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Semester -1

Course Code	Course Title	Course Type	Load Distribution			Marks Distribution		Total Marks	Credits
			L	T	P	Int.	Ext.		
BSMB101-20	Introduction to Microbiology	Core	3	1	-	40	60	100	4
BSMB102-20	Introduction to Microbiology (Lab)	Core Practical	0	0	3	60	40	100	2
BSMB103-20	Chemistry-I	Core	3	1	-	40	60	100	4
BSMB104-20	Chemistry-I (Lab)	Core Practical	0	0	3	60	40	100	2
BSMB105-20	Cell Biology	Core	3	1	-	40	60	100	4
BSMB106-20	Cell Biology (Lab)	Core Practical	0	0	3	60	40	100	2
BSMB107-20	Basics of Biosciences *	Foundation Course *	2	0	0	20	30	50	0
BSMB108-20	Basics of Biosciences Lab *	Foundation Course *	0	0	2	20	30	50	0
BTHU103-18	English	(AECC)	2	0	0	40	60	100	2
BTHU104-18	English Lab	(AECC) Lab	0	0	2	30	20	50	1
HVPE101-18	Human Values, De-addiction and Traffic Rules	(AECC)	3	0	0	40	60	100	3
HVPE102-18	Human Values, De-addiction and Traffic Rules (Lab-seminar)	(AECC) Lab	0	0	1	25	-	25	1
BMPD102-18	Mentoring & Professional Development		0	0	2	25	-	25	1
TOTAL			**16**	**3**	**16**	500	500	1000	**26**

***** Basics of biosciences and Basics of Biosciences Lab - For students having passed 10+2 with Mathematics to take compulsory deficiency course and to be awarded Satisfactory and Non- Satisfactory during their final results by PTU. This course is a deficiency course for a specific section of students so no credits have been allotted.

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Second Semester

Course Code	Course Title	Course Type	Load Distribution			Marks Distribution		Total Marks	Credits
			L	T	P	Int.	Ext.		
BSMB201-20	Bacteriology	Core	3	1	-	40	60	100	4
BSMB202-20	Bacteriology (Lab)	Core Practical	-	-	3	60	40	100	2
BSMB203-20	Fundamentals of Biochemistry	Core	3	1	-	40	60	100	4
BSMB204-20	Fundamentals of Biochemistry (Lab)	Core Practical	-	-	3	60	40	100	2
BSMB205-20	Molecular Biology	Core	3	1	-	40	60	100	4
BSMB206-20	Molecular Biology (Lab)	Core Practical	-	-	3	60	40	100	2
BSBMB 207-20	Microbial Physiology and Metabolism	Core	3	1	-	40	60	100	4
BSBMB 208-20	Microbial Physiology and Metabolism (Lab)	Core Practical	-	-	3	60	40	100	2
BMPD209-18	Mentoring & Professional Development		-	-	2	25	-	25	1
TOTAL			**12**	**4**	**14**	425	400	825	**25**

Third Semester

Course Code	Course Title	Course Type	Load Allocation			Marks Distribution		Total Marks	Credits
			L	T	P	Internal	External		
BSMB301-20	Virology	Core Theory	3	-	0	40	60	100	3
BSMB302-20	Virology Lab	Core Practical	-	-	4	60	40	100	2
BSMB303-20	Microbial Genetics	Core Theory	3	-	0	40	60	100	3
BSMB304-20	Microbial Genetics Lab	Core Practical	-	-	4	60	40	100	2
BSMB305-20	Microbes in Environment	Generic Elective	3	-	0	40	60	100	3
BSMB306-20	Microbes in Environment	Generic Elective Practical	-	-	4	60	40	100	2
BSMB307-20	Microbiological Analysis in Air and Water	Skill Enhancement Elective	2	-	0	20	30	50	2
BSMB308-20	Biostatistics	Discipline Specific Elective	3	1	0	40	60	100	4
BSMB309-20	Mentoring and Professional Development		-	-	2	25	-	25	1
Total								775	21

Semester: 4

Sr No	Code	Subject (Theory and Labs)	Course Type	Load Distribution			Marks Distribution		Total Marks	Credits
				L	T	P	IE	EE		
1	BSMB401-20	Phycology and Mycology	CT	3	1	-	40	60	100	4
2	BSMB402-20	Phycology and Mycology Lab	CL	0	0	4	40	60	100	2
3	BSMB403-20	Agriculture Microbiology	CS	3	1	-	40	60	100	4
4	BSMB404-20	Agriculture Microbiology Lab	CL	0	0	4	40	60	100	2
5	BSMB405-20	Food and dairy Microbiology	CS	3	1	-	40	60	100	4
6	BSMB406-20	Food and dairy Microbiology Lab	CL	0	0	4	60	40	100	2
7	BSMB407-20	Analytical techniques in Microbiology	SE	3	1	0	40	60	100	4
8	BSMB408-20	Analytical techniques in Microbiology Lab	SE L	0	0	2	60	40	100	1
9	BMPD409-20	Mentoring & Professional Development		0	0	2	25	-	25	1
	TOTAL			**12**	**4**	**16**	**385**	**440**	**825**	**24**

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BSMB101-20 Introduction to Microbiology

Unit 1

History of Microbiology: A. Leeuwenhoek, L.Pasteur, R.Koch, J.Lister, J.Tyndall, etc. Biogenesis v/s Abiogenesis, Koch Postulates, Discovery of antibiotics. Principle of Microscopy: Bright field, Dark field, Phase contrast, Fluorescent, Electron Microscopy.

Unit 2

Microbial classification: Bacteria, Fungi and Algae. Morphology of bacteria, viruses, algae and fungi with major emphasis on bacterial structure specially cell wall. Gram positive and Gram negative bacteria. Microbial spores, Sporulation and germination process. Nitrogen fixing microbes in agriculture.

Unit 3

Microbial growth, nutritional biodiversity, phases of growth, generation time, growth rates, monoauxic, diauxic and synchronous growth, chemostat, Microbes in extreme environment like high temperature and high/ low pH Physical and chemical agents to kill microbes, sterilization and pasteurization processes.

Unit 4

Normal micro flora in humans, Types of microbial pathogens and diseases caused by them. Microbial interactions like symbiosis and antibiosis etc. Aerobic and Anaerobic fermentation, production of heterologous proteins in microbes.

Suggested Readings / Books

1. Davis, B.D Dulbecco, R., Eiser, H.N. and Ginsberg, H.S. (1990). Microbiology, 4th edition, Harper and Row, Publishers, Singapore.
2. Tortora, G.J., Funke, B.R., and Case, C.L. (1994). Microbiology: an introduction, 5th edition, the Benjamin/Cummings Publishing Company, Inc.
3. Stanier, R.Y. (1995). General Microbiology, MacMillian Press London.
4. Pelczar, M.T. (1995). Microbiology, Tata McGraw Hill Publication, New Delhi.
5. Schegel, H.G., (1995). General microbiology 7th ed. Cambridge University Press.
6. Prescot and Dunn (1999). Industrial Microbiology, 4th ed. By S.K Jain for CBS Publishers and Distributors.
7. Purohit, S.S. (2000). Microbiology: Fundamentals and Applications (6th edition), Agrobios (India)
8. Postgate, J. (2000). Microbes and Man : 4th ed, Cambridge University Press.

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BSMB102-20 Introduction to Microbiology Lab

List of Practical

1. Aseptic techniques
2. Cleaning of glass wares, Preparation of media, Cotton plugging and sterilization
3. Isolation of bacteria from air, water and soil
4. Personal hygiene- Microbes from hands, Tooth-Scum and other body parts.
5. Dilution and pour plating techniques.
6. Growth curve of microorganisms.
7. Culture from body fluids (Stools, Urine, Blood).
8. Alcoholic and mixed acid fermentation.
9. Simple staining.
10. Differential staining- Gram staining
11. Identification of bacteria by Biochemical analysis of bacteria: Oxidase test, catalase test, MR-VP test.
12. Slide identification from permanent slides.

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BSMB103-20 Chemistry-I

Unit-1

Atomic Structure : Bohr's atomic model & limitation. Idea of de Broglie matter weaves. Hisenberg's uncertainty principle. Schrödinger's wave equation. Significance of wave function. Quantum numbers. Multielectron system-Pauli's exclusion principal, Hunds rules of maximum multiplicity. Stability of half filled full field orbitals, Afbau principal & its limitation. Electronic configuration of atoms.

Unit-2

Bonding in organic compounds: Classification, trivial names and IUPAC system of nomenclature of organic compounds. Nature of covalent bond and its orbital representation. Hybridization, bond energy, polarity of bond & dipole moment of molecules, inductive effect, hydrogen bond, conjugation, resonance. Hemolytic & heterolytic fission of bonds electrophiles & nucleophiles, carbonation, carbon ions and radicals- there stability, geometry & generation.

