BHARATHIDASAN UNIVERSITY, TIRUCHIRAPPALLI – 620 024.

B.Sc. Microbiology Course Structure under CBCS

(For the candidates admitted from the academic year 2016-2017 onwards)

Sem	Part	Course	Title	Inst. Hours/ Week	Credit	Exam Hours	Marks		Total
							Int	Ext	
I	I	Language Course–I (LC) – Tamil*/Other Languages ** #		6	3	3	25	75	100
	II	English Language Course - I (ELC)		6	3	3	25	75	100
	III	Core Course–I (CC)	Fundamentals of Microbiology	6	6	3	25	75	100
		Core Practical – I (CP)	Fundamentals of Microbiology & Microbial Metabolism (P)	3	-	-	-	-	-
		First Allied Course–I (AC)	Biochemistry I	4	4	3	25	75	100
		First Allied Practical–II (AP)	Biochemistry I and II (P)	3	-	-	-	-	-
	IV	Value Education	Value Education	2	2	3	25	75	100
	Total			**30**	**18**				**500**
II	I	Language Course–II (LC)– Tamil*/Other Languages ** #		6	3	3	25	75	100
	II	English Language Course–II (ELC)		6	3	3	25	75	100
	III	Core Course–II (CC)	Microbial Metabolism	6	6	3	25	75	100
		Core Practical – I (CP)	Fundamentals of Microbiology & Microbial Metabolism (P)	3	3	3	40	60	100
		First Allied Practical–II (AP)	Biochemistry-I & II (P)	3	3	3	40	60	100
		First Allied Course–III (AC)	Biochemistry II	4	2	3	25	75	100
	IV	Environmental Studies	Environmental Studies	2	2	3	25	75	100
	Total			**30**	**22**				**700**
III	I	Language Course – III (LC)– Tamil*/Other Languages ** #		6	3	3	25	75	100
	II	English Language Course-III (ELC)		6	3	3	25	75	100
	III	Core Course – III (CC)	Immunology	6	6	3	25	75	100
		Core Practical– II (CP)	Immunology &Introductory Virology (P)	3	-	-	-	-	-
		Second Allied Course–I (AC)	Biostatistics	4	4	3	25	75	100
		Second Allied Practical-II (AP)	Biostatistics and Bioinformatics (P)	3	-	-	-	-	-
	IV	Non Major Elective I-for those who studied Tamil under Part-I a) Basic Tamil for other language students b) Special Tamil for those who studied Tamil upto +2 but opt for other languages in degree programme	Mushroom Technology	2	2	3	25	75	100
	Total			**30**	**18**				**500**

IV	I	Language Course –IV (LC) - Tamil*/Other Languages ** #		6	3	3	25	75	100
	II	English Language Course – IV (ELC)		6	3	3	25	75	100
	III	Core Course – IV (CC)	Introductory Virology	5	5	3	25	75	100
		Core Practical– II (CP)	Immunology & Introductory Virology (P)	3	3	3	40	60	100
		Second Allied Practical-II (AP)	Biostatistics and Bioinformatics (P)	3	3	3	40	60	100
		Second Allied Course - III(AC)	Bioinformatics and Computer Applications In Biology	3	2	3	25	75	100
	IV	Non Major Elective II-for those who studied Tamil under Part I a) Basic Tamil for other language students b) Special Tamil for those who studied Tamil upto +2 but opt for other languages in degree programme	Biofertilizer Technology	2	2	3	25	75	100
		Skill Based Elective - I	Skill Based Elective - I	2	2	3	25	75	100
			Total	**30**	**23**				**800**
V	III	Core Course – V (CC)	Medical Microbiology	5	5	3	25	75	100
		Core Course – VI (CC)	Agricultural and Environmental Microbiology	5	5	3	25	75	100
		Core Course – VII (CC)	Molecular Biology and Microbial Genetics	6	5	3	25	75	100
		Core Practical– III (CP)	Medical Microbiology, Agricultural and Environmental Microbiology & and Molecular Biology Microbial Genetics (P)	3	3	3	40	60	100
		Major Based Elective – I	Fundamentals of Botany and Zoology	5	5	3	25	75	100
	IV	Skill Based Elective – II	Skill Based Elective – II	2	2	3	25	75	100
		Skill Based Elective – III	Skill Based Elective – III	2	2	3	25	75	100
		Soft Skills Development	Soft Skills Development	2	2	3	25	75	100
			Total	**30**	**29**				**800**
VI	III	Core Course – VIII (CC)	Food Microbiology	6	6	3	25	75	100
		Core Course – IX (CC)	Industrial Microbiology	6	6	3	25	75	100
		Core Practical– IV (CP)	Food and Industrial Microbiology (P)	6	5	3	40	60	100
		Major Based Elective II	Recombinant DNA Technology	6	6	3	25	75	100
		Major Based Elective III	Microbial Biotechnology and Bioethics	5	5	3	25	75	100
	V	Extension Activities	Extension Activities	-	1	-	-	-	-
		Gender Studies	Gender Studies	1	1	3	25	75	100
		Total		**30**	**30**				**600**
Grand Total				**180**	**140**				**3900**

Language Part – I	-	4	
English Part –II	-	4	
Core Paper	-	9	
Core Practical	-	4	
Allied Paper	-	4	
Allied Practical	-	2	
Non-Major Elective	-	2	
Skill Based Elective	-	3	
Major Based Elective	-	3	
Environmental Studies	-	1	
Value Education	-	1	
Soft Skill Development	-	1	
Gender Studies	-	1	
Extension Activities	-	1	(Credit only)

* for those who studied Tamil upto 10th +2 (Regular Stream)

+ Syllabus for other Languages should be on par with Tamil at degree level

those who studied Tamil upto 10th +2 but opt for other languages in degree level under Part I should study special Tamil in Part IV

** Extension Activities shall be outside instruction hours

Non Major Elective I and II – for those who studied Tamil under Part I

a) Basic Tamil I and II for other language students
b) Special Tamil I and II for those who studied Tamil upto 10th or +2 but opt for other languages in degree programme

Note:

	Internal Marks	**External Marks**
1. Theory	25	75
2. Practical	40	60

3. Separate passing minimum is prescribed for Internal and External marks

FOR THEORY

The passing minimum for CIA shall be 40% out of 25 marks [i.e. 10 marks]
The passing minimum for University Examinations shall be 40% out of 75 marks [i.e. 30 marks]

FOR PRACTICAL

The passing minimum for CIA shall be 40% out of 40 marks [i.e. 16 marks]
The passing minimum for University Examinations shall be 40% out of 60 marks [i.e. 24 marks]

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CORE COURSE I

FUNDAMENTALS OF MICROBIOLOGY

OBJECTIVE

This subject aims to introduce the history and development of Microbiology. The contents of this course will help students understand history, biology of microorganisms, growth and control of microbes. Thus the beginners are rightly exposed to foundation of Microbiology which would lead them towards progressive advancement of the subject.

