	04	15
	II	Microbial Diversity		15
	III	Extremophiles		15
	IV	Environment & Natural resource Management & Safety Standards		15
PSMB 103 Biochemistry	**I**	Concepts in chemical reactivity and aqueous solution	04	15
	II	Bioorganic molecules		15
	III	Degradation and transformation of organic molecules		15
	IV	Physiology and metabolism of anaerobic bacteria		15
PSMB 104 Medical Microbiology and Microbial pathogenesis	I	Mechanisms of Pathogenesis- 1	04	15
	II	Mechanisms of Pathogenesis-2 and Human Microbiome		15
	III	Emerging infectious diseases in India(with emphasis on etiology, virulence mechanism, diagnosis and prevention) and Epidemiology		15
	IV	Clinical Bacteriology		15

PRACTICALS

PSMBP-101	Molecular Genetics -1	2	04
PSMBP-102	Environmental Microbiology & sustainability	2	04
PSMBP- 103	Biochemistry	2	04
PSMBP-104	Medical Microbiology and Microbial pathogenesis	2	04

Semester II

THEORY

Course Code	Unit	Topics	Credits	Lec/week
PSMB201 Molecular Genetics Part 2	I	Regulation of Gene Expression in Eukaryotes	04	15
	II	Genetic regulation of the development of Drosophila , organelle DNA & population genetics		15
	III	Molecular tools for genetics,		15
	IV	Metagenomics, comparative & functional Genomics, Proteomics		15
PSMB 202 Research Methodology ,Bioinformatics & Biostatistics	I	Research terminology and fundamentals	04	15
	II	Processing & analysis of data		15
	III	Statistics in research		15
	IV	Bioinformatics		15
PSMB 203 Applied Biochemistry	I	Enzymology	04	15
	II	Signalling and stress		15
	III	Unusual biomolecules and bioactive compounds		15
	IV	Proteomics		15
PSMB 204 Applied Immunology	I	Adversarial strategies during infection	04	15
	II	Immunodeficiency		15
	III	Advances in Allergy and other hypersensitivity		15
	IV	Tumor Immunology & Autoimmune diseases		15

PRACTICALS

PSMBP-201	Molecular Genetics -2	2	04
PSMBP-202	Research Methodology ,Bioinformatics & Biostatistics	2	04
PSMBP- 203	Applied Biochemistry	2	04
PSMBP-204	Applied Immunology	2	04

SEMESTER I DETAIL SYLLABUS

PSMB-101 (MOLECULAR GENETICS -1)

Learning Objectives

- to achieve the understanding of fundamental genetic processes for all organisms, especially through the use of in vivo and in vitro genetic tools.
- To provide insights to transfer of genes, genetic exchange and DNA repair.
- To understand the regulation of gene expression in prokaryotes.

Learning Outcome:

At the end of the course students will

- Be able to understand the molecular mechanism of DNA transfer, and Homologous recombination in *E.coli* and in eukaryotes that will enable the students to have a complete view of genetic transfer and exchange mechanisms.

- Be able to reason out the correlation between Oncogenes, Cellular Proto-Oncogenes, and Tumor Suppressor Genes and thus realizes their role in the development of Cancer
- Be able to understand at molecular levels the different types of operons in *E.coli* as well as in *Bacillus subtilis* besides knowing about Riboswitch regulation.
- Be able to enhance their knowledge about Regulation of Nitrogen assimilation, Heat Shock response, Stress response and sulphur regulation and genetic analysis of sporulation.

Course Code	Unit	Sub unit	Title	No of lectures	Credits
PSMB 101			**Molecular Genetics -1**	**60L**	**04**
	1		**Genetic Exchange among bacteria and Molecular basis of Homologus Recombination**	15 L	01
		1.1	**Conjugation :** 1.1.1 Overview, Classification of self transmissible plasmids 1.1.2 Mechanism of DNA transfer during Conjugation in Gram negative bacteria- 1.1.3 Chromosome transfer by plasmids-Formation of Hfr strains, transfer & mobilization of chromosomal DNA by integrated plasmids, prime factors 1.1.4 Transfer system of gram positive bacteria-Plasmid pheromones	05	

		1.2	**Transformation** 1.2.1 Development of Competence in Gram positive bacteria and Gram negative bacteria, competence based on type IV secretion systems. 1.2.2 Regulation of competence in *Bacillus subtilis*- Competence pheromones**.** 1.2.3 Role of natural transformation- Nutrition, repair, recombination, Importance of natural transformation for forward and reverse genetics. 1.2.4 Artificially induced competence- Calcium ion induction, transformation by plasmids, transfection by phage DNA, transformation of cells with chromosomal genes, Electroporation.	05	
		1.3	**Homologus recombination at molecular level** 1.3.1 Models for Homologues recombination 1.3.2 Homologues recombination protein machines 1.3.3 Homologous recombination in *E.coli* (Rec BCD pathway) 1 .3.4 Homologous recombination in eukaryotes- Mating type switching 1.3.5 Site Specific recombination	05	
	2		**Transposable elements, DNA repair and Genetics of Cancer**	**15L**	**01**
		2.1	2.1.1 Transposable genetic elements in eukaryotes : Transposable Ac and Ds Elements in Maize, P Elements and Hybrid Dysgenesis in *Drosophila* . 2.1.2 Retrovirus and Retro transposons : Retrovirus, Retrovirus like elements, Retroposons 2.1.3 Transposable elements in Humans 2.1.4 The Genetic and Evolutionary Significance of Transposable Elements: Transposons as mutagens, Genetic transformation with transposons , Transposons and Genome organization, Evolutionary Issues Concerning Transposable Elements	07L	
		2.2	**DNA repair** 2.2.1 Eukaryotic Nucleotide Excision repair, 2.2.2 Mismatch repair mechanism in humans, 2.2.3 Non-homologous end joining (NHEJ) pathway for repairing double stranded breaks	02L	

		2.3	**Genetic Basis Of Cancer** 2.3.1Cancer: A Genetic Disease, Forms of Cancer, Cancer and the Cell Cycle 2.3.2 Oncogenes: Tumor-Inducing Retroviruses and Viral Oncogenes, Cellular Proto-Oncogenes, protein products of proto-oncogenes, Changing cellular proto-oncogenes into oncogenes, Chromosome Rearrangement and Cancer. 2.3.3 Tumor Suppressor Genes: the Retinoblastoma tumor suppressor gene- RB, P53, Breast cancer tumor suppressor genes, MicroRNAs genes, Mutator genes, Telomere shortening genes 2.3.4. The multistep nature of cancer	06L	
	3		**Regulation of gene expression in prokaryotes**	15L	01
		3.1	**Operon Systems** (Detailed Molecular structure of repressor and operator sites) 3.1.1 The *E. coli Lac* operon 3.1.2 The *E.coli Gal* operon, 3.1.3 The E. coli *ara* operon, 3.1.4 The *E. coli* Maltose operon, 3.1.5 Trp operon of *Bacillus subtilis*, 3.1.6 Riboswitch regulation	15	
	4		**Global regulation in bacteria**	15 L	01
		4.1	**Global regulation systems** 4.1.1 Regulation of Nitrogen assimilation: 4.1.2 Pathways for nitrogen assimilation, regulation of nitrogen assimilation by the Ntr system. 4.1.3 Stress response In Bacteria: Heat shock regulation in *E coli* 4.1.5 Iron regulation in *E coli.* 4.1.6 Regulation of Sporulation in *Bacillus subtilis*	01 03 03 02 06	
			Self-study : Solve at least five problems on gene transfer and regulation given at the end of the chapter in Lehninger/schaum series/Russell etc		