Unit-3

Stereochemistry: Dissymmetric Molecules: Different types of Isomerism, Structural Isomers, Geometrical, Stereoisomerism, Configurational Isomers, Conformational Isomers, Concept of asymmetric carbon atom, Enantiomers, Diastereiosmers, Stereogenic atom / center, Chirotopic / Achirotopic Centre, Protereoisomerism, Concept of Topicity of Ligands and Faces (Homotopic, Enantiotopic, Diastereotopic atoms and groups; Prochiral, Homotopic, Enantiotopic, Diastereotopic Faces), Projection Structures of Streoisomers (Fischer, Swahorse, Newman, Flying-Wedge projection and Interconversion of these projections formulas) of simple molecules containing one or two asymmetric carbon atom,

Unit-4

Optical isomerism, Optical activity, Element of symmetry and chirality, Meso compounds, Chiral centers and the number of stereoisomers, Racemic modifications, Racemic mixture or (+/-)-Conglomerate, Racemic Compounds or racenate, Stereochemical nomenclature of Stereoisomers containing chiral centers(R/S and E/Z or cis-trans or sec cis- sec trans of C=C system);D,L system of designation; Pro-R, Pro-S, Re, Si, Erythro, threo, Pref and Praf designation of enantiotopic groups and atoms; Chirality of Organic molecules without chiral center and concept of chiral axis.

Suggested Readings / Books

1. J.D. Lee, Inorganic Chemistry, 5th edition chapman & Hall, London.
2. Inorganic Chemistry by Puri, Sharma and Kalia
3. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry
4. F. Basalo and R.C. Johson, Co-ordination Chemistry,1964.
5. Organic Chemistry – FINAR IL
6. Organic Chemistry _ Morrison and Boyd
7. Voge's text book of Organic Chemistry – Furniss
8. Organic Chemistry – Ege Sezham
9. Atkin's Physical Chemistry by Peter Atkins and Julio de Paulk. Publisher Oxford University Press • Textbook of Physical chemistry by Samuel Glasston. MacMillan India Ltd
10. Kalyani Physical Chemistry by K.L. Chug and S.L. Agnish. Kalyani Publisher

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BSMB104-20 Chemistry -1 Lab

List of practical's

1. Separation of constituents present in an inorganic mixture containing two cations only (constituents having large difference in Rf values to be provided.
2. Preparation of any one of the following compounds
(i). Acetanilide
(ii). Asprin
(iii). p-Nitroacetanilide
(iv). Aniline yellow or 2 - Naphthol Aniline dye.
3. Qualitative analysis

Determination of one cation and one anion in a given salt. Cation:- Pb^{2+}, Cu^{2+} As^{3+}, Al^{3+}, Fe^{3+}, Mn^{2+} , Zn^{2+}, Cu^{2+}, Co^{2+}, Ni^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Mg^{2+}, NH_4^+
Anions:- CO_3^{2-}, S^{2-}, SO_3^{2-}, SO_4^{2-}, NO_2^-, NO_3^-, Cl^-, Br^-, I^-, PO_4^{3-}, $C_2O_4^{2-}$, CH_3COO^-
(Note: Insoluble salts included)
4. Tests for the functional groups present in organic compounds:
Unsaturation, alcoholic, phenolic, aldehydic, ketonic, carboxylic and amino (Primary) groups.
5. Characteristic tests of carbohydrates, fats and proteins in pure samples and their detection in given food stuffs.
6. Detection of adulteration in various samples like oil, milk, pulses, spices etc

BSMB105-20 Cell Biology

Unit I Cell as a basic unit of living systems: Cell structure and the cell theory, Broad and detailed classification of cell types within an organism. Different levels of organization of cells.

Unit -2 Cell division and Cell cycle: Cell interaction; Cell locomotion, Muscle and Nerve cells, Cell senescence and death, Cell differentiation.

Unit -3 Structure and function of cell organelles: Ultrastructure of cell membrane, cytosol, golgi bodies, endoplasmic reticulum (rough and smooth), ribosomes, Cytoskeletal structures (actin, microtubules etc.), Mitochondria, chloroplasts, lysosomes, peroxisomes. Nucleus (nuclear membrane, nucleoplasm, nucleolus, chromatin).

Unit -4 Fixation and Staning; Freeze drying and freeze substitution, Microtome and Embedding, Chemical basis of staining, Cytophotometric Methods.

Suggested Readings / Books

1. Cell and molecular Biology: De Roberties
2. Cell Biology: Bruce Albert's
3. Cell Biology: Dowben

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BSMB106-20 Cell Biology Lab

List of Practicals

1. Sub Cellular Fractionation and marker enzymes
2. Mitosis and Meiosis
3. Vital staining for visualizing cell organelles
4. Histochemical Techniques
5. Centrifugation
6. Chromatogarphy-Paper and Thin Layer chromatography
7. Microscopy: Bright field

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BSMB107-20 Basics of Biosciences

Unit 1

Diversity in the living world; The living world, Biological classification, Kingdom Monera, Kingdom Protista, Kingdom Fungi, Plant kingdom; Classification of animals in general.

Unit 2

Structural organization in plants; Morphology of flowering plants, Anatomy of plants.

Unit 3

Structural organization in animals; Structural organization in animals: animal tissues, morphology and anatomy of animals.

Unit 4

Cell- Basic unit of life; Cell theory, Cell structure and functions; Cell cycle and cell division; Bio-molecules.

BSMB108-20 Basics of Bioscience Lab
List of Practicals

1. General guidelines for Good lab Practices
2. Description of flowers including floral diagram, floral formula, V.S. of flower of the representative genera of families mentioned in syllabus.
3. Simple staining
4. Tissue sectioning and microscopic analysis
5. Bright field microscopy
6. Each student required to submit a family wise herbarium consisting of at least 20 properly pressed and mounted plants.
7. Identification of animal specimens (chordates and non chordates).

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BTHU103-18 English

Unit-1 (Introduction)
Theory of Communication, Types and modes of Communication, Communication at Workplace.

Unit- 2 (Language of Communication)
Verbal and Non-verbal, Spoken and Written, Personal, Social and Business, Barriers and Strategies, Intra-personal, Inter-personal and Group communication.

Unit-3 (Reading and Understanding)
Close Reading, Comprehension, Summary Paraphrasing, Analysis and Interpretation, Translation (from Hindi/Punjabi to English and vice-versa), Literary/Knowledge Texts, Common Everyday Situations: Conversations and Dialogues.

Unit-4 (Writing Skills)
Documenting, Report Writing, Making notes, Letter writing-Formal and Informal.

Suggested Readings:

1. Fluency in English - Part II, Oxford University Press, 2006.
2. Business English, Pearson, 2008.
3. Language, Literature and Creativity, Orient Blackswan, 2013.
4. Language through Literature (forthcoming) ed. Dr. Gauri Mishra, Dr Ranjana Kaul, Dr Brati Biswas • On Writing Well. William Zinsser. Harper Resource Book. 2001
5. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.

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BTHU104-18 English Lab

Interactive practice sessions in Language Lab on Oral Communication •Listening Comprehension
•Self Introduction, Group Discussion and Role Play
•Common Everyday Situations: Conversations and Dialogues
•Communication at Workplace •Interviews

•Formal Presentations
•Monologue
•Effective Communication/ Mis-Communication
•Public Speaking

Suggested Readings:

1. Fluency in English -Part II, Oxford University Press, 2006.
2. Business English, Pearson, 2008.
3. Practical English Usage. Michael Swan. OUP. 1995.
4. Communication Skills. Sanjay Kumar and Pushp Lata. Oxford University Press. 2011.
5. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

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HVPE101-18 Human Values, De-addiction and Traffic Rules
Ability enhancement Compulsory Course (AECC)

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

1. Understanding the need, basic guidelines, content and process for Value Education
2. Self Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the mechanism for self exploration
3. Continuous Happiness and Prosperity- A look at basic Human Aspirations
4.Right understanding, Relationship and Physical Facilities- the basic requirements for fulfillment of aspirations of every human being with their correct priority
5.Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario.
6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels

Module 2: Understanding Harmony in the Human Being - Harmony in Myself

7. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
8. Understanding the needs of Self ('I') and 'Body' - Sukh and Suvidha
9. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)
10.Understanding the characteristics and activities of 'I'and harmony in 'I'
11. Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail.
12. Programs to ensure Sanyam and Swasthya - Practice Exercises and Case Studies will be taken up in Practice Sessions.

Module 3: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship.