Unit I

Historical development of Microbiology- Theories of spontaneous generation – Biogenesis-The scope of Microbiology and the opportunities for microbiologists-between the prokaryotic and eukaryotic microorganisms. General principles and nomenclature – Haeckel's three kingdom concept, Whittaker's five kingdom concept- Carl Woese three domain classification. Eight kingdom classification.

Unit II

Microscopy: Principles and applications of bright field, dark field, phase contrast, fluorescent SEM and TEM. Specimen preparation of Electron Microscopy. Principles and types of staining– Simple, differential (Gram, Spore, AFB) Capsule staining (Negative), Sterilization: Principles and methods – physicalmoist heat, dry heat, filtration (Membrane and HEPA). Radiations-chemical agents and mode of action.

Unit III

General characteristics and nature of Archaebacteria, Cyanobacteria, Mycoplasma, Rickettsiae, Chlamydia, Spirochaetes, Actinobacteria, Protozoa, Algae, Fungi and Viruses. Basic understanding of classification of viruses (ICTV), algae (ChapmanFritch), fungi (Alexopoulos) and protozoa.

Unit IV

Outline classification for bacteria as per the Bergey's Manual of Systematic Bacteriology (9th edition) -Structural organization of bacteria – Size, shape and arrangement of bacterial cells -Ultrastructure of a bacterial cell - cell wall, cell membrane, ribosomes, nucleoid, slime, capsule, flagella, fimbriae, spores , cysts, plasmid, mesosomes and cytoplasmic inclusions**.**

Unit V

Cultivation of microbes- Types of culture media with specific examples for each type. Aerobic and Anaerobic culture techniques-Pure culture techniques (Tube dilution, Pour plate, Spread plate and Streak plate)- Methods of maintenance and preservation of microbes, safe decontamination practices.

REFERENCES

1. Alcamo IE. Fundamentals of Microbiology, sixth edition, Addison wesley Longman, Inc. California. 2001.
2. Alexopoulos CJ, Mims CW and Blackwell M. Introductory Mycology. Fifth edition John Wiley and Sons. Chichester. 2000.
3. Atlas RA and Bartha R. Microbial Ecology. Fundamentals and Application, Benjamin Cummings, New York. 2000.
4. Black JG. Microbiology-principles and explorations, 6th edition. John Wiley and Sons, Inc. New York. 2005.
5. Cappuccino and Sherman. Microbiology – A Laboratory Manual. 7th edition, Dorling Kindersley (India) Pvt. Ltd., New Delhi. 2012.
6. Dubey RC and Maheswari DK. A Text Book of Microbiology. S Chand, New Delhi. 2010
7. Johri RM, Snehlatha, Sandhya Shrama. A Textbook of Algae. Wisdom Press, New Delhi. 2010.
8. Kanika Sharma. Textbook of Microbiology – Tools and Techniques. 1st edition, Ane Books Pvt. Ltd., New Delhi. 2011.
9. Madigan MT, Martinko JM, and Parker J. Biology of Microorganisms, 12th Edition, MacMillan Press, England. 2009.
10. Moselio Schaechter and Joshua Leaderberg. The Desk encyclopedia of Microbiology. Elseiver Academic press, California. 2004.
11. Pelczar MJ, Chan ECS and Kreig NR. Microbiology, fifth edition. McGraw-Hill. Book Co. Singapore. 2009.
12. Prescott LM, Harley JP, and Klein DA. Microbiology (7th edition) McGraw Hill, Newyork. 2008.
13. Schlegel HG. General Microbiology, Cambridge University Press, U.K. 2008.
14. Tortora GJ, Funke BR and Case CL. Microbiology: An Introduction. 9th Edition, Pearson Education, Singapore. 2009.
15. Rajan S and Selvi Christy R. Essentials of Microbiology, Anjanaa Book House, Chennai, 2015.

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CORE PRACTICAL I

FUNDAMENTALS OF MICROBIOLOGY & MICROBIAL METABOLISM (P)

Fundamentals of Microbiology

1. Safety practices in Microbiological laboratory
2. Microscope and its operation
3. Principles and operations – Autoclave, Hot Air Oven, Filtration, Laminar Air Flow, Incubators, colony counter, Centrifuge, pH meter, Colorimeter and Spectrophotometer
4. Preparation of culture media, cleaning of glassware and sterilization methods
5. Demonstration of ubiquitous nature of microorganisms.
6. Measurement of size of microbes – micrometry.
7. Observation of permanent slides to study the structural characteristics of algae (*Anabena, Nostoc, Spirulina, Oscillotoria*), fungi (*Pythium, Rhizopus, Saccharomyces, Penicillium, Aspergillus, Agaricus*) and protozoa (*Entamoeba histolytica* and *Plasmodium* spp.).
8. Enumeration of bacterial numbers by Viable count (Plate count) and Total count (Haemocytometer count)
9. Pure culture techniques - Streak plate, Pour plate and Spread plate.
10. Test for motility of bacteria – Hanging drop method.
11. Staining techniques – Simple staining, Gram's staining, Spore-staining, Capsular staining.
12. Isolation of bacteria, actinobacteria, fungi and cyanobacteria.

Microbial Metabolism

1. Bacterial growth curve: Cell count/viable count/absorbance (total count)
2. Carbohydrate fermentation tests: Glucose, Lactose, Sucrose and Mannitol.
3. Biochemical test for identification of bacteria: IMViC tests - TSI agar test- Urease- Catalase- Oxidase.