PRACTICALS BASED ON PSMB 101

1. Demonstration of Conjugation in *E. coli*
2. Preparation of competent *E. coli* cells,
3. Isolation of plasmid DNA from minicultures and maxi cultures.
4. Transformation of competent cells using plasmid DNA
5. Endospore formation in *Bacillus subtilis*: Requirements for germination and outgrowth of spores, correlation between sporulation and protease activity.
6. Response of nutrient stress on the growth and size of Pseudomonas spps
7. Problems on gene transfer mechanisms, and regulation.
8. Cancer genetics- visit to ACTREC, TIFR, BARC etc

REFERENCES :

1. iGenetics- A Molecular Approach, Russell, P.J., 3rd edition, 2010, Pearson International edition
2. Fundamental Bacterial Genetics, Trun Trempy, 1st edition, 2004, Blackwell Publishing
3. Molecular Biology of the Gene, Watson, Baker, Bell, Gann, Levine, Losick, 7th edition, 2007, Pearson Education
4. Genes IX, Lewin, B., 2006, Jones and Bartlett Publishers
5. Genetics: A Conceptual Approach, Benjamin Pierce 4th edition, 2008, W. H. Freeman & Co
6. Principals of Genetics, Snustad & Simmons, 6th edition, 2012, John Wiley & Sons Inc
7. Molecular biology –Genes to proteins 3rd ed. by Burton E. Tropp (Jones & Bartlett publishers)
8. Molecular Genetics of bacteria, 3rd Edition by Larry Snyder and Wendy Champness (ASM press)

PSMB-102 (ENVIRONMENTAL MICROBIOLOGY AND SUSTAINABILITY)

Learning Objectives

- To introduce to the various theories of evolution
- To enhance Knowledge about microbial world in space
- To understand microbial biodiversity in different habitats
- To know the adaptations of microorganisms to extreme environmental conditions and their applications
- To understand waste management, biohazard and biosafety standards.
- To inculcate sense of scientific responsibilities and social and environment awareness

Learning Outcomes

At the end of the course students will:

- Be able to understand how life has evolved on earth and in space

- Be able to elaborate the characteristics of different groups of microorganisms found in different habitats
- Be able to discuss microorganisms in extreme environments and their adaptations
- Be able to reflect their role as global citizens, consumers and environment protectors.

Course Code	Unit	Sub unit	Title	No of lectures	Credits
PSMB 102			**Environmental Microbiology and Sustainability**	**60L**	**04**
Unit 1	1		**Theories of evolution and astrobiology**	15 L	01
		1.1	History of evolution	01	
		1.2	Theories of organic evolution -Lamarckism - Darwinism -Modern synthetic theory -Germplasm theory -Mutation theory	04	
		1.3	Introduction to molecular evolution	01	
		1.4	Neutral theory of evolution - Polymorphism - Divergence - Near neutral theory of evolution	03	
		1.5	Mechanisms of Molecular Evolution and the Modern Molecular Clock	02	
		1.6	Astrobiology - Introduction - The space environment - Microbiological studies in the space environment - Microbial transfer through space	04	
Unit 2	2		**Microbial Diversity**	15L	01
		2.1	The expanse of microbial diversity	01	
		2.2	Estimates of total number of species, measures and indices of diversity, the species concept for prokaryotes and eukaryotes	03	
		2.3	Culture-dependent microbiology	03	
		2.4	Newer approaches for exploring uncultivable bacteria: Culture independent molecular methods	04	
		2.5	Methods of extracting total bacterial DNA from a habitat; the metagenomic approach	02	
		2.6	Bioprospecting • Pharmacologically active agents of microbial origin	04	

			• Industrial enzymes • Novel antifoulants and anti-biofilm agents from microbes		
Unit 3	3		**Extremophiles**	15L	01
		3.1	Physiology, Biochemistry and Applications of - Thermophiles - Psychrophiles - Piezophiles - Radiation resistant organisms	07	
		3.2	Physiology, Biochemistry and Applications of- - Acidophiles - Alkaliphiles - Halophiles	05	
		3.3	Geo Microbiology – Bio corrosion and Bioleaching	03	
Unit 4	4		**Environment & Natural Resource Management & Safety Standards**	15L	01
		4.1	Natural resources: - Renewable/ non-renewable resources of Land, water, forest, minerals, energy, food. - Associated problems and management practices. - Environmental Impact Assessment and Sustainable Development	02	
		4.2	Solid waste management: - Classification of solid waste - Effects of solid waste pollution, - Key components of solid waste management. - On site disposal options - Offsite disposal options - Biodegradable waste from kitchen, abattoirs and agricultural fields and their recycling by aerobic composting or bio-methanation. - Non-biodegradable waste like plastics, glass, metal scrap, e waste and building materials, and its recycling	04	
		4.3	Hazardous waste management: -Hazardous wastes: definition, levels of biohazards, Risk assessment and handling procedures. - Xenobiotic compounds and its biodegradation - Management of hazardous waste using biotechnological applications	05	

			- Examples: cyanide detoxification, petrochemical industry effluents, phenols, Hazardous waste from paint, pesticides and chemical industries Probable means to reduce these waste through Common Effluent		
		4.4	Biosafety: - Need for biosafety levels, - Biosafety guidelines for GMOs and LMOs. - Role of Institutional bio safety committee. RCGM, GEAC, etc. for GMO applications in food and agriculture. - Environmental release of GMOs. - Overview of national regulations and relevant international agreements. - Ecolabelling, ISO 14001, - Generally Recognized as Safe (GRAS)	04	
			Self study topics :1. Methods of extracting total bacterial DNA from a habitat 2.Case study : EIA report of a polluted ecosystem		

PRACTICALS

1. Enrichment and isolation of cellulose degraders from natural resources
2. Isolation and characterization of thermophiles and thermotolerant organisms from hot spring water samples.
3. Screening of Halophilic bacteria from salt pans and identification of an isolate by conventional biochemical as well as by VITEK systems
4. Extraction of membrane lipids of halophilic archaea and its detection by TLC
5. Determination of Bacteria, algae and fungi present in natural ecosystems samples and calculate their relative abundance and frequency of occurrence
6. Determine the microbial activities in the soil samples by estimating hydrolysis of FDA

REFERENCES

Unit 1

1. Cell biology, genetics, Molecular Biology, Evolution and Ecology by P.S. Verma and V.K. Agarwal by S Chand publishers
2. Population Genetics by Matthew Hamilton, Wiley Blackwell, A John Wiley & Sons, Ltd., Publication
3. Principles of population genetics by Daniel Hartl and Andrew Clark 3rd edition, Sinauer Associates, Inc. Publishers

4. The causes of molecular evolution by John Gillespie, New York Oxford University Press 1991
5. Basic concepts of molecular evolution Anne- Mieke Van Damme (https://www.kuleuven.be/aidslab/phylogenybook/firstEdition/Chapter1.pdf)
6. Mechanisms of molecular evolution Tomoko Ohta National Institute of Genetics, Mishima, 411- 8540, Japan (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1692885/pdf/11127908.pdf)
7. Molecular Evolution Lecture Notes Anders Gorm Pedersen (http://www.cbs.dtu.dk/dtucourse/cookbooks/gorm/27615/lecturenotebook.pdf)
8. .Space Microbiology ,Gerda Horneck, David M. Klaus, Rocco L. Mancinelli https://mmbr.asm.org/content/74/1/121.full
9 . Venturing into new realms? Microorganisms in space, Christine Moissl-Eichinger Charles Cockell Petra Rettberg (https://academic.oup.com/femsre/article/40/5/722/2198066)
10 . Minireview The theory and application of space microbiology: China's experiences in space experiments and beyond (https://onlinelibrary.wiley.com/doi/pdf/10.1111/1462-2920.13472)