13. Understanding harmony in the Family- the basic unit of human interaction
14. Understanding values in human-human relationship; meaning of Nyaya and program for its fulfillment to ensure Ubhay-tripti; Trust (Vishwas) and Respect (Samman) as the foundational values of relationship
15.Understanding the meaning of Vishwas; Difference between intention and competence
16. Understanding the meaning of Samman, Difference between respect and differentiation; the other salient values in relationship
17. Understanding the harmony in the society (society being an extension of family): Samadhan, Samridhi, Abhay, Sah-astitva as comprehensive Human Goals
18. Visualizing a universal harmonious order in society- Undivided Society (AkhandSamaj), Universal Order (SarvabhaumVyawastha)- from family to world family! - Practice Exercises and Case Studies will be taken up in Practice Sessions.

Module 4: Understanding Harmony in the Nature and Existence - Whole existence as Co-existence.

19.Understanding the harmony in the Nature
20.Interconnectedness and mutual fulfillment among the four orders of nature- recyclability and self- regulation in nature
21.Understanding Existence as Co-existence (Sah-astitva) of mutually interacting units in all-pervasive space
22. Holistic perception of harmony at all levels of existence - Practice Exercises and Case Studies will be taken up in Practice Sessions.

Module 5: Implications of the above Holistic Understanding of Harmony on Professional Ethics.

23. Natural acceptance of human values
24. Definitiveness of Ethical Human Conduct
25.Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
26. Competence in professional ethics: a) Ability to utilize the professional competence for augmenting universal human order, b) Ability to identify the scope and characteristics of people-friendly and eco-friendly production systems, c) Ability to identify and develop appropriate technologies and management patterns for above production systems.
27. Case studies of typical holistic technologies, management models and production systems
28. Strategy for transition from the present state to Universal Human Order: a) At the level of individual: as socially and ecologically responsible engineers, technologists and managers b) At the level of society: as mutually enriching institutions and organizations

Reference Books

1. Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and HarperCollins, USA
2. E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.
3. A Nagraj, 1998, Jeevan Vidya ek Parichay, Divya Path Sansthan, Amarkantak.
4. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991
5. PL Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Purblishers.
6. A.N. Tripathy, 2003, Human Values, New Age International Publishers.
7. Subhas Palekar, 2000, How to practice Natural Farming, Pracheen(Vaidik) Krishi Tantra Shodh, Amravati.
8. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, Limits to Growth – Club of Rome's report, Universe Books.
9. E G Seebauer & Robert L. Berry, 2000, Fundamentals of Ethics for Scientists & Engineers , Oxford University Press
10. M Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics (including Human IK Gujral Punjab Technical University Jalandhar B.Sc. Biotechnology Batch 2018 Onwards Values), Eastern Economy Edition, Prentice Hall of India Ltd.
11. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
12. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.

Relevant CDs, Movies, Documentaries & Other Literature:

1. Value Education website, http://uhv.ac.in
2. Story of Stuff, http://www.storyofstuff.com
3. Al Gore, An Inconvenient Truth, Paramount Classics, USA
4. Charlie Chaplin, Modern Times, United Artists, USA
5. IIT Delhi, Modern Technology – the Untold Story

HVPE102-18 Human Values, De-addiction and Traffic Rules Lab
Ability enhancement Compulsory Course (AECC)

One each seminar will be organized on Drug De-addiction and Traffic Rules. Eminent scholar and experts of the subject will be called for the Seminar atleast once during the semester. It will be binding for all the students to attend the seminar.

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BSMB201-20 Bacteriology

Unit I Cell organization Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids Endospore: Structure, formation, stages of sporulation.

Unit II Bacteriological techniques
Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non-culturable bacteria. Microscopy Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluoresence Microscope, Confocal microscopy, Scanning and Transmission Electron Microscope

Unit III Growth and nutrition Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation Chemical methods of microbial control: disinfectants, types and mode of action. Reproduction in Bacteria Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate

Unit IV Important archaeal and eubacterial groups
Archaebacteria: General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota (Nanoarchaeum), Crenarchaeota (Sulfolobus, Thermoproteus) and Euryarchaeota [Methanogens (Methanobacterium, Methanocaldococcus), thermophiles (Thermococcus, Pyrococcus, Thermoplasma), and Halophiles (Halobacterium, Halococcus)]
Eubacteria: Morphology, metabolism, ecological significance and economic importance of following groups: Gram Negative and Gram Positive Bacteria

Suggested Readings / Books

Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.

Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall

Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.

Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.

Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht

Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.

Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.

Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited

BSMB 202-20 Bacteriology (Lab)

1. Preparation of different media: synthetic media BG-11, Complex Media-Nutrient agar, McConkey agar, EMB agar.]
2. Simple staining
3. Negative staining
4. Gram's staining
5. Acid fast staining-permanent slide only.
6. Capsule staining
7. Endospore staining.
8. Isolation of pure cultures of bacteria by streaking method.
9. Preservation of bacterial cultures by various techniques.
10. Estimation of CFU count by spread plate method/pour plate method.
11. Motility by hanging drop method.

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BSMB 203-20 Fundamentals of Biochemistry

Unit I Chemical foundations of life: Water: unique properties, its interactions in aqueous systems and ionization, water as a reactant. Chemical bonds: ionic, covalent, hydrogen, hydrophobic, vanderwaal interactions and salt bridges.
Carbohydrates: Families of monosaccharides Stereo isomerism of monosaccharides, epimers, mutarotation and anomers, enantiomers. Haworth projection formulae for glucose; Structures of biologically important sugar derivatives. Disaccharides, concept of reducing and non-reducing sugars, Polysaccharides, homo and hetero polysachharides, structural and storage polysaccharides. Carbohydrates as informational molecules.

Unit II Lipids Building blocks of lipids -fatty acids, glycerol, ceramide Storage lipids: triacyl glycerol and waxes; Structural lipids. Phosphoglycerides. Galactolipids, sulpholipids, etherlipids, sphingolipids and sterols Lipid functions: cell signals, cofactors, prostaglandins, pigments. Introduction of lipid micelles, monolayers, bilayers, structure, distribution and role of membrane lipids. Plant steroids, glycolipids (gangliosides and lipopolysaccharides)

Unit III Proteins: Amino acids: Structural features and classification, notation; Physical and optical properties (Stereoisomerism); Chemical properties (acid base properties, titration curve); Uncommon amino acids and their functions, Peptide bond and its properties; Oligopeptides: Structure and functions of naturally occurring glutathione and insulin and synthetic aspartame. Primary, secondary, tertiary and quaternary protein structure, Functions of proteins, Forces holding the polypeptide together. Structure and role of glycoconjugates - proteoglycans, glycoproteins.

Unit IV Nucleic Acids and vitamins Nucleic acids: Structure and properties of purine and pyrimidine bases, nucleosides, nucleotides, nucleic acids. DNA structure – Watson-Crick model of DNA, forms of DNA; Structures of mRNA, tRNA and rRNA; Effect of acid and alkali on DNA. UV absorption by nucleic acids; Other functions of nucleotides - energy source, component of coenzymes and second messengers
Vitamins: Sources, structures, properties and functions of water and fat soluble vitamins. TPP, pyrodoxal phosphate, nicotinamide, flavin nucleotide, coenzyme A and biotin as coenzymes.

Suggested Readings / Books

1. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freemanand Company,
2. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons
3. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.

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BSMB 204-20 Fundamentals of Biochemistry (Lab)

1. Use of pH meter.
2. Preparation of normal and molar solutions
3. Preparation of phosphate and Tris buffers
4. Qualitative test for carbohydrates
5. Identification of reducing vs non reducing sugars
5. Qualitative test for lipids
6. Qualitative and quantitative test for amino acids and proteins
7. Qualitative and quantitative test for nucleic acids
8. Study of protein secondary and tertiary structures with the help of models
9. Separation of amino acids by thin layer chromatography
10. Estimation of vitamin C

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BSMB 205-20 Molecular Biology

Unit I Structures of DNA and RNA / Genetic Material DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology - linking number, topoisomerases; Organization of DNA Prokaryotes,Viruses, Eukaryotes.RNA Structure, Organelle DNA -- mitochondria and chloroplast DNA.

Unit II Replication of DNA (Prokaryotes and Eukaryotes)
Bidirectional and unidirectional replication, semi- conservative, semi- discontinuous replication Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends Various models of DNA replication including rolling circle, D- loop (mitochondrial), Θ (theta) mode of replication and other accessory protein, Mismatch and excision repair

Unit III Transcription in Prokaryotes and Eukaryotes
Transcription: Definition, difference from replication, promoter - concept and strength of promoter RNA Polymerase and the transcription unit Transcription in Eukaryotes: RNA polymerases, general Transcription factors Post-Transcriptional Processing Split genes, concept of introns and exons, RNA splicing, spliceosome machinery, concept of alternative splicing, Polyadenylation and capping, Processing of rRNA, RNA interference: si RNA, miRNA and its significance

Unit IV Translation in Prokaryotes and Eukaryotes
Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Fidelity of translation, Inhibitors of protein synthesis in prokaryotes and eukaryote Regulation of gene Expression in Prokaryotes and Eukaryotes Principles of transcriptional regulation, regulation at initiation with examples from lac and trp operons, Sporulation in Bacillus,Yeast mating type switching , Changes in Chromatin Structure - DNA methylation and Histone Acetylation mechanisms.