REFERENCES

1. Cappuccino and Sherman. Microbiology – A Laboratory Manual. 7th Edition, Dorling
   Kindersley (India) Pvt. Ltd., New Delhi. 2012.
2. Gunasekaran P. Laboratory Manual in Microbiology, New Age International (P) Ltd. Publishers, New Delhi. 2008.
3. Harry W. Seeley JR, Paul J. Van Demark and John J Lee. Microbes in Action – A Laboratory Manual of Microbiology. W.H.Freeman and Company, New York. 1997.
4. Kanika Sharma. Manual of Microbiology – Tools and Techniques. 2nd edition, Ane Books Pvt. Ltd., New Delhi. 2009.

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FIRST ALLIED COURSE I

BIOCHEMISTRY I

OBJECTIVES

To understand the structure, function and interrelationship of various biomolecules and consequences of deviation from normal.

Unit I

Carbohydrate– Definition, sources, classification, structure of glucose, biological significance, digestion and absorption.

Unit II

Proteins – Definition, sources, classification and structure of proteins (Primary, secondary, tertiary), Amino acids–structure- classification - essential and non-essential, protein and non-protein amino acids.

Unit III

Lipids - Definition, sources, classification, structure, properties and functions, Fatty acids-saturated, unsaturated and essential fatty acids

Unit IV

Nucleic acids – Definition, structure, forms and functions of DNA. Types, structure and functions of RNA (mRNA, tRNA, rRNA).

Unit V

Vitamins – Definition, sources, deficiency syndromes and functions of Fat soluble vitamins (A, D, E and K) and Water soluble vitamins (B complex and C).

REFERENCES

1. Deb AC. Fundamentals of Biochemistry, 10th edition, New Central Book Agency (p) ltd, London. 2011.
2. Ambika Shanmugam. Fundamentals of Biochemistry for Medical students. Nagaraj and Company Pvt ltd, India. 1998.
3. Thomas M Devlin. Textbook of Biochemistry with Clinical Correlations, 7th edition, Wiley publisher. 2010.
4. Charlotte W Pratt and Kathleen Comely. Essential Biochemistry, 3rd edition Wiley publisher. 2013.
5. Albert L Lehninger, David L Nelson and Michael M Cox. Lehninger Principles of Biochemistry, 2nd edition, Wiley publisher. 2010.
6. Rajagopal G. Concise textbook of biochemistry, 2nd edition, Ahuja Publishing House. 2010.
7. Reginald H Garrett and Charles M Grisham, 5th edition. Biochemistry, Brooks Cole publishers. 2012.
8. Denise R Ferrier. Biochemistry, 6th edition, LWW publishers. 2013.
9. Sathyanarayana U and Chakrapani U. Biochemistry, 4th edition, Elsevier publishers. 2013.
10. Rafi MD. Textbook of Biochemistry for medical students, 2nd edition, Universities Press, (India) Pvt. Ltd, Hyderabad, India. 2014.

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FIRST ALLIED PRACTICAL

BIOCHEMISTRY I AND II (P)

1. Qualitative and Quantitative estimation of carbohydrates, amino acids, proteins, lipids and nucleic acids.
2. Estimation of ascorbic acid (from biological sample)

REFERENCES

1. Keith Wilson and John Walker. Principles and Techniques of Practical Biochemistry, 4th edition, Cambridge University press, Britain. 1995.
2. Oser BL Hawks. Physiological Chemistry, TATA Mc Graw Hill. 1965.
3. Shawn O' Farrell and Ryan T Ranallo. Experiments in Biochemistry: A Hands on Approach-A manual for the undergraduate laboratory, Thomson Learning, Inc., Australia. 2000.
4. Strolv BA, Makavora VC. Laboratory manual in Biochemistry. MIR Publisher, Moscow. 1989.

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CORE COURSE II

MICROBIAL METABOLISM

OBJECTIVE

To understand the growth, enzymology and physiological processes of microbes

Unit I

Nutrition and growth of microorganisms: Nutritional types of microorganisms, nutritional requirements. Factors influencing the growth of microorganisms – temperature, pH, Osmotic pressure, moisture, radiations and different chemicals, Physiology of growth – Significance of various phases of growth. Growth measurements – batch, continuous and synchronous.

Unit II

Bacterial enzymes – classification, properties, kinetics of enzyme action – Michaelis Menton equation for simple enzymes - coenzymes and cofactors, isozymes.

Unit III

Metabolism of carbohydrates : Anabolism – phototsynthesis – oxygenic – an oxygenic, synthesis of carbohydrate – catabolism of glucose – Embden Mayer – Hoff – Parnas pathway – Pentose pathway, Kreb's cycle (TCA) – electron transport system and ATP production.

Unit IV

Metabolism of protein – synthesis and degradation of amino acids – glycine tyrosine, cysteine, serine, glutamine, synthesis of peptides and proteins – urea cycle.

Unit V

Anaerobic Respiration – Nitrate, sulphate and Methane respiration – Fermentations – alcohol, mixed acid, lactic acid fermentation – Metabolism of lipids – biosynthesis of fatty acids and cholesterol – oxidation of fatty acids.

REFERENCES

1. Nelson David L, Albert L Lehninger and Michael M Cox. Lehninger principles of biochemistry. Macmillan.2008.

2. Murray RK, Granner DK, Mayes PA and Rodwell VW. "Harper's Biochemistry, Appleton and Lange: New York, NY. 2004.
3. Doelle HW. Microbial Metabolism, Academic Press. 2005.
4. Gerhart G. Bacterial Metabolism, Springer Verlag. 1986.
5. Hall DC and Rao KK. Phototsynthesis, 6th edn, Cambridge University Press.1999.
6. Lansing M. Prescott JP, Harley and Donald A Klein. Microbiology, 5th edition, McGraw-Hill Company, New York. 2003.
7. Mathews CK and Holde KEV. Biochemistry – The Benjamin/Cummings Publishing company, Inc., New York. 2003.
8. Murray RK, Granner MD, Mayes PA and Rodwell VW. Biochemistry – Prentice Hall International Inc., London. 2000.
9. Salle AJ. Fundamental principles of Bacteriology, 7th edition, Tata McGraw-Hill publishing company limited, New Delhi. 1996.
10. Stryer L. Biochemistry, 4th edition, W.H. Freeman and company, New York. 1995.
11. Zubey CL. Parson WW and Vance DE. Principles of Biochemistry – Wim. C. Brown Publishers, Oxford, England. 1994.