Unit 2

1. Microbial diversity and bioprospecting by Alan T Bull
2. Microbial diversity – Exploration and Bioprospecting by S Ram Reddy, M A Singara Charya and Girisham , Scientific publishers (India)
3. Review Microbial Diversity: The Gap between the Estimated and the Known Luciana Cristina Vitorino https://pdfs.semanticscholar.org/f2d9/70d4ca8a5069cf95df1da44322dcaa01353a.pdf
4. https://biomed.brown.edu/Courses/BIO48/20.SpeciesConcepts.HTML
5. https://www.researchgate.net/publication/264238213_Bioprospecting- download the pdf

Unit 3

1. Gerday, C., Glansdorff, N., & American Society for Microbiology. (2007). Physiology and biochemistry of extremophiles. Washington, D.C: ASM Press.
2. Horikoshi, K., Antranikian, G., Bull, A.T., Robb, F.T., Stetter, K.O. (Eds.) (2011), Extremophiles Handbook. Springer
3. Fred A. Rainey and Aharon Oren (2006). Methods in Microbiology - Volume 35, Extremophiles, 1st edi., Academic Press.
4. S.K.Kawatra and K.A. Natarajan,"Mineral Biotechnology- Microbial Aspects of Mineral Beneficiation, Metal Extraction, and Environmental Control", published by SME, Littleton, CO (USA) 2001
5. S.W.Borenstein, Microbiologically influenced corrosion handbook, Woodhead pub. Ltd., Cambridge (1994)
6. Microorganisms In Biofouling and Biocorrosion: https://nptel.ac.in/courses/113108055/module7/lecture34.pdf

Unit 4

1. Textbook for Environmental Studies For Undergraduate Courses of all Branches of Higher Education by Erach Bharucha for University Grants Commission
2. Essential environmental studies, S.P.Mishra, S.N.Pandey,Ane books pvt ltd
3. Environmental management, Jadhav H. V., 2002, Vipul Prakashan.
4. Environmental Biotechnology (Industrial Pollution Management) by S N Jogdand, Himalaya publishing house
5. Environment and Ecology, S.P.Mishra, S.N.Pandey, Ane books pvt ltd
6. Technical EIA guidance manual for Common Hazardous Waste Treatment, Storage and Disposal Facilities, Prepared by Ministry of environment and forests, Government of India, 2010: http://environmentclearance.nic.in/
7. Guidelines for environmentally sound management of e-waste, ministry of environment & forests central pollution control board, Delhi,2008: http://www.cpcb.nic.in/latest/e waste pdf
8. Evidence-Based Biosafety: a Review of the Principles and Effectiveness of Microbiological Containment Measures, 2008: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2493080/

PSMB-103 (BIOCHEMISTRY)

Learning Objectives

- To strengthen the fundamental concepts of Biochemistry and understand the broad domains of biochemistry.
- To endeavour training of Post –graduate students to design and carry out various projects.
- To improve their practical biochemistry knowledge especially while preparing media for their experiments, to calculate various parameters of acid -base chemistry and reason out chemical reactions observed during experiments.
- To improve their logical skills so as to efficiently find solutions to problems encountered during research activity.

Learning Outcomes:

- Think independently and work in the laboratory
- Perform better in competitive exams
- Gaining employability in industry and take on research- oriented careers**.**

Course Code	Unit	Sub unit	Title	No of lectures	Credits
PSMB 103			**Biochemistry**	**60L**	**04**
	1		**Concepts in chemical reactivity and aqueous solution**	15 L	01
		1.1	Aqueous solutions: concentrations based on weight, volume and degree of saturation. [Only problem solving]	5L	
		1.2	Acids and bases Bronsted concept of conjugate acid-conjugate base, pH, pOH, buffers, titration curves, Hendersen-Hasselbach equation, polyprotic acids, amphoteric salts [problem solving]	6L	
		1.3	Chemical reactivity and forces between molecules	4L	
	2		**Bioorganic molecules**	15 L	01
		2.1	Protein Chemistry: peptides and the peptide bond, protein structures, protein types, factors determining structure , dynamics of globular proteins, Chaperonins, prion motifs and domains	7L	
		2.2	Carbohydrates: derivatives of monosaccharides, glycoconjugates, carbohydrates as informational molecules.	4L	
		2.3	Lipids: structural lipids, lipids as signal, cofactors and pigments	2L	
		2.4	Coenzymes, antioxidants and metals	2L	
		2.5	**Self-study** : Solve at least five problems given at the end of the chapter in Lehninger or any other textbook		
	3		**Degradation and transformation of organic molecules**	15 L	01
		3.1	Biotic reactions, mechanistic aspects Environmental factors affecting biodegradation	3L	
		3.2	Degradation and transformation of aromatic compounds: monocyclic, polycyclic, carboxylates and related compounds, halogenated hydrocarbons.	10L	
		3.3	Persistence and biomagnification of xenobiotics	2L	
		3.4	**Self-study**: identify a product containing aromatic compound and design a flow sheet to degrade or transform it.		
	4		**Physiology and metabolism of anaerobic bacteria**	15L	01

		4.1	Anaerobes and oxygen, physiology of anaerobes, anaerobes in natural environments, types of anaerobic and microaerophilic bacteria	8L	
		4.2	Techniques in Anaerobic Microbiology	3L	
		4.3	Applications of anaerobes	4L	

REFERENCES

Unit I:

1. Biochemical calculations, Segel I.R., John Wiley and Sons, 1995
2. Schaum's solved problem series. 3000 solved problems in Chemistry. David E. Goldberg. McGraw Hill International Editions 1997.
3. Biochemistry: The chemical reactions of living cells (Vol 1) David E. Metzler Academic Press.

Unit II:

1. Biochemistry 3rd edition, Mathew, Van Holde and Ahern , Pearson Education
2. Lehninger-Principles of Biochemistry, Michael M. Cox and David L. Nelson, 5th Edition. W.H. Freeman and Company, New York reprinted 2008.
3. Biochemistry, Voet D. and Voet J.G., 4th edition, 1995, John Willey and Sons Inc.

Unit III:

1. Environmental degradation and transformation of organic chemicals- Alasdair H. Neilson and Ann-Safie Allard. CRC press, 2008
2. Biotransformations: Microbial degradation of health-risk compounds edited by Ved Pal Singh. Elsiever 1995.
3. Microbial Ecology: Fundamentals and applications 4th ed. Ronald H. Atlas and Richard Bartha. Reprint 2005. Pearson Education.
4. Environmental Microbiology. Raina M. Maier, Ian L. Pepper, Charles P. Gerba. Academic Press (Elsevier) 2000

Unit IV

1. Anaerobic bacteria K.T.Holland, J.S. Knapp, J.S. Shoesmith. Chapman &Hall, New York. 1987.
2. Bacterial Metabolism, Gottschalk, G., 2nd edition, 1985, Springer-Verlag
3. Brock Biology of Microorganisms. Michael Madigan, John M. Martinko. Pearson International edition. 11th edition

ADDITIONAL READING MATERIAL

1. Biochemistry and Physiology of anaerobic bacteria. Lars G. Ljungdahl, Michael Adams, Larry L. Barton et al. 2003 Springer-Verlag New York, Inc.
2. Principles of Biochemistry, Zubay, G., 4th edition, 1998, Wm.C. Brown Publishers.