Suggested Readings/ Books

Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication

Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco

De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia

Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.

Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.

Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning

Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

IKG Punjab Technical University
B.Sc. (Hons) Microbiology Batch 2020 onwards

BSMB 206-20 Molecular Biology Lab

1. Study of different types of DNA and RNA using micrographs and model / schematic representations
2. Study of semi-conservative replication of DNA through micrographs / schematic representations
3. Isolation of genomic DNA from E. coli
4. Estimation of salmon sperm / calf thymus DNA using colorimeter (diphenylamine reagent) or UV spectrophotometer (A260 measurement)
5. Estimation of RNA using colorimeter (orcinol reagent) or UV spectrophotometer (A260 measurement)
6. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
7. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).

BSMB 207-20 Microbial Physiology and Metabolism

Unit I: Introduction

Microbial Growth and Effect of Environment on Microbial Growth. Definition and measurement of microbial growth, batch and continuous cultures, generation time and specific growth rate, synchronous growth, diauxic growth curve. Effect of environment (temperature, pH, oxygen and water activity) on microbial growth, extremophiles. Effect of nutrition and energy on microbial growth

Unit II Specialized Cell Structures and Function

Structure of microbial cell surfaces, peptidoglycan and LPS synthesis. Nutrient uptake and Transport: Passive and facilitated diffusion, Primary and secondary active transport, concept of uniport, symport and antiport. Group translocation, Iron uptake. Periplasm, microbial biofilms. Microbial mobility: organs and their functions.

Unit III Carbohydrate Metabolism

Sugar degradation pathways: EMP, ED, Pentose phosphate pathway, phosphoketolase pathway. Aerobic Respiration Concept of aerobic respiration, TCA cycle, glyoxalate cycle, oxidative phosphorylation: components of respiratory chain, comparison of mitochondrial and bacterial ETC, uncouplers and inhibitors. Anaerobic respiration and fermentation: Alcohol fermentation and Pasteur effect, concept of linear and branched fermentation pathways, Lactic Acid Fermentation (homo and heterofermentative pathways), Basics of Yeast Fermentation, Mixed-Acid Fermentations, Propionic and acetic Acid Fermentation. *Metabolism of lactose, galactose, maltose, pectin, cellulose, starch and glycogen by bacteria.*

Unit IV Photosynthesis, Nitrogen Metabolism and Inorganic Metabolism

Characteristics of Autotrophs: Photosynthetic, Cyano and purple bacteria, anoxygenic vs. oxygenic photosynthesis,eria and cyanobacteria Autotrophic CO2 Fixation and Mechanisms of Photosynthesis, Hydrogen oxidation (definition and reaction), methanogenesis (definition and reaction), Sulfur Bacteria, Iron Bacteria, Methylotrophs, , Nitrogen Metabolism - an overview, Introduction to biological nitrogen fixation, Ammonia assimilation, Dissimilatory and assimilatory nitrate reduction (Denitrification; nitrate/nitrite and nitrate/ammonia respiration); fermentative nitrate reduction, Nitrifying Bacteria.

Suggested Readings / Books

Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. PrenticeHall International Inc.

Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag

Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition,McMillan Press.

Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition.McGraw Hill Higher Education

BSMB 208-20 Microbial Physiology and Metabolism (Lab)

1. Study and plot the growth curve of *E. coli* by turbidometric and standard plate count methods.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data
3. Effect of temperature on growth of *E. coli*
4. Effect of pH on growth of *E. coli*
5. Effect of carbon and nitrogen sources on growth of *E.coli*
6. Effect of salt on growth of *E. co*li
7. Demonstration of alcoholic fermentation

IKG Punjab Technical University
B.Sc. (Hons) Microbiology Batch 2020 onwards

BSMB301-20 VIROLOGY

Course Objectives – This course is designed to impart basic knowledge about viruses including nature, types (bacteriophages, plant and animal viruses), their mode of replication, reproduction and methods for prevention and control of viral infections to undergraduate level students.

Learning outcomes – After the course is finished the students are expected to know and understand about basics of viruses and their importance for bacteria, plants and animals. They are expected to be conversant with modes of replication strategies adopted by different viral pathogens including strategies and methods to mitigate viral pathogens.

UNIT 1 BASIC CONCEPTS AND CLASSIFICATION OF VIRUSES (8 hours)

Discovery and origin of viruses, General properties of viruses, Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses Isolation, purification and cultivation of viruses, Classification and taxonomy of viruses.

UNIT 2 BACTERIOPHAGES (8 hours)

T4 phage- structure, life cycle, genetic map and DNA replication. Lamda temperate phage: Structure, genetic map, lytic and lysogenic cycle, lysogenic repression and phage immunity, Lambda regulon, applications of phages in microbial genetics.

UNIT 3 ANIMAL VIRUSES AND PLANT VIRUS(20 hours)

Life cycle and Replication strategies of different animal viruses namely SARS-CoV-2, Herpes virus, Dengue virus, Poliovirus, Influenza virus, VSV, SV40 and Adeno Virus, Poxviruses, Hepatitis Viruses, Retroviruses. Salient features and replication pattern of Plant virus such as Tobacco Mosaic virus, cauliflower mosaic virus, Rhabdo virus and wound tumor virus

UNIT 4 VIRAL PATHOGENESIS AND ANTI-VIRAL STRAGEGIES (9 Hours)

Stages of infection, Salient features of some viral diseases-epidemiology, transmission, infection, symptoms, risk, Host specific and nonspecific defense mechanisms involved in resistance to and recovery from virus infections, Antiviral compounds and their mode of action, Interferon and their mode of action, General principles of viral vaccination

SUGGESTED READINGS/ BOOKS [Kindly mention updated books not beyond 2010 ideally.]

Dimmock, NJ, Easton, AL, Leppard, KN (2016). Introduction to Modern Virology. 7th edition, Blackwell Publishing Ltd.

Carter J and Saunders V (2013). Virology: Principles and Applications. John Wiley and Sons. 2nd Edition, John Wiley & Sons

Wagner EK, Hewlett MJ. Bloom DC, Camerin D (2007). Basic Virology. 3rd edition. Blackwell Publishing.

Mathews. (2004). Plant Virology. Hull R. Academic Press, New
York. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.

Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.

Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.

Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.

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B.Sc. (Hons) Microbiology Batch 2020 onwards

BSMB302-20 VIROLOGY LAB

1. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo hepatitis B and retroviruses) using electron micrographs
2. Study of the structure of important plant viruses (caulimo, Gemini, tobacco ring spot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs
3. Study of the structure of important bacterial viruses (ϕX 174, T4, λ) using electron micrograph.
4. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique
5. Determining the genome characteristic of viruses (Genome size, GC content, number of genes and proteins)

IKG Punjab Technical University
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BSMB303-20 MICROBIAL GENETICS

UNIT 1 GENOME ORGANIZATION AND MUTATIONS

Genome organization: *E. coli, Saccharomyces cerevisiae, Neurospora crassa.* Mutations and mutagenesis: Definition and types of Mutations: substitutions, frameshift, inversion, insertion, duplication, deletion. Silent, conditional and lethal mutations. Mutagens: Chemical & physical; loss and gain of function mutants; Uses of mutations, Reversion and suppression: True revertants; Intra- and inter-genic suppression; Mutator genes; Ames test.

UNIT 2 PLASMIDS

Types of plasmids (F, R, colicinogenic, Ti, linear, 2 μ), Replication and partitioning of plasmids, plasmid incompatibility, Host range, plasmid amplification, Plasmid copy number and control, curing of plasmids

UNIT 3 MECHANISMS OF GENETIC EXCHANGE

Transformation - Discovery, mechanism of natural competence, Conjugation - Discovery, mechanism, Hfr and F' strains, gene mapping by interrupted mating and time of entry, Transduction - Generalized & specialized, LFT & HFT lysates, Mapping by recombination and co-transduction of markers

UNIT 4 PHAGE GENETICS AND TRANSPOSABLE ELEMENTS

Basic genetics of T4 phage, lytic and lysogenic switching of phage lambda, Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon, Eukaryotic transposable elements - Yeast (Ty retrotransposon) & Drosophila (P elements), Maize (Ac/Ds), Uses of transposons.

Suggested Readings/ Books

Concepts of Genetics by W.S. Klug, M.R. Cummings, C. Spencer and M. Palladino. 12th edition. Pearson Education, USA. 2018.

Lewin's Essential Genes by J. Krebs, E. Goldstein and S. Kilpatrick. 3rd edition. Jones and Bartlett Learning, USA. 2013.

Genomes by Terence A Brown. 2nd edition.Oxford: Wiley-Liss; 2002.