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FIRST ALLIED COURSE III

BIOCHEMISTRY II

OBJECTIVE

To understand the structure and functions of blood, hormones and phtohormones.

UNIT I

Blood–Introduction, origin, composition, characterization, functions and coagulation of blood.

UNIT II

Hormones–Definition, classification of hormones, Human- Endocrine glands – Pituitary, thyroids, Para thyroid, pancreas, adrenal, testis and ovary.

UNIT III

Diseases associated with deficiency of endocrine hormones- hypo and hyper secretions.

UNIT IV

General account and secondary metabolites. Major and accessory plant pigments – chlorophylls, carotenoids, phycobilins and anthocyanins.

UNIT V

Phytohormones –structure and functions of auxin, gibberellins, cytokinins and abscissic acid.

REFERENCES

1. Deb AC. Edition. Fundamentals of Biochemistry, 10th edition, New Central Book Agency (p) ltd, London. 2011.
2. Ambika Shanmugam. Fundamentals of Biochemistry for Medical students. Nagaraj and Company Pvt ltd, India. 1998.
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8. Denise R Ferrier. Biochemistry, 6th edition, LWW publishers. 2013.
9. Sathyanarayana U and Chakrapani U. Biochemistry, 4th edition, Elsevier publishers. 2013.
10. Rafi MD. Textbook of Biochemistry for medical students, 2nd edition, Universities Press, (India) Pvt. Ltd, Hyderabad, India. 2014.

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CORE COURSE III

IMMUNOLOGY

OBJECTIVES

The aim of the course is to learn about the types of immunity, immune system, antigen, antigen anti-body reaction, hyper sensitivity reaction, immune deficiency disorders and concept of auto and transplantation of immunity.

Unit I

Introduction- History of immunology – Immunohematology- Blood groups, Blood transfusion, Rh- *Erythroblastosis faetalis* – immunity – types of immunity – innate and acquired immunity.

Unit II

Immune systems- Anatomy of lymphoid organ- Primary and Secondary Lymphoid organs – Cells of the immune system- detailed aspects of T and B cells receptors -subsets– Humoral and cell medicated immune response- activation and function, Complement, MHC.

Unit III

Antigen- Types, properties, haptans- adjuvants- vaccines- types – toxoids, antitoxins, Immunoglobulins- structure, types and properties. Theories of antibody production.

Unit IV

Antigen – antibody reaction- *in-vitro* methods- Agglutination – Precipitation, Complement fixation, Immunofluorescence, ELISA, RIA, *in-vivo* methods- Skin test, immunodeficiency disorder – AIDS.

Unit V

Hypersensitivity reactions – Immediate type - Type I Anaphylaxis, Type II Antibody dependent cell cytotoxicity, Type III Immune complex mediated, Type V Stimulatory; Delayed type- Type IV Cell mediated delayed hypersensitivity. Lymphokines and Cytokines. Basic concept in auto immunity and transplantation.

REFERENCES

1. Charles A Janeway, Jr. Paul Travers, Mark Walport and Donald Capra J. Immunobiology – The immune system in health and disease, 4th edition, Current Biology Publications, London.1999.
2. Goldsby RA, Kindt TK, Osborne BA and Kuby J. Immunology, 5th edition, W.H. Freeman and Company, New York, 2007.
3. Ivan Roitt, Jonathan Brostoff and David Male. Immunology, 8th edition, Elsevier science Ltd., New York.2012.
4. Kuby J. Immunology, 7th edition WH Freeman and company, New York. 2008.
5. Patricks S and Larkin MJ. Immunological and molecular aspects of bacterial virulence. John wiley and sons, England. 1995.
6. Playfair JHL. Immunology at a glance. 6th edition, Blackwell Science, London. 1996.
7. Richard Hunt, Becker, Holger, Hlawatsch, Nadine, Julich, Sandra and Miethe Peter. Microbiology and Immunology Online**.** University of South Carolina.2004.
8. Tak W Mak and Mary Saunders. The immune response basic and clinical practices. Elsevier Academic press, New York. 2012.
9. Tak W Mak and Mary Saunders. Primer to the Immune Response. 2nd edition from Tak Mak, Mary Saunders, Bradley Jett. New York. 2014.
10. Thomas J Kindt, Barbara A Osborne and Richard A Golds. Immunology online, University of South Carolina.2006.
11. William E Paul. Fundamental Immunology. 7th revised edition, Raven press, New York. 2012.
12. Sudha Gangal and Shubhangi Sontakke. Textbook of Basic and clinical Immunology, Universities Press, (India) Pvt. Ltd, Hyderabad, India. 2013.

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CORE PRACTICAL II

IMMUNOLOGY & INTRODUCTORY VIROLOGY (P)

Immunology

1. ABO Blood grouping
2. Rh typing
3. WIDAL Test
4. RPR
5. CRP
6. ASO
7. Total and differential blood cell count by haemocytometer
8. Double immunodiffusion
9. Demonstration of ELISA

Virology

1. Isolation of Bacteriophage from sewage
2. Concentration of bacteriophages
3. Demonstration of mechanical transfer of viruses in plants
4. Demonstration of cultivation of viruses by embryonated egg method.
5. Observation of selected bacterial, plant and animal viruses – T4 and M13 Phages, TMV, CaMV, HIV, Influenza, HSV, HBV, Rabies and Blue tongue virus

REFERENCES

1. Atlas Ronald M. Hand book of media for clinical and public health microbiology, Boca Raton, FL: CRC press, Francis. 2013.
2. Li Zongxi, Zheng Li, Feng Hui, Cao Yan, Li Cheng and Pang Wei. Immunology Methods for Medical Students. Department of Immunology, China medical university.2006.
3. Fleming, Diane O, Debra long and Hunt. Biological safety: Principles and practices, 4th edition, ASM press, Washington, DC.2006.
4. Florence G Burleson, Thomas M Chambers and Danny L Wiedbrauk. Virology: A laboratory Manual. Academic Press, UK.1992.
5. Goldman, Emanuel and Lorrence H Green. Practical Handbook of Microbiology, Boca Raton, FL: CRC press, Francis. 2009.
6. James G Cappuccino. Microbiology. The Benjamin / Cummings Pub. Co. California.1996.
7. Morag C Timbury. Medical Virology. 10th edition, Churchill Livingston.1994.
8. O'Gorman, Manrice RG and Albert David Donnenberg. Hand book of human Immunology. Boca Raton, FL: CRC press, Francis.2008.
9. Rajan S and Selvi Christy R. Experiments in Microbiology. Anjana Books House, Chennai. 2015.
10. Richard A Glodsby, Thosmas J Kindt and Barbera A Osborne. Kuby 10. Immunology (4th edition). W.H. Freeman and Company, New York. 2000.
11. Roitt I Brostoff J and Male D. Immunological Tests. In: Immunology. Toronto: The C. V. Mosby Company.1985.