3. Laboratory manual in biochemistry by Jayaraman J. , New Age International Publishers .
4. An introduction to Practical biochemistry 3rd edition, David T Plummer, Tata McGraw Hill edition 1998

PRACTICALS BASED ON PSMB 103

1. Preparation of buffers.
2. Extraction, isolation, partial purification (if necessary), calculation of percentage yield and performing a confirmatory test for the following:
   a. lactose from milk
   b. Albumins and globulins from egg white
3. Determination of pk values by titration curves
4. Interpretation of Ramchandran plot.
5. Degradation of aromatic compounds like napthalene
6. Cultivation of anaerobic bacteria using Gaspak method
7. Cultivation of anaerobes- *Closridium* species using litmus milk, observation of stormy fermentation of milk, use of Robertson's cooked meat medium and anaerobic chamber

PSMB-104 (MEDICAL MICROBIOLOGY AND MICROBIAL PATHOGENESIS)

Learning Objectives:

Modern techniques have helped to elucidate mechanisms of pathogenicity expression and evasion of host defence which in turn have helped in a better understanding of disease mechanisms. Such studies have also thereby opened doors to newer methods of combating infections or preventing them. At the same time, microbes too are devising new mechanisms to overpower the antibiotics used as therapeutics, compelling us to understand and combat the threat of antibiotic resistance. The curriculum also wishes to touch upon the recent growing interest on the concept of Microbiome.

- To introduce the students to molecular mechanisms of pathogenesis, their regulation and mechanisms of delivery.
- To make the student community aware of the threat of antibiotic resistance and to understand molecular mechanisms of antibiotic resistance.
- To introduce to the student the concept of Microbiome- its significance in health and disease
- To acquaint the student to emerging/ re-emerging diseases in India
- To reinforce the basic concepts in epidemiology and to elaborate on terms and methodologies in infectious diseases
- To emphasize on clinical laboratory practices followed in Bacteriology labs.

Learning Outcomes

- Student will be able to correlate molecular mechanisms of virulence expression, regulation and secretion to disease by different pathogens that cause chronic infections, toxin associated,& biofilm mediated infections
- Students will be able to correlate post interventional procedures to biofilm associated infections on implants and prosthetic devices.
- Students will be able to reason out
    - the threat of antibiotic resistance and can create awareness
    - the importance of microbiome and can be equipped to research on it
- Student will be well informed about Emerging and re-emerging diseases in India
- Student will be equipped with skills and an understanding about
    - Epidemiological practices
    - Clinical lab practices in bacteriology like QC and AST

Course Code	Unit	Sub unit	Title	No of lectures	Credits
PSMB 104			**Medical Microbiology and Microbial Pathogenesis**	**60L**	**04**
	1		**Mechanisms of Pathogenesis-1**	15 L	01
		1.1	i. Overview of bacterial mechanisms of evading/surviving host defense ii. Bacterial persistence within the host- a. Surviving phagocytosis eg: *Legionella, Salmonella,* and *Mycobacterium* b. Chronic infections eg: Brucellosis and typhoid fever	1 4	
		1.2	Toxins and secretion systems i. Bacterial toxins and intoxications- eg Diphtheria and Botulism-its regulation , mode of action ii. Secretion Systems specific to Gram-Negative Bacteria and Gram-Positive Bacteria	2 3	
		1.3	Mechanisms of Virulence Regulation: i. Types of Regulation ii. Bacterial communication and virulence: a. Quorum Sensing signaling molecules b. Mechanisms of quorum sensing in Gram Negative and Gram positive bacteria	2 3	

	2		**Pathogenesis and Human Microbiome**	15 L	01
		2.1	Microbial biofilms i. Structure, properties and formation ii. Biofilm-related Infections on Tissue Surfaces iii. Biofilms Associated with Medical Devices and Implants	5	
		2.2	Antibiotic Resistance i. Genetic Basis of antimicrobial resistance ii. Mechanistic basis of antimicrobial resistance- modification of antibiotic molecules, decreased penetration and efflux, changes in target sites, Resistance Due to Global Cell Adaptations	4	
		2.3	The Human Microbiome: i. Introduction to the concept of Microbiome, The Human Microbiome Project ii. Gut microbiome- types of organisms, functions, role in health and disease	6	
			Self Study: • Current developments in the Human Microbiome project • Microbiome of any other system or organ other than gut		
	3		**Emerging infectious diseases in India and Epidemiology**	15L	01
		3.1	Emerging infectious diseases in India(with emphasis on etiology, virulence mechanism, diagnosis and prevention) i. Pandamic Influenza ii. Nipah Virus *iii. Acinetobacter* *iv. Candida auris* v. Hepatitis C **vi.** Rickettsial infections	10L	
		3.2	Epidemiology i. Methods and procedures for epidemiological study of infections. ii. Epidemiology of infectious diseases, case studies- food borne diseases, XDR-TB	5L	
	4		**Clinical Bacteriology**	**15 L**	**01**
		4.1	Laboratory Methods for Antimicrobial susceptibility testing	04 L	

			i. Conventional testing methods ii. Commercial Testing methods iii. Other methods- Time kill curves, Serum killing curves iv. Testing antibiotic combinations		
		4.2	Detection of specific types of Antibiotic Resistance a. Methicillin(Oxacillin) resistant and decreased Vancomycin susceptibility in Staphylococci spps b. Beta lactam resistance and Decreased susceptibility to Vancomycin in Enterococci	04	
		4.3	Quality Control in Medical Microbiology i. Laboratory design and safe microbiological practice GLP in culture and media preparation ii. Sample management and Process control (an overview) iii. Quality control of culture media, reagents, equipments, process, personnel, report	07	

PRACTICALS:

- Study of few virulence mechanisms in pathogens
- Study of Quorum Sensing and Quorum sensing inhibitors in *C.violaecium*
- Microbial Biofilm formation on various surfaces
- Determination of Minimum Biofilm Inhibition Concentration of an antibiotic
- Detection of specific types of Antibiotic Resistance.
    - MRSA
    - VRE
- Antibiotic susceptibility testing- Conventional micro broth dilution method according to CLSI guideline.
- Checker Board Assay for detecting synergistic activity of two antibiotics
- Determination of Quality Assurance of laboratory media, reagents.
- Problems on Epidemiology

TEXTBOOKS:

1. Bacterial Pathogenesis- A Molecular Approach by Brenda Wilson, Abigail Saylers et al, Third ed, ASM Press, 2011
2. Virulence Mechanisms of Bacterial Pathogens, by Indira Kudva, Nancy Cornick et al, Fifth ed, ASM Press, 2016
3. Medical Biofilms-Detection Prevention and Control by Jana Jass, Susanne Surman et al, Wiley, 2003
4. The Human Microbiota and Microbiome ed by Julian Marchesi, Advances in Molecular and Cellular Microbiology 25, CAB International, 2014
5. A brief guide to emerging infectious diseases and zoonoses.WHO.

6. Understanding emerging and re-emerging infectious diseases by Suparna Duggal and Jyoti Mantri Himalaya Publishing House
7. Friis, Robert H_Sellers, Thomas A, Epidemiology for Public Health Practice-Jones and Bartlett Learning (2014).pdf.
8. Principles of Epidemiology in Public Health Practice-Third Edition,An Introduction to Applied Epidemiology and Biostatistics –Centers for Disease Control and Prevention (CDC).
9. Handbook of Microbiological Quality Control, Pharmaceutical and Medical Devices-Rosamund M Baird. (CRC Press)
10. Introduction to Diagnostic Microbiology for the Laboratory Sciences, Maria DannessaDelost, 2015, Jones and Bartlett Learning
11. Ananthanarayan and Paniker's Textbook of Microbiology, by Reba Kanungo, 10thedUniversities Press; Tenth edition, 2017
12. Bailey and Scotts Diagnostic Microbiology Forbes, Sahem et al 12thed, Moshby

REFERENCE ARTICLES:

1. Micromanagement in the gut: micro environmental factors govern colon mucosal biofilm structure and functionality by Rosemarie De Weirdt and Tom Van de Wiele, Biofilms and Microbiomes (2015) 1, 15026; doi:10.1038/npjbiofilms.2015.26
2. Clinical and Pathophysiological Overview of Acinetobacter Infections: a Century of Challenges, Clin Microbiol Rev 30:409 –447.https://doi.org/10.1128/CMR.00058-16.Published on 14th Dec, 2016
3. Nett JE (2019) *Candida auris:* An emerging pathogen "incognito"? PLoSPathog 15(4): e1007638. https://doi.org/10.1371/journal.Published: April 8, 2019
4. Spivak ES, Hanson KE. 2018. *Candida auris*: an emerging fungal pathogen. J Clin Microbiol56:e01588-17. https://doi.org/10.1128/JCM.01588-17.
5. Ang BSP, Lim TCC, Wang L. 2018. Nipah virus infection. J Clin Microbiol 56:e01875-17.https://doi.org/10.1128/JCM.01875-17.
6. Abdad MY, Abou Abdallah R, Fournier P-E, Stenos J, Vasoo S. 2018. A concise review of the epidemiology and diagnostics of rickettsiases: Rickettsia and Orientia spp. J Clin Microbiol56:e01728-17. https://doi.org/10.1128/JCM.01728-17.
7. Rickettsial Infections: Indian Perspective Narendra Rathi And Akanksha Rathi, Indian Pediatrics Vol 47 February 17, 2010
8. Special Article on Quality Assurance in Microbiology by D.R. Arora- Indian Journal of Medical Microbiology, (2004) 22 (2) : 81-86.