Genetics: A Conceptual Approach by B.A. Pierce. 4th edition. Macmillan Higher Education Learning, UK. 2011.

Molecular Biology of the Gene by J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levine and R. Losick. 7th edition. Pearson Education, USA. 2017.

iGenetics- A Molecular Approach by P.J. Russell. 3rd edition. Benjamin Cummings, USA. 2009.

Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.

Microbial Genetics by S.R. Maloy, J.E. Cronan and D. Friefelder. 2nd edition. Jones and Barlett, USA. 2004

Principles of Genetics by E.J. Gardner, M.J. Simmons and D.P. Snustad. 8th edition. John Wiley & Sons Ltd, UK. 2008.

Molecular Genetics of Bacteria by L. Snyder, J.E. Peters, T.M. Henkin, W. Champness. 4th edition. ASM Press, USA. 2015.

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BSMB304-20 MICROBIAL GENETICS LAB

1. Preparation of bacterial master and replica plates
2. Effect of chemical (HNO_2) and physical (UV) mutagens on bacterial cells
3. Survival curve of bacteria after exposure to ultraviolet (UV) light
4. Plasmid isolation from E.coli
5. Study of different plasmid DNA conformations by Agarose gel electrophoresis.
6. Demonstration of Bacterial Conjugation
7. Demonstration of bacterial transformation
8. Demonstration of AMES test

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BSMB 305-20 MICROBES IN ENVIRONMENT

UNIT 1 MICROORGANISMS AND THEIR HABITATS- I

Structure and function of ecosystems, Terrestrial Environment: Soil profile and soil microflora, Aquatic Environment: Microflora of fresh water and marine habitats, Atmosphere: Aeromicroflora and dispersal of microbes.

UNIT 2 MICROORGANISMS AND THEIR HABITATS- II

Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body, Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels.

UNIT 3 MICROBIAL INTERACTIONS

Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation. Microbe-Plant interaction: Symbiotic and non symbiotic interactions. Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria

UNIT 4 WASTE MANAGEMENT

Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill). Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment

SUGGESTED READINGS/ BOOKS

Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA

Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ Benjamin Cummings

Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press

Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York

Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg

Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.

Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.

Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.

Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.

Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.

Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.

Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

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BSMB 306-20 MICROBES IN ENVIRONMENT LAB

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.

2. Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC).

3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.

4. Assessment of microbiological quality of water.

5. Determination of BOD of wastewater sample.

6. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.

7. Isolation of Rhizobium from root nodules

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BSMB 307-20 MICROBIOLOGICAL ANALYSIS IN AIR AND WATER

UNIT 1 AEROMICROBIOLOGY, AIR SAMPLE COLLECTION AND ANALYSIS

Bioaerosols, Air borne microorganisms (bacteria, Viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres, allergens. Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics

UNIT 2 WATER MICROBIOLOGY AND MICROBIOLOGICAL ANALYSIS OF WATER

Water borne pathogens, water borne diseases. Sample Collection, Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive/MPN tests, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests

Suggested Reading

Microbiological Examination Methods of Food and WaterA Laboratory Manual, CRC Press

da Silva N, Taniwaki MH, Junqueira VC, Silveira N, Nascimento MS, Gomes RAR (2012)

Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA

Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press

Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007) Manual of Environmental Microbiology, 3rd edition, ASM press

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BSMB 308-20 BIOSTATISTICS

UNIT 1 INTRODUCTION TO STATISTICS

Data types and presentation, Populations and samples, Measures of central tendency; means, median and mode, quantiles Measures of dispersion; Range, variance, standard deviation, skewness, kurtosis, Shannon-Weaver index; Elementary Probability and basic laws; Discrete and Continuous Random variable.

UNIT 2 STATISTICS HYPOTHESIS TESTING

Normal distribution, normal curve and normal deviate, statistical hypothesis testing and probability, type I and type II errors, statistical power, confidence limits binomial distribution and Poisson distribution.

UNIT 3 COMMONLY USED STATISTICAL TEST

One sample hypothesis testing (t-test), two tailed and one tailed tests. two sample t-test, Variance ratio test, Non-parametric tests, Mann-Whitney test, paired sample t-test, Wilcoxon, paired sample test, Analysis of variance test. Chi-square test for testing goodness of fit.

UNIT 4 CORRELATION AND REGRESSION

Simple linear correlation, covariance, coefficient of correlation, coefficient of determination, hypotheses about the correlation coefficient, Spearman's rank correlation, Simple linear regression, regression coefficient and intercept.

Suggested Readings/ Books

J. H. Zar: Biostatistical Analysis, Pearson publication; 2014

A. B. Khanal: Mahajan's Methods in Biostatistics for Medical Students and Research Workers, Jaypee publishers; 2016

Edmondson and D. Druce : Advanced Biology Statistics, Oxford University Press; 1996.

W. Danial : Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc; 2004.

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BSMB401-20 Phycology and Mycology

Unit 1

Classification of Algae, Study of the following classes with reference to genera listed below (occurrence, thallus organization and life cycle): (a) Chlorophyceae: Volvox, Coleochaete (b) Charophyceae: Chara (c) Diatoms: General features with reference to pinnate and centric diatoms (d) Xanthophyceae: Vaucheria (e) Phaeophyceae: Ectocarpus (f) Rhodophyceae: Polysiphonia(g) Cyanobacteria: Nostoc.

Unit 2

Classification of fungi, Study of the following classes with reference to the genera listed below (occurrence, somatic structure and life cycle): (a) Cellular slime molds - Dictyostelium(b) True slime molds (Myxomycetes) – Physarum (c) Oomycetes - Saprolegnia, Phytophthora (d) Chytridiomycetes - Neocallimastix(e) Zygomycetes – Mucor (f) Ascomycetes - Saccharomyces, Penicillium, Neurospora (g) Basidiomycetes - Agaricus(h) Deuteromycetes - Candida, Alternaria.

Unit 3

Applications of algae, fungi in agriculture, environment, medicine, food, bioremediation, and biofuel, Lichens

Unit 4

Fungal infections (Symptoms, Pathogenesis, transmission, prophylaxis and control)Dermatophytoses (Trichophyton, Microsporum and Epidermophyton) Subcutaneous infection (Sporothrix, Cryptococcus), systemic infection (Histoplasma, Coccidoides) and opportunistic fungal infections (Candidiasis, Aspergillosis), Mycotoxins

Suggested Readings/ Books

1. Barasanti L and Guaaltieri P. (2006). Algae: Anatomy Biochemistry and Biotechnology. Taylor and Francis Group, New York.
2. Graham LE, Graham JM and Wilcox LW. (2009). Algae. 2nd edition. Benjamin Cumming, New York.
3. Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press.
4. Kumar HD. (1995). The Text Book on Algae. 4th edition. Affiliated East Western Press.
5. Lee RE. (1999). Phycology. 4th edition. Cambridge Press.
6. Sharma OP. (2005). Textbook of Algae. Tata McGraw Hill Publishing Co. Ltd.
7. Vashishta BR. (2005). Algae. 3rd edition. S. Chand and Company Ltd., New Delhi.
8. Alexopoulos CJ, Mims CW and Blackwell M. (1996). Introductory Mycology. 4th edition. John Wiley and Sons, Inc
9. Dube HC. (1981). An Introduction to Fungi. Vikas Publishing House Pvt. Ltd.
10. Sumbali G. (2005). The Fungi. 1st edition. Narosa Publishing India House.

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BSMB402-20 Phycology and Mycology Lab

Section A - Phycology

1.Study of the following genera through temporary and permanent slides: Volvox, Coleochaete, Vaucheria, Ectocarpus, Polysiphonia and Nostoc**.**
2.Production of algae in lab bottles.

Section B - Mycology

1. Preparation and sterilization of different types of media for phycology and mycology.
2. Study of the vegetative and reproductive structures of following genera through temporary and permanent slides: Mucor, Saccharomyces, Penicillium, Agaricus and Alternaria.
3. Simple staining of fungal spores.
4. Isolation and identification of fungi from natural resources.

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BSMB 403-20 Agricultural Microbiology

Unit 1

Soil Microbiology-Composition of Lithosphere, Phosphorus, sulphur, Nitrogen and other elements - Chemistry, cycles, mineralization and immobilization and oxidation/reduction, Soil Microbes, Factors influencing soil microbial population. The soil environment-distribution and abundance, generic groups and nutrition of bacteria, actinomycetes, fungi, algae, protozoa and viruses.

Unit 2

Nitrogen Fixation-Legume-Rhizobium symbiosis, Ammonia assimilation in Nitrogen-Fixing legume nodules-Hydrogen Metabolism, actionof Hydrogenase - factors controlling the Legume - Rhizobium symbiosis, non-Leguminous associations and biofertilizer production Azotobacter sp and Azospirillumsp and their functions - Cyanobacteria (BGA) and their associations in Nitrogen fixation.