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SECOND ALLIED COURSE I

BIOSTATISTICS

OBJECTIVES

1. To find numerical solutions to scientific data
2. To Analyse and interpret scientific data using numerical and mathematical equations

UNIT I

Introduction to biostatistics - Definition, statistical methods, biological measurement, kinds of biological data, functions of statistics and limitation of statistics.

UNIT II

Collection of data, sampling and sampling design, classification and tabulation, types of representations, graphic–bar diagrams, pie diagrams and curves.

UNIT III

Measures of central tendency, mean, median, mode, geometric mean, harmonic mean.

UNIT IV

Measures of dispersion and variability-changes. Deviations–Mean Deviation, Standard Deviation, Coefficient of variation, Loren Zen's curve.

UNIT V

Skewness, Kurtosis, Moments, Meaning, test of skewness, characteristics of dispersion and skewness. Measures of skewness, objectives. Karl Pearson's Coefficient of skewness, Bocoley's coefficient of skewness.

REFERENCES

1. Bernard Rosner. Fundamentals of Biostatistics, 7th edition, Cengage Learning, 2010.
2. Maicello Pagano and Kimberlee Gauvreau, 2nd edition Principles of Biostatistics, Duxbury Press.2000.
3. Roland Ennos. Statistical and Data Handling Skills in Biology, Pearson. 2011.
4. Jerrold H Zar. Bio statistical Analysis, 5th Ed, Prentice Hall. 2010.
5. Sundar Rao and Richard. Introduction to Biostatistics and Research Methods, 5th edition, PHI Learning Pvt. Ltd. 2012.
6. Arora PN and Malhan PK. Bio statistics, Himalaya Publishing house.2008.
7. Pranab Kumar Banerjee. Introduction to Bio statistics. 4th edition, S. Chand and company Ltd. 2014.

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SECOND ALLIED PRACTICAL

BIOSTATISTICS AND BIOINFORMATICS (P)

1. Collection of data, sampling designs, tabulation and graphic representation using biological materials.
2. To find Mean, Mode, Median, Co-efficient of variance using biological materials.
3. Tests of significance 't' test, 'chi' square, standard error and standard deviation.
4. 't' Test, chi square, statistical error, standard deviation also, to be practically done through SPSS programme [statistical Package for Social Sciences].
5. Study of Nucleic acid sequence databanks – GenBank, EMBL nucleotide sequence databank, DDBJ.
6. Study of Protein Structure and Classification databases – PDB, SCOP and CATH.
7. Multiple alignment - ClustalW.
8. Evaluation of protein structure by Swiss PDB viewer and RASMOL.

REFERENCES

1. Maicello Pagano, Kimberlee Gauvreau. Principles of Biostatistics, 2nd edition, Duxbury Press. 2000.
2. Roland Ennos. Statistical and Data Handling Skills in Biology, 3rd edition. Pearson. 2011.
3. http://en.m.wikipedia.org/wiki/Nucleotide sequence database
4. http://en.m.wikipedia.org/wiki/Multiple sequence alignment
5. http://en.m.wikipedia.org>wiki>Swiss PDB viewer
6. http://en.m.wikipedia.org>wiki>Rasmol

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NON MAJOR ELECTIVE I

MUSHROOM TECHNOLOGY

OBJECTIVES

1. To develop an Entrepreneurial skills.
2. To study the medicinal values of mushrooms.

Unit I

Introduction-History-Scope and importance of mushroom cultivation. Present status of mushroom industry in India – Mushroom research and development – National and international agencies.

Unit II

Pure Culture – Media – Preparation and maintenance of mother culture in test tube slants –Petriplates- saline bottle – poly propylene bags. Spawn production – types- methods- storage and transportation.

Unit III

Cultivation Technology – Infrastructure – culture rack – thatched house – substrates –vessels- inoculation methods. Mushroom bed preparation. Preservation technology – long term storage – short term storage.

Unit IV

Types, importance and post-harvest handling of edible mushroom –*Agaricus, Pleurotus, Volvariella, Lentinula, Calacybe* spp. Mushroom contamination.

Unit V

Nutritional and medicinal values of mushroom – protein – carbohydrates – vitamins – minerals – fibre content. Preparation of low calorie foods – soups-curry. Marketing values in India – export value.

REFERENCES

1. Paul Stamets JS and Chilton JS. Mushroom Cultivator: A practical guide to growing mushrooms athome, Agarikon Press. 2004.
2. Shu-Ting Chang, Philip G Miles, Chang ST. Mushrooms: Cultivation, nutritional value, medicinal effect and environmental impact, 2nd edition, CRC press. 2004.
3. Swaminathan M. Food and Nutrition, Bappco. The Bangalore Printing and Publishing Co. Ltd., Bangalore. 1990.
4. Suman BC and Sharma VP. Mushroom Cultivation, Processing and Uses. Agribios (India) Publishers, Jodhpur. 2005.

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CORE COURSE IV

INTRODUCTORY VIROLOGY

OBJECTIVES

To make the student and learn about the structure, classification, morphology, pathological importance of viruses and viral diseases.

Unit I

History of virology, terminologies, origin of viruses, occurrence, morphology of viruses, helical, icosahedral and complex viruses. Viral envelope, nucleic acids, proteins, carbohydrates, classification of viruses- LHT and ICTV system of classification.

Unit II

Purification, Characterization, Separation and Assay. Cultivation and quantification of viruses, Separation and characterization of viral components.

Unit III

Bacteriophages- Life Cycle, Classification, Morphological groups, the virulent dsDNA phage, the ssDNA phage, phage lambda, Temperate and Transposable phage, Phage Mu the ssDNA phages, phage M13, Bacteriophage typing, Phage therapy (bacteriophage therapy), Cyanophages, Mycoviruses (Mycophages), Rhizobiophages.