SEMESTER II DETAIL SYLLABUS

PSMB-201 (MOLECULAR GENETICS -2)

Learning objectives

- The learner will know the role of Chromatin in Regulating Gene Transcription, repression of Gene Activity by Histones
- The student will know about Drosophila developmental stages which is the traditional geneticist's and embryologist 's tool.
- The learner will also be conversant about Population genetics Hardy-Weinberg Law and related topics.
- The student will have theoretical knowledge of important tools and techniques like PCR, DNase Footprinting, DMS footprinting and other footprinting methods,
- The student will gain information about Functional genomics-DNA Microarray technology, as well as Proteomics

Learning Outcomes

At the end of the course the student will be

- well versed in knowing the various techniques required to perform molecular genetics experiments
- have the basic and advanced knowledge about Drosophila Development which are an geneticts tool to study gene organization will be known
- have Information about functional genomics

Course Code	Unit	Sub unit	Title	No of lectures	Credits
PSMB 201			**Molecular Genetics -2**	**60L**	**04**
	1		**Regulation of Gene Expression in Eukaryotes**	15 L	01
		1.1	1.1 Control of Gene Expression in Eukaryotes: 1.1.1 role of regulatory proteins, activators and repressors molecules 1.1.2 The Role of Chromatin in Regulating Gene transcription: 1.1.3 Silencing and Genomic Imprinting 1.1.4 RNA Processing Control 1.1.5 RNA Interference 1.1.6 Post transcriptional regulation of gene expression	05 02L 02L 02L 02L 02L	
	2		**Genetic Regulation Of The Development Of Drosophila , Organelle DNA & Population Genetics**	15L	01
		2.1	**Drosophila developmental** - Stages ,	04	

			- Embryonic development, - Maternal effect genes, - segmentation genes, - Homeotic genes		
			Self study : Drosophila a traditional geneticist's and embryologist 's tool.		
		2.2	**2.2.1Organelle DNA:** - The genetics of organelle encoded traits, - The endosymbiotic theory, **2.2.2 Mitochondrial DNA** - The gene structure and organization of mitochondrial DNA, - Non universal codons in Mitochondrial DNA, replication, transcription and translation of Mitochondrial DNA, - Evolution of Mitochondrial DNA, **2.2.3 Chloroplast DNA** - Properties similar to Eubacterial DNA - Gene structure and organization of chloroplast DNA, - Replication, transcription and translation of chloroplast DNA	01 03 02	
		2.3	**Population genetics** - Genetic structure of population - Hardy-Weinberg Law - Genetic variation in space and time - Genetic variation in Natural population - Forces that change gene frequencies in populations: i. Mutation, ii. Random genetic drift iii. Migration iv. Natural selection v. Balance between mutation and selection vi. Assertive mating vii. Inbreeding - Summary of the effects of evolutionary forces on the genetic structure of population - The role of genetics in conservation Biology	05	
	3		**Molecular Tools For Genetics**	15L	01
		3.1	**Polymerase Chain Reaction-** Fundamentals of the PCR, Variations/ Modifications of PCR: Reverse transcriptase PCR, Differential display PCR, Real time Fluorescent PCR, Hot- Start PCR, Multiplex PCR, Nested PCR, Applications	5L	
		3.2	**Molecular tools for studying genes and gene activity**	10L	

			3.2.1 Molecular separations: Gel electrophoresis, Two-dimensional gel electrophoresis 3,2.2 Labelled tracers: Autoradiography, Liquid scintillation counting Nonradioactive tracers 3.2.3 Using nucleic acid hybridization: Southern blots, DNA fingerprinting and DNA typing, In situ hybridization: Locating genes in chromosomes, Immunoblots 3.2.4. DNA sequencing and physical mapping: The Sanger Chain-Termination Sequencing method, High-throughput Sequencing, Restriction Mapping, Site-directed mutagenesis 3.2.4 Mapping and quantifying transcripts, Northern blots, S1 mapping, Primer extension, Run-off transcription and G-less cassette transcription 3.2.5 Measuring transcription rates in vivo: Reporter gene transcription, Measuring protein accumulation in vivo: Assaying DNA – protein interactions, foot printing methods, Chromatin immune-precipitation (ChIP) 3.2.6 Knockouts: Gene knock out in yeast, Gene knockouts in mouse, Knocking down expressed gene by RNA interference (RNAi)		
	4		**Metagenomics, Comparative & Functional Genomics, Proteomics**	15L	01
		4.1	Metagenomics 4.1.1Comparative Genomics: finding Genes that make us human, recent changes in the human genome, 4.1.2 Characterization of Gene amplification and deletions in Cancer using DNA microarrays (Representational Oligonucleotide Microarray Analysis (ROMA) 4.1.3 Functional genomics-DNA Microarray technology, Serial analysis of gene expression (SAGE)	08	
		4.2	Proteomics- 4.2.1Separation and identification of proteins (2D PAGE, MALDI –TOF), Protein profiling (LC-MS), 4.2.2 Protein interaction by Co-immunoprecipitation, protein tagging system, Protein Microarrays, Protein-protein interaction Mapping (Two hybrid assay, TAP tag procedure) **Self study** : Use of MALDI-TOF for identification of microbial cultures	07L	

PRACTICALS BASED ON PSMB 201

1. Southern hybridization technique [Demonstration]
2. Northern Blotting technique [Demonstration]
3. Western blotting [Demonstration]
4. Restriction digestion of DNA &Restriction mapping

5 Design of primer & PCR

6. DNA electrophoresis
7. Protein electrophoresis (PAGE)
8. Problems on population genetics
9. LC-MS protein expression profile , MALDI-TOF, Microarray- Visit to research institute

REFERENCES:

1. iGenetics- A Molecular Approach, Russell, P.J., 3rd edition, 2010, Pearson International edition
2. Fundamental Bacterial Genetics, Trun, Trempy, 1st edition, 2004, Blackwell Publishing
3. Molecular Biology of the Gene, Watson, Baker, Bell, Gann, Levine, Losick, 7th edition, 2007, Pearson Education
4. Genes IX, Lewin, B., 2006, Jones and Bartlett Publishers
5. Genetics: A Conceptual Approach, Benjamin Pierce 4th edition, 2008, W. H. Freeman & Co
6. Principals of Genetics, Snustad & Simmons, 6th edition, 2012, John Wiley & Sons Inc
7. Molecular biology –Genes to proteins 3rd ed. by Burton E. Tropp (Jones & Bartlett publishers)
8. Molecular Genetics of bacteria, 3rd Edition by Larry Snyder and Wendy Champness (ASM press)
9. Molecular biology -Understanding the Genetic Revolution by David P. Clark(Elsevier Academic press)
10. Molecular Biotechnology Principles and applications of Recombinant DNA 4th edi Glick, Pastermak, Patten
11. Recombinant DNA J.D. Watson 2nd ed
12. PCR, Clive R. Newton, Alex Graham. (1997); BIOS Scientific Publishers.
13. Molecular Biology by R. F. Weaver 3rd edition, McGraw-Hill international edition

PSMB-202 (Research Methodology , Bioinformatics & Biostatistics)

Learning objective

Research in advancement of the subject is essential for the progression of the students at postgraduate level. This course is designed for postgraduate students in microbiology to introduce the importance of research, process of research and analysis of data to draw

correct conclusions. The Course includes concept of research, types of research, sampling, data collection, processing of data. Course also enables the candidates the use of statistics in research and explains the concept of scientific writing. This course includes one unit of bioinformatics. This is advancement of the basics science learnt at undergraduate level. Students will not only learn this unit theoretically but also with hands on during practical classes.