Unit 3

Introduction to microbial interactions with plants- Pre-penetration, Penetration and Post-penetration of microorganisms with plants. Nature of plant-microbe interaction: Symbiotic relationship of microorganisms with plants: Rhizobium and mycorrhizalfungi.Role of pathogen enzymes in pathogenesis- production of different enzymes and action of pathogen enzymes on host tissues and significance of these enzymes in disease development.

Unit 4

Plant pathogenic microorganisms-Plant-pathogen interactions: Biology of Agrobacterium, Peronospora, Alternaria and
TMV interactions with their hosts. Role of receptors, elicitors, lectins, cell wall surface components, suppressors, enzymes, toxins, PR-proteins and growth regulators in plant-microbe interactions. Role of phytotoxins in plant pathogenesis-types of toxins produced by plant pathogens, effect of toxins on disease development. Role of plant growth regulators in plant pathogenesis.

Suggested Readings/books

References 1. Gaur, A.C., 1999. Microbial technology for Composting of Agricultural Residues by Improved Methods, 1st print, ICAR, New Delhi.
2. Glick, B.R. AND Pasternak, J.J 1994. Molecular Biotechnology, ASM Press, Washington DC.
3. Purohit, S. S., Kothari, P. R. and Mathur 1993. Basic and Agricultural Biotechnology, Agrobotanical Publishers (India). Bikaner.

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BSMB404-20 Agriculture Microbiology (lab)

1. Isolation of beneficial microbes from soil: Rhizobium sp., Azotobacter sp., Azospirillum sp., VAM, etc
2. Isolation and Characterization of plant pathogenic bacteria
3. Isolation and Characterization of plant pathogenic fungi
4. Demonstration of Koch postulates for bacterial plant pathogen.

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BSMB 405-20 Food and Dairy Microbiology

Unit 1

Historical Background and Introduction, food as a substrate for microorganisms,food spoilage and food contamination, nutritional components of food, balanced diet, food preservation techniques –High temp, low temp, drying, food additives and radiation. Single cell Protein Microorganisms, substrates, production of SCPs, biomass recovery, safety and nutritional evaluation

Unit 2

Value addition products like high fructose syrup and invert sugar. Microbiology of pickling, color and flavor changes in pickling. Traditional fermented foods – meat, fish, bread, sauerkraut, soybean, coffee, cocoa and tea. Fermented food- fermented milk, yoghurt, pickles, types of cheese and cheese production.

Unit 3

Role of enzymes. Use of protease, amylase, glucose oxidase and catalase in food processing. Role of lactase in dairy technology. Enzymes in fruit juice and brewing industry. Production of fruit juices. Mushroom production- advantages and scope of mushroom production. Different types of substrates, types of mushrooms. Harmful mushrooms.

Unit 4

Milk: Definition, composition and nutritive value, environmental and biological factors affecting composition of milk. physicochemical properties of milk, milk and milk products standards and legislations in India, grading of milk and criterion of grading, newer concepts in dairy products- cream powder, sterilized cream, butter spread, butter powder, cheese spread, caseinates, co-precipitates, WPC, lactose powder.

Suggested Readings/ Books

1. Food microbiology by Frazier
2. Food chemistry by Shakuntlamanay
3. Food processing technology P.J. Fellows, published by Ellis Horword Ltd

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BSMB 406-20 Food and Dairy Microbiology Laboratory

1. Food Microbiology Laboratory Safety Rules
2. Isolation of Food borne Pathogens on Selective, Differential, and Enriched Medium by Streak Plating
3. Enumeration of Aerobic Plate Counts, Coliforms, and Escherichia coli of Organic Fruit Juice.
4. Thermal Inactivation of microorganisms.
5. Cultivation of Anaerobic Bacteria in Canned Food.
6. Testing of milk- Methylene blue reductase test.
7. Observation and enumeration of moulds from spoiled bread.
8. Production of fermented food, yoghurt and pickles etc.

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BSMB 407-20 Analytical techniques in Microbiology

Unit 1

General Biophysical methods – Measurement of pH, Radioactive labeling & counting, Autoradiography.Separation & Identification of Materials - concept of Chromatography (Partition Chromatography, Paper Chromatography, Adsorption Chromatography, TLC, GLC, Ion Exchange Chromatography, Gel Chromatography, HPLC, Affinity Chromatography);

Unit 2

Centrifugation – Basic Principle of Centrifugation, Instrumentation of Ultracentrifuge (Preparative, Analytical), Factors affecting Sedimentation velocity, Standard Sedimentation Coefficient,Rate-Zonal centrifugation, sedimentation equilibrium Centrifugation, types of rotors.
Theory of Electrophoresis, Factors affecting the migration of substances, supporting media in electrophoresis, Boundary electrophoresis, Paper electrophoresis, Gel electrophoresis, PAGE, Agarose Electrophoresis of Nucleic Acid, Isoelectric Focusing of Protein, 2D, 3D electrophoresis, Pulse Gel Electrophoresis.

Unit 3

Basics of spectrophotmetry, spectroscopy, UV-Vis spectroscopy, Principle and instrumentation.Absorption Spectroscopy – Simple theory of the absorption of light by molecules, Beer-Lambert law, Factors affecting the absorption properties of a Chromophore, X-ray diffraction, mass spectrophotometry.

Unit 4

Spectroscopy: Raman Spectroscopy, Raman effect, Quantum mechanical reason of Raman effect, Molecular Polarizability, Polarizability ellipsoid, Experimental technique of Raman effect, Basic concept of Pure Rotational & Vibrational, Raman spectra of simple molecule (linear molecule). NMR Spectroscopy – Basic principle of NMR spectroscopy, Experimental technique & instrumentation, Chemical shift, Hyperfine splitting, Relaxation process.

Suggested Readings / Books

1. Wilson, K, Walker, J., Principles and Techniques of Practical Biochemistry. 5th Ed. - Cambridge University Press. Cambridge 1999.
2. Biotechniques, Theory & Practice: Second Edition by SVS Rana, Rustogi Publications.
3. Biochemical Methods of Analysis, Saroj Dua And NeeraGarg :Narosa Publishing House, New Delhi.
4. Bioanalytical Techniques, M.L. Srivastava, Narosa Publishing House, New Delhi.

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BSMB 408-20 Analytical techniques in Microbiology Lab

1. Principle & operation of Incubators & Shakers
2. Principle & operation of Centrifuge
3. Principle & operation of pH meter
4. Principle & operation of Colorimeter
5. Principle & operation of UV visible Spectrophotometer
6. Working of compound microscope.
7. Principle & operation of chromatography- Paper chromatography and TLC
8. Electrophoresis- Agarose gel electrophoresis

Scheme and Syllabus of B.Sc. Honors Microbiology (Sem 5 and Sem 6)

Semester: 5

CourseCode	Course Title	Course Type	Load Distribution			Marks Distribution		Total Marks	Credits
			L	T	P	IE	EE		
BSMB501-20	Immunology	Core	3	1	0	40	60	100	4
BSMB 502-20	Immunology lab	Core-Practical	0	0	3	60	40	100	2
BSMB 503-20	Medical Microbiology	Core	3	1	-	40	60	100	4
BSMB 504-20	Medical Microbiology lab	Core Practical	-	-	3	60	40	100	2
BSMB 505-20	Biosafety and Intellectual Property Rights	Core	2	-	-	20	30	50	2
BSMB 506-20	Biosafety and Intellectual Property Rights Lab	Core Practical	-	-	1	30	20	50	1
BSMB 507-20	Computer science and Bioinformatics	Core	3	-	-	40	60	100	4
BSMB 508-20	Computer science and Bioinformatics Lab	Core Practical	-	-	2	30	20	50	1
BSMB 509-20	Enzyme technology	Core	3	-	-	40	60	100	4
Mentoring & Professional Development			0	0	1	25	-	25	1
TOTAL			**14**	**2**	**10**	**385**	**390**	**775**	**25**

Immunology BSMB501-20

Unit 1

Overview of immune system: Concept of innate, adaptive immunity. Cells and organs of the immune system: Hematopoiesis lymphoid cells, mononuclear phagocytes, granulocytic cells, organs of the immune system: primary and secondary lymphoid organs and their functions- bone marrow, thymus, lymph node, spleen, GALT, MALT, CALT, tonsils etc.
Antigens: antigenicity, immunogenicity, characteristics of immunogens, haptens; epitopes (T & B cell epitopes); T-dependent and T-independent antigens; adjuvants, antigen binding sites, pattern recognition receptors.

Unit 2

Antibodies: Basic structure and functions of antibodies, Classes of antibodies, Antigen-Antibody Interactions: Strength of Antigen-Antibody Interactions, antibody affinity, avidity, Cross-Reactivity, Precipitation Reactions, agglutination, Overview of Radioimmuno assay, ELISA, Flow cytometry.