Unit IV

General characteristics and multiplication of DNA containing viruses- Adenoviruses, Herpes viruses, Poxviruses. RNA containing viruses- Picorna virus, Rhabdo viruses, Orthomyxo viruses, Reoviridae, SARS and H1N1- Influenza A virus. Subviral agents - Viroids, Prions.

Unit V

History, Classification and nomenclature of plant viruses, Transmission, Multiplication, symptoms and control of plant viral diseases - DNA containing virus - Cauliflower mosaic virus, RNA containing virus - Tobacco mosaic virus - Poty virus, Tomato spotted wilt, Potato leaf roll virus, Rice tungro virus, Mosaic disease of sugarcane. Sub viral agents –Virusoids and Satellite virus.

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SECOND ALLIED PRACTICAL III

BIOINFORMATICS AND COMPUTER APPLICATIONS IN BIOLOGY

OBJECTIVES

1. To obtain basic knowledge about computers and internet.
2. To develop the computational methods to utilize expression data's of cellular biology.
3. To study of the inherent structure of biological information.
4. To analyze the gene and protein sequences to reveal protein evolution.

UNIT I

Computers – Characteristics of Computers – Areas of computer applications- I-P-O Cycle. Components of Computers – Memory and control units-Input devices and output devices- Hardware and Software -Operating Systems.

UNIT II

Internet –History of Internet-Uses of internet. Connection to Internet - Getting connection-Web page-Modem-Internet Service providers-E-mail and Voice Mail, Creating E-mail Address.

UNIT III

Introduction to bioinformatics – history and its development – Scope and applications of bioinformatics.

UNIT IV

Biological database – NCBI-GenBank, EMBL, DDBJ. Sequence Alignment-Pairwise (BLAST and FASTA) and Multiple sequence alignment (ClustalW).

UNIT V

Structure of Protein, Classification –PDB, Swiss-PROT, SCOP, CATH. Protein visualization tools-RASMOL, Swiss PDB viewer.

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11. blast.ncbi.nlm.nih.gov
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14. http://en.m.wikipedia.org>wiki>Rasmol
15. www.rasmol.org

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NON MAJOR ELECTIVE II

BIOFERTILIZER TECHNOLOGY

OBJECTIVES

The aim of the course is to make the student to learn importance of biofertilizers in agriculture and to know about field application and production technologies.

Unit I

Definition and types, importance of biofertilizers in agriculture, Application technology: Standards and quality control, application for field and tree crops, nursery plants and seedlings. National and Regional Biofertilizers Production and Development centers. Biofertilizers – carrier materials - storage, shelf life, foliar applications, quality control and marketing.

UNIT II

Isolation, identification, characterization, mass multiplication, formulation, field application and benefits of *Rhizobium*, Cyanobacteria and *Frankia*.

UNIT III

Isolation, identification, characterization, classification, mass cultivation, formulation, field application and benefits of *Azospirillum* and *Azotobacter*.

UNIT IV

Phosphate solubilizing bacteria - isolation, identification, characterization, mass cultivation, formulation, field application and benefits.

UNIT V

Mycorrhizae – Ecto and Endo (Arbuscular mycorrhizae). Isolation, identification, characterization, mass cultivation, formulation, field application and benefits.

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1. Dinesh K Maheswari. Bacteria in Agrobiology, Springer Heidelberg, New York. 2012.
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CORE COURSE V

MEDICAL MICROBIOLOGY

OBJECTIVES

To impart the knowledge of medically important human diseases with respect to their causative agent, clinical symptoms, pathogenesis, mode of transmission, prevention and treatment.

UNIT I

History, Koch's and River's postulates - A brief account on the normal microbial flora of the healthy human body - Host-pathogen interactions: Definitions of infection, invasion, primary and opportunistic pathogens, pathogenicity, virulence, toxigenicity, carriers, endemic, epidemic, pandemic diseases and epidemiology – putative virulence factors of human pathogens – infectious disease cycle.

UNIT II

Diseases of various organ systems: Causative agent, clinical symptoms, pathogenesis, mode of transmission, prevention and treatment of the following bacterial diseases (a) Streptococcal infections, (b) Staphylococcal infections, (c) Meningitis, (d) Leprosy, (e) Leptospirosis, (f) Respiratory diseases: Tuberculosis (g) Gastrointestinal disorders: typhoid, cholera, bacillary dysentery, (h) Sexually transmitted diseases: syphilis, gonorrhea. (i) Anaerobic wound infection – tetanus, gas gangrene.

UNIT III

Diseases of various organ systems: Causative agent, clinical symptoms, pathogenesis, mode of transmission, prevention and treatment of the following viral diseases (a) Respiratory diseases: common cold, influenza, measles. (b) Neurological diseases: Dengue, Rabies (c) Liver diseases: Viral hepatitides (d) Immunodeficiency disease: - AIDS. A brief account on Prion diseases.

UNIT IV

Causative agent, clinical symptoms, pathogenesis, mode of transmission, prevention and treatment of the following fungal and protozoan diseases (a) Fungal – superficial and subcutaneous mycoses, (b) Protozoan: Amoebiasis, Malaria (c) Helminths – Filariasis, Ascariasis, Zoonotic diseases, A brief account on nosocomial and community acquired infections.

UNIT V

Steps in the isolation and identification of pathogens from an infected patient: Collection and transport of various clinical specimens for diagnosis – General methods of isolation and identification of bacterial, fungal and viral pathogens and protozoan parasites.

REFERENCES

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CORE COURSE VI

AGRICULTURAL AND ENVIRONMENTAL MICROBIOLOGY

OBJECTIVES

To provide the fundamental knowledge about the various scopes on Agricultural and Environmental microbiology and their concepts, Plant diseases, Aeromicrobiology, Aquatic microbiology, disposal of wastes and commercial aspects of soil microbiology.

UNIT I

Microorganisms in the rhizosphere, root surfaces and phylloplane -Biofertilizer – Advantages over chemical fertilizers, types, production and - quality control of biofertilizers - Isolation, mass inoculum production, field application, importance and marketing of bioinoculants – Rhizobium, Azotobacter, Azospirillum, Frankia, Cyanobacteria, Azolla and phosphate solubilizing microorganisms - Mycorrhizal biofertilizers.