Learning outcome

At the end of the course students:

- Will be able to understand Fundamentals of research, process of research
- Search the literature
- Understand the concepts of reliability and validity of ideas
- Write a research proposal
- Understand concept and use statistics in research
- Able to understand process of scientific writing
- Use bioinformatic tools in various aspects of research.

Course Code	Unit	Sub unit	Title	No of lectures	Credits
PSMB 201			**Research Methodology , Bioinformatics & Biostatistics**	**60L**	**04**
Unit 1	**1**		**Research terminology and fundamentals**	**15 L**	
		1.1	1.1.1 Definition of research, Scientific thinking, significance of research, general characteristics of research, objectives of research, classification and types of research, types of research methods, 1.1.2. Research methods verses methodology, research and scientific method, Criteria of good research 1.1.3. Identification and formulation of research problem, 1.1.4. Study designs	05	01
		1.2	**Communication & Scientific Writing** 1.2.1 **Communication skills** 1.2.1.1. The importance of communication through English 1.2.1.2. The process of communication and factors that influence communication sender, receiver, channel, code, topic, message, context, feedback, noise, filters & barriers 1.2.1.3. Verbal and non-verbal communication: body language 1.2.1.4. comparison of general	05	

			communication and business communication, science communication 1.2.1.5. Presentation skills- structure of presentation- Types of presentation, oral, power point -Handling power point, slides organisation, content, body language, gestures, voice modulation **1.2.2 Scientific Writing** 1.2.2.1 General structure of scientific reports :- Different types of scientific documents - journal articles, books, thesis, conference and project reports 1.2.2.2 Components of a research paper - Publication process, copyright transfer. Open access 1.2.2.3. Literature search 1.2.2.4. Formulation of research proposal 1.2.2.5. Style of referencing(citation styles)- Harvard, Vancouver, APA, MLA reference writing, Vancouver, APA, MLA reference writing	05	
Unit 2	**2**		**Processing & analysis of data**	**15**	**01**
		2.1	**Hypotheses-** 2.1.1 Meaning, nature of hypothesis, 2.1.2Functions of hypothesis, 2.1.3 Importance of hypothesis, 2.1.4Kinds of hypothesis, 2.1.5Characteristics of good hypothesis, 2.1.6Fformulation of hypothesis	07	
		2.2	**Data collection and processing** 2.2.1 Definition, scope and limitations of data collection and processing 2.2.2Sampling-sampling frame, importance of probability sampling, simple random sampling, systemic sampling, stratified random sampling, cluster sampling 2.2.3Types of data, Collection of data, classification & tabulation-diagrammatic & graphical representation ,Primary data, secondary data 2.2.4Measurement scales, variables & their measurements 2.2.5Validity, effect measure and choice of statistical test 2.2.6 Experimental protocols	08	

Unit 3	**3**		**Statistics in research**	**15**	**01**
		3.1	3.1.1Measures of central tendency -mean, median, mode, geometric mean 3.1.2Measures of dispersion- Range, Q.D., M.D., variance, standard deviation 3.1.3Correlation and Regression analysis: Correlations and regressions-: Relation between two variables, scatter diagram, definition of correlations & their equations, interpretation of regression coefficients, principles of least squares, Two regression lines, curve fitting Karl Pearson's coefficient of correlation, Spearman's coefficient of correlation	05	
		3.2	**Hypothesis testing** 3.2.1Null and alternate hypothesis 3.2.2Type-I & Type-II errors 3.2.3 Level of significance, 3.2.4 Power of test 3.2.5 p value	03	
		3.3	**Parametric tests** 3.3.1 Large sample Tests i. Testing significance of single population mean ii. Testing significance of two population mean 3.3.2 Small sample Tests i. Testing significance of single population mean ii. Testing difference between two independent normal population mean iii. Testing difference between two correlated normal population mean iv. Testing significance of correlation coefficient 3.3.3 $\chi 2$ test i. Testing single population variance ii. Testing Goodness of fit iii. Testing association between two attributes 3.3.4 F-test- Testing equality of variance i. ANOVA- one-way classification, two way classification	07	
Unit 4	**4**		**Bioinformatics**	**15**	**01**
		4.1	4.1 Introduction and Revision of T.Y.B.Sc topics to give an overview of bioinformatics	01L	

			4..1.1 Biological databases-nucleic acid sequence databases- gene bank/ EMBL/ DDBJ	01L	
			4.1.2 Protein sequence data bases- (UniProtKB), Derived databases(Prosite, BLOCKS, Pfam/Prodom) Structural databases (PDB , NDB) and Enzyme databases	03L	
		4.2	4.2.1 Concept in sequence analysis- Needleman & Wunsch , Smith & Waterman alignment algorithms	01L	
			4.2.2.Scoring Matrix for nucleic acids and protein- MDM.BLOSUM.CSW	01L	
			4.2.3Alignment: Pair wise BLAST, FASTA	01L	
			4.2.4 Multiple sequence alignment, PRAS, CLUSTAL W	01L	
		4.3	Phylogenetic analysis and Tree construction Basic concepts of phylogenetic analysis, rooted/uprooted trees, approaches for phylogenetic tree construction	02L	
		4.4	Structure predictions for proteins- Basic approaches for protein structure predictions, comparative modelling, fold recognition	02L	
		4.5	Chemo-informatics- Introduction, applications in pharmaceutical industries	01L	
		4.6	Immuno-informatics- Overview, Reverse vaccinology , Rational Vaccine design	01L	
			Self Study : Study of 3D structures of enzymes /protein		

Practicals

1) Literature review on any current research of 30-40 types pages (It can be on the research project topic that the student wishes to do in MSC part2)
2) Problem solving in biostatistics
3) Practicals Based On Bioinformatics-

- Visiting NCBI and EMBL websites & list services available, software tools available and databases maintained
- Visiting & exploring various databases mentioned in syllabus
- Using BLAST and FASTA for sequence analysis
- Fish out homologs for given specific sequences (by teacher) - decide sequence of some relevance to their syllabus and related to some biological problem e.g.

evolution of a specific protein in bacteria, predicting function of unknown protein from a new organism based on its homology)

- Six frame translation of given nucleotide sequence
- Restriction analysis of given nucleotide sequence
- Pair-wise alignment and multiple alignment of a given protein sequences
- Formation of phylogenetic tree

Books

1) Research Methodology: A guide for Researchers in Agricultural Science, Social Science and other related fields. Pradip kumar Sahu. Springer 2006
2) Ranjit Kumar, 2005 Research Methodology- A step-by-step Guide for beginners, 3rd edition, Sage publications.
3) Fundamentals of Research methodology and statistics- Yogesh Kumar Singh, New Age International Publishers
4) Biostatistics: A foundation for analysis in health sciences. Daniel WW, Cross CL. 10thEdn, Wiley.2013
5) Mount, D. W. (2001) Bioinformatics: sequence and genome analysis. Cold Spring Harbor Laboratory Press, New York.
6) Introduction to Bioinformatics T.K. Attwood and D.J Perry-Smith
7) Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Baxevanis A.D. and Ouellette, Third Edition. John Wiley and Son Inc., 2005