Unit 3

Major Histocompatibility Complex: Organization and inheritance of MHC locus (Mice &Human); Structure and Functions of MHC I & II molecules; cellular distribution of MHC molecules, Antigen processing and presentation (Cytosolic and Endocytic pathways), Overview of graft rejection.
T-Cell Receptors, TCR genes, T-cell receptor complex, T cell maturation, activation and differentiation, B-cell generation, activation and differentiation.

Unit 4

Complement System: Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); regulation of complement system. Cytokines: receptors, antagonists, therapeutic use. Hypersensitivity and its types, Immunodeficiency, Autoimmunity-organ specific and systemic. Overview of transplantation.

Suggested Readings/Books

1. Kuby's Immunology (2007) Goldsby RA, Kindt TJ, Osborne BA. 6th edition W.H. Freeman and Company, New York.

2. Cellular and Molecular Immunology (2007) Abbas AK, Lichtman AH, Pillai S. 6th edition Saunders Publication, Philadelphia.
3. Immunology (2009) Richard C and Geiffrey S. 6th edition. Wiley Blackwell Publication.

Immunology LabBSMB502-20

1. Identification of human blood groups (Agglutination reaction).
2. To perform Total Leukocyte Count of the given blood sample.
3. To perform Differential Leukocyte Count of the given blood sample.
4. To perform precipitation based test: Immunodiffusion by Ouchterlony method
5. Separation of monocytes from the blood sample and to study their adherence to glass surface.
6. To demonstrate the Direct and Indirect ELISA
7. Serum separation and demonstrate Immunoelectrophoresis.

Medical MicrobiologyBSMB503-20

Unit 1

Host-pathogen interaction, Overview of invasion, pathogen, parasites and parasitic infections, pathogenicity, toxigenicity, virulence, carriers and their types, nosocomial infections, opportunistic infections, septicemia, septic shock, transmission and spread of infection. Sample collection, transport and culturing of clinical samples.

Unit 2

Bacterial diseases (with reference to symptoms, pathogenesis, transmission, prophylaxis and control). Respiratory Diseases: *Streptococcus pyogenes, Mycobacterium tuberculosis*. Gastrointestinal Diseases: *Escherichia coli, Salmonella typhi, Vibrio cholerae*, Others: *Staphylococcus aureus, Clostridium tetani*.

Unit 3

Emerging Viral diseases like Covid-19, Monkeypox etc. Protozoan infections (with reference to symptoms, pathogenesis, transmission, prophylaxis and control).Viruses-Corona virus, Picornavirus,Herpes virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses. Gastrointestinal infections (Amoebiasis, Giardiasis). Blood-borne infections (Leishmaniasis, Malaria)

Unit 4

Antimicrobial agents: General characteristics and mode of action. Antibacterial agents: Five modes of action, Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism. Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin. Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine Antibiotic resistance and MDR

Suggested Readings/ Books

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition

Medical Microbiology Lab BSMB504-20

1. Identify bacteria E. coli, Salmonella, Pseudomonas, Staphylococcus, Bacillus (any three) on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests.
2. Study of composition and use of important differential media for identification of bacteria: EMB Agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS.
3. Study of bacterial flora of skin by swab method.
4. Perform antibacterial sensitivity by Kirby-Bauer method.
5. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, HPV warts, *Vibrio Cholerae* AIDS (candidiasis), dermatomycoses (ring worms).
6. Study of various stages of malaria parasite in RBCs using permanent mounts/Photomicrographs.
7. Studies on histopathology of normal and infected tissue with the help of permanent slide.

Biosafety and IPR BSMB505-20

Unit1

General Principles for the Laboratory and Environmental Biosafety: Health aspects; toxicology, allergenicity, creation of superbugs etc. Good laboratory practices (GLP) in pharmaceutical industry. Regulatory aspects of quality control. Quality assurance and quality management in pharmaceuticals, NABL and ISO.

Unit 2

Sterilization control and sterility testing (heat sterilization, D value, z value, survival curve, Radiation, gaseous and filter sterilization). Design and layout of sterile product manufacturing unit, Designing of Microbiology laboratory, Safety in microbiology laboratory.

Unit 3

Biosafety: Introduction; Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals. Biosafety committee- composition and role of biosafety commiittee. Institutional ethics committee.

Unit4

Introduction to Intellectual Property: Historical perspectives and need for the introduction of Intellectual Property Right, Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications,Protection of GMOs IP as a factor in R&D. Protection of plant varieties.

Suggested books/readings

1. Deepa GoelShominiParashar,IPR, Biosafety and Bioethics,Pearson Education India
2. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd
3. S Chawla,Introduction to Plant Biotechnology oxford and ibhpublishing,third edition
4. Neeraj Pandey and KhushdeepDharni ,“Intellectual Property Rights” ; 1 edition PHI Learning

Biosafety and IPR BSMB506-20

1. Proxy filing of Indian Product patent
2. Proxy filing of Indian Process patent
3. Case study on medical microbiology errors and negligence.
4. Establishment of Biosafety Lab (Level 1 and 2)
5. Demonstration of biomedical waste management, radioactive waste and classification in relation to Microbiology

Computer Science and Bioinformatics BSMB507-20

Unit I

Introduction of computer fundamentals: General introduction of computers: evolution of computing devices. Basic computer organization: CPU, memory, input/output devices. Computers as a system: basic concepts, stored programs, functional units and their interrelation: communication with computer. Introduction to database, use of spreadsheet as database, different types of data storage devices.

Unit 2

Introduction to Bioinformatics: Goals, applications and limitations of bioinformatics, Biological sequence and molecule, file formats, DNA and protein sequence databases, Structure databases; database searching using keywords, Data Submission tools.

Unit 3

Sequence alignment: Role of bioinformatics in microbial diagnostics and applications. Pair wise sequence alignment and Multiple Sequence Alignment for studying microbial diversity.

Unit 4

Phylogeny -Database similarity search, Heuristic methods: FASTA, BLAST and types of BLAST. Molecular evolution and phylogenetics. Phylogenetic trees constitution for microbial diversity.

Suggested Readings/ Books

1. Goel A. (2010). Computer Fundamentals, Pearson Education.
2. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. OxfordUniversity Press.

3. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley- Blackwell.
4. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. IIEdition. Benjamin Cummings.
5. Mount D W, Bioinformatics - Sequence and Genome Analysis, Cold Spring Harbour Laboratory Press (2001).
6. Liu, YX., Qin, Y., Chen, T. et al. A practical guide to amplicon and metagenomic analysis of microbiome data. Protein Cell 12, 315–330 (2021). https://doi.org/10.1007/s13238-020-00724-8
7. https://www.cd-genomics.com/microbioseq/amplicon-based-next-generation-sequencing-vs-metagenomic-shotgun-sequencing.html

Computer Science and Bioinformatics LabBSMB508-20

1. How to use MS Office with special mention to MS word, Excel and Power point
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR), Genome-NCBI.
3. Understanding and using: PDB, Swissprot, TREMBL
4. Retrieval of information from nucleotide databases.
5. Using various BLAST and interpretation of results.
6. Sequence alignment using BLAST.
7. Multiple sequence alignment using Clustal W.
8. Construction of phylogenetic tree using MEGA tool.
9. Submission of nucleotide sequence in NCBI/EMBL.

Enzyme Technology BSMB 509-20

Unit 1

General characteristics of enzymes, enzyme specificity, Nomenclature, definition with examples of holoenzyme, apoenzyme, coenzymes, cofactors, activators, inhibitors, Unit of enzymes. Definition of IU, Enzyme turn over number and specific activity. Mechanism of enzyme action, Active site. Factors affecting enzyme activity- enzyme concentration, substrate concentration, pH and temperature.

Unit 2 General mechanism, Feedback inhibition, Enzyme repression induction- Operon model. Derivation of Michaelis Menton equation for substrate reactions. Km and its significance. Line weaver-Burk plot. Immobilized enzymes and their industrial applications.

Unit 3 Reversible and irreversible inhibition, competitive inhibition, non-competitive inhibition and un-competitive inhibition. Allosteric enzymes. Isoenzymes and their medical applications

Unit 4 Application of enzyme based tests in microbiology for biochemical analysis of various microorganisms. Application of microbial enzymes in environment and industrial process.

Suggested books

1. Enzyme Technology: MF Chaplin and DC Bucks
2. Industrial Enzymology: Godfrey and West
3. Enzyme: Copeland
4. Enzymes in Industry: W Gerhartz

Guidelines regarding Mentoring and Professional Development

The objective of mentoring will be development of:

- Overall Personality
- Aptitude (Technical and General)
- General Awareness (Current Affairs and GK)
- Communication Skills
- Presentation Skills

The course shall be split in two sections i.e. outdoor activities and class activities. For achieving the above, suggestive list of activities to be conducted are:

Part – A (Class Activities)

1. Expert and video lectures
2. Aptitude Test
3. Group Discussion
4. Quiz (General/Technical)
5. Presentations by the students
6. Team building Exercises

Part – B (Outdoor Activities)

1. Sports/NSS/NCC/Club Activities
2. Activities related to social service Evaluation shall be based on rubrics for Part – A & B

Mentors/Faculty incharges shall maintain proper record student wise of each activity conducted and the same shall be submitted to the department.