UNIT II

Plant diseases (Mode of entry of pathogens, Symptoms, Disease cycle and control measures) Bacterial disease – Citrus canker - Fungal disease – Rust of wheat- Mycoplasmal disease – Grassy shoot of sugar cane -Viral disease – cauliflower mosaic- Microbial Pesticides – types and applications – *Pseudomonas fluorescens, Bacillus thuringiensis, Trichoderma viride* and Nuclear Polyhedrosis Virus (NPV).

UNIT III

Concepts of microbial ecology: Relationship between microorganism and different environments land, water and air. Microorganisms inhabiting extreme environments. Microbiology of air – distribution and sources. Droplet nuclei, aerosol, assessment of air quality. Brief account of air borne transmission of harmful microbes.

UNIT IV

Types of aquatic ecosystems: fresh water – ponds, lakes, streams. Marine habitats – estuaries, mangroves, deep sea. Zonations – upwelling – eutrophication – food chain. Potability of water – microbial assessment of water quality – water purification – brief account of water borne diseases.

UNIT V

Types of wastes – characterization of solid and liquid wastes. Solid waste treatment – saccharification – gasification – composting, Utilization of solid wastes for mushroom production. Liquid waste treatment - Treatment methods – primary and secondary (anaerobic – methanogenesis) aerobic: trickling, activated sludge, oxidation pond – tertiary treatment.

REFERENCES

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CORE COURSE VII

MOLECULAR BIOLOGY AND MICROBIAL GENETICS

OBJECTIVE

To provide the students with the fundamental principles and concepts of prokaryotic genes and genomes, their molecular organization, replication and functioning.

Unit I

Milestones in history – Definition of nucleic acids - Experimental proofs of DNA as the genetic material (Griffith and Hershey Chase) – Experimental proofs of RNA as the genetic material - Chemistry and molecular structure of DNA double helix - Discovery of DNA structure – Brief account on types and forms of DNA – Types of RNA - Definition of a gene. Organization of DNA in prokaryotes (*E. coli*) and viruses. Brief note on plasmids: structure and types.

Unit II

DNA Replication in prokaryotes: Meselson and Stahl experiment – Mechanism, enzymes and proteins of replication – Theta replication and Rolling circle replication. Replication of RNA – reverse transcriptase.

Unit III

DNA Transcription: Definition – Brief account on transcriptional machinery and mechanism of transcription – Genetic code – RNA Translation: Definition -– Brief account on translational machinery and mechanisms of translation. Regulation of gene expression in prokaryotes – Operon concept – *lac* and *trp* operons.

Unit IV

Transformation - Discovery, mechanism of natural competence - Conjugation - Discovery, F^+ *v/s* F^-, Hfr^+ *v/s* F^- - Transduction – Generalized and specialized transductions.

Unit V

Definitions of mutations, mutagenesis and mutants - types of mutations; Physical and chemical mutagens. Transposons - Applications of mutations, Carcinogenicity testing. DNA repair mechanisms.

REFERENCES

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CORE PRACTICAL III

MEDICAL MICROBIOLOGY, AGRICULTURAL AND ENVIRONMENTAL MICROBIOLOGY & MOLECULAR BIOLOGY AND MICROBIAL GENETICS (P)

Medical Microbiology

- Isolation of bacterial flora of skin by swab method.
- Isolation of bacteria from urine, stool and sputum
- Identification of Gram positive organisms (using laboratory strains): *Streptococcus pneumoniae, Staphylococcus aureus* and *Bacillus* sp. *and* Gram negative organisms (using laboratory strains): *Escherichia coli, Proteus* sp. and *Klebsiella pneumoniae* on the basis of microbiological, cultural and biochemical characteristics.
- Saline and iodine wet mount to demonstrate protozoan parasites
- Giemsa staining for the demonstration of blood parasites
- KOH and Lactophenol cotton blue mount to demonstrate fungi.
- Germ tube technique to identify *Candida albicans.*
- Antibacterial sensitivity test – Kirby- Bauer method.
- Observation of symptoms of diseases caused by bacterial, fungal, viral and protozoan pathogens using photographs.

Agricultural and Environmental microbiology

- Water analysis by MPN technique – presumptive coliform test – confirmed coliform test and completed coliform test.
- Microbial assessments of air quality – open plate method and air sampler-technique.
- Isolation and counting of faecal bacteria from water.
- Soil Analysis -pH, chlorides, nitrate, calcium, magnesium and total phosphorus.
- Isolation of cyanobacteria from water (any two)
- Isolation of *Rhizobium* form legume nodule.
- Isolation of phosphobacteria from soil.
- Observation of VAM from plant roots.

Microbial genetics and Molecular biology

- Isolation of chromosomal DNA from bacteria
- Isolation of plasmid DNA from bacteria
- Isolation of Auxotrophic mutants.
- Demonstration of bacterial transformation technique.
- Demonstration of Agarose gel electrophoresis (to study DNA/ RNA) and SDS – PAGE (to study proteins).

REFERENCES

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MAJOR BASED ELECTIVE I

FUNDAMENTALS OF BOTANY AND ZOOLOGY

OBJECTIVES

1. To gain the basic knowledge about plants and animals.
2. To study the bio- control measures of plants.

UNIT I

Introduction, Plant nomenclature- Binomial system, International code of Botanical Nomenclature (ICBN). Classification - Artificial and Natural system. Plant taxonomy.

UNIT II

Salient features, distribution and economic importance of angiosperms, gymnosperms, pteridophytes, bryophytes and Lichens.

UNIT III

Physiology and reproduction of plants - photosynthesis, sexual and asexual reproduction.

UNIT IV

Introduction to animal kingdom - Evolution theory. – Brief introduction of invertebrates and vertebrates.

UNIT V

Cell reproduction – Mitosis and Meiosis - Origin of germ cells - process of spermatogenesis and oogenesis. Types of eggs.

REFERENCES

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CORE COURSE VIII

FOOD MICROBIOLOGY

OBJECTIVES

The subject aims to study about the food microflora, food fermentations, food preservation, food spoilage, food poisoning and food quality control.