Reference books

1) Biostatistical Analysis. Zar JH. 5th Edition Pearson Education.2010.
2) Principles of Biostatistics. Pagano M., Gauvreau K., 2ndEdn. Cargege Learning, 2010
3) Fundamentals of Biostatistics. Rosner B. 7thEdn. Duxbury Thomson 2011
4) Introductory Applied Biostatistics D'Agostino RB., Sullivan LM., Beiser AS., Thomson Brooks/Cole 2006
5) Statistical Analysis In Microbiology: Statnotes, By Richard A. Armstrong And Anthony C. Hilton, A John Wiley & Sons, Inc. Publication, ISBN: 978-0-470-55930-7 December 2010 Wiley-Blackwell 192 Pages

PSMB-203 (Applied Biochemistry)

Learning Objectives

- To open the domains of applied biochemistry.
- To gain an insight in the multifaceted field of enzymology.
- The practically train students to understand the challenges and problems encountered while dealing with bio-molecules like proteins.
- Commercial outcomes are understood through pharmaceutical products and proteomics-an already established field with extensive applications in diverse fields of biological sciences**.**

Learning Outcomes

At the end of the course students will be able to

- Understand and relate to metabolic and physiological complexities shown by living organisms.
- Appreciate and understand the intricate manner of communications at the cellular and sub cellular level employing bio-molecules.
- Apply the biological processes at molecular level for production and synthesis of bioactive molecules of commercial significance. Learning the unusual bio-molecules and bioactive compounds will open new avenues for research to the young scientists.
- Obtain Knowledge of Proteomics which will give them a new perspective about diagnosis of diseases and make them competent to handle new challenges if they are employed in modern diagnostic laboratories.
- Undertake advanced studies on enzyme kinetics will help them alter conditions favourably to increase industrial productions.

Course Code	Unit	Sub unit	Title	No of lectures	Credits
PSMB 201			**Applied Biochemistry**	**60L**	**04**
	1		**Enzymes: the catalysts of Cells**	15 L	01
		1.1	Information from kinetics, specificity of enzymatic action, mechanisms of catalysis	7L	
		1.2	Inhibition and activation of enzymes	2L	
		1.3	Enzyme isolation and purification	6L	
			Self-study: Draw Eadie-Hofstee,Hanes-Woolf plot, Dixon plot and Cornish-Bowden plot and interpret.		
	2		**Signalling and stress**	15L	01
		2.1	Introduction to two-component signalling systems	7L	
		2.2	Synthesis of virulence factors in response to temperature, pH, nutrient, osmolarity and quorum sensors, chemotaxis, photoresponses, aerotaxis,	4L	
		2.3	Bacterial development and quorum sensing: Myxobacteria, Caulobacter, bioluminescence systems similar to LuxR/LuxI in nonluminescent bacteria	4L	
	3		**Natural and Unusual bio-molecules and bioactive compounds**	15 L	01 .
		3.1	Bioactive proteins & peptides: peptides as	09 L	

			bioactive agents, peptides with anti-oxidative activity, antimicrobial peptides, enzyme based antimicrobial proteins, non-enzyme based antimicrobial proteins, commercialization of antimicrobial proteins and peptides. Lectins, surfactants, albumin, cryoprotectants, lyoprotectants		
		3.2	Classes of Natural Products: polyketides, terpenes & steroids, alkaloids, phenylpropanoids, Flavonoids. Non coding RNAs	04 L	
		3.3	Functional carbohydrates and hydrocolloids Cereal βGlucans, modified starch, microbial Polysaccharides, Chitosan	02L	
			Self-study : A report on source, structure and application on unusual hydrocolloid/ lipid(etc) molecules other than that listed above		
	4		**Proteomics**	15 L	01
		4.1	Proteomics and the proteome, branches	05	
		4.2	Overview of techniques and challenges	05	
		4.3	Applications : Disease diagnosis[cancer biology, autoimmune, allergic response], Glycomics, use of protein biomarkers	05	
			Self-study: one application in agriculture / environmental/toxicogenomics/nutraceuticals etc.		

Practicals for Paper 203

1. Isolation, partial purification and study of enzyme kinetics of amylase.
2. Adaptation of *E. coli* to anaerobiosis
3. Effect of temperature and water activity on swarming of *Proteus spps*
4. Isolation of amylopectin and amylose from potato starch.
5. Isolation of Lycopene from tomatoes
6. Preparation of lectin from plant source and its application

REFERENCES:

Unit I

1. Biochemistry: The chemical reactions of living cells (Vol 1) David E. Metzler. Academic Press.
2. Fundamentals of enzymology. 2nd edition. Nicholas C. Price and Lewis Stevens. Oxford Science Publication. Reprint 1998.

Unit II:

1. The physiology and biochemistry of prokaryotes, White D., Drummond, T. J. and Fuqua C., 3rd edition, 2007, Oxford University Press

Unit III:

1. Bioactive food proteins & peptides Applications in human health, ed Navam S. Hettiarachchy, CRC press, 2012
2. Natural products: the secondary metabolites. James R. Hansen. Royal Society of Chem.
3. Development & manufacture of Protein Pharmaceuticals. Ed Steven L. Nail and Michael J. Akers. Springer Science 2002 [ISBN 978-1-4615-0549-5]
4. Functional food carbohydrates. Costas G. Biliaderis and Marta S. Izydorczyk. CRC press 2007.
5. Chemistry of Natural products by SV Bhat, BA Nagasampagi& M Sivakumar, Berlin Springer (2005) (ISBN 3-540-40669-7).
6. Handbook of hydrocolloids. 2nd edition. Ed G.O. Phillips and P.A. Williams. CRC Press. Woodhead Publishing Limited [ISBN-978-1-84569-587-3]

Unit IV

1. Introduction to proteomics Tools for the new Biology. Daniel C. Liebler. Humana Press 2002
2. OMICS Applications in Biomedical, Agricultural and Environmental Sciences. Ed Debmalya Barh, Vasudeo Zambare, Vasco Azevedo. CRC press. 2013

REFERENCE BOOKS

1. Laboratory manual in biochemistry by Jayaraman J. , New Age International Publishers .
2. Enzymes 3rd edition. Malcolm Dixon and Edwin C. Webb. Longman Group 1979.
3. An introduction to practical biochemistry 3rd. edition, David T Plummer, Tata McGraw Hill edition 1998
4. Experimental biochemistry –A student companion, Rao Beedu, S. Deshpande, IK international Pvt. Ltd.
5. Laboratory manual in biochemistry, Immunology and Biotechnology, Nigam A and Ayyagiri A. Tata McGraw Hill edition
6. Source of Experiments for teaching Microbiology, Primrose and Wardlaw
7. Microbial Physiology and Biochemistry Laboratory manual: A quantitative approach , David White

PSMB-204 (Applied Immunology)

Learning Objectives:

One of the most important areas of immunology is Applied Immunology which encompasses the study of Adversarial strategies during various infections, Vaccines, Immunodeficiency disorders, Immune Tolerance, Advances in Allergy and other hypersensitivities, Transplantation and Transfusion Immunology, Tumor Immunology, Autoimmune diseases that are enlisted and properly covered in the syllabus.

This course will help students to build on the advance information regarding the applications of the basic immunology they have studied during their undergraduate course.

Learning Outcomes:

Students should be able to-

- Give details of the adversarial strategies during various infections, recent advances in vaccines production and difficulties encountered in it.
- Correlate the causes, principles involved, examples, control and treatment of immunodeficiency disorders, hypersensitivity reactions, autoimmune diseases and cancer.
- Comment on the organs, tissue transplantation and blood transfusion-principle involved, types of transfusion reactions and their control, tests to be performed for safe transplantation.