BSc Honors Microbiology Sem 6

CourseCode	Course Title	Course Type	Load Distribution			Marks Distribution		Total Marks	Credits
			L	T	P	IE	EE		
BSMB 601-20	Recombinant DNA Technology	Core	3	1	-	40	60	100	4
BSMB 602-20	Recombinant DNA Technology Lab	Core Practical	0	0	3	60	40	100	2
BSMB 603-20	Microbial Biotechnology	Core	3	1		40	60	100	4
BSMB 604-20	Microbial Biotechnology Lab	Core Practical	0	0	3	60	40	100	2
BSMB 605-20	Plant Microbial interactions	Core	3	1	-	40	60	100	4
BSMB 606-20	Plant Microbial interactions lab	Core	3	-	-	40	60	100	3
BSMB 607-20	Biopesticides & Biofertilizers	Core	3	0	0	40	60	100	3
BSMB 608-20	Minor Project/Training	Project	Satisfactory/Non satisfactory						4
TOTAL			**18**	**3**	**6**	**320**	**380**	**700**	**26**

Recombinant DNA Technology BSMB 601-20

Unit-1

Introduction: Fundamentals of rDNA Technology, Enzymology of recombinant DNA: enzymes that break, mend and synthesize DNA and RNA backbone bonds, remove phosphates at nucleic acid termini, and proteins which protect, coat, twist and untwist DNA. Cloning vectors: Characteristics of cloning plasmid, phage and cosmid vectors, multipurpose cloning vectors, shuttle vectors, bacterial, yeast, plant and mammalian vectors.

Unit-2

Application of rDNA technology in medicine- Production of heterlogous protein with reference to therapeutic drugs- Insulin and growth hormone production. Recombinant vaccines production-viral vaccine and bacterial vaccine.

Unit-3

Application of rDNA technology in Agriculture and Fermentation. Introduction of *Agrobacterium* and its role in agriculture. Virus resistant plants and insect resistant plants. Genetically modified microbes used in agriculture (*Bacillus thuringenesis*).Fermentation-Introduction, production of antibiotics and organic acids. Strain improvement for production of fermented beverages.

Unit-4

Application of rDNA technology in environment –Role of genetically engineered microbes in bioremediation, phytoremediation and bioleaching like *Pseudomonas and E.Coli*. Overview of bioplastics.

Recommended Books:

1. Molecular cloning: A Laboratory Manual- J.Sambrook, E.F. Fritsch and T.Maniati
2. Principles of Gene Manipulation: An introduction to Genetic Engineering- R.W. Old and S.B. Primrose
3. Gene Probes I.A. Practical Approach- B.D.Hames and S.J.Higginis
4. Recombinant Gene Expression Protocols- Tuan Rockey S
5. PCR Cloning Protocols- White Bruce A

Lab Recombinant DNA Technology BSMB 602-20

1. Plasmid DNA isolation
2. Restriction digestion of DNA
3. Demonstration of PCR
4. Competent cell formation
5. Electroporation

Microbial Biotechnology BSMB 603-20
Unit 1

Biotechnological innovations in the chemical industry, biocatalyst in organic chemical synthesis. Efficiency of growth and product formation, growth stoichiometry, maintenance of energy requirement and maximum biomass yield. P/o quotients metabolites, over production and growth efficiency.

Unit 2

Microbial substrates and Media formulation; Components of microbial fermentation process; types of fermentation processes- Solid state and submerged fermentation; Design of laboratory bioreactor; Types of Bioreactors: Stirred tank reactor, bubble column etc. Downstream processing.

Unit 3

Fermenter design – stirred tank, airlift fermenter, hollow fibre bioreactor and immobilized cell reactors, Instrumentation and control; Large scale production; Aeration and agitation – oxygen transfer kinetics.

Unit 4

Microbial beverages and food: Production of wine, beer and vinegar. Microbial food: Oriental foods, Baker's yeast, cheese, SCP, SCO (PUFA), mushroom cultivation, sauerkraut, silage, probiotics. Nutraceuticals, bioconservation, biofuels, gasohol, biogas; waste utilization to generate biofuels.

Suggested readings:

1. Lee Y. K., Microbial Biotechnology: Principles and applications. World Scientific Publisher, 2003.
2. Tortora, Funke and Case, Microbiology, An Introduction, 5 th Edition. Benjamin/Cummings Publishing Company, Redwood City, CA, 1995.
3. Board RG, Jones D, Skinner FA, Identification methods in applied and Environmental Microbiology, 1 st Ed. Blackwell Science, 1992.
4. Funke, Study Guide for Microbiology, 5 th Ed. Benjamin/Cummings Publishing Company, Redwood City, CA, 1995

LAB - Microbial Biotechnology BSMB 604-20

1. To study submerged fermentation.
2. To study solid state fermentation.
3. Estimation of microbial enzymes.
4. Wine production
5. Beer production
6. Biodeisel production
7. Fermented food production like sauerkraut, kimchi, dosa batter

Plant Microbial Interactions BSMB 605-20

Unit 1

Plant Microbial interactions- Overview, Introduction to commensalism, Mutualism, parasitism and phylosphere. Microbial occurrence and interaction. Root- root interaction, root microbe interaction. Contribution made by different scientists. Plant defense mechanism against microbes.

Unit 2

Symbiosis, Nitrogen fixation and nitrogen fixing microbes, lichens, Mycorrhizae. Multitude of

functions of microbial consortia in rhizosphere with emphasis on phytohormones, nutrients and microbial defense mechanisms.

Unit 3

Microbial plant parasites with examples of diseases caused by them. Important plant pathogenic organisms.Various plant extracts and their role as antifungal and antimicrobial agent.

Unit 4

Toxicology of microbes in relation to food, dairy products, medicinal plants and vegetables. Endotoxins, Exotoxins, Role of bactericidal agents for plants. Future prospects challenges and limitations of plant microbial interactions.

Suggested Readings:

1. Introduction to principles of plant pathology by R. S. Singh, Oxford and IBH Publ. Co., New Delhi (1996)
2. Essentials of plant pathology by V. N. Pathak, Prakash Publ., Jaipur (l972)
3. Plant pathology by G. N. Agrios 4th edition, Academ. Press, New york (1997)
4. Introductory Plant Pathology by M. N. Kamat, PrakashPubl, Jaipur (l967)
5. Plant diseases by R. S. Singh
6. Introductory Mycology by Alexopoulos, Mims and Blackwel (2004)
7. Introductory Plant Pathology by H.C. Dube

Lab - Plant Microbial Interactions BSMB 606-20

1. Acquaintance with various laboratory equipments and microscopy.
2. To study symptoms produced by plant pathogens like fungi, bacteria, viruses and phytoplasmas using images or slides.
3. Collection of disease specimen and preparation of mounts, preservation of disease samples.
4. Staining and identification of plant pathogenic bacteria.
5. Study of fungicides and their formulations.
6. Field visit at botanical garden to study plant microbe interaction.

Biopesticides & Biofertilizers BSMB 607-20

Unit 1

Biopesticides- Introduction, scope and potential of biopesticides. Classification of biopesticides

viz. pathogen, botanical pesticides, and biorationales.

Unit 2

Botanicals and their uses-Mass production technology of bio-pesticides. Methods of application of biopesticides. Methods of quality control and techniques of biopesticides. Impediments and limitation in production and use of biopesticide.

Unit 3

Biofertilizers – Introduction and scope. Structure and characteristic features of bacterial biofertilizers- *Azospirillum, Azotobacter, Bacillus, Rhizobium* and *Frankia*; Cynobacterial biofertilizers- *Anabaena, Nostoc,* and fungal biofertilizers, Mycorrhiza.

Unit 4

Production technology of Biofertilizer: Strain selection, sterilization, growth and fermentation, mass production of carrier based and liquid biofertiizers. Storage, shelf life, quality control and marketing of Biofertilizers. Factors influencing the efficacy of biofertilizers.

Suggested Readings:

1. Singh and Purohit, 2008.Biofertilizer Technology, Agrobios
2. Shalini Suri, Biofertilizers and Biopesticides, 2011. APH Publishing Corporation
3. Handbook of Biofertilizers and Biopesticides by RajaramChoyal
4. Recent Advances in Biopesticides by Jayandra Kumar Johnri
5. Biopesticides Handbook by Jeo M.L. Nollet and Hamir Singh Rathore