Unit I

Concepts of food and nutrients - Physicochemical properties of foods - Food and microorganisms – Importance and types of microorganisms in food (Bacteria, Mould and Yeasts) - Sources of contamination- Factors influencing microbial growth in food – pH, moisture, Oxidation-reduction potential, nutrient contents and inhibitory substances.

Unit II

Food Fermentations – Manufacture of fermented foods - Fermented dairy products (yoghurt and Cheese) - plant products- Bread, Sauerkraut and Pickles - Fermented beverages- Beer. Brief account on the sources and applications of microbial enzymes – Terminologies - Prebiotics Probiotics and synbiotics. Advantages of probiotics.

Unit III

Contamination, spoilage and preservation of cereals and cereal products - sugar and sugar products -Vegetables and fruits- meat and meat products- Spoilage of canned food.

Unit IV

Food borne diseases and food poisoning – *Staphylococcus*, *Clostridium*, *Vibrio parahaemolyticus* and *Campylobacter jejuni. Escherichia coli* and *Salmonella* infections, Hepatitis, Amoebiosis. Algal toxins and Mycotoxins.

Unit V

Food preservations: principles- methods of preservations-Physical and chemical methods- food sanitations- Quality assurance: Microbiological quality standards of food. Government regulatory practices and policies. FDA, EPA, HACCP, ISI. HACCP – Food safety- control of hazards.

REFERENCES

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5. Khetarpaul Neelam. Food Processing and Preservation, Daya Publishing House, Delhi. 2005.
6. Raheena Begum M. A Text Book of Foods, Nutrition, and Dietetics, Sterling Publishers Pvt. Ltd. 2010.
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CORE COURSE IX

INDUSTRIAL MICROBIOLOGY

OBJECTIVES

To train the students on bioprocess technology so as to develop them for employment in bioprocess industry.
To learn the screening of industrial strains, fermenters, media, fermentation process and downstream process.

UNIT I

Historical development of Industrial Microbiology, Industrially important microorganisms, sources and characters; Primary and secondary screening and preservation of industrially important strains, Major classes of products and processes. Strain improvement.

UNIT II

Fermenter - Design, types and basic functions. Characteristics of production media, Fermentation media - formulation strategies, economical means of providing energy, carbon, nitrogen, vitamin and mineral sources, role of buffers, precursors, inhibitors, inducers and antifoams. Sterilization of fermentation equipment, air and media. Types of fermentation.

UNIT III

Downstream processing - recovery and purification of fermentations products (intracellular and extracellular), cell disruption, precipitation, filtration, centrifugation, solvent recovery, chromatography, Ultrafiltration and drying, Quality assurance (QC) of finished product. Immobilization of cell and enzymes.

UNIT IV

Microbial products of pharmaceutical value – raw materials, organism and industrial processes involved in the production of Penicillin, Streptomycin, Vitamin B12, Riboflavin and rabies vaccine.

UNIT V

Microbial products of industrial value – raw materials, organism and industrial processes involved in the production of ethanol, vinegar, amylase, protease, glutamic acid. Recycling and disposal of industrial wastes through microbes.

REFERENCES

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CORE PRACTICAL IV

FOOD AND INDUSTRIAL MICROBIOLOGY (P)

1. Assessment of milk quality by methylene blue reduction test
2. Performance of phosphatase test for pasteurized milk.
3. Isolation of bacteria from food by Standard Plate Count
4. Isolation of Yeast from grapes.
5. Wet mount preparation of spoiled bread, tomato, grapes, potato.
6. Observation of food samples to study *Leuconsostoc*, *Lactobacillus, Streptococcus lactis* and *Saccharomyes*.
7. Immobilization of yeast cell using sodium alginate
8. Alcohol fermentation by *Saccharomyces cerevisiae*.
9. Estimation of alcohol using Potassium Di-chromate method.
10. Production of Citric acid using *Aspergillus niger*
11. Starch (Amylase), casein (Protease) and lipid (Lipase) hydrolyses tests

Demonstration

1. Preparation of fermented food – Yoghurt and cheese
2. Screening of bacteria and actinobacteria for antibiotic production
3. Screening of bacteria and actinobacteria for enzyme production

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MAJOR BASED ELECTIVE II

RECOMBINANT DNA TECHNOLOGY

OBJECTIVES

To educate the learners with the fundamental knowledge and importance of recombinant DNA (rDNA) technology. To teach the jargons of genetic engineering/ rDNA technology as well as the basic tools, techniques and methods employed in gene cloning and gene expression strategies.

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

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MAJOR BASED ELECTIVE III

MICROBIAL BIOTECHNOLOGY AND BIOETHICS

OBJECTIVES

To provide the first- line knowledge of utilizing microbes for the industrial production of an array of economically viable products possessing a variety of human applications.

UNIT I

Biotechnology: Definition – Milestones in History - Scope of microbial biotechnology and its applications - Microbial production of pharmaceuticals – antibiotics, hormones (insulin), enzymes (streptokinase), recombinant vaccines (Hepatitis B vaccine) - Edible vaccine, Monoclonal antibodies.

UNIT II

Microbial production of biofertilizers – (*Rhizobia, Azospirillum, Frankia* and VAM). Microbial production of bio-pesticides (*Bacillus thuriengiensis*). Microbial production of bioplastics. Microorganisms in bioremediation: Degradation of xenobiotics.

UNIT III

Single cell protein (algae and yeast). Microalgal technology – Industrial cultivation methods of *Spirulina* – biotechnological potentials of *Spirulina* as: food and feed – fuel production from microalgae – pharmaceutically valuable compounds from microalgae. Commercial production of bio-ethanol and bio-diesel using lignocellulosic waste.

UNIT IV

Genetic engineering of plants: Ti plasmid vectors and gene transfer in plants – Development of insect, virus and herbicide resistant plants. Transgenic animals: methods of creating transgenic mice and sheep. Human gene therapy – *in vivo* and *ex vivo* gene therapy.

UNIT V

Intellectual Property Rights (IPR) - different types of IPRs - Principles of Bioethics (IB) - Definition of Ethics and Bioethics. - Ethics committee - Brief account on risks and ethics of modern biotechnology - Ethical concerns in human gene therapy - Ethical limits of animal use. Ethical issues at the beginning of life (abortion) – Ethical issues at the end of life (withholding and withdrawing medical treatment and euthanasia).

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