Course Code	Unit	Sub unit	Title	No of lectures	Credits
PSMB 201			**Applied Immunology**	**60L**	**04**
	1		**Adversarial strategies during infection**	15 L	01
		1.1	1.1.1 Bacterial survival strategies - Evading complement, - Evading killing by macrophages 1.1.2 The host counter attack against bacteria - Toxin neutralization - Opsonization of bacteria 1.1.3 The habitat of intracellular bacteria: Bacterial survival strategies - Defence against intracellular bacteria - Role of activated Macrophages 1.1.4 Viral survival strategies - antigenic variations - non functional T- cell epitopes - interference with antigen processing and/ or presentation - interference with immune effector mechanism	10	

			1.1.5 Immunity to fungi		
		1.2	**Vaccines** 1.2 .1. Subunit vaccines - purified components as bacterial vaccines - Viral subunit as vaccine - carbohydrate vaccine - DNA and RNA vaccines 1.2.2 Newer approaches to vaccine development 1.2.3 Current vaccines 1.2.4 Difficulties in the development of Parasitic vaccines : -Malaria 1.2.5 Vaccines for protection against bioterrorism 1.2.6 Immunization against cancer	05	
			Self study : Vaccines under development		
	2		**Immunodeficiency**	15L	01
		2.1	2.1.1 Deficiencies of pattern recognition -Receptor signaling 2.1.2 Phagocytic cell defects 2.1.3 Complement system deficiencies 2.1.4 Cytokine and cytokine receptor deficiencies 2.1.5 Primary B-cell deficiency 2.1.6 Primary T- cell deficiency 2.1.7 Severe combined immunodeficiency 2.1.8 Diagnosis and treatment of primary immunodeficiency	08	
		2.2	**Immune Tolerance** 2.2 .1 Major mechanisms for achieving tolerance 2.2.2 Central Tolerance 2.2.3 Peripheral Tolerance 2.2.4 Tolerance induction 2.2.5 Immunoprivileged sites-The brain, the eyes	07	
	3		**Advances in Allergy and other hypersensitivities**	15L	01
		3.1	3.1.1 Type –I hypersensitivity 3.1.2 Type –II hypersensitivity 3.1.3 Type –III hypersensitivity 3.1.4 Type –IV hypersensitivity 3.1.5Type -V hypersensitivity (Mechanism/principle, examples,	07	

			diagnosis and treatment of these hypersensitive)		
		3.2	**Transplantation and Transfusion Immunology** 3.2.1 Types of Graft 3.2.2 Types of graft rejection 3.2.3Mechanisms of graft rejection 3.2.4 Matching the donor and recipient 3.2.5 Immuno suppression 3.2.6The foetus as an allograft 3.2.7 Blood transfusion - Blood grouping and cross matching - Transfusion reactions - Criteria for selection and rejection of Blood Donor	08	
	4		**Immunological disorders**	15L	01
		4.1	**Tumor Immunology** 4.1.1Cell- intrinsic and extrinsic mechanisms of tumor suppression 4.1.2 Role of inflammation in the enhancement of tumor initiation, promotion and progression 4.1.3 Tumor antigens and their classes 4.1.4Approaches to cancer immunotherapy - Passive immunotherapy with monoclonal antibodies - Unmasking of the latent T- cell responses - Antigen independent cytokine therapy	07	
		4.2	**Autoimmune diseases** 4.2.1 Causes 4.2.2 Mechanisms 4.2.3 Pathogenic effects of autoantibody 4.2.4 Pathogenic effects of complexes with auto antigens 4.2.5 T cell mediated hypersensitivity as a Pathogenic factor in autoimmune disease	08	
			Self Study Topics 1. Case studies – Autoimmune diseases **2.** Case studies - Use of Immune therapies in cancer, transplantation and other immunological disorders		

PSMBP 204 – Practicals based on Semester II -paper IV-Applied Immunology

1. Hemoglobin estimation by Cyanmethaemoglobin method using Drabkins Fluid as one of the criteria used for selection of blood donor during collection of blood for safe transfusion.
2. Blood grouping and Compatibility testing /cross matching of blood for safe blood transfusion.
3. Determination Of Enzymes Of Oxidative Stress (SOD And Catalase)
4. NBT Analysis Of Blood Sample
5. Serum Lysozyme Activity
6. Serum Myeloperoxidase Activity (MPO)
7. Rheumatoid factor test for laboratory diagnosis of Rheumatoid arthritis
8. Lupus erythematosus (LE) cell preparation-Principle, Procedure and Significance to be explained during the practicals using permanent slides/ color atlas of diagnostic immunology/Microbiology
9. RIST and RAST- Principle, Procedure and Significance to be explained during the practicals using power point presentation/ youtube.

Text books:

1. Roitt's Essential Immunology 13th Ed. –Wiley Blackwell
2. Kuby Immunology 6th Ed – W. H. Freeman and Company, New York

Reference Books:

1. Immunology –Essential and Fundamental – Sulbha Pathak, Urmi Palan, 3rd Ed. Capital Publishing Company (New Delhi-Kolkata)
2. Kuby Immunology 7th Ed – W. H. Freeman and Company, New York
3. Kuby Immunology 8th Ed – Macmillan education
4. Immunology – An Introduction 4th Ed – Tizard
5. Elements of Immunology- Fahim Halim Khan –Pearson Education
6. Medical Laboratory Technology - Kanai Mukherjee vol. 1

Modality of assessment

A. Theory -Internal assessment 40% **40 marks**

Sr No	Evaluation type	Marks
1.	Assignment that can include article writing , report writing , preparation of a review, on any topic selected from each course paper. The topic selected will besides the content should be assessed by any plagiarism software by the staff (Software to be kept ready by college)	20
2	Submission of Self study topics / One class Test (multiple choice questions / objective)	10
3	**a.** Active participation in routine class instructional deliveries **b** Overall conduct as a responsible student, wrt manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular activities, etc.	05 05

B. Theory -External examination -60%

. Semester End Theory Assessment **60 marks**

- The duration of these exam will be of 2.5 hrs
- The theory question paper will have 5 questions each of 12 marks .
- For each unit there will be one question and the fifth will be based on all the four units
- All questions shall be compulsory with internal choice within the questions such that each question will be set of 20-23 marks with options.
- Questions shall be subdivided into sub questions a, b, c, d, and e only and the allocation of marks will depend on the weight age of the topic

II. Practical Examination pattern

Semester 1

Practical Course	Major Technique	Minor Technique	Journal	Viva	Spots	Total
PSMBP 101	25 Marks	10 marks	05	05	05	50 marks
PSMBP 102	25 Marks	10 marks	05	05	05	50 marks
PSMBP 103	25 Marks	10 marks	05	05	05	50 marks
PSMBP 104	25 Marks	10 marks	05	05	05	50 marks

Semester 2

Practical Course	Major Technique	Minor Technique	Journal	Viva	Spots	Total
PSMBP 201	25 Marks	10 marks	05	05	05	50 marks
PSMBP 202	25 Marks	10 marks	05	05	05	50 marks
PSMBP 203	25 Marks	10 marks	05	05	05	50 marks
PSMBP 204	25 Marks	10 marks	05	05	05	50 marks

Overall Examination pattern

Semester 1

Course	PSMB101			PSMB102			PSMB103			PSMB104			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal
Theory	40	60	100	40	60	100	40	60	100	40	60	100	400
Practicals	-	50	50	-	50	50	-	50	50	-	50	50	200

Semester II

Course	PSMB201			PSMB202			PSMB203			PSMB204			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal
Theory	40	60	100	40	60	100	40	60	100	40	60	100	400
Practicals	-	50	50	-	50	50	-	50	50	-	50	50	200